

CoolRater
Instructions for Use

by

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coolRater.co.uk **v1.1 09/11/26**

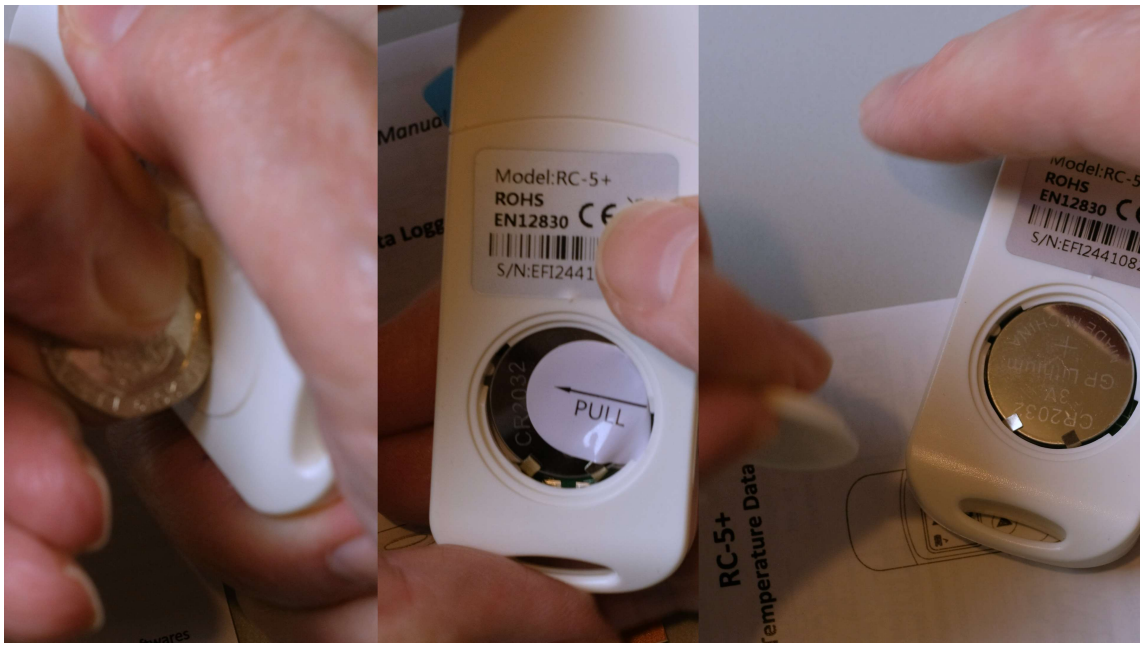
Background

CoolRater is a desktop app which will measure the Heat Transfer Coefficient (HTC) for a building, a function that has become important in recent years for use in sizing heat pumps, measuring the improvement resulting from upgrades to insulation and providing insight into financial and environmental costs.

This document explains the procedure for using the app.

Reset and configure the Thermometers

If the thermometers are new then the battery needs to be connected by removing an insulating sheet of plastic from underneath it. Use a coin to open the panel on the back, and then pull the tab on the sheet. This will probably dislodge the battery. When replacing it, ensure that the writing on it is uppermost and the battery is underneath the two contacts which hook over the edge of it.



Install the app by downloading the installer:

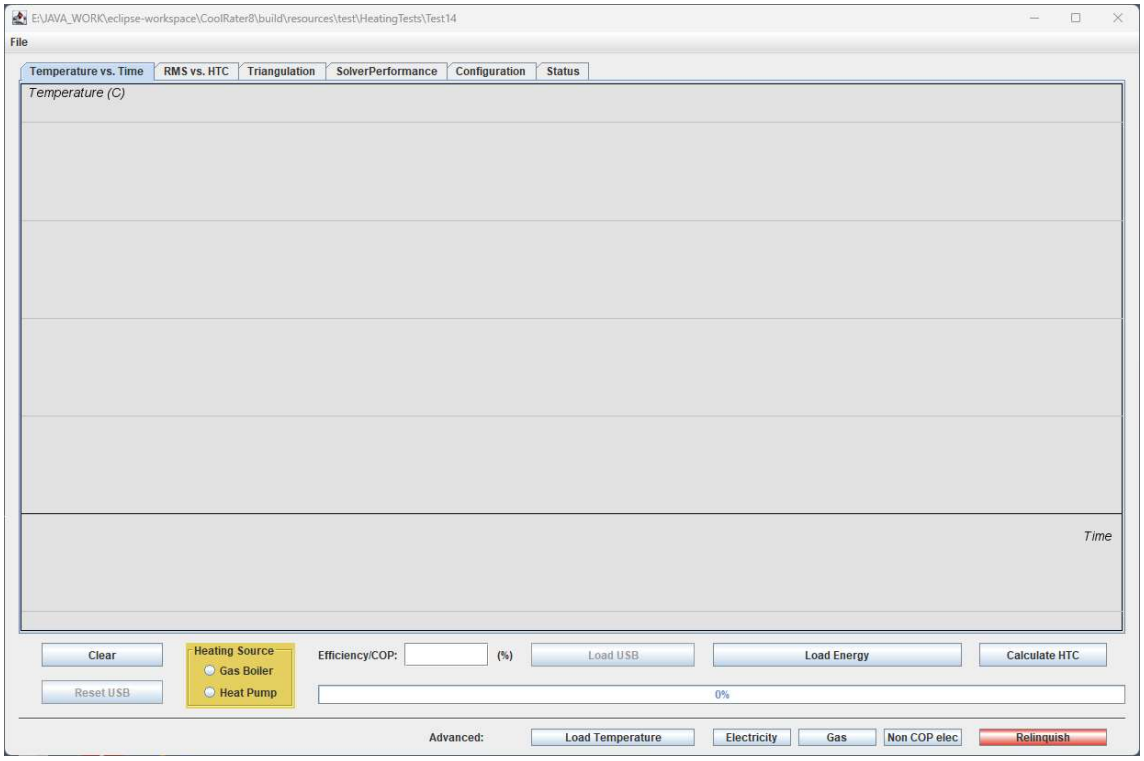
CoolRater.co.uk/downloads/CoolRater-1.0.1.exe (or later version) and executing it.

As trial software it has not been possible to digitally sign it and it has had few downloads. Therefore the operating system will treat it with suspicion and advise you not to run it. You can run it against this advice by clicking “More Information” and “Run Anyway”.

The installer will create a desktop icon (unless you specifically turn off that option in the installation process):



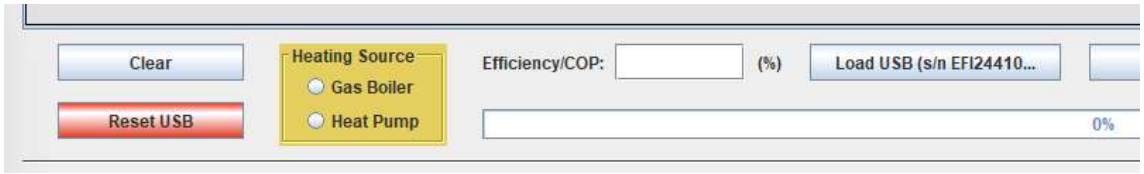
Double click the icon, and the app will load up.



Resetting and Configuring the Thermometers

CoolRater is able to reset, configure and load data from certain logging thermometers directly if they are plugged into a USB socket. Currently the only supported thermometer type is Elitech RC-5+. For other thermometers you will need to upload the data to a CSV file with other software, usually provided by the thermometer manufacturer, and upload the data into the app from the CSV file. See the “Advanced” section at the end of this document for more information.

For RC-5+ devices, Insert the device into a USB socket. Wait around 10 seconds for it to be recognised, and then the buttons relating to USB will illuminate to show that they are active:



Reset and configure it by pressing “Reset USB”, confirm, and confirm the message saying its done. Then remove the thermometer from USB and repeat the procedure for the other three thermometers.

Start each of the thermometers recording by long pressing the “play” button so that the characters “rEC” appear briefly on its LCD, and then the symbol on the LCD screen changes to a “play” symbol. The thermometers are now measuring the temperature and recording it once per minute. To stop them, long press the “pause” button, but note that once you do that they can’t be started recording again unless they are reset.



Thermometer Placement

This step is critical to getting a reliable and accurate result.

Place one of the thermometers outside. I have enclosed a zip-lock bag that you can use to keep it clean. Alternatively use a thin-walled tin can with lid, but it was not practical to send that by mail. Place the thermometer at least 5 metres from the house and use a stone or other means of preventing it being carried away by the wind or pets, but do not cover it so that it responds quickly to changes in temperature.

Place the other thermometers inside, somewhere where they will not be disturbed for around a week, and where they will record the general temperature of the property, so they should not be:

- close to heating such as radiators, radiator pipes or fan heaters;
- incidental sources of heat such as hi-fi, computers, televisions, lamps or refrigerators;
- on a windowsill, as this may be colder, particularly if it is on the far side of the cavity wall.

Within those constraints it will helpful to sample different temperatures, such as close to the floor, upstairs and downstairs, or in areas of the house with different insulation levels. The app used in the field trial treats each inside thermometer separately, but it is planned that later versions will combine the information, and the data from the field trial will help with the development of that.

Run the Test

Wait up to one week. Avoid touching the thermometers as the heat from your hand will warm them up and give a false reading. During the test, you must not use energy from Octopus for anything that will not result in heating the house such as:

- EV charging
- heating outdoor swimming pools
- outdoor flood lighting
- using power in unheated outbuildings such as garages or sheds
- Water heating. This uses energy, but it is uncertain as to whether the energy contributes to heating or goes down the plughole! Try to schedule it to occur during the day.

The test is only active after sunset and before sunrise so you can do those activities during the day.

Recover the thermometers and stop them by long pressing the “stop” button until “StoP” is seen on the LCD display.

It takes around two days for the smart meter data to become available on the Octopus website, so either wait another two days so that all your temperature data can be analysed, or proceed to the next step immediately knowing that the last two days of temperature data will be ignored.

Process the Results

Run the CoolRater app again. Work from left to right filling in the amber controls:

Select Gas Boiler as the Heating Source.

Efficiency. Set to 90% for a modern condensing boiler, 70% for an older non-condensing boiler. If you have way of measuring the efficiency accurately, all the better, but there is no general way of doing that. In the video at:

https://www.youtube.com/watch?v=Xaf2dzC_D3Q&t=941s

I explain how I measured the efficiency of my gas boiler, but this is probably not practical for most people.

Load the temperatures. Insert each thermometer into USB, and when it is recognised, hit “Load USB …”. There is no need to worry about which thermometer is which, as the app will automatically choose the one with the lowest temperatures as the one outside.

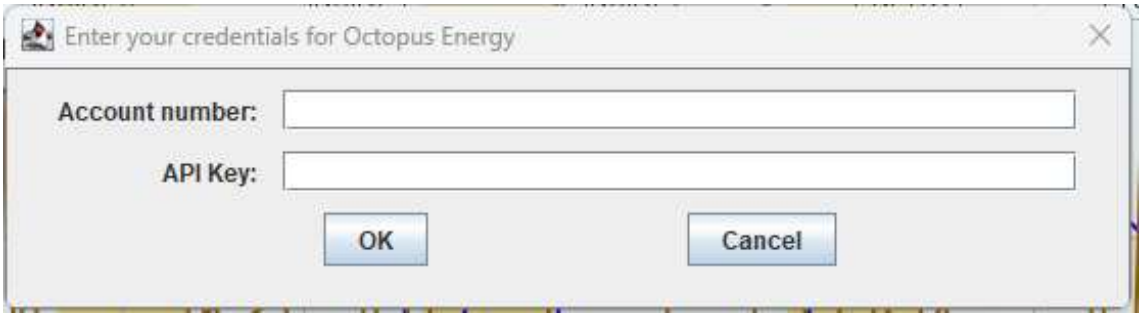
Load the energy. For this you will need your Octopus “credentials” – your account number and API Key. To find your API Key:

- log on to your Octopus account;
- click your name in the top right-hand corner;

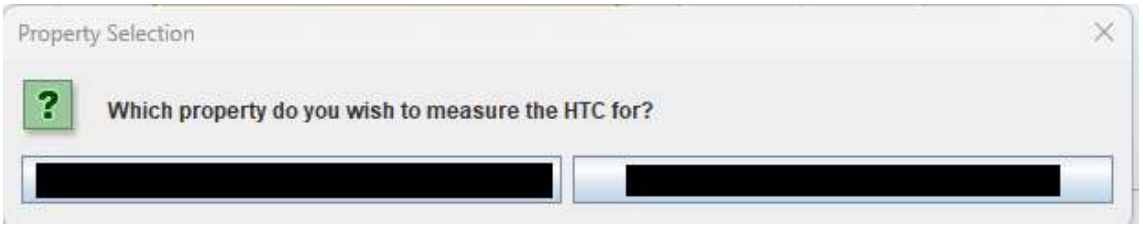
- click “personal details”, scroll down to developer settings;
- click “API access”;
- scroll down to and click the “Regenerate my API key” button.

The API Key is only displayed once so you will need to copy and keep it somewhere safe.

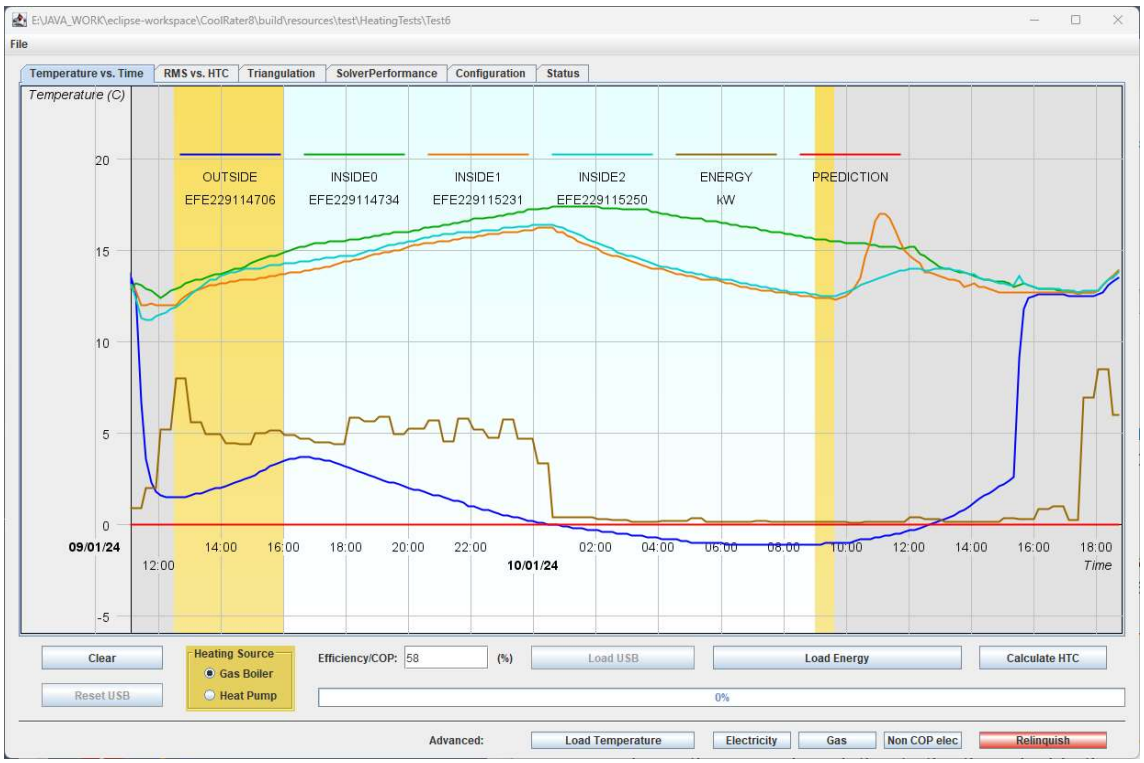
Click “Load Energy” and a dialogue box will appear.



Copy your credentials to the dialogue box, and click “ok”. If multiple properties are listed for you on the Octopus website, which may well happen if you have moved house, then a menu will be displayed for you to indicate which property the temperature readings relate to:



Select the appropriate property, and then the progress bar will show two datasets being loaded, one for electricity, and one for gas.

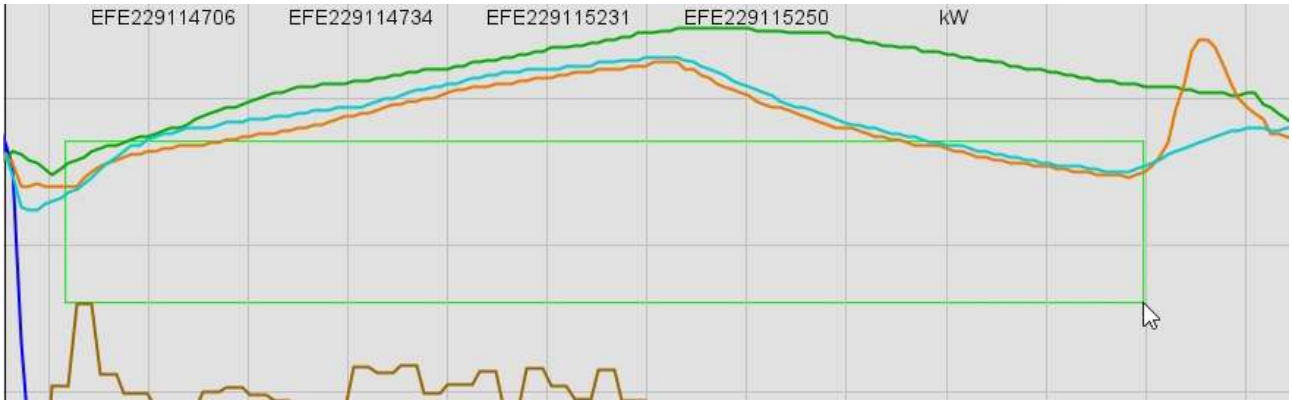


The energy is shown on the graph by the brown line, the height of which is unrelated to the other curves as it is in units of kW, not Celsius. Note how the temperature starts to fall when the gas boiler is switched off at about 12:20.

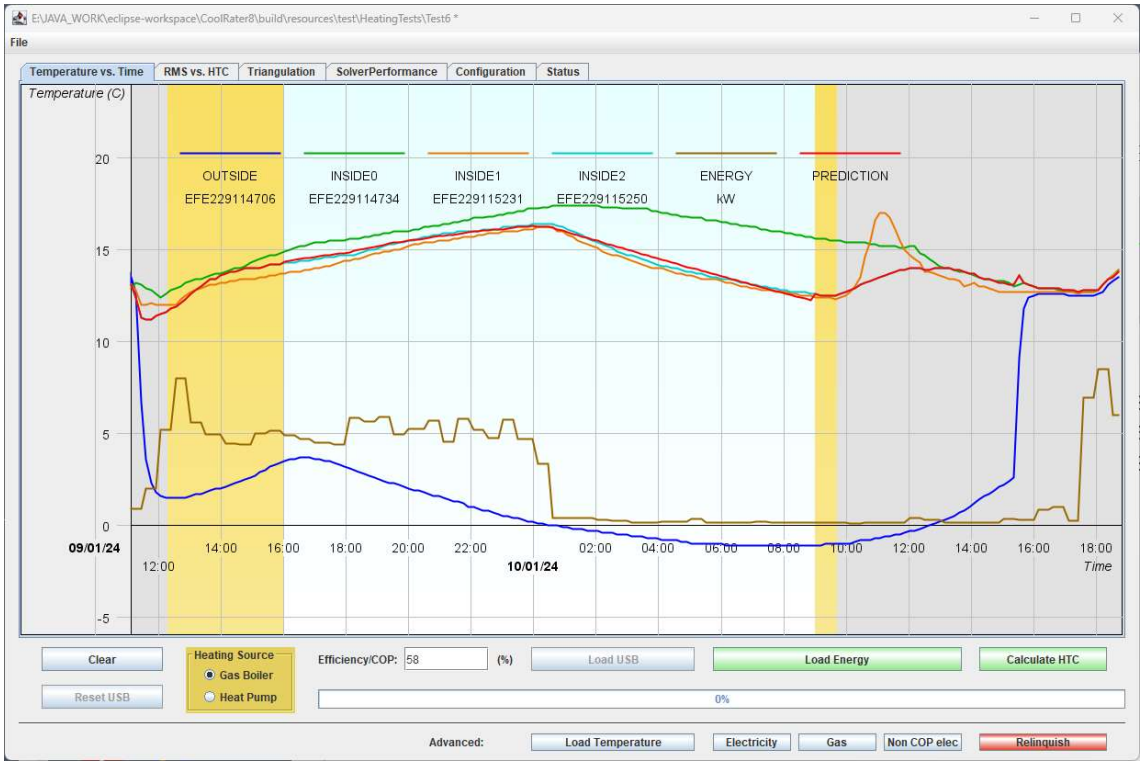
Save Your Work

At this stage, save your work. It is important not to overload the API service, so by saving your work which now includes the energy data, you can start from that point at any time without downloading the energy data again. From the title bar at the top of the app, File→Save As and a file chooser appears. When you run the app again, go to File→Load and load the file. The file chooser will be set to the directory where you last loaded or saved a file. The project files should be given the extension ".csv" as they are CSV files that can be opened in Excel or LibraOffice, or a text editor. This has been done so that the temperature and energy data can easily be used for other applications or for casual perusal, for instance to check that it doesn't contain any data that you are not comfortable sending back to me.

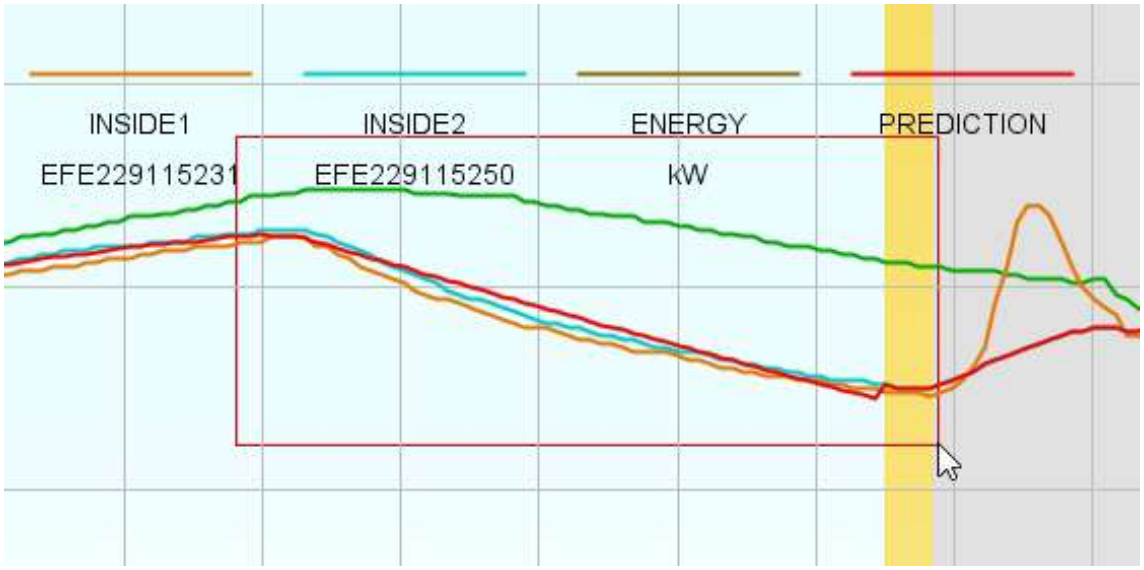
Select the usable temperature data. After you positioned the thermometers, they will take some time to warm up or cool down to give a correct reading, and as soon as you collect them in the data will no longer be reliable. Look at the Temperature vs. Time graph. Select this range with the mouse, holding down main mouse (Left if you are right handed) as you drag the mouse across the valid data. The vertical mouse movement is not significant.



Then hit “Calculate”. The red “Prediction” curve will cover each of the inside temperatures in turn.



It is possible to zoom in on the graph. Hold down “Ctrl” and drag main mouse.



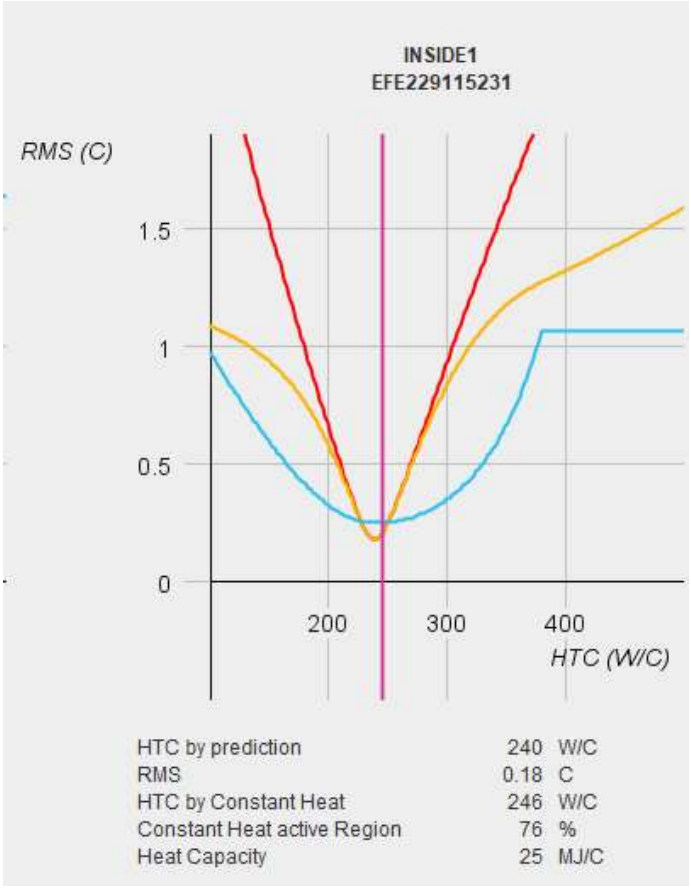
When you release the mouse the graph is zoomed in. To restore the view, click the other mouse button.



Once the process completes, switch the tabbed graph to “RMS vs. HTC”. This shows three graphs. each relating to one of the three inside thermometers.


E:\JAVA_WORK\eclipse-workspace\CoolRater8\build\resources\test\HeatingTests\Test6
File
Temperature vs. Time
RMS vs. HTC
Triangulation
SolverPerformance
Configuration
Status
RMS
Best RMS
Heat Capacity * 1e-8
HTC Constant Heat
INSIDE0
EFE229114734
INSIDE1
EFE229115231
INSIDE2
EFE229115250
RMS (C)
HTC (W/C)
HTC by prediction 120 W/C
RMS 0.16 C
HTC by Constant Heat 131 W/C
Constant Heat active Region 81 %
Heat Capacity 39 MJ/C
HTC by prediction 240 W/C
RMS 0.18 C
HTC by Constant Heat 246 W/C
Constant Heat active Region 76 %
Heat Capacity 25 MJ/C
HTC by prediction 249 W/C
RMS 0.16 C
HTC by Constant Heat 260 W/C
Constant Heat active Region 70 %
Heat Capacity 27 MJ/C
Clear
Reset USB
Heating Source
Gas Boiler
Heat Pump
Efficiency/COP: 58 (%)
Load USB
Load Energy
Calculate HTC
0%
Advanced:
Load Temperature
Electricity
Gas
Non COP elec
Relinquish

Middle Example



The app has found that with an HTC of 240 W/C, and a Heat Capacity of 25 MJ/C the prediction can be made to match the actual inside temperature best, by achieving the lowest RMS between them. The red line on this graph shows what happens if the HTC is varied over a range while the Heat Capacity is held constant. As HTC moves away from 240 W/C, the RMS increases. But the RMS may be lower if for each value of HTC we optimise Heat Capacity to minimise RMS. This is shown by the yellow line. Close to the optimal value of HTC it makes little difference, but for larger deviations there is some improvement.

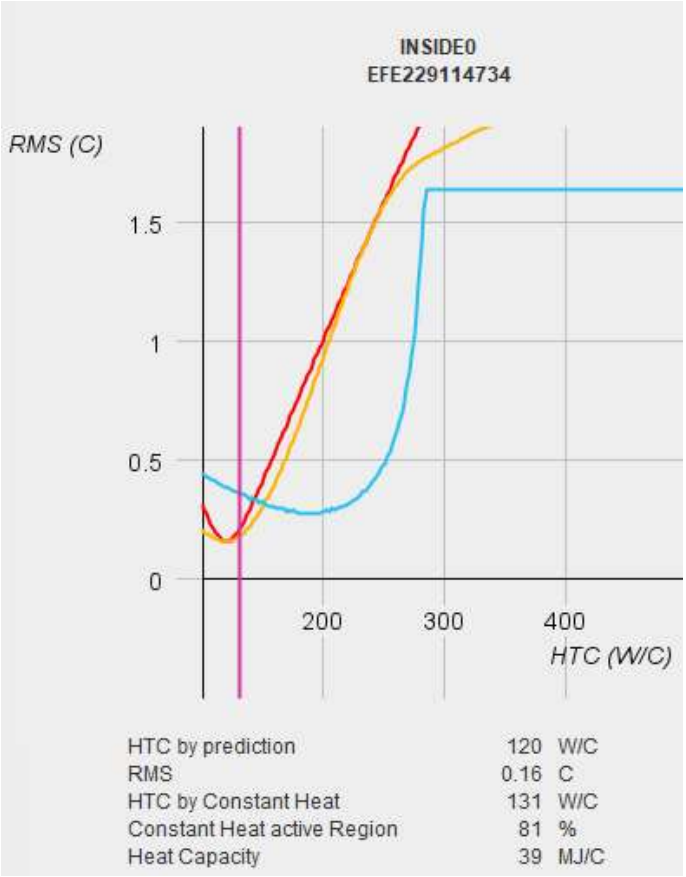
The blue line shows the optimised Heat Capacity value found as the yellow line was drawn. It has different units to the RMS and is scaled by 1 C = 100 MJ/C,
so the optimal value of 25 MJ/C shows as 0.25 C. The blue line can be expected to have this dish curve. Increasing the Heat Capacity means the house heats up and cools down more slowly. As the HTC moves away from the actual value the app will try to make the prediction match the actual value a well as possible by increasing the Heat Capacity to flatten out the prediction. In this example, notice that the minimum of the blue line is very close to the minimums of the red and yellow lines.

There is a third way of extracting the HTC from the data. If the inside temperature is the same at the beginning and end of the test then all of the energy used by the heating has been lost from the building, and none has been used to heat the building up. So the Heat Capacity is not needed, which removes a major uncertainty in the calculation of the HTC. This HTC value is referred to as the “HTC by Constant Heat” in the table and shown by the

magenta line on the graph. In this example, it is also close to the HTC obtained by prediction.

The app has to deal with some extra complexity to calculate the HTC by Constant Heat. During the day time the data is unreliable due to solar insolation. So if the temperature changes between sunrise and sunset the “target temperature” has to be shifted in the same direction to compensate for the effect, and it may be that the target temperature is never reached again during the test. The app will try to maximise the amount of data that can be used by artificially delaying sunset, advancing sunrise, or start using the data at a later point. It reports how much of the data it was able to use as the “Constant Heat active Region” of 76% in this case.

Left Hand Example



This example presents a confused picture. RMS is lowest when HTC has a low value of 120 W/C, and Heat Capacity has a high value of 39 MJ/C. Increasing the HTC to 200 allows the the Heat Capacity to moderate while minimising the RMS, but it has increased by a factor of 6. This indicates that the result is unreliable, and looking back at the Temperature vs. Time graph it behaves quite differently. The temperature does not start to reduce as promptly when the boiler switches off, and then reduces at a slower rate. It is believed that this is due to the temperature being captured in the main bedroom which had the chimney containing the flue for the gas boiler on one wall, so when the boiler switched off the room continued to heat and when it did cool down it did so more slowly.

Advanced Features

Buttons

There is a row of buttons along the bottom of the GUI that you should not normally need.

Load Temperature	Load the temperature data from a file rather than from the thermometers directly via USB.
Electricity/Gas	Load the smart meter data from a file rather than from the internet. The Octopus Energy website has a facility to generate files for this, but you need to enter the start and stop times manually.
Non COP	Needed if the heat source is a heat pump rather than a gas boiler. With a heat pump some electricity is converted to heat with typically 400% efficiency according to the heat pump's Coefficient of Performance (COP), while electricity used for lighting and other purposes only results in 100% heat. A power meter is required to measure the amount of electricity not used by the heat pump, which is recorded in another file loaded here.
Relinquish	Clear program lock-ups resulting from faulty program logic.

Editing the Project Files

The files that you save with File→Save As and load with File→Load are csv files that you can open with Excel or Libra Office. In general you shouldn't edit these as the CoolRater app may not work, but there are three things that it may be useful to edit:

Row 13 – Header Row

Columns D, E, F and G correspond to the four thermometers, and the cells on this row contain the serial numbers. You can edit them to short meaningful descriptions. I suggest no more than 15 characters, and must not be the characters '/', ',' or ':'.

Rows 11 and 12

The values in column B specify the range of HTC values covered by the horizontal axis of the graphs on the results page. If you have a large property, you may need to increase them or for a small flat reduce them.

Rows 9 and 10

The values in column B specify the range of temperatures covered by the vertical axis on the main Temperature graph. You may need to extend these if it is very warm inside or very cold outside. Remember that there is also a zoom facility on the graph.