

# Efficient Homes Project 2013-2014: Final Report

May 2014

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## 1. Project Aims

The aims of this project are to assist the community in knowing cost effective and efficient methods of heating and cooling their home, and also assist people who are thinking of building a new house or renovating in knowing how they can design their house to be comfortable, efficient and cheap to heat and cool. This project involves installing temperature loggers in houses constructed of a variety of materials – limestone, brick veneer, timber, and mixed materials – and leaving them in situ for 12 months. Heating and cooling actions will ideally be recorded by residents. The project is focused on the climate of Mount Gambier.

## 2. Intended Outcomes

- Assist people who are thinking of building a new house or renovating in knowing how they can design their house to be comfortable, efficient, and cheap to heat and cool.
- Highlight the amounts of energy (and hence cost) required to heat or cool homes constructed of various materials in Mount Gambier.
- Assist the community in knowing the most cost effective, efficient and environmentally friendly methods of heating and cooling their home.

## 3. Exclusions & Clarifications

- Room temperatures are not only affected by the building envelope materials, but can also be affected by their position in the house – e.g. north vs south facing, microclimate, position and geography of the house, level of insulation etc.
- No fan pressurisation testing was undertaken to measure air leakage rates and identify draughts.
- Outside temperatures are all correlated, but likely to be affected by their placement at their particular location and micro climates.

## 4. Method

All temperature loggers were tested in an office environment prior to their use in the project. All loggers recorded temperatures within 0.2 of a degree when placed at the same location within a building.

In April 2013 HOBO temperature loggers were placed in three different types of house: Limestone, Brick Veneer and Mixed Materials (referred to in this report as “Modern Eclectic”). A set of Geosignal XT100 temperature loggers were placed in a Timber house. The purpose of using the two different types of temperature loggers was to compare performance and price.

All loggers were removed from the houses at the end of October 2013 so the data could be downloaded and the batteries replaced if necessary. The loggers were returned to the same locations within the houses after the data was downloaded. All loggers were once again removed at the end of the 12 months – in April 2014.

## 5. Temperature Loggers



HOBO UX100 Temperature Data Logger



Geosignal XT100 Temperature Logger

The HOBO temperature loggers are the more expensive variety (\$102 vs \$24 for a Geosignal logger), but they are much better quality. It is expected that the HOBO loggers will last much longer, and so be able to be reused more times than the Geosignal loggers. The HOBO loggers can be attached to surfaces by a magnet or Velcro strap, the Geosignal loggers do not come with any attachment features.

The HOBO loggers come with their own software which makes downloading the data and exporting it very user friendly. The Geosignal loggers do not come with any software and changing the settings and downloading data is not as straight forward.

As with the majority of products, you get what you pay for. The Geosignal loggers are cheaper, but they are significantly lower quality and nowhere near as user friendly. The other main advantage of the HOBO loggers is that they have a temperature display, so residents can see the temperature in the room at any time, hence they can play a role in behaviour change through knowledge provision. Finally, the battery does not last as long in the Geosignal loggers, these batteries only lasted just over 6 months, whereas the batteries in the HOBO loggers are expected to last over 12 months.

If more temperature loggers are purchased for future stages of the Efficient Homes Project then it is recommended to purchase HOBO temperature loggers.

## 6. Results

The period from April to October is generally a heating period in Mount Gambier, with residents using heating appliances on most days during this time. This study has found that Mount Gambier residents commonly actively heat their homes between 100-150 days per year. December to February is the period of the year when active cooling is more likely to be used. This study has found that Mount Gambier residents actively cool their homes with an air conditioner between 0-15 days per year. Less intensive methods such as ceiling fans, pedestal fans and opening windows of an evening are used more often – but still much less often than heaters are used.

Overall, Mount Gambier residents use active heating much more often than active cooling throughout the year.

A number of graphs have been produced from the data downloaded from all of the temperature loggers.

More graphs are located in Appendix A – House Temperature Graphs.

### a. *Unheated Rooms*

The efficiency of a home, or more specifically a room within a home, can be ascertained by looking at the temperature change over a 24 hour period and comparing that with the outside temperature change. In order to assess this characteristic without the interference of artificial heating, temperature loggers were

placed in unheated rooms that are isolated from the rest of the house by a closed door. However, this did not occur in the Modern Eclectic house as the entire house is heated by a gas central heating system, apart from the laundry, but this was not deemed adequate for the purpose as it has a large north-facing glass door.

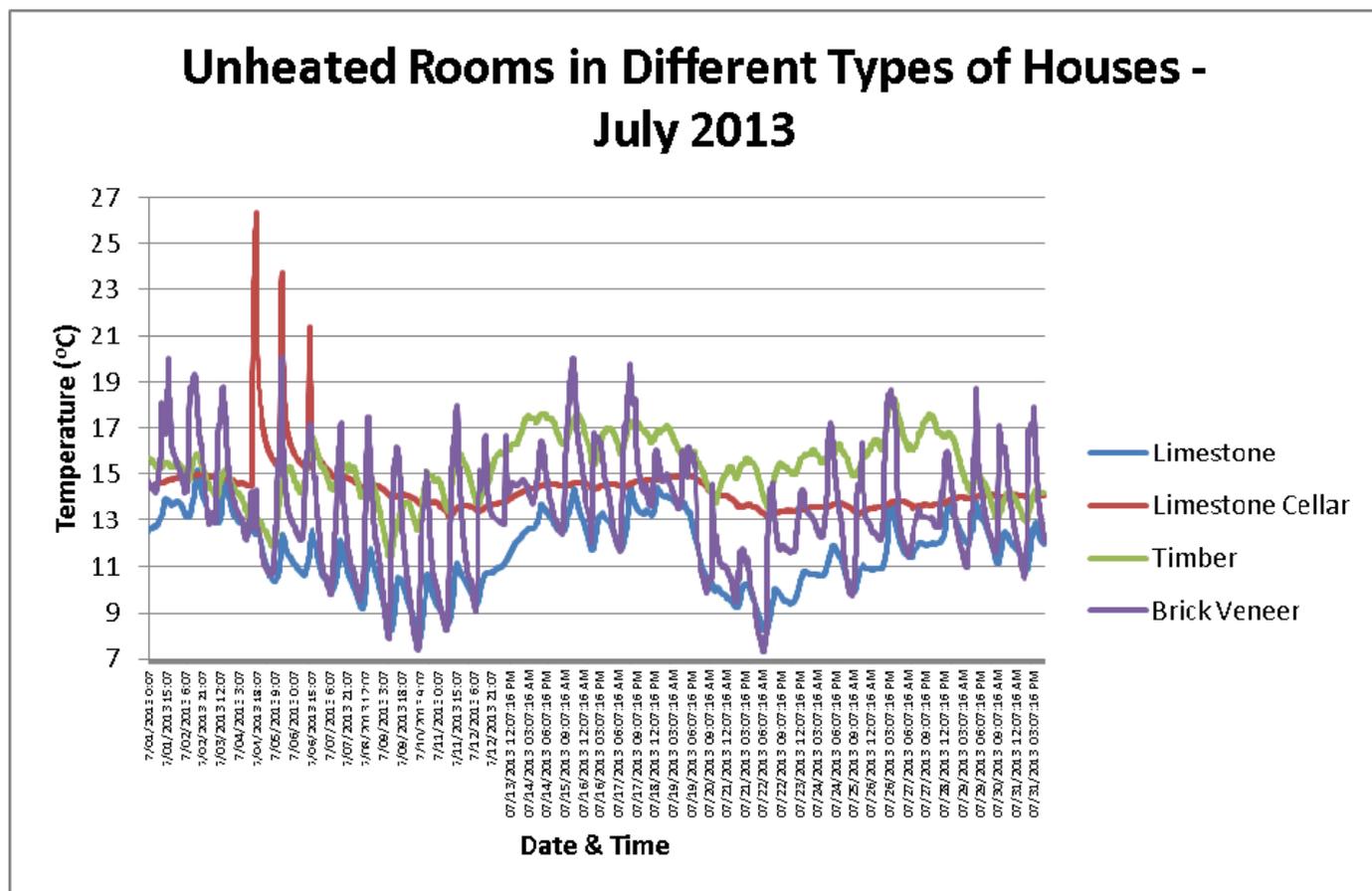
The room that changed the least was the Limestone Cellar, followed by the Timber and Limestone unheated rooms. The unheated room with the greatest temperature change was in the Brick Veneer house. The temperature in this room was closely correlated with the outside temperature, suggesting minimal efficiency.

The most surprising of these results is the Timber unheated room, it did not vary as much as the other buildings, apart from the Limestone Cellar. However, this room is a downstairs room on the south side of the house, and so is well protected from outside influence. If the temperature logger was placed in an upstairs room on the north side of the house the result may well be quite different.

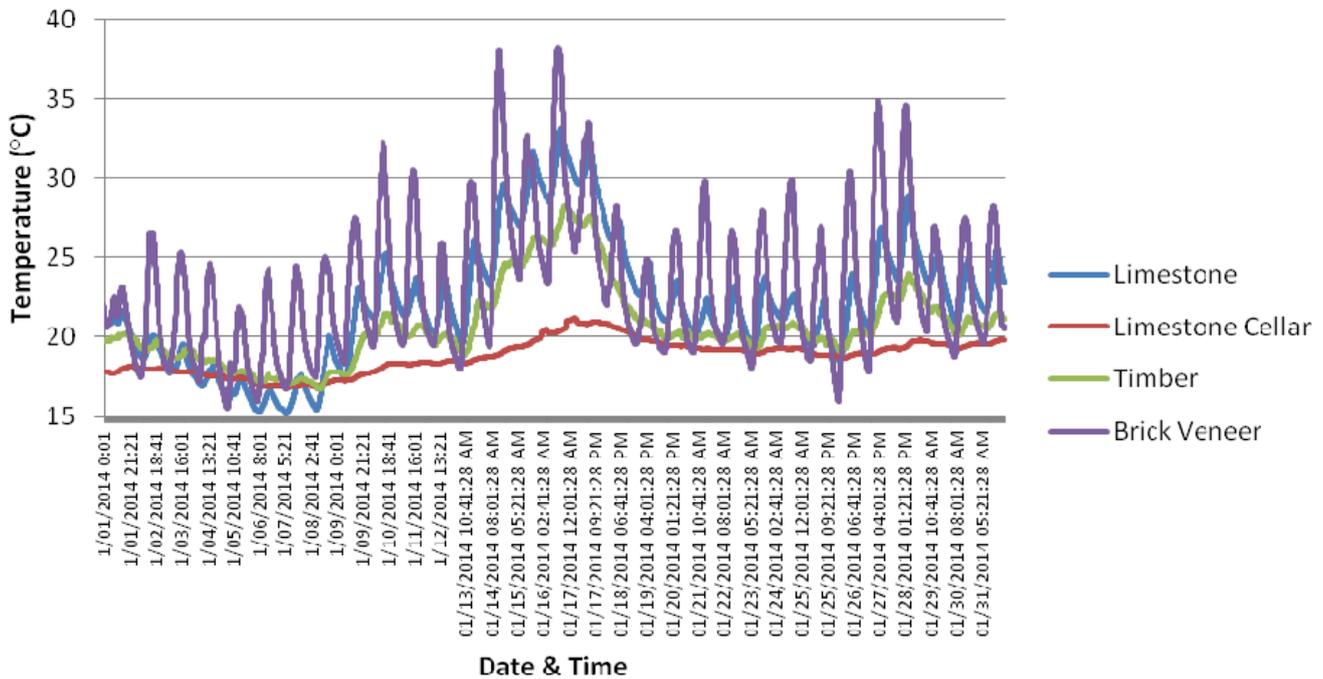
It should be noted that the Timber building is not an old-style weatherboard home, it is constructed with timber logs. Also, the unheated room is located in a southerly downstairs room that is quite protected by the north-facing section of the house, as well as an embankment on the southern side.

It is expected that the Limestone house would have a smaller temperature range than the Brick Veneer as it has a much higher thermal mass, and hence a lot more energy is required to change its temperature than a building with less thermal mass such as Brick Veneer.

By far the greatest variance, and hence susceptibility to the external weather, was the Brick Veneer home.



## Unheated Rooms in Different Types of Houses - January 2014



### b. Heated (& Cooled) Rooms

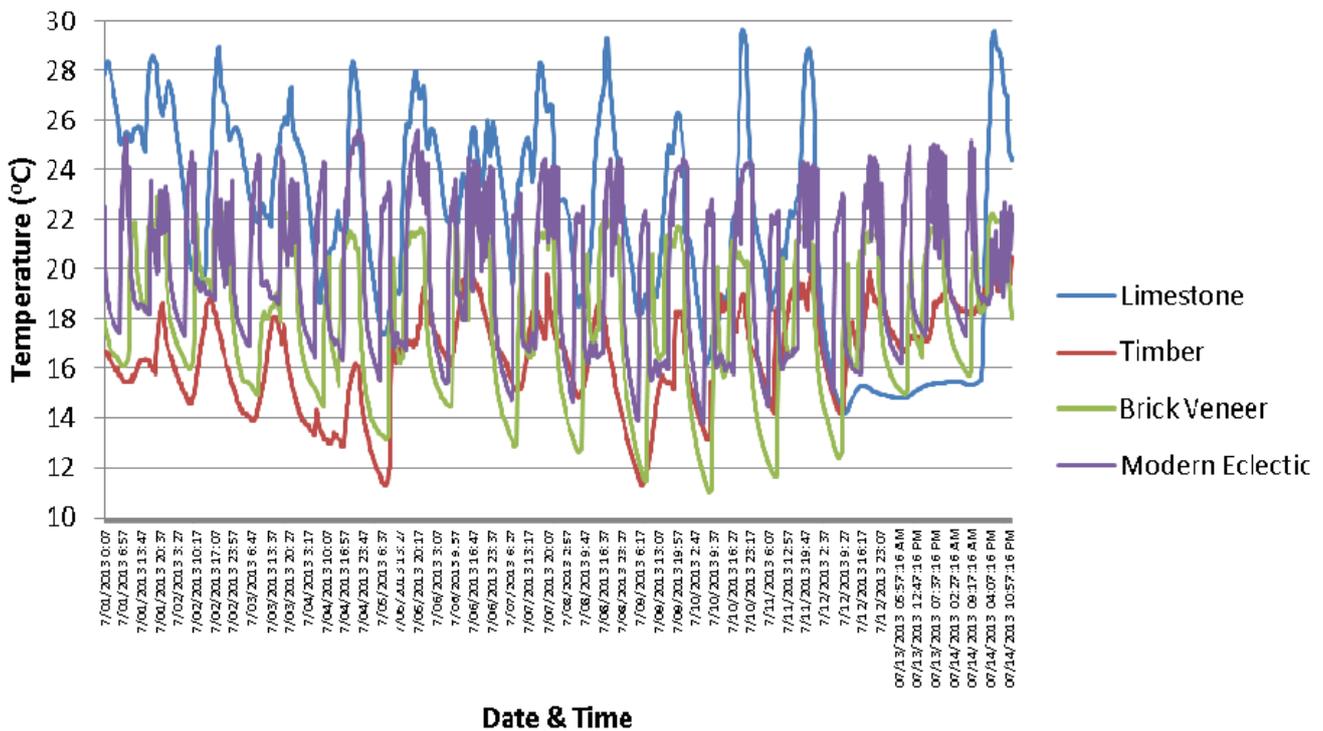
The performance of heated and cooled rooms is largely influenced by the behaviour of the residents. Some residents use heaters, air conditioners, fans etc. more often than others, and also like to have the temperature at a higher or lower set point than others.

During the cooler months the Limestone heated room had the greatest daily temperature change, due to the fact that this room was heated to a higher temperature than the heated rooms in the other houses. The Timber heated room experienced the smallest daily temperature change, due to it not being heated as highly as the other houses.

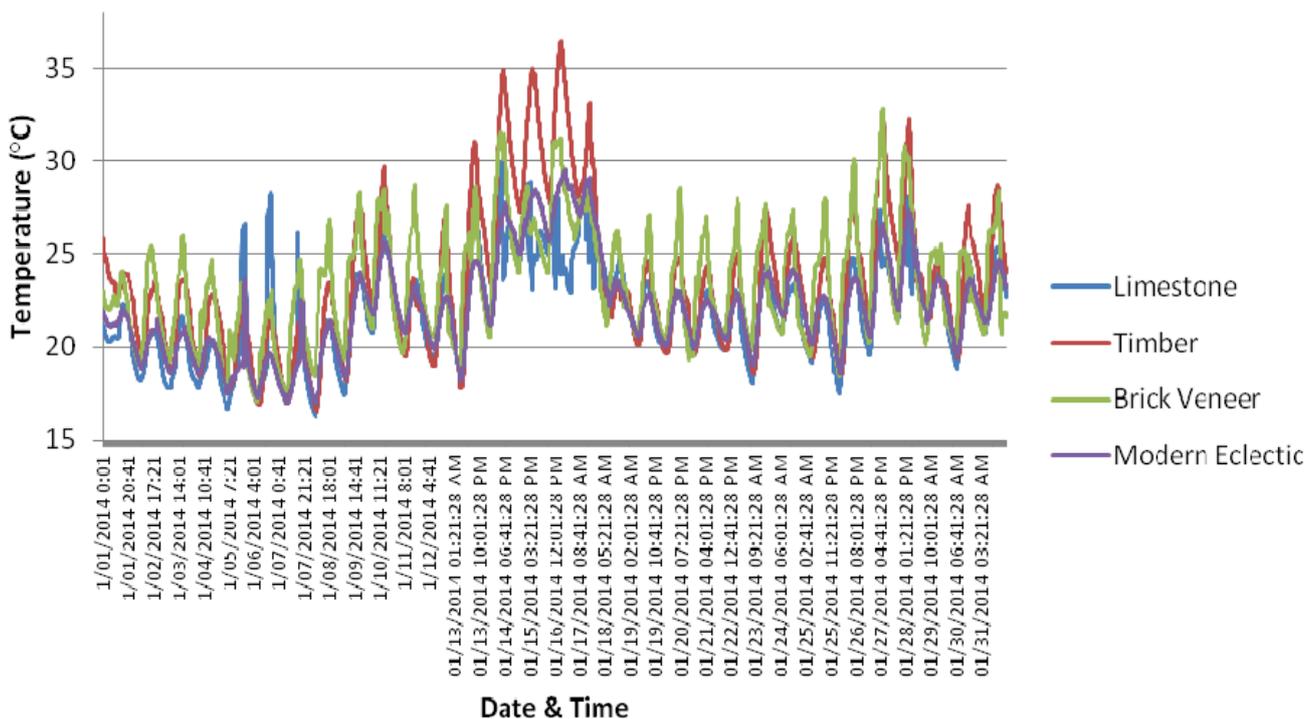
During the hotter months the Timber heated/cooled room reached the highest temperature, probably partly due to the fact that the room is located on the upper storey, has northern windows, and has no roof cavity. The roof is comprised of the outer metal layer, then insulation, then the ceiling material – there is no air gap, nor room to add in extra insulation.

During the hotter months the Brick Veneer room got more consistently hotter, and generally had the greatest temperature variance. This indicates the susceptibility of Brick Veneer homes to the external temperature.

## Heated Rooms in Different Types of Houses - Part July 2013

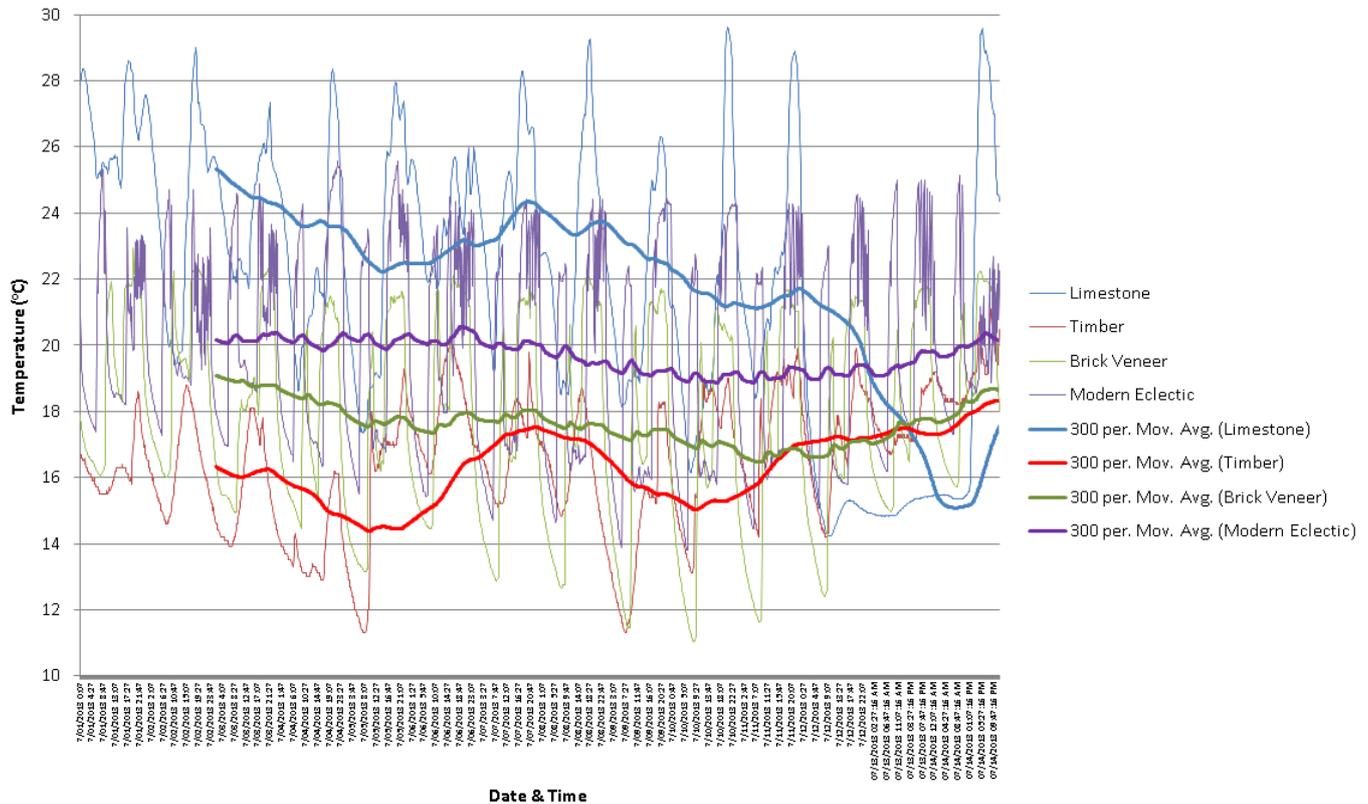


## Conditioned Rooms in Different types of Houses - January 2014



When moving average lines are fitted to the July 2013 graph they show that the Modern Eclectic and Brick Veneer houses have the smallest variation. This is because the Modern Eclectic house has a gas central heating system with an automatic set point, and the Brick Veneer has a reverse cycle system with an automatic set point. The Limestone house uses a wood heater, where the temperature is set by the user's feel of the temperature. The Timber house has a gas space heater that is also set by the user's feel.

### Heated Rooms in Different Types of Houses (Moving Average) - Part July 2013



When the same is done for January 2014, the hottest houses are the Timber and Brick Veneer, followed by Modern Eclectic then Limestone.

In terms of overnight temperatures within the heated rooms during the cooler months, the Brick Veneer and Timber houses had the lowest temperatures, suggesting less efficiency. However, the timber house was not heated as highly as the Brick Veneer, so the latter experienced the greatest overnight temperature change. On numerous days the temperature of the Modern Eclectic house dropped to a similar level as the Timber house. The Limestone house had the highest overnight temperatures, which is likely due to its high amount of thermal mass, but also partly because it was heated to the highest temperature of the four houses.

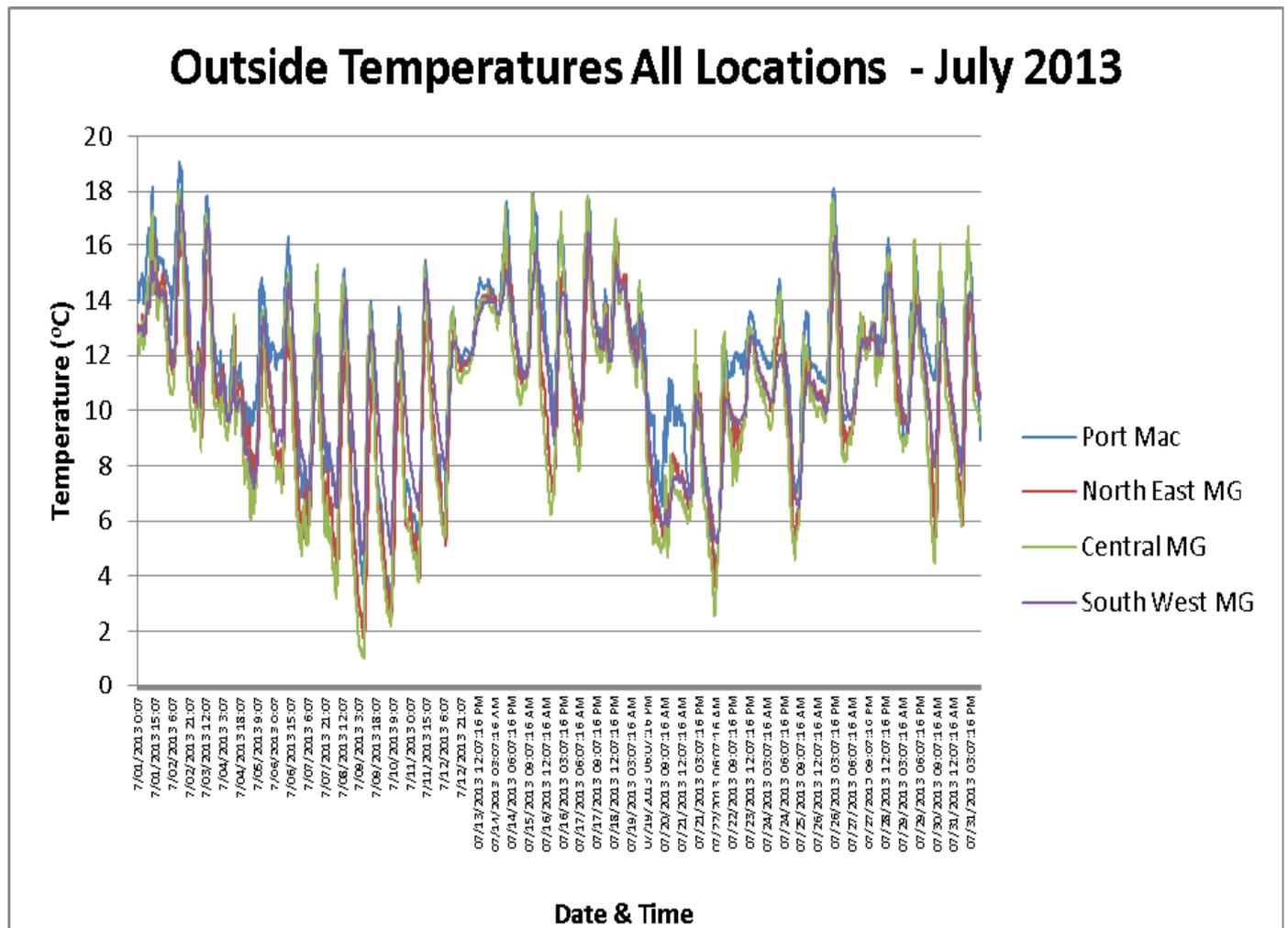
#### c. Outside Temperatures

Outside temperatures at all houses were well correlated, generally within 2-3 degrees of each other. The Port MacDonnell residence experienced the smallest variance in outside temperature, which is not surprising given its location on the coast. The correlation of these loggers demonstrates that they are working properly.

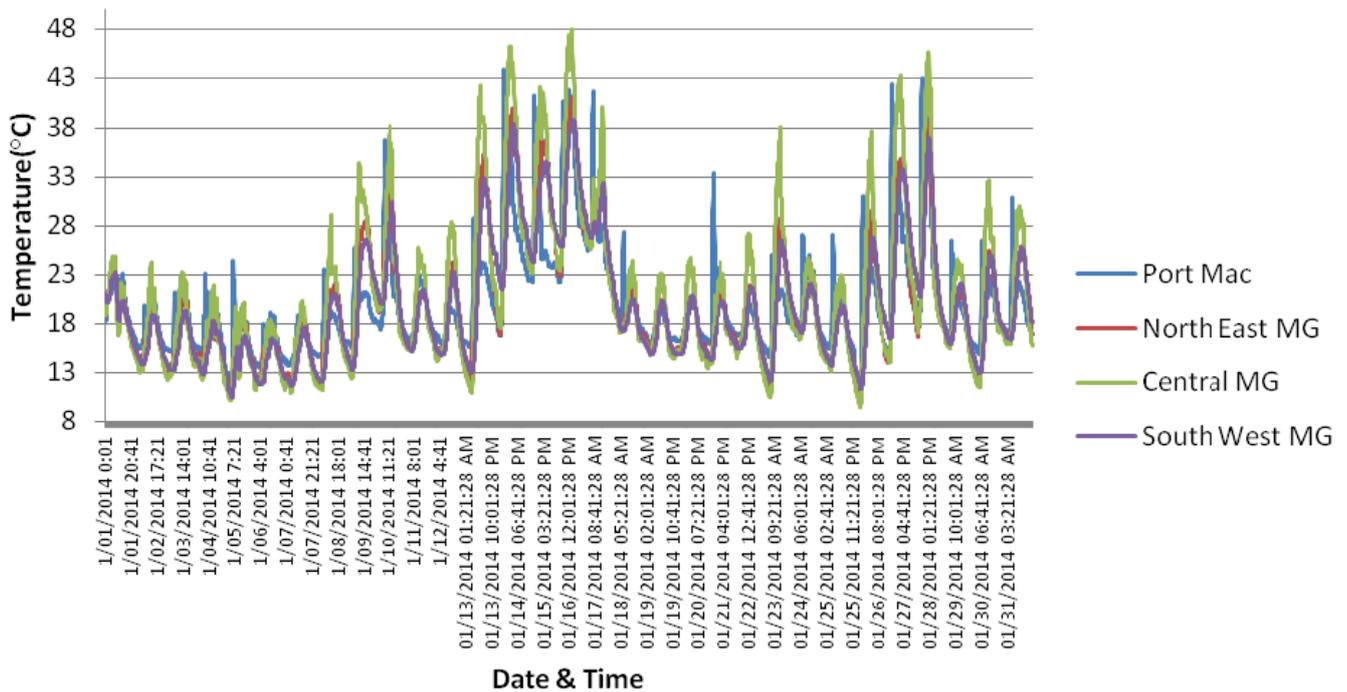
Over the hotter days the Central Mount Gambier logger was generally hotter than the other two Mount Gambier locations. This is most likely due to the specific location of the logger at each site. The Central MG logger was located under a tin verandah, whilst the other two were in more covered positions, protected by materials that are less sensitive to heat and direct sun. In overcast conditions and cooler days the Central MG logger was more closely correlated.

The correlation of night time temperatures was quite close for the three Mount Gambier locations. Port MacDonnell generally was slightly warmer at night time, which is what one would expect when comparing a coastal location to an inland location.

For future rounds, all outside loggers should ideally be placed in more protected locations, in order to reduce the influence of heat sensitive materials such as metals.



## Outside Temperature All Locations - January 2014



### d. Overall

These results seem to indicate that two factors are important in determining a house's ability to be isolated from outside temperature changes, and retain heat – those being thermal mass and placement of the room within the building (though these are certainly not the only factors – especially the level of insulation). The temperature of the unheated Timber room did not change a great deal, most likely because of its protected placement within the house.

Like the majority of older limestone homes in Mount Gambier, the subject house does not have insulation in the walls, only above the ceiling in the heated/cooled room – there is no insulation above the unheated/cooled room. It would be interesting to see the performance of a Limestone room that also has insulation. Insulation would further assist this isolation from outside temperature influence.

Going one step further, isolated thermal mass within an insulated building envelope would regulate the internal temperature even more. For example, this may be an internal stone or brick wall or feature which is not directly connected to an exterior wall, but fully contained within the insulating layer.

The results also clearly demonstrate the variation within houses, as demonstrated by the Timber house – which has a very stable room on the south side downstairs, but the upper northern rooms are more susceptible to the outside weather. Building designs must take into account not only the materials, but also the site location, in order to design a building that will take a minimal amount of active energy to heat or cool.

The ideal is a house that is completely passively heated and cooled, with no requirement for energy for this purpose. This may be difficult in Mount Gambier's predominantly heating climate, but a building that only requires minimal active heating (and cooling) could surely be achieved.

## Heating

Heating every room regardless of whether someone is using them or not is very inefficient. Many modern homes have central heating (and cooling), but they heat every room on the system regardless of whether they are occupied or not. Energy (and money) is being used to heat rooms that are not being used.

Home owners thinking of installing central heating should make sure that it can be zoned. This may involve having vents that can be closed when the room is not being used.

Home owners should also seriously consider if they really need (central) heating in the bedrooms. In Mount Gambier's climate, heating should generally only be required in bedrooms for people with special needs e.g. infants, elderly, those who are sick etc. Generally, healthy adults in a reasonably constructed home should not need heating in their bedroom in this climate.

## 7. Future Recommendations

As far as possible, install the temperature loggers in similar locations within (and outside) each house e.g. unheated room on the south side of the house. This will not always be possible, but some consideration should be given to this when selecting houses for subsequent rounds of the project.

## 8. Next Steps

Given that all the temperature loggers are still working, place them in another set of houses for 12 months. Preferably place the loggers in homes made of different materials to those tested in the 2013-2014 round.

## 9. Enquiries

Enquiries about this project can be made to:

Aaron Izzard

Environmental Sustainability Officer

City of Mount Gambier

E: [aizzard@mountgambier.sa.gov.au](mailto:aizzard@mountgambier.sa.gov.au)

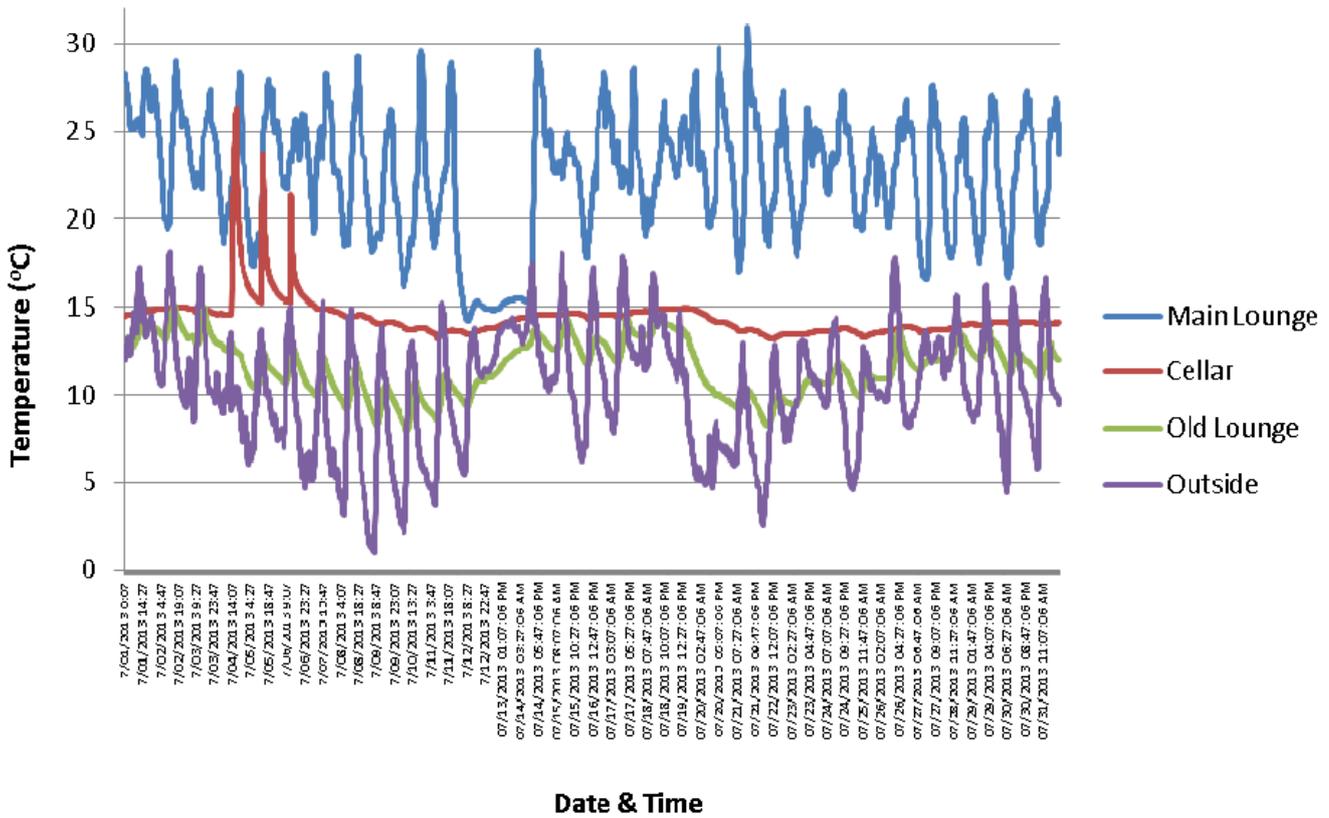
T: 08 8721 2528

## 10. Further Information on Home Energy Efficiency

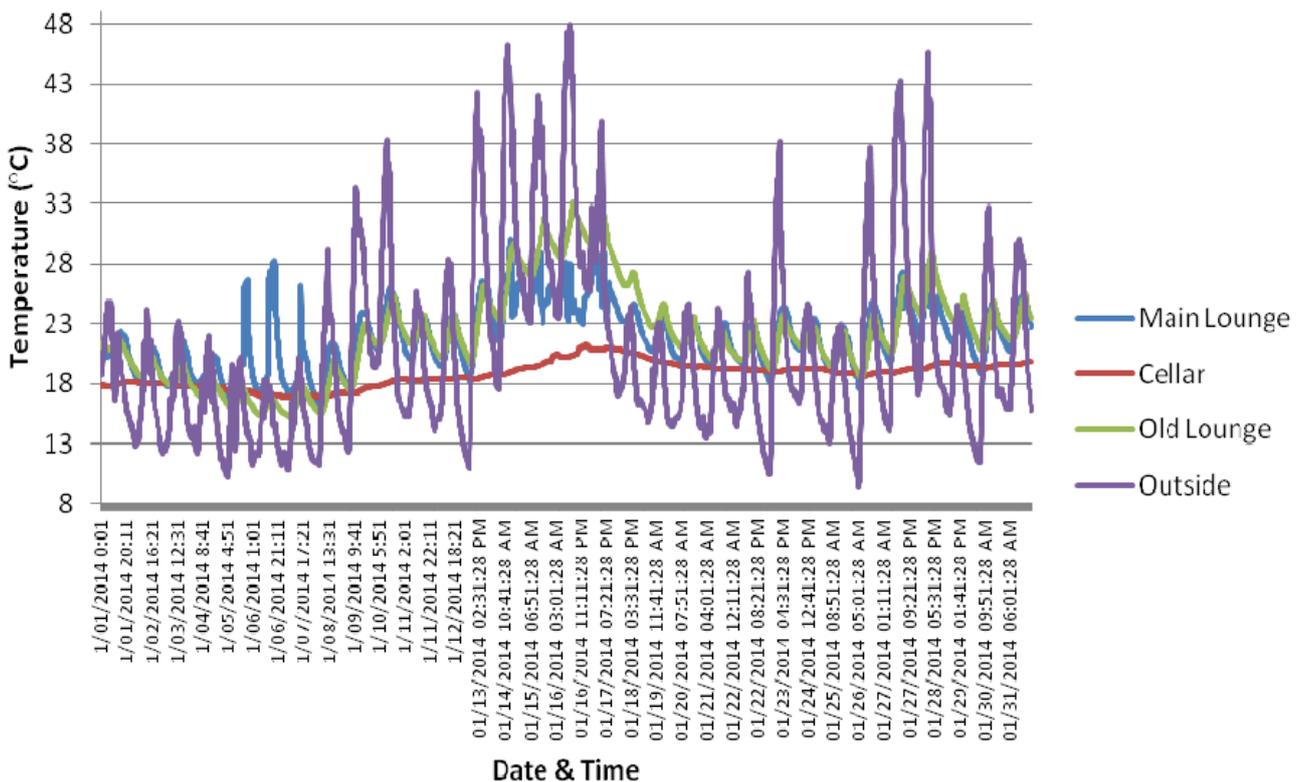
For a more detailed discussion on the energy efficiency of a variety of existing homes see this report commissioned by Sustainability Victoria: [On-Ground Assessment of the Energy Efficiency Potential of Victorian Homes](#)

# Appendix A – House Temperature Graphs

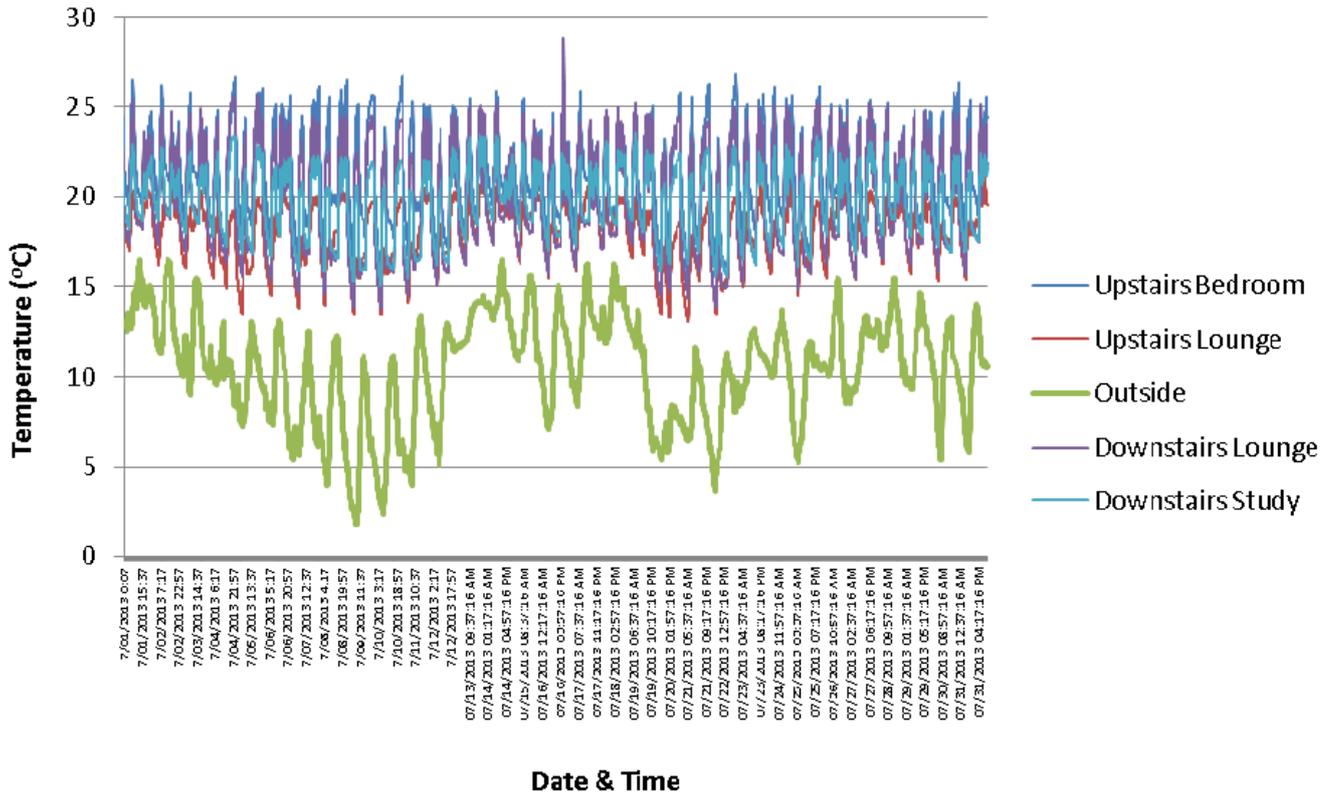
## Limestone All Loggers - July 2013



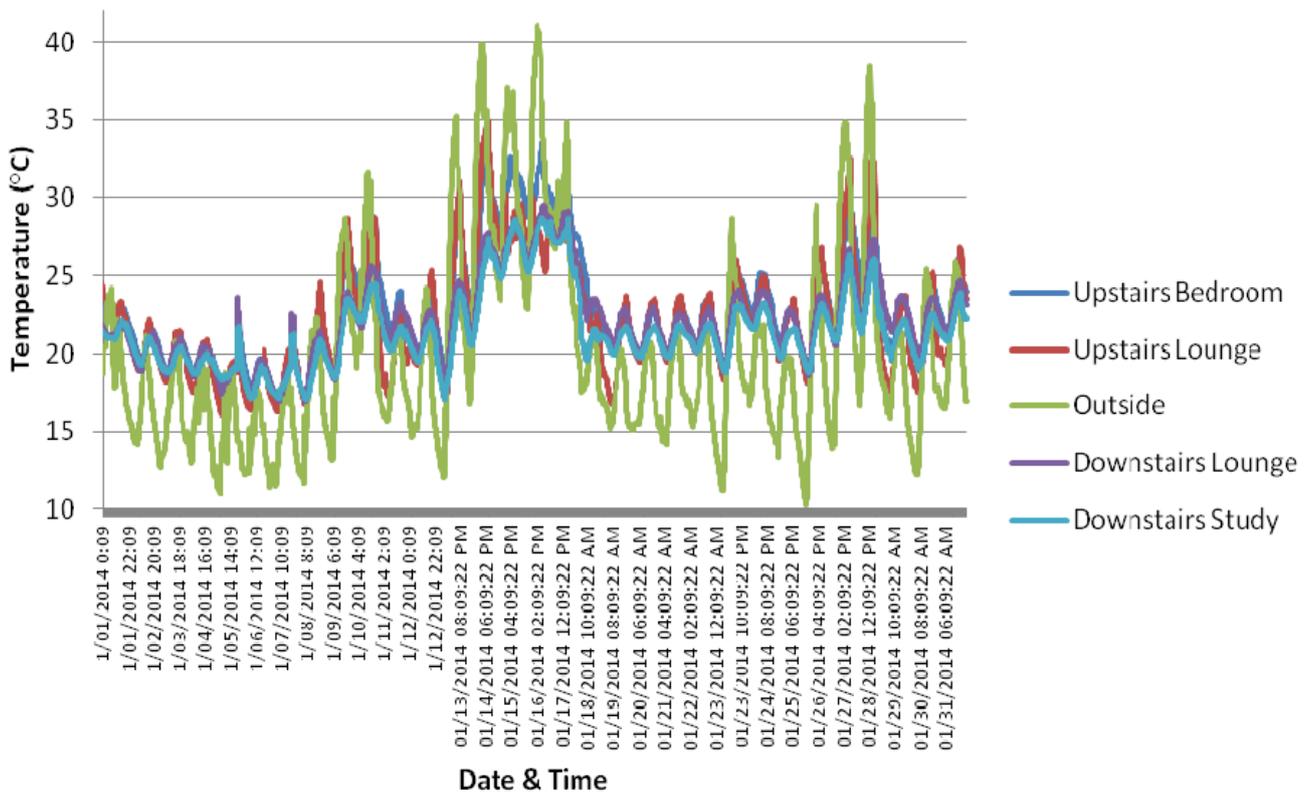
## Limestone All Loggers - January 2014



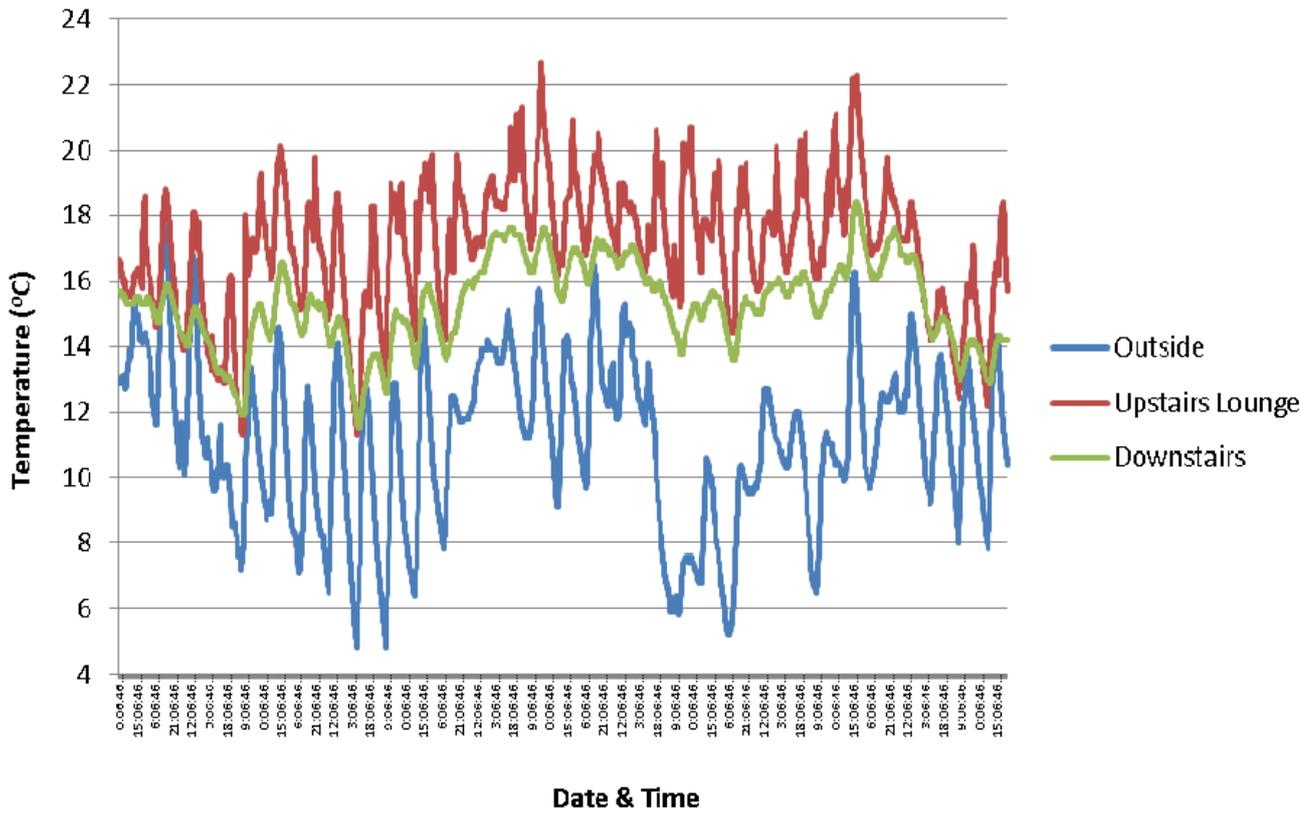
## Modern Eclectic All Loggers - July 2013



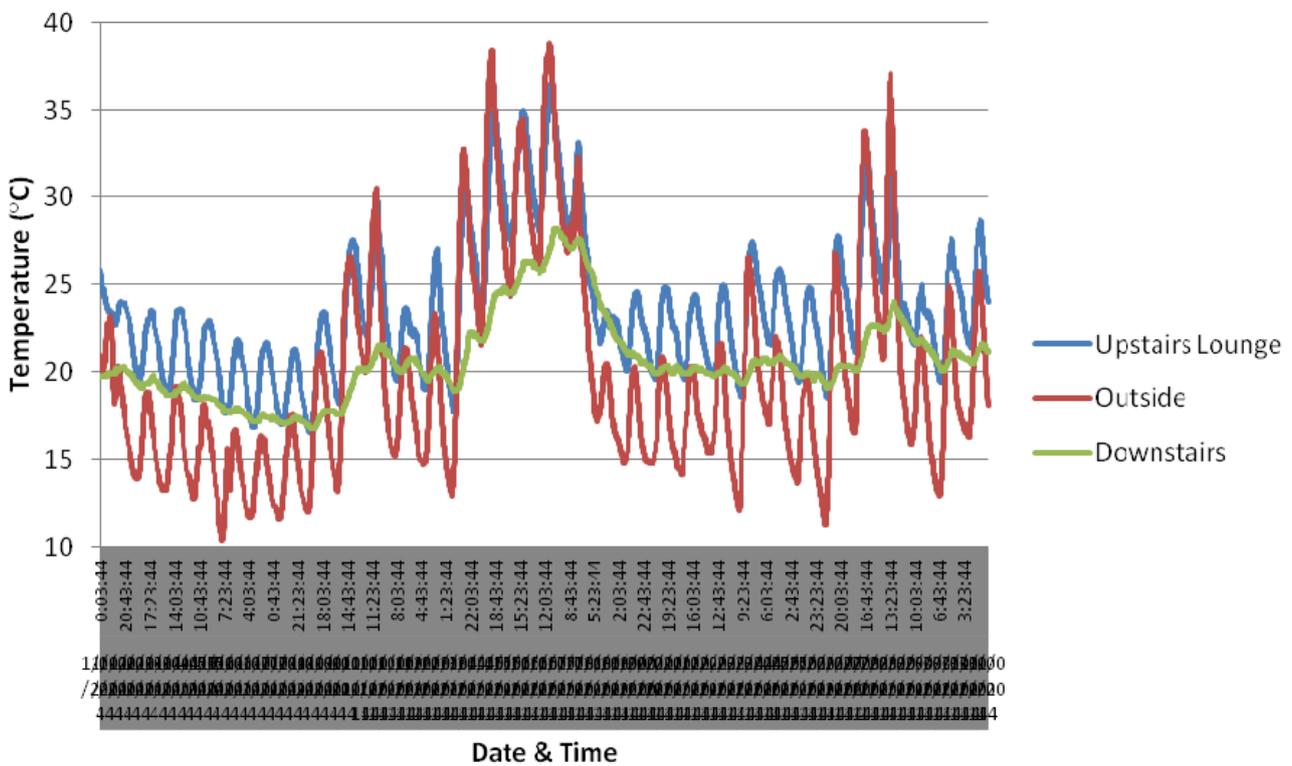
## Modern Eclectic All Loggers - January 2014



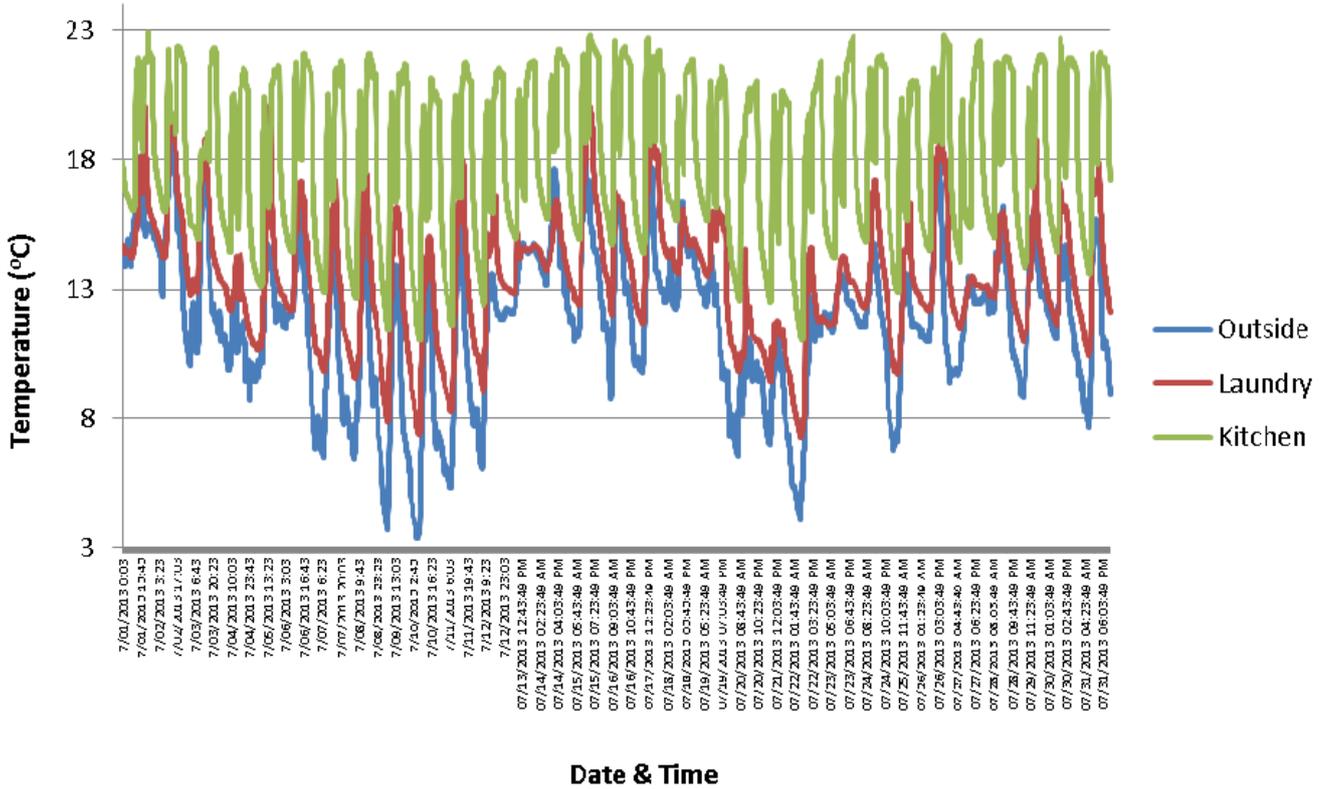
## Timber House All Loggers - July 2013



## Timber House All Loggers - January 2014



## Brick Veneer All Loggers - July 2013



## Brick Veneer All Loggers - January 2014

