

**NBSLM03E Course Work – June 2010 – updated to include instructions on using the
computer software Version 21st June 2010**

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1. Formalities:

**Deadline for Submission: Wednesday July 28th: 15:00 – to be submitted via Blackboard or
emailed to Jessica: j.hutchison@uea.ac.uk**

The course work data files, and copies of these instructions may be accessed from the Course WEB site which can be accessed either:

- i) Accessing the general Energy WEB site <http://www2.env.uea.ac.uk/gmmc/env/energy.htm>
and clicking on the module link NBSLM03E
- or**
- ii) Going directly to the Module WEB Page:
<http://www2.env.uea.ac.uk/gmmc/energy/nbslm03e/nbslm03e.htm>

2. Assessment Criteria

- i) 20% of the mark will come from analysis of the data from the office buildings in Edinburgh
- ii) 80% will come from completing the heat loss appraisal of the house (for which you can use the software and appraising the predicted energy requirements with the actual consumption as shown in Section

In both sections the basic requirement will be to investigate the variations in energy consumption over the period of the data and identify any trends.

Simple factual information indicating that consumption rose/fell/or stayed the same from one period to another will result in a basic mark. Credit will be given for exploring trends – e.g. consumption variations with temperature (possibly daylight hours?) or any other factors you identify e.g. weekends/weekdays in the case of house energy consumption.

3. Introduction

For this module there will be two elements for the course work, both relating to actual data and analysis of actual data collected,

Part 1: constituting 20% relates to energy data collected from offices of three companies in Edinburgh.

Part 2: constituting 80% relates to domestic energy consumption associated. For this actual energy consumption should be reconciled with the heat loss calculations as demonstrated in the practical session on Friday afternoon 11th June.

The primary aim of the coursework is to process real energy data together with the inevitable problems which always occur – e.g. missed readings etc and to estimate the associated carbon footprints. There are several subsidiary aims including:

- a) Processing the real data,
- b) Allowing for different time intervals between readings,
- c) Exploring any general trends over the period of the data collection,
- d) Examine whether there are different trends at different times of the year or day of the week etc.
- e) Critically reviewing what can be deduced from the processed results and what any lessons can be learnt – e.g. what effect, if any did the replacement of a new boiler in the house have on energy consumption and carbon emissions in the house?

In both exercises there are several opportunities to explore over and above the basic analysis. Credit will be given for the way you complete the basic analysis and any other aspects you explore. For instance, aspects which might be explored include:

- Are there a noticeable differences between consumption and carbon footprint from one year to the next?
- Are these related to climatic variations over the time period?
- Are other factors at play – e.g. in the house
 - Did the reduction in household size from three people to two in the house after the first year affect the consumption and is this directly related to the number of people in the household? If not what can you deduce from the data as to the impact of household size?
 - Did the replacement of the new boiler have a noticeable effect on consumption.
 - Is there any relationship between the solar energy gained and gas consumption?
 - Are there differences between weekday and weekend use of energy?

4. Tasks to Complete

- a) **Part 1: (20%):** Analysis of Energy consumption data in three commercial Offices in Edinburgh.

The electricity and gas consumption data for the three moderate sized offices over a period of three years together with some background information such as floor area and employee numbers may be downloaded from the course WEB SITE.

The data were all manually read on the 1st of each month over the period in question. The gas readings were originally taken in cubic metres but have already been converted to kWh.

To complete your analysis you will need to extract degree-day information for the relevant period for the Edinburgh area. Degree-Day information may be accessed at www.vesma.com.

Relevant carbon emission factors for electricity and gas may be obtained from the tables in Section 13 of the handouts.

- b) **Part2: (80%):** Analysis of Energy Consumption in a house (this will require some supplementary information on U-values etc which is displayed at the end of this document.

This part of the exercise has two separate sections:

- i. To complete a basic heat loss evaluation of the house from the plans and relevant information from the U-values of the components of the fabric etc. Once this has been done it is possible to explore what impact conservation measures might have such as:

1. Increasing insulation levels
 2. Changing the heating appliance – e.g. to heat pumps
- ii. To analyse the energy used for heating (i.e. gas) and examine whether the consumption data is consistent with the heat loss calculation approach above and if not what can be learnt about both? E.g. efficiency of the heating appliance? Air exchange rate etc.

In both the above, changes in consumption and emissions should be addressed.

In addition you may wish to investigate the following and credit will be given for addressing these issues. Further credit will be given for the exploration of other issues not listed below.

- iii. Is there anything to indicate that the overall consumption has changed since the installation of the new boiler and controls in June 2009?
- iv. What impact did the change in household size at the end of January 2008 have on electricity consumption?
- v. From approximately February 2008 a concerted effort was made to reduce electricity consumption. How successful has this been?
- vi. Since May 2009 a smart meter was installed. What impact, if any has this had?
- vii. Is there any difference between weekday and weekend consumption?
- viii. Can the impact of the solar panel be detected? And what impact in energy saving and reduction in carbon emissions can be ascertained?
- ix. What are the annual savings in energy/carbon emissions arising from the solar collector? To do this you may assume that the hot water from the solar collector replaces hot water provided by the gas boiler at the relevant seasonal efficiency.

Technical information relating to the house – information on U-values where not given below may be found in data book.

Technical Issues and other information relating to energy consumption in House

Item	U-Value
Original House – brick – cavity brick construction with cavity insulation – inner leaf brick	0.6 W m ⁻² °C ⁻¹
Kitchen Extension Walls – cavity construction – brick – filled cavity – block	0.45 W m ⁻² °C ⁻¹
Garage Window: Single Glazing	See data book
Hall, Porch, Landing and external doors, upstairs toilet: Double Glazing with low – e Glass (Pilkington K-Glass)	2.0 W m ⁻² °C ⁻¹
All other windows: Double Glazing	See data book
Floor main house	1.0 W m ⁻² °C ⁻¹
Floor Kitchen Extension	0.6 W m ⁻² °C ⁻¹
Loft Insulation (100mm)	0.29 W m⁻²°C⁻¹

Severity of exposure for windows: North and South elevations - Normal
East and West: Sheltered.

New Boiler fitted 2nd June 2009: Type: British Gas 330+ see SDBUK Database for details: www.sedbuk.com.

Air Exchange Rates

Estimation of Air-Exchange rates is always somewhat approximate as it depends not only on structural infiltration through the walls, but also the amount to which windows are opened and whether there are any vents in the room – e.g. toilets, bathrooms, kitchens etc where higher

ventilation rates are needed to combat condensation and in the case of the kitchen, removal of cooking fumes, particularly if gas is used for cooking as it is in this case. Rooms opening to the outside – e.g. the hall etc will inevitably have higher ventilation rates arising from door openings.

The following are suggested Air-exchange rates to use

Room	Air Changes per hour	Room	Air Changes per hour
Bedrooms	0.80	Kitchen and extension	1.2
Airing Room (next to bathroom)	0.60	Lounge	0.8
Bathroom	1.25	Dining Room	0.8
Toilets/Cloakroom	1.5	Garage	0.8
Hall/Landing	1.0		

Suggested Room Temperatures for use in the software:

Room	Temperature (°C)	Room	Temperature (°C)
Bedrooms except one over garage	18.0	Hall/Landing	17.0
Bedroom over garage – occasional use as guest bedroom	16.0	Kitchen and extension	17.0
Airing Room (next to bathroom)	22.0	Lounge	20.0
Bathroom	20.0	Dining Room	18.0
Toilets/Cloakroom	16.0	Garage	10.0

The above temperatures take due account of time switching and represent typical mean daily temperatures over whole day.

5. Historic Factors which might affect energy performance in the house

1. Until January 21st 2008, there were normally three adults living in house, thereafter two, although there were periods with visitors..
2. Until end of first week in April 2008 extensive monitoring of solar panels on minute by minute basis was underway requiring a constant use of a dedicated computer – thereafter this detailed monitoring was switched off. Separate individual metering indicated that the power drain for the monitoring was averaging around 30W.
3. From April 2008 there was also a concerted effort was made to minimise use of unnecessary lights – particularly the fluorescent tubes in bathroom and kitchen and also use of other appliances.
4. There were extended absences during holidays - 24th July – 11th August 2008 and also 28th July – 8th August 2009.
5. From April 2009 a smart meter has been in place with numerous peripherals associated with its operation – however, this meter has only normally been in operation for 4 – 5 hours a day.

If you have any queries about the above please contact me via email: k.tovey@uea.ac.uk

6. Instructions on using the software for Heat Loss Calculations

6.1 PRELIMINARIES

There are two parts to this software – a program file with the name HEATPROG.XLS and also a data template file with a name “TEMPLATE.XLS”. Both of these are accessible from the WEB

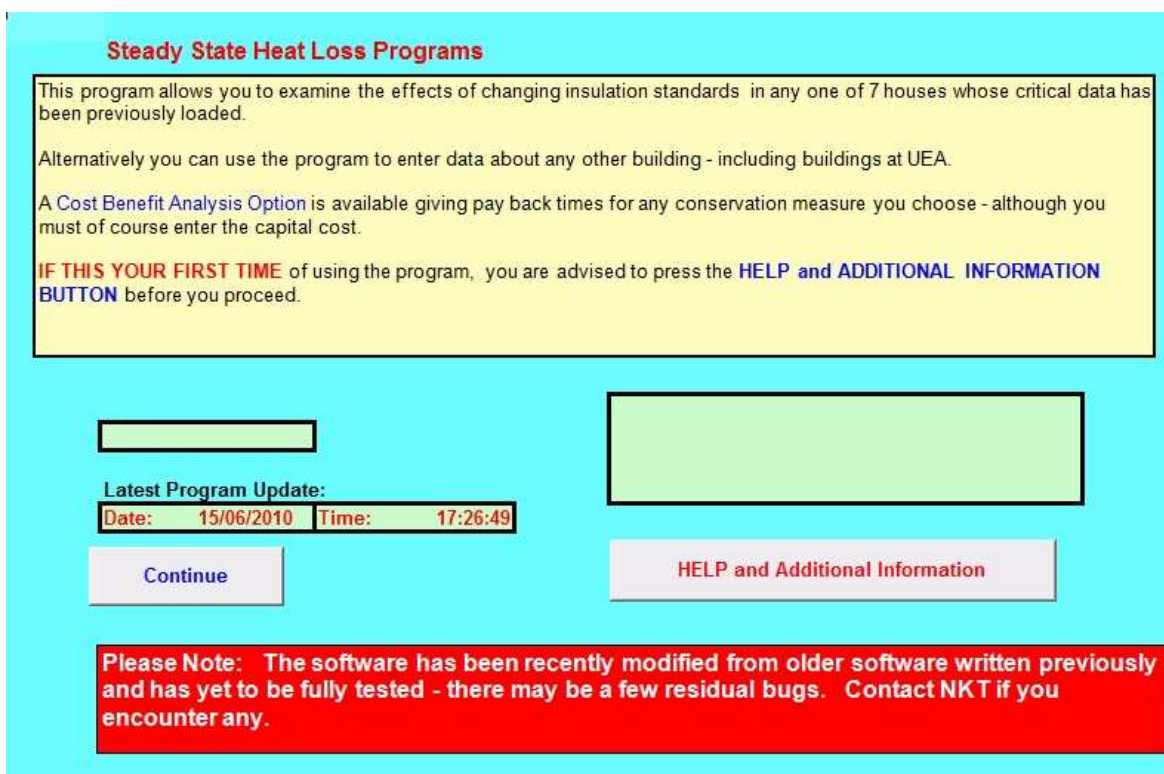
PAGE. Please note however, **EXCEL** is a little particular and you must follow the following instructions:

- 1) Create a folder on the C: drive C:\NBSLM03E
- 2) Create a sub-folder of this DATA – i.e. C:\NBSLM03E\DATA
- 3) Copy the program file to folder C:\NBSLM03E
- 4) Copy the template file to folder C:\NBSLM03E\DATA

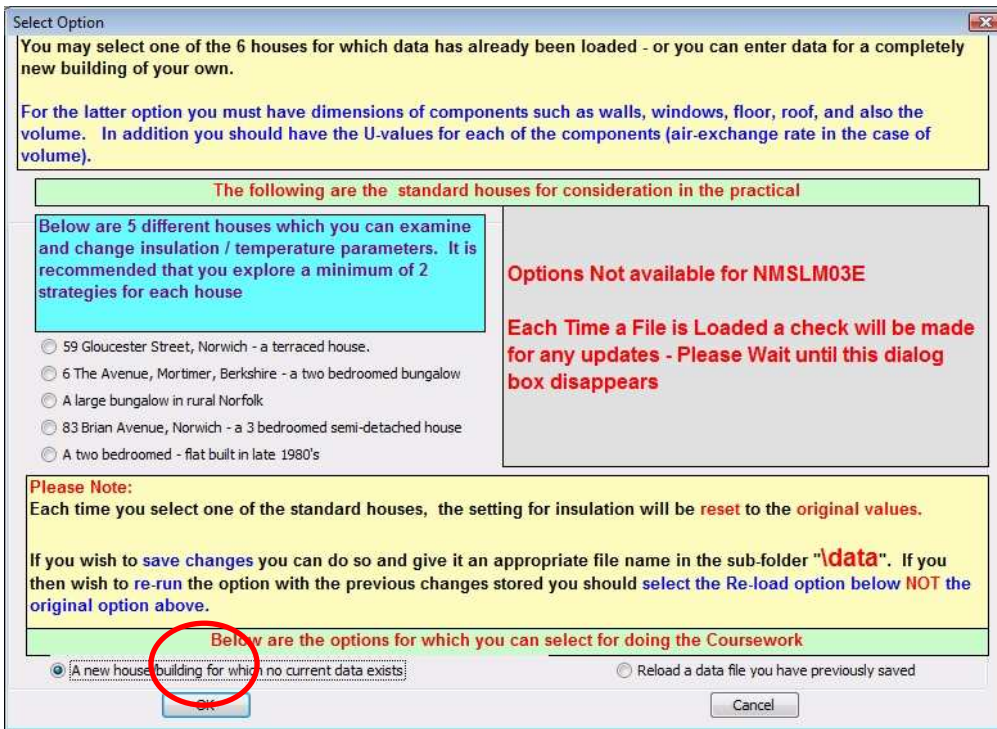
You only have to do the above once to initialise unless you are told to update the program file.

6.2 *RUNNING THE SOFTWARE*

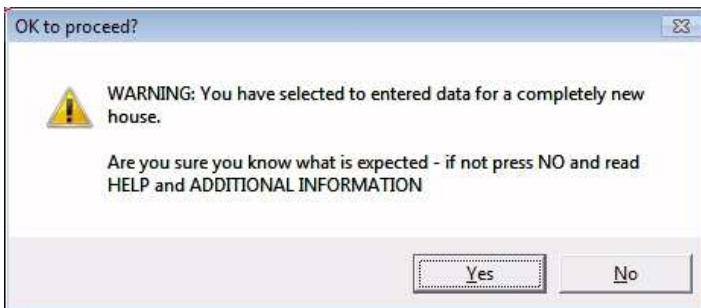
- Now start EXCEL and open file HEATPROG.XLS from the C:\NBSLM03E folder
- You should see a display such as shown below.



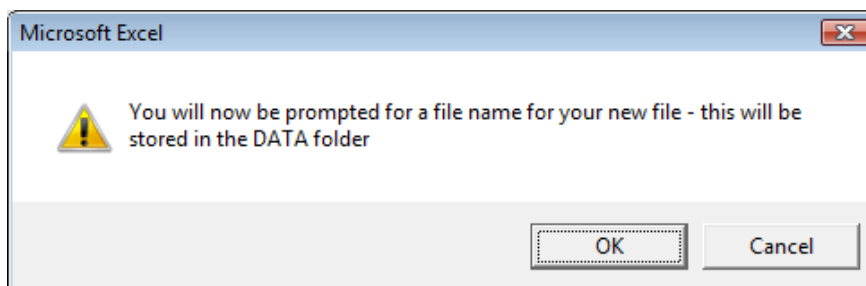
- If the above is not displayed you must make sure “MACROS” are enabled. The method you do this depends on whether you are using Office 2003 or Office 2007. Most of you seemed to have accessed things correctly on Friday 11th apart from those who did not have access to a PC on that day.
- Note the version of the program is shown in the two boxes above the **Continue** button
- Press the continue button when the following dialog should appear.



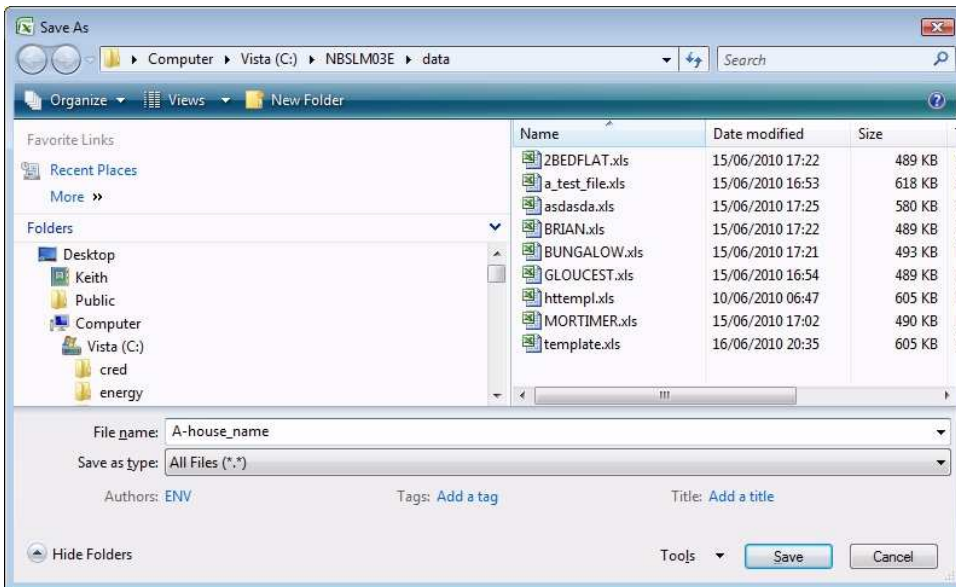
- Check the NEW House option highlighted and press OK – the following message will be displayed
- Please note that you can also explore options with the standard examples for five standard houses for which data are already stored. If you wish to explore options on these then these files should be downloaded from the WEB Site to the DATA folder before running.



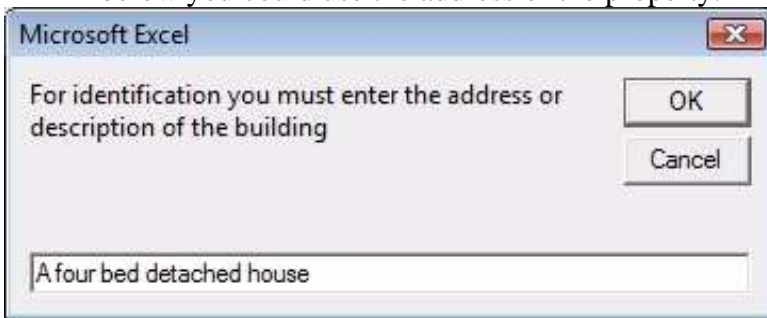
- A further message box will now be displayed saying that you must choose a file name for the file you are creating.



- You may choose any relevant name as shown in the normal dialog box below. **DO NOT CHANGE THE FOLDER** – the software will do things automatically



- Finally a further box appears asking for a description of the property. This is for reference purposes if you create different files as this description will appear within each spreadsheet to help with subsequent identification. As an alternative to an identification as shown below you could use the address of the property.



- If all has gone according to plan you should finally see the master menu sheet shown overleaf with a filename as chosen by you with an additional extension “_temp”

Energy Conservation - Steady State Heat Loss Run [0]

A four bed detached house Existing Heating 5

External Design Temperature Mean External Temperature in Winter Gas (Condensing)

Data Entry / Modification

View or Enter / Modify Room Names/ Dimensions/ Temperatures and /or U - Values

Freeze Current Costs - i.e. make them the reference set

Cost Benefit Analysis of Conservation Measures

Printing and Display of Results

View Individual Room Data View Summary Results

View Weekly Consumption data - in tabular and graphical form Select Year of Temperature Record

View CBA Results

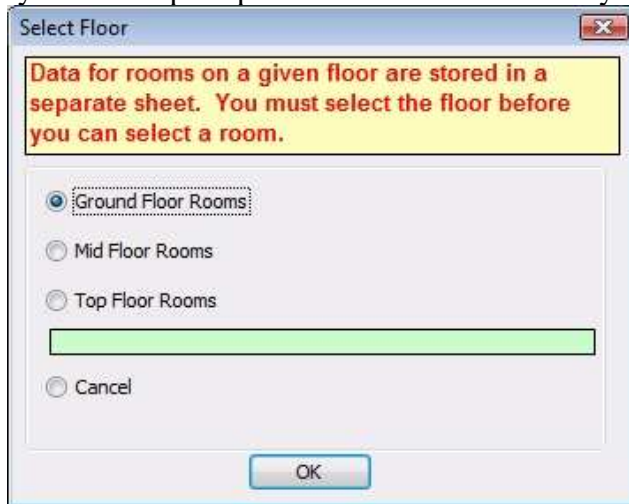
NOTE: The first time you this file you should FIRST get a printout of the stored data
Select the "Print Individual Room Data and Summary Results" Button

Save file and return to Main Steady State Heat Loss Menu

Return to Main Steady State Heat Loss Menu WITHOUT saving

The above display now contains the menu options for all subsequent actions.

On selecting either the View or Enter/Modify Room Names/Dimensions... or the View Individual Room Data you will be prompted to indicate which floor you wish.



- For the coursework you will first need to enter dimensions of the rooms taken from the plans following the procedure we employed in the session on Friday 11th June. – the bank template for this is shown below – you may only enter values in the white cells.
- **NOTE** in the example shown, dummy values have been entered for the first room as an example – they are **NOT** the values for the actual room for the coursework.

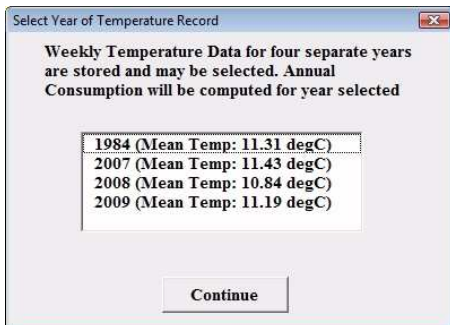
Steady State heat Loss Calculations							0		Return to Analysis Options				
A four bed detached house							Heating Type		5				
Mean External Temperature			8.94		This Floor		Whole House <td colspan="2">Change to Another Floor</td>		Change to Another Floor				
External Design Temperature			-1.0		Heat Loss rate		52 W		52 W				
Data for ground floor in house							Overall Heat Loss		0.08 kW				
Original Heating Method			Net Annual Demand		0.00 GJ		CO2		0.00 tonnes				
Gas (Condensing)			Cost (current heating)		£0.00		Saving		0.00 tonnes				
Room Name	Fabric Component	Area (m2)	U - Value	Heat Loss Rate (W °C ⁻¹)	Total heat Loss Rate for Room (W °C ⁻¹)	Room Temperature (°C)	Design Heat Loss (W)	Note: Roof Data Values will not be relevant except for single storey buildings.					
		Area (m2)	U - Value	orientation		solar gain							
Room 1	Walls	15.00	0.60	9.00	s		2432 MJ/m2				77.1 W		
	Windows	4.00	2.80	11.20									
Lounge	Roof			annual gain		mean							
	Floor	17.00	1.00	17.00	Overall Room Data								
		volume	air change rate	(W °C ⁻¹)		temperature	Watts				For orientation Use N, NE, S, SE etc. For unknown orientation use U		
		ventilation	35.00	1.20	15.16	52.4							
		Area (m2)	U - Value	orientation		solar gain							
Room 2	Walls			annual gain		mean							
	Windows												
Room 3	Roof			annual gain		mean							
	Floor			Overall Room Data									
		volume	air change rate	(W °C ⁻¹)		temperature	Watts						
		ventilation											

- You should note that for the ground floor, you should not enter any data for the roof unless the building is a one storey one (bungalow), or the room is a single storey extension to a two storey building (e.g. the kitchen extension in the coursework).
- If you select the top floor, then data for the floor are not relevant, but you should ensure you enter data for the roof.
- If you enter data for a mid-storey room (not relevant for the coursework, but for your interest) you should just enter the floor area but no U-values.

- Note that with the exception of floor area data for mid-storey rooms, only external surfaces, e.g. walls windows etc should be entered.
- For windows you must enter an orientation e.g S, SW, W etc – however if the orientation is unknown then “U” should be entered here.
- Remember to enter information about the room temperature for each room otherwise an error message will be displayed.

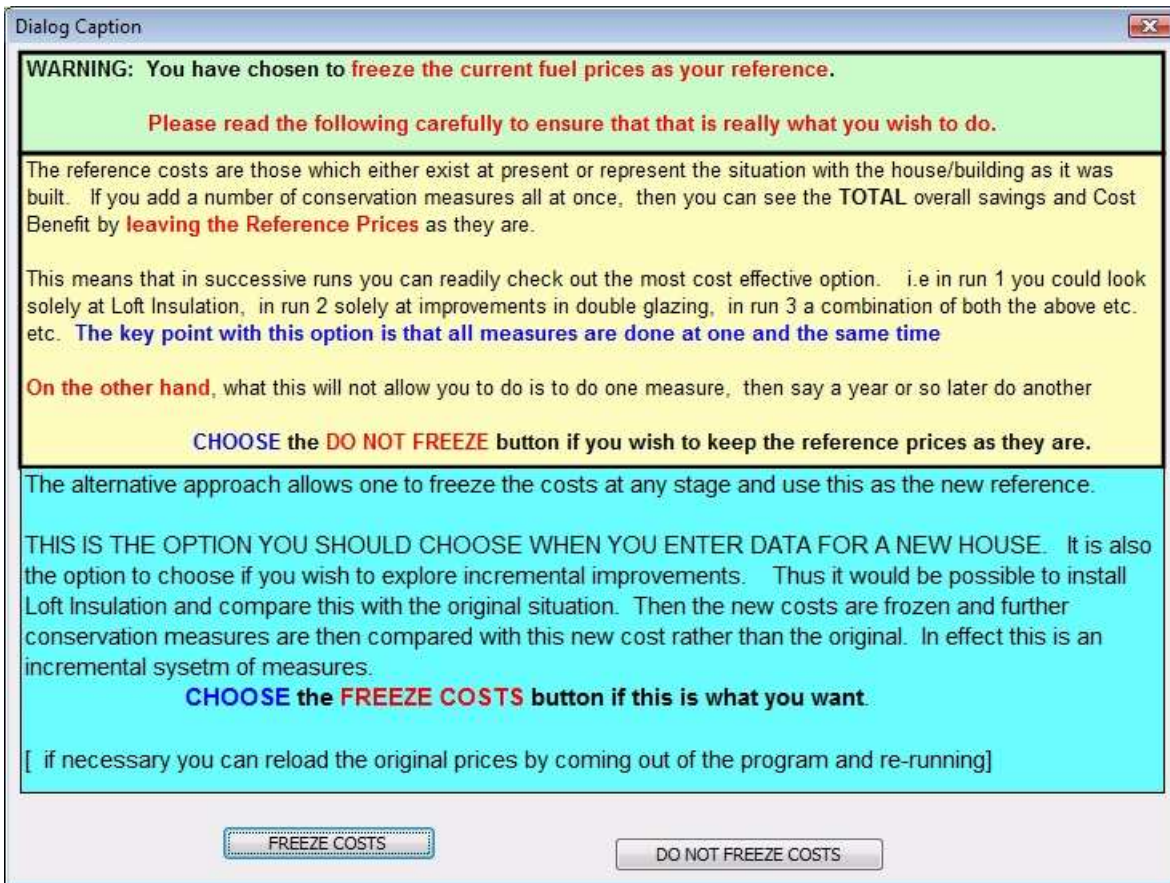
Once you have entered all data for all rooms for a given floor you can swap to enter data for another floor or alternatively return to the main menu.

If there are any incompatible errors – e.g. missing temperature information these will be displayed in the red box at the bottom of the Main Menu.



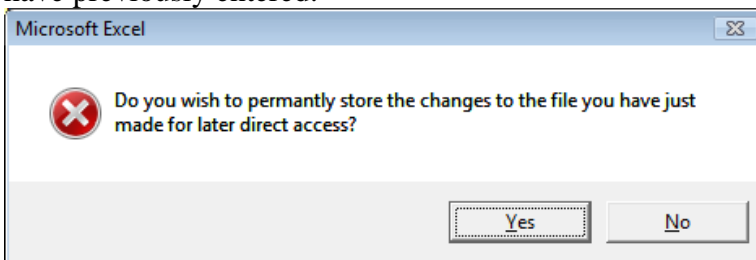
You should now select the year for which you wish to study the performance of the house. Temperature data is stored on a weekly basis for four separate years – 1984 (the original default), 2007, 2008, and 2009. The relevant year may be chosen using the dialog box shown.

Once you have entered all relevant dimension, U-value and temperature data you should check that there are no obvious residual errors and if there are none you should press the **FREEZE PRICES** button. This action needs a little of explaining. When doing a cost benefit analysis it is essential that an initial reference price is set. For the reference files used in the practical session on Friday 11th June, these have been already frozen, but for the coursework and any new house data you must freeze the prices once all dimensional data and U-values have been entered. You will see the following message displayed. In general this is not an issue for the very first time you freeze the prices after data entry, but may be if you do several CBA runs in the same session.



6.3 SAVING THE DATA FILE

Once you have entered the basic data and frozen the initial prices, you should use the **Save File and Return to Main Steady State Program File button**. On doing this you may see the following message if you have entered a new data file or rerunning a file containing data which you have previously entered.



This will automatically store the file in the DATA folder which you can automatically re-access on rerunning the program using the “Reload a data file” option.

Some background information on how the program works.

The program file has the name HEATPROG.XLS and must be in folder c:\NBSLM03E

All data files must be located in folder c:\NBSLM03E\DATA

Any new file generated will automatically be stored in this folder.

On running the program a temporary file name is generated with an extension name “_temp”. this is to preserve the original file in case an inadvertent change is made.

If you do a Cost benefit analysis, each time you do so in a given session a new worksheet in the file is generated with the name RUN1, RUN2, RUN3 ... etc.

When you save a new file you will be given the option to save it as the original file name in the DATA folder as indicated above, but you should only do this BEFORE you start any CBA runs – other wise respond “NO” to the dialog prompt above.

When you press the save button you will automatically also save a copy of the file together with any CBA runs so far completed in a sub folder RESULTS with a file name the same as the original but with the extension “_RESULTS”. At the same time the temporary file will be deleted. It is not expected that you will necessarily do any CBA runs for the coursework unless you are interested as the main aim is to compare the actual predictions with the actual measured data and examine whether you can explain any discrepancies.

6.4. INTERPRETING THE RESULTS

The key information i.e. the **heat loss coefficient** is computed automatically in the spreadsheet is the heat loss coefficient and this is related to the energy consumption data. The relevant heat loss coefficient is shown in the cells circled in red.

Steady State heat Loss Calculations				Climate Data for		0		Return to Analys Options
6 The Avenue, Mortimer - a 2-bedroom bungalow				Year	1984	Heating Type	4	
Mean External Temperature		8.94		This Floor		Whole House		Change to Anoth Floor
External Design Temperature		-1.0		Heat Loss Coefficient		500 W/oC 500 W/oC		
Data for ground floor in house				Overall Heat Loss		9.53 kW 9.53 kW		Note: Roof Data will not be releva except for single buildings.
Original Heating Method		Net Annual Demand		83.30 GJ		CO2 8.87 tonnes		
Gas (Normal)		Cost (current heating)		£925.84		Saving 0.00 tonnes		
Room Name	Fabric Component	Area (m2)	U - Value (Wm-2degC-1)	Heat Loss Rate (W °C ⁻¹)	Total heat Loss Rate for Room (W °C ⁻¹)	Room Temperature (oC)	Design Heat Loss (W)	
Ground Floor								
Room 1	Walls	7.50	1.00	7.50	orientation solar gain			
	Windows	1.80	5.00	9.00	U	773.1 MJ/m2	24.5 W	
Hall	Roof	18.00	0.29	5.22	annual gain mean			
	Floor	18.00	1.00	18.00	Overall Room Data			
	ventilation	45.00	2.00	32.49	(W °C ⁻¹)	temperature	Watts	
		Area (m2)	U - Value					
Room 2	Walls	19.90	1.00	19.90	orientation solar gain			
	Windows	7.60	5.00	38.00	U	3264 MJ/m2	103.5 W	
Lounge	Roof	29.60	0.29	8.58	annual gain mean			
	Floor	29.60	1.00	29.60	Overall Room Data			
	ventilation	74.00	2.00	53.43	(W °C ⁻¹)	temperature	Watts	

The left hand of the two cells shows the heat loss coefficient for the floor in question, whereas the right cell is the total heat loss coefficient for the building. It is this last value which is critical. It is independent of the actual climate conditions and is an intrinsic parameter for the building and will be the same whether the building is in the north of Scotland or South of France. On the other hand the cells highlighted in blue representing the total annual consumption, carbon emissions and cost do depend on the climate and will vary from year to year and also from location to location. It is the **TOTAL HOUSE HEAT LOSS COEFFICIENT** which is of particular importance in this coursework – in this example it is 500W°C⁻¹.

This value is the intrinsic demand for heat and must be corrected by the efficiency before the value is compared with the actual real consumption data.

In the actual boiler installed in June 2009, the actual efficiency may be obtained from the SEDBUK data base – see the main coursework guidelines.

This heat loss coefficient should be equal to the gradient of the line of plotting gas consumption against mean external temperature taking due note of when no heating is required. In the modelling the spreadsheets, the areas/ volumes of the different components will have adequate accuracy and the estimates of U-value for the walls, windows, floor and room will be reasonable assessments as given in the main table of the coursework guide. The only area where the values

will be somewhat imprecise will be in the estimation of the ventilation rates and you may wish to adjust these to see if you can get better agreement with the gradient of the line from the actual data (making due allowance for the efficiency).