Efficient Homes Project 2014-2015: Final Report

August 2015

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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 May & June 2014 HOBO temperature loggers were placed in three different types of house: Modern Brick Veneer, Rammed Earth and Mixed Materials (referred to in this report as "Modern Eclectic"). A set of Geosignal XT100 temperature loggers were placed in an old Limestone 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 in July 2015 so the data could be downloaded and the batteries replaced if necessary.

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. The first round of this study 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. The first round of this study 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.

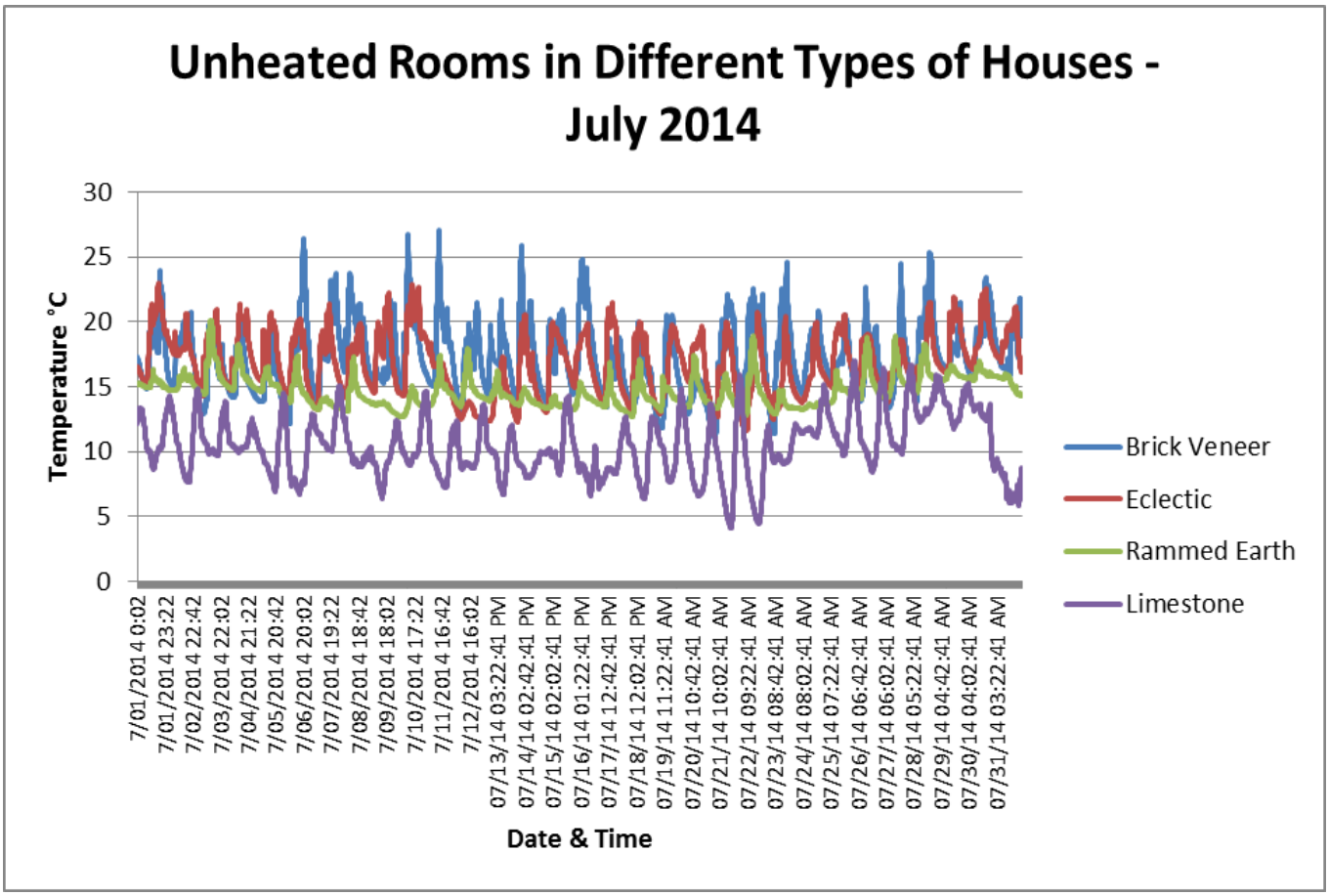
The room that changed the least was the Rammed Earth. Ordinarily one would expect the Limestone house to also have less change, but the unheated/conditioned room was an external laundry that has been added on, and does not form part of the original envelope of the building.

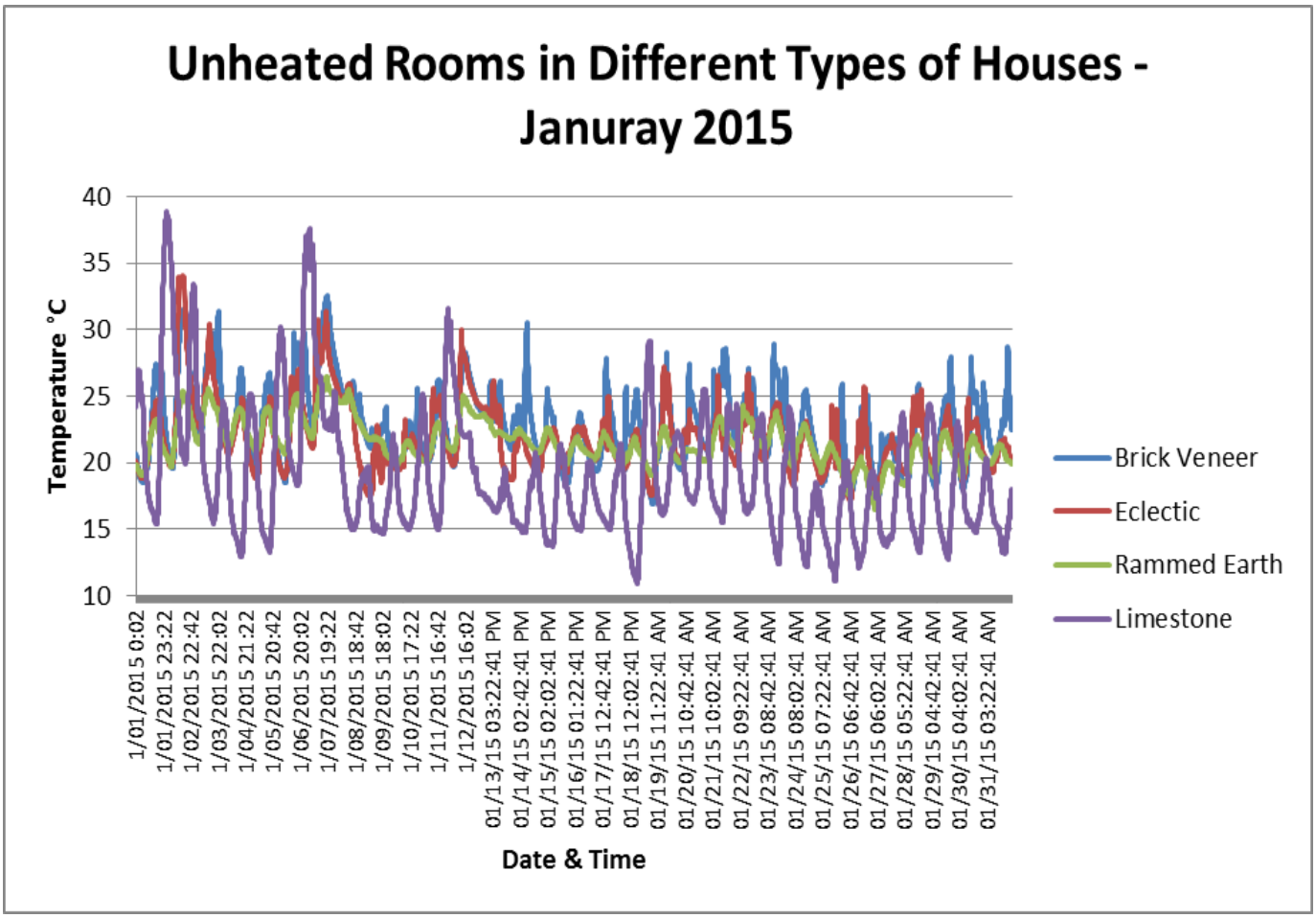
The unheated rooms with the greatest temperature change was in the Modern Brick Veneer house, and also the Limestone house for the reason cited above.

It is expected that the Rammed Earth 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.

The Rammed Earth had the least susceptibility to the external weather.

In both the Modern Brick Veneer and Modern Eclectic the only unheated room was a laundry. This is not ideal as both laundries had a dryer, and if the door was left open they are connected to the rest of their house which is heated. These factors would have affected the results for these two houses to some degree.





b. *Heated (& Cooled) Rooms*

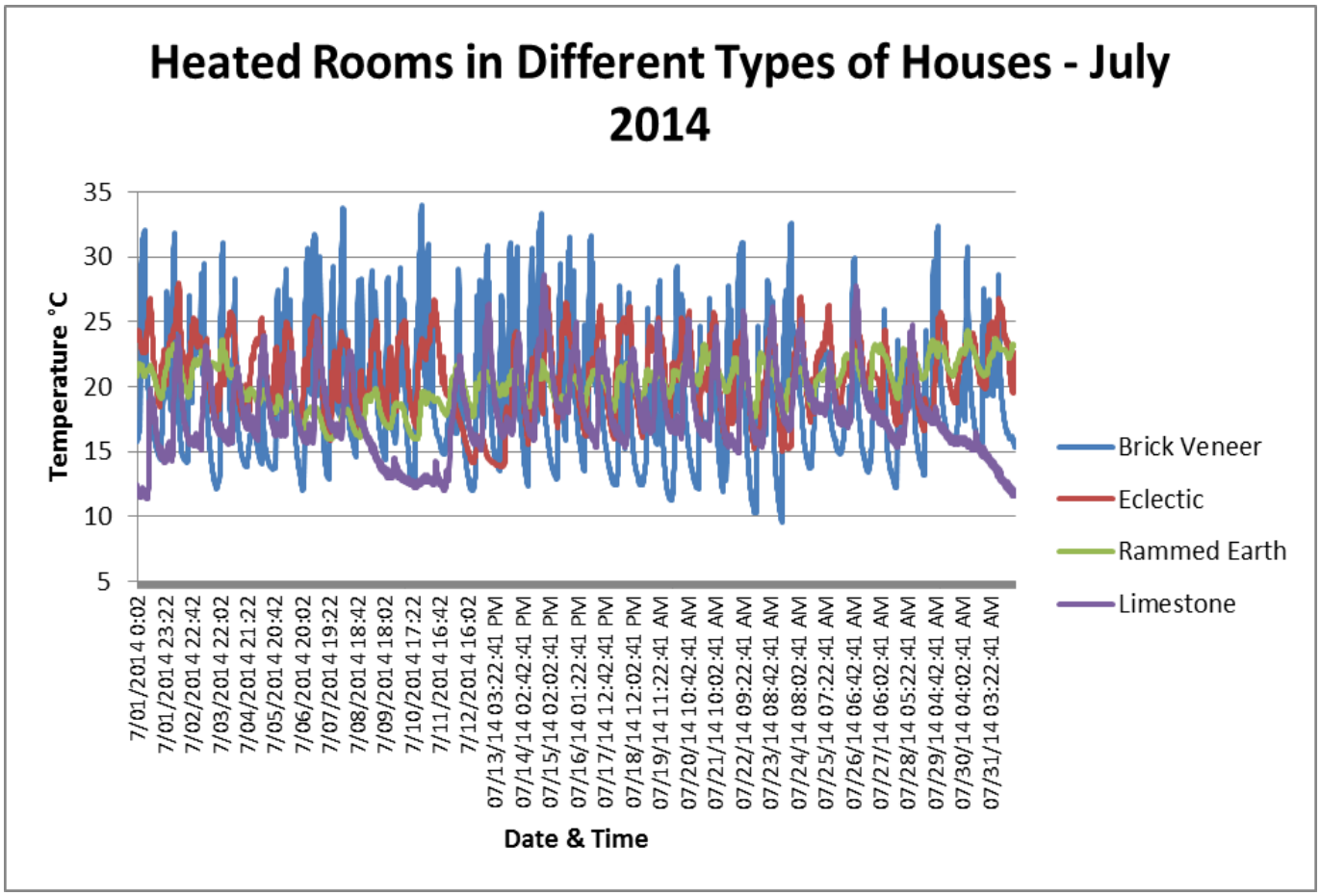
The performance of heated and cooled rooms is largely influenced by the behaviour of the residents. Some residents use heaters, air conditioners, fans etc. more often than others, and also like to have the temperature at a higher or lower set point than others.

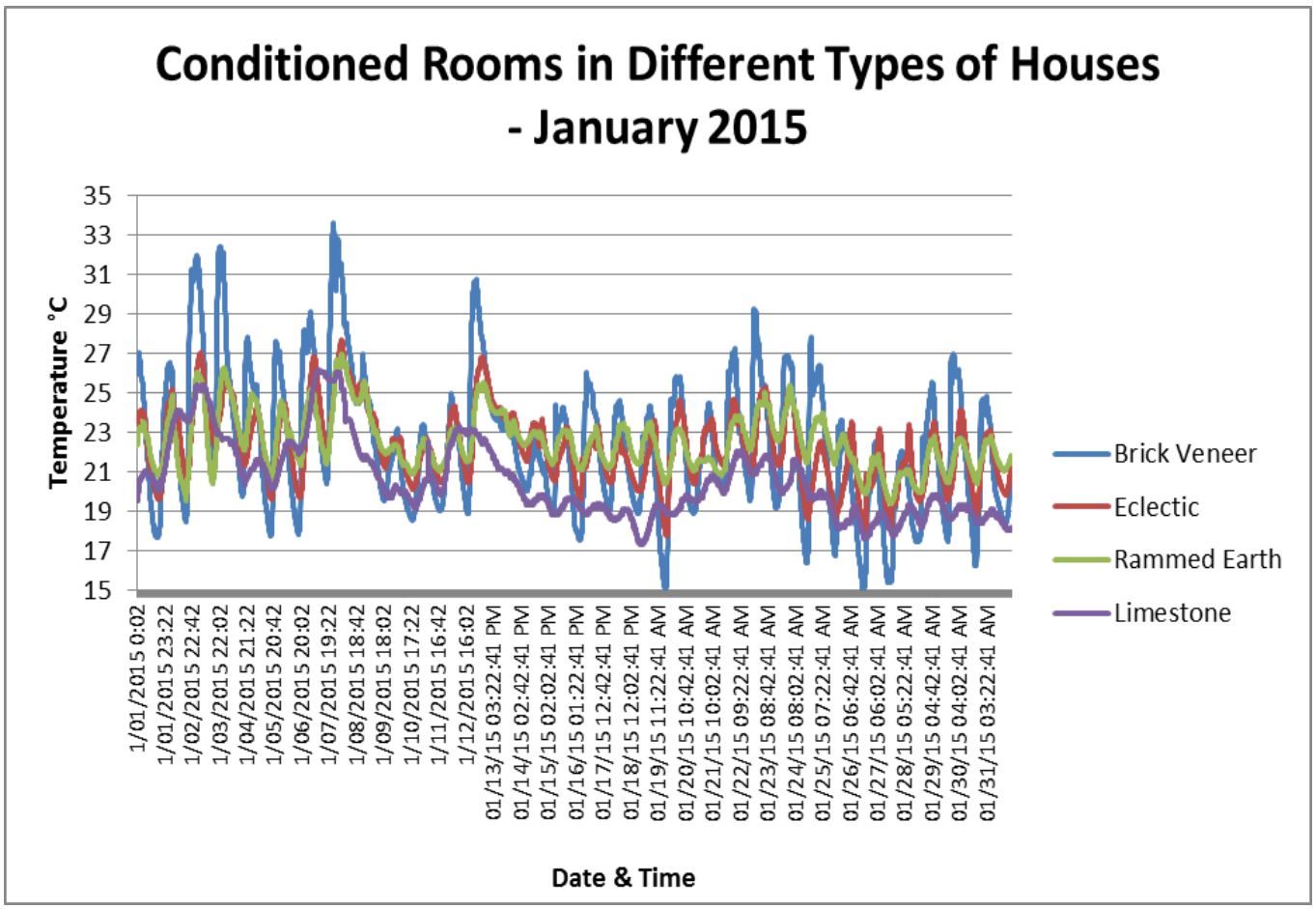
During the cooler months the Brick Veneer heated room had the greatest daily temperature change, due to the fact that this room was heated to a higher temperature than the heated rooms in the other houses. It also seemed to drop to the lowest temperature overnight.

The Rammed Earth heated room experienced the smallest daily temperature change, due to it not being heated as highly as the other houses. It also held its temperature well overnight.

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.

The Rammed Earth and Limestone had the least variance over summer, due to their high thermal mass – much higher amounts of energy are required to change their temperature.


Heated Rooms in Different Types of Houses - July 2014
Temperature °C
35
30
25
20
15
10
5
7/01/2014 0:02
7/01/2014 23:22
7/02/2014 22:42
7/03/2014 22:02
7/04/2014 21:22
7/05/2014 20:42
7/06/2014 20:02
7/07/2014 19:22
7/08/2014 18:42
7/09/2014 18:02
7/10/2014 17:22
7/11/2014 16:42
7/12/2014 16:02
07/13/14 03:22:41 PM
07/14/14 02:42:41 PM
07/15/14 02:02:41 PM
07/16/14 01:22:41 PM
07/17/14 12:42:41 PM
07/18/14 12:02:41 PM
07/19/14 11:22:41 AM
07/20/14 10:42:41 AM
07/21/14 10:02:41 AM
07/22/14 09:22:41 AM
07/23/14 08:42:41 AM
07/24/14 08:02:41 AM
07/25/14 07:22:41 AM
07/26/14 06:42:41 AM
07/27/14 06:02:41 AM
07/28/14 05:22:41 AM
07/29/14 04:42:41 AM
07/30/14 04:02:41 AM
07/31/14 03:22:41 AM
Date & Time
Brick Veneer
Eclectic
Rammed Earth
Limestone


Conditioned Rooms in Different Types of Houses - January 2015
Temperature °C
35
33
31
29
27
25
23
21
19
17
15
1/01/2015 0:02
1/01/2015 23:22
1/02/2015 22:42
1/03/2015 22:02
1/04/2015 21:22
1/05/2015 20:42
1/06/2015 20:02
1/07/2015 19:22
1/08/2015 18:42
1/09/2015 18:02
1/10/2015 17:22
1/11/2015 16:42
1/12/2015 16:02
01/13/15 03:22:41 PM
01/14/15 02:42:41 PM
01/15/15 02:02:41 PM
01/16/15 01:22:41 PM
01/17/15 12:42:41 PM
01/18/15 12:02:41 PM
01/19/15 11:22:41 AM
01/20/15 10:42:41 AM
01/21/15 10:02:41 AM
01/22/15 09:22:41 AM
01/23/15 08:42:41 AM
01/24/15 08:02:41 AM
01/25/15 07:22:41 AM
01/26/15 06:42:41 AM
01/27/15 06:02:41 AM
01/28/15 05:22:41 AM
01/29/15 04:42:41 AM
01/30/15 04:02:41 AM
01/31/15 03:22:41 AM
Date & Time
Brick Veneer
Eclectic
Rammed Earth
Limestone

c. 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).

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 Rammed Earth house keeps a very stable temperature, which would make it more pleasant for the occupants. Overall this appears to be a good design for this southern climate.

The results also clearly demonstrate the variation within houses. 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 extra 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.

High thermal mass seems to make a significant contribution to this end. If a house contained isolated thermal mass that could be relatively passively activated, this would mean an even more stable temperature for the occupants.

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 2014-2015 round.

9. Enquiries

   Enquiries about this project can me made to:

   Aaron Izzard

   Environmental Sustainability Officer

   City of Mount Gambier

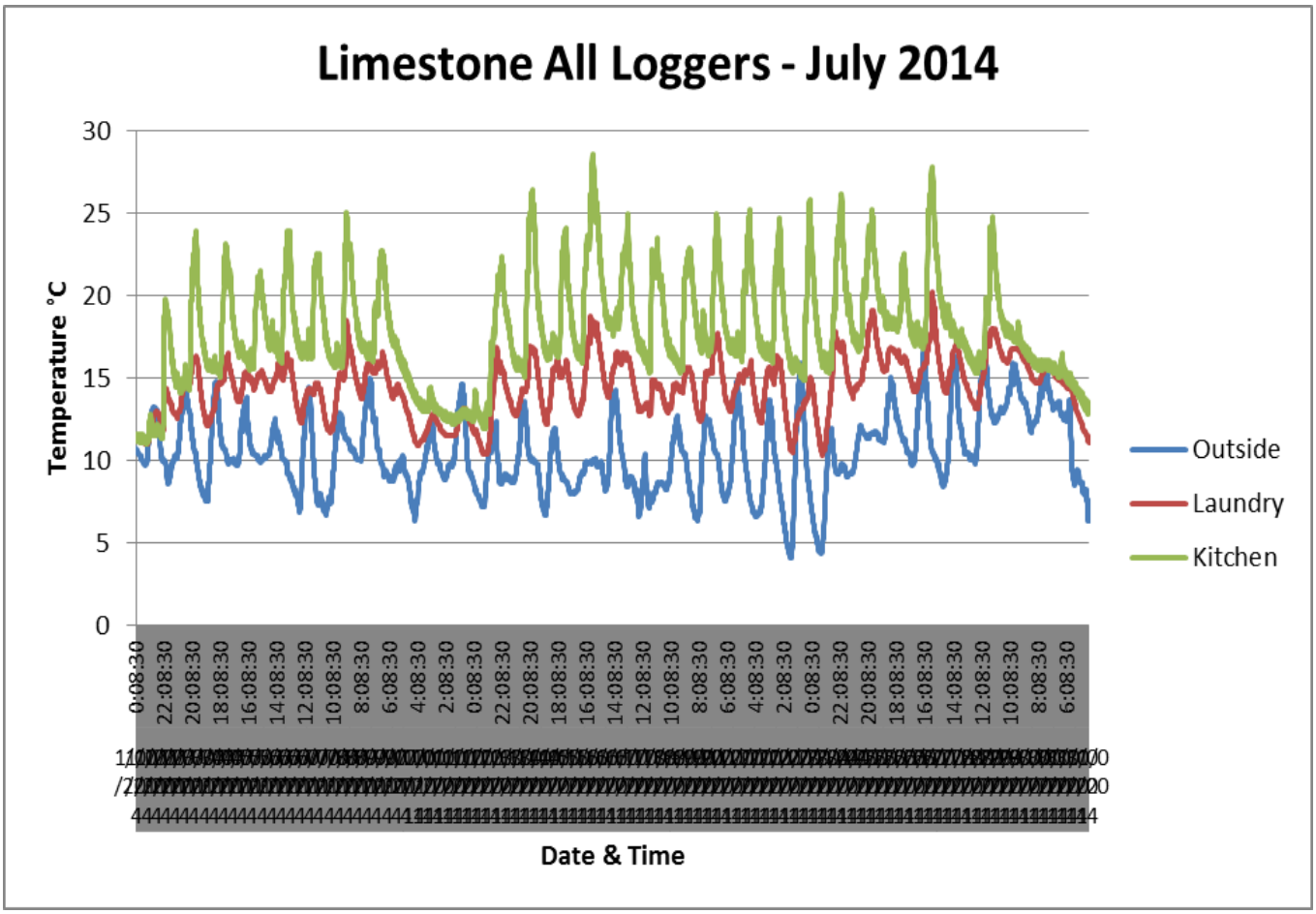
   E: aizzard@mountgambier.sa.gov.au

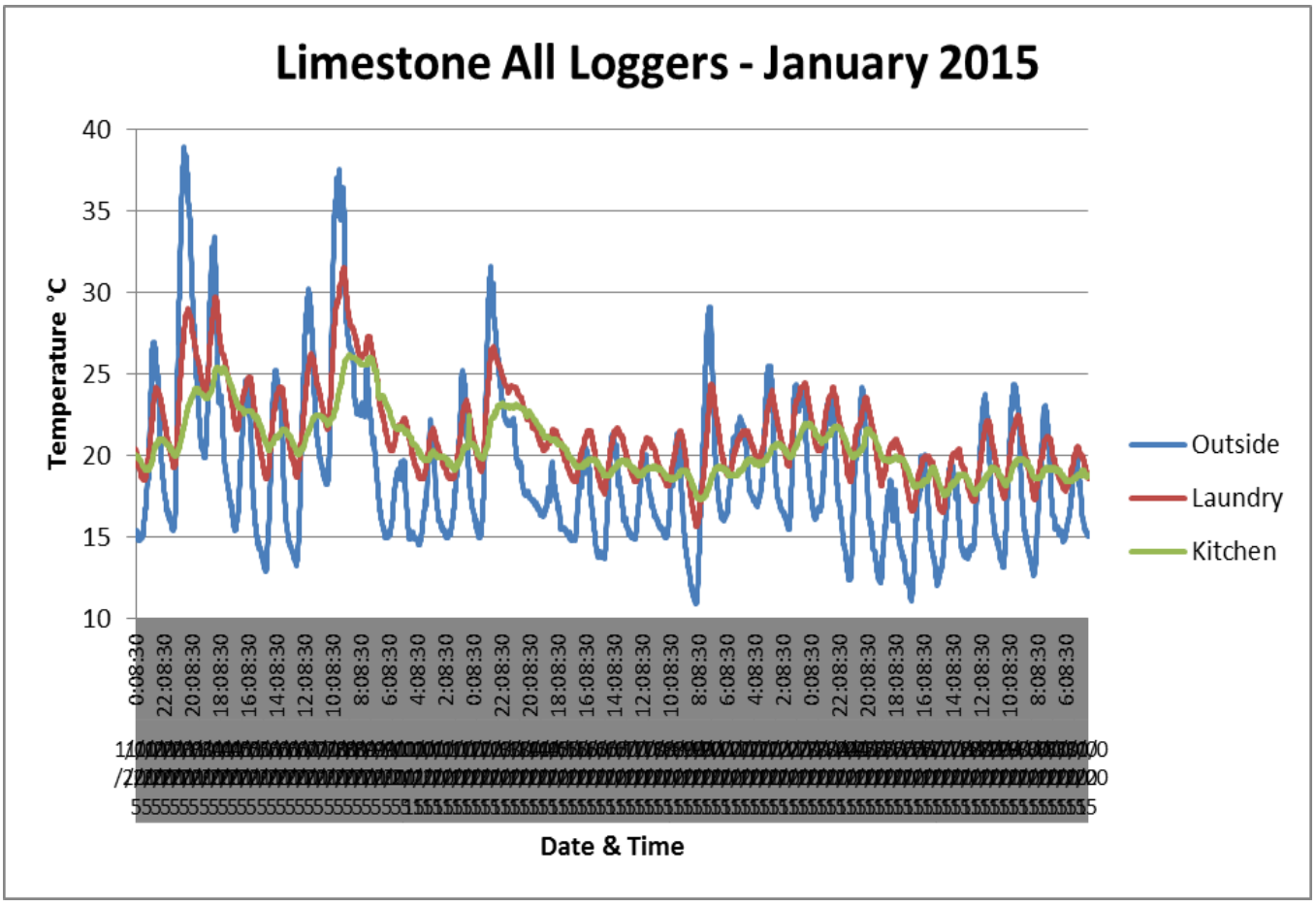
   T: 08 8721 2528

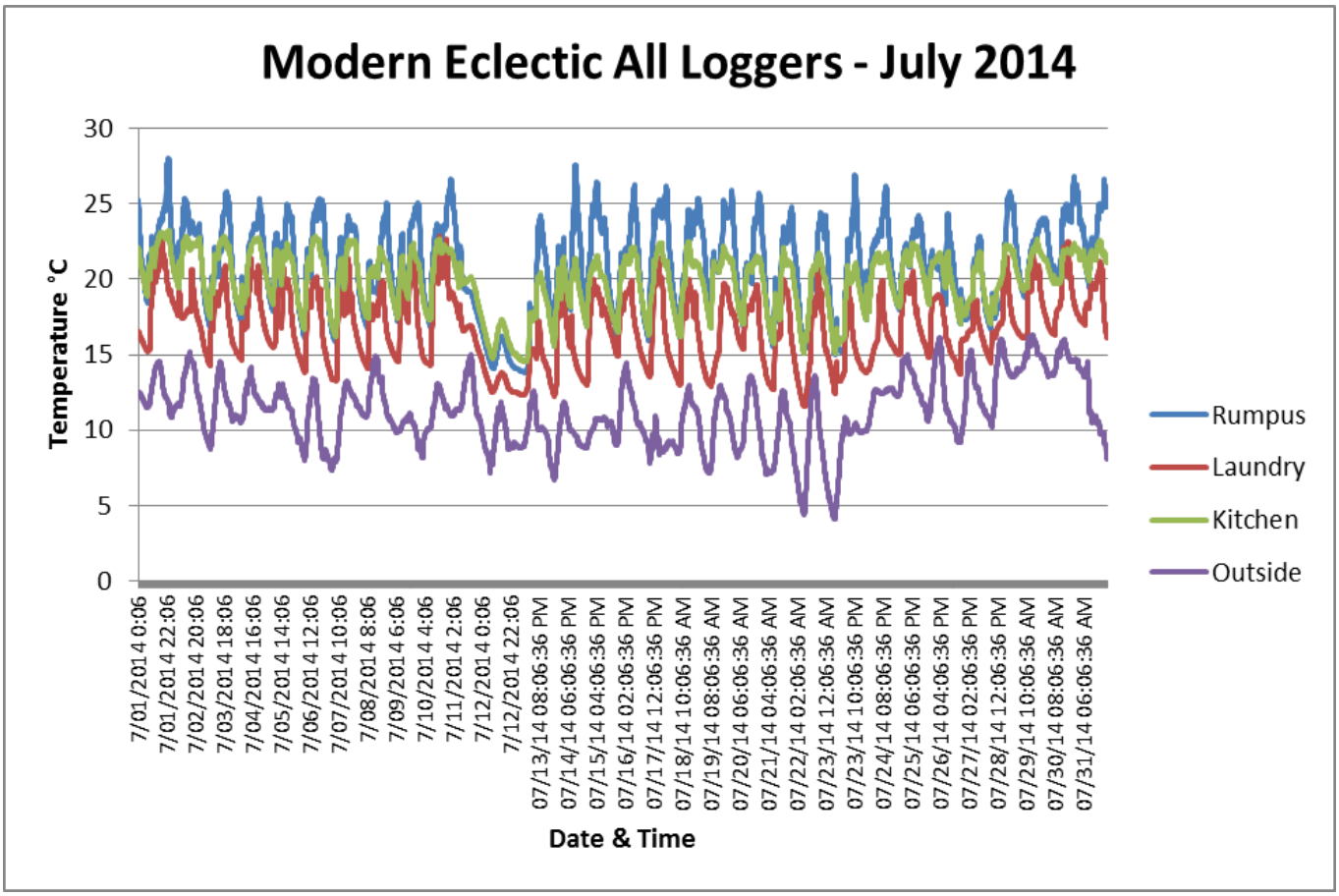
10. Further Information on Home Energy Efficiency

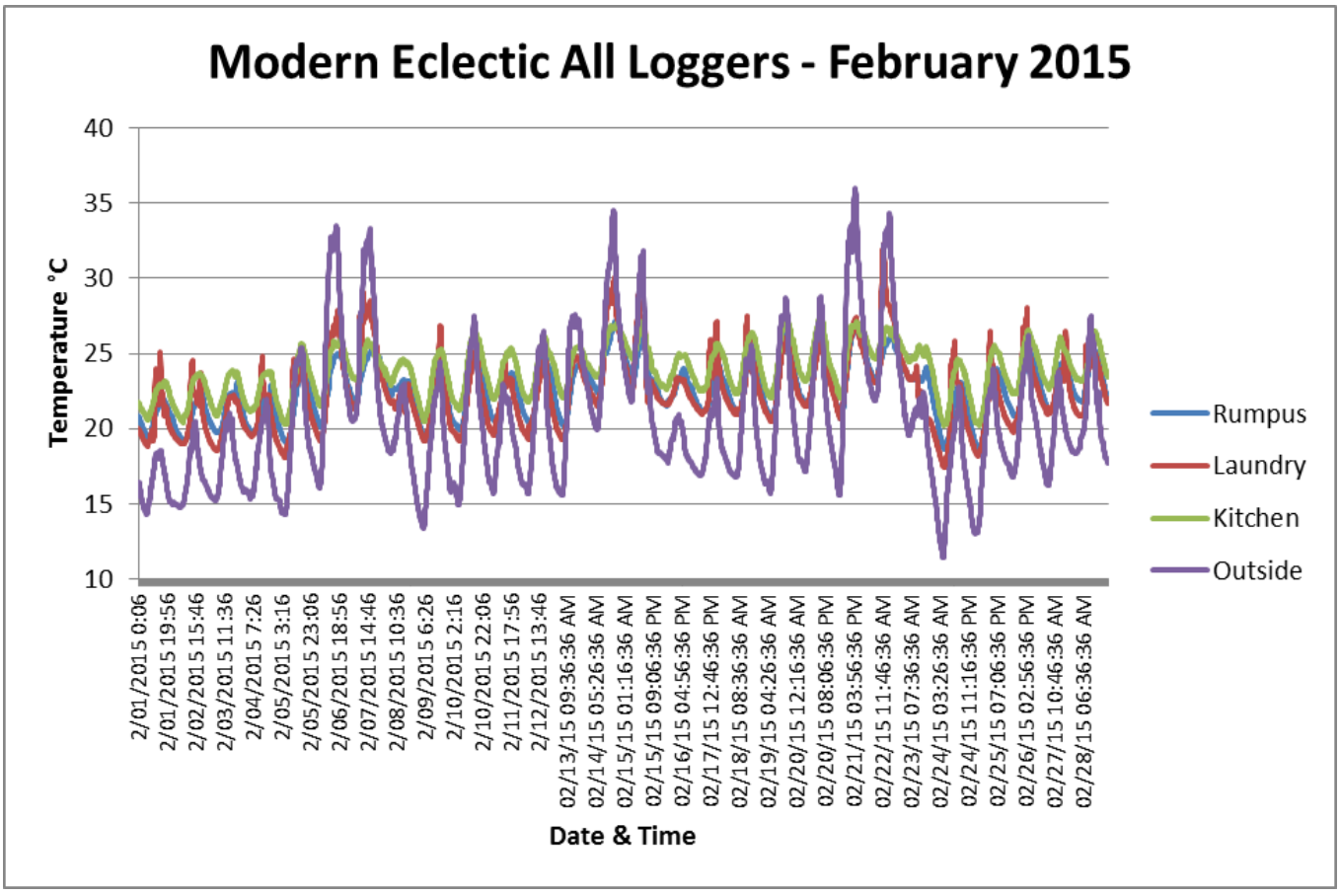
    For a more detailed discussion on the energy efficiency of a variety of existing homes see this report commissioned by Sustainability Victoria: On-Ground Assessment of the Energy Efficiency Potential of Victorian Homes

Appendix A – House Temperature Graphs






Modern Eclectic All Loggers - July 2014
Temperature °C
30
25
20
15
10
5
0
7/01/2014 0:06
7/01/2014 22:06
7/02/2014 20:06
7/03/2014 18:06
7/04/2014 16:06
7/05/2014 14:06
7/06/2014 12:06
7/07/2014 10:06
7/08/2014 8:06
7/09/2014 6:06
7/10/2014 4:06
7/11/2014 2:06
7/12/2014 0:06
7/12/2014 22:06
07/13/14 08:06:36 PM
07/14/14 06:06:36 PM
07/15/14 04:06:36 PM
07/16/14 02:06:36 PM
07/17/14 12:06:36 PM
07/18/14 10:06:36 AM
07/19/14 08:06:36 AM
07/20/14 06:06:36 AM
07/21/14 04:06:36 AM
07/22/14 02:06:36 AM
07/23/14 12:06:36 AM
07/23/14 10:06:36 PM
07/24/14 08:06:36 PM
07/25/14 06:06:36 PM
07/26/14 04:06:36 PM
07/27/14 02:06:36 PM
07/28/14 12:06:36 PM
07/29/14 10:06:36 PM
07/30/14 08:06:36 AM
07/31/14 06:06:36 AM
Date & Time
Rumpus
Laundry
Kitchen
Outside


Modern Eclectic All Loggers - February 2015
Temperature °C
40
35
30
25
20
15
10
2/01/2015 0:06
2/01/2015 19:56
2/02/2015 15:46
2/03/2015 11:36
2/04/2015 7:26
2/05/2015 3:16
2/05/2015 23:06
2/06/2015 18:56
2/07/2015 14:46
2/08/2015 10:36
2/09/2015 6:26
2/10/2015 2:16
2/10/2015 22:06
2/11/2015 17:56
2/12/2015 13:46
02/13/15 09:36:36 AM
02/14/15 05:26:36 AM
02/15/15 01:16:36 AM
02/15/15 09:06:36 PM
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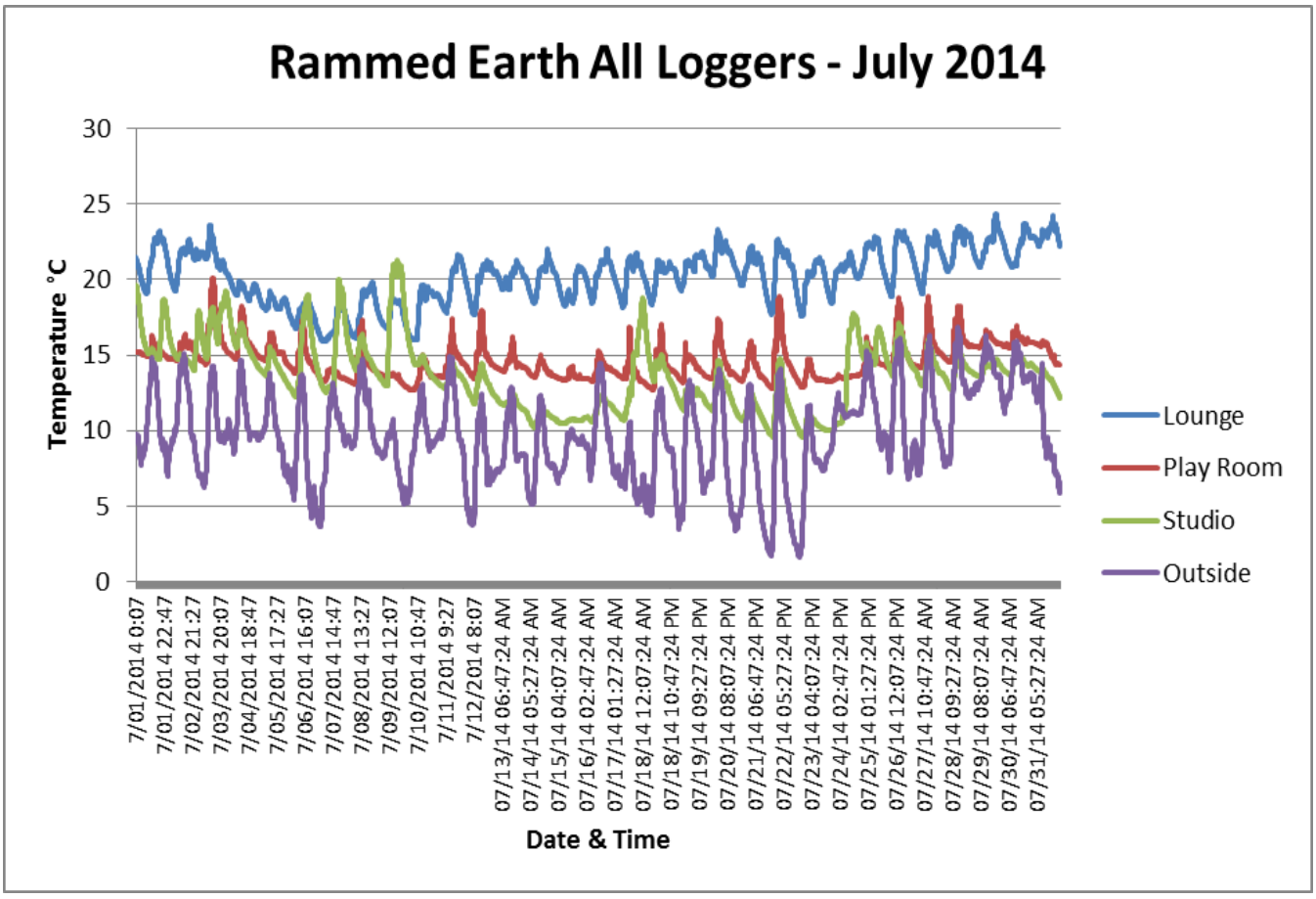
02/17/15 12:46:36 PM
02/18/15 08:36:36 AM
02/19/15 04:26:36 AM
02/20/15 12:16:36 AM
02/20/15 08:06:36 PM
02/21/15 03:56:36 PM
02/22/15 11:46:36 AM
02/23/15 07:36:36 AM
02/24/15 03:26:36 AM
02/24/15 11:16:36 PM
02/25/15 07:06:36 PM
02/26/15 02:56:36 PM
02/27/15 10:46:36 AM
02/28/15 06:36:36 AM
Date & Time
Rumpus
Laundry
Kitchen
Outside


Rammed Earth All Loggers - July 2014
Temperature °C
30
25
20
15
10
5
0
7/01/2014 0:07
7/01/2014 22:47
7/02/2014 21:27
7/03/2014 20:07
7/04/2014 18:47
7/05/2014 17:27
7/06/2014 16:07
7/07/2014 14:47
7/08/2014 13:27
7/09/2014 12:07
7/10/2014 10:47
7/11/2014 9:27
7/12/2014 8:07
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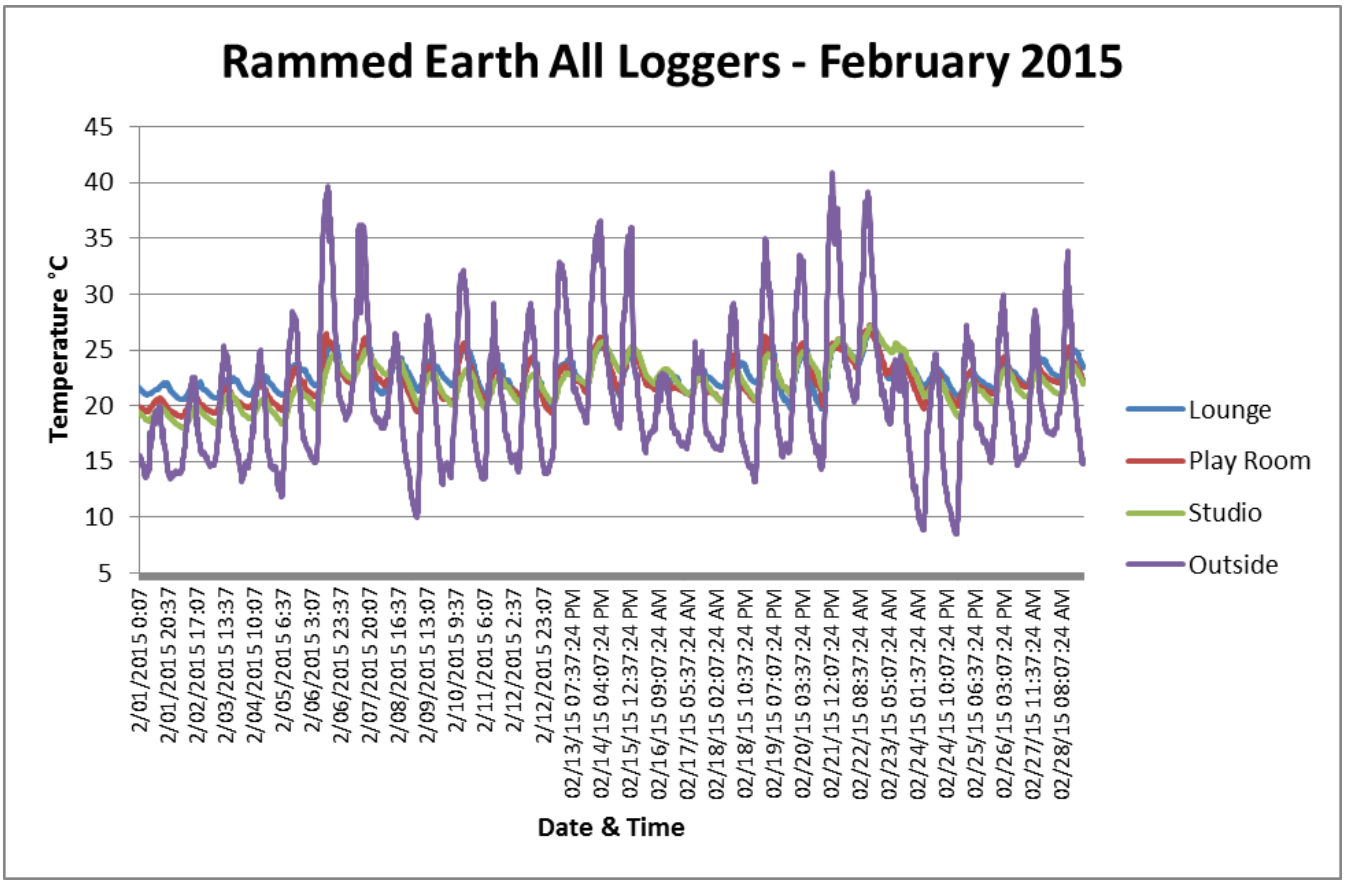
07/15/14 04:07:24 AM
07/16/14 02:47:24 AM
07/17/14 01:27:24 AM
07/18/14 12:07:24 AM
07/18/14 10:47:24 PM
07/19/14 09:27:24 PM
07/20/14 08:07:24 PM
07/21/14 06:47:24 PM
07/22/14 05:27:24 PM
07/23/14 04:07:24 PM
07/24/14 02:47:24 PM
07/25/14 01:27:24 PM
07/26/14 12:07:24 PM
07/27/14 10:47:24 AM
07/28/14 09:27:24 AM
07/29/14 08:07:24 AM
07/30/14 06:47:24 AM
07/31/14 05:27:24 AM
Date & Time
Lounge
Play Room
Studio
Outside


Rammed Earth All Loggers - February 2015
Temperature °C
45
40
35
30
25
20
15
10
5
2/01/2015 0:07
2/01/2015 20:37
2/02/2015 17:07
2/03/2015 13:37
2/04/2015 10:07
2/05/2015 6:37
2/06/2015 3:07
2/06/2015 23:37
2/07/2015 20:07
2/08/2015 16:37
2/09/2015 13:07
2/10/2015 9:37
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2/12/2015 2:37
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02/15/15 12:37:24 PM
02/16/15 09:07:24 AM
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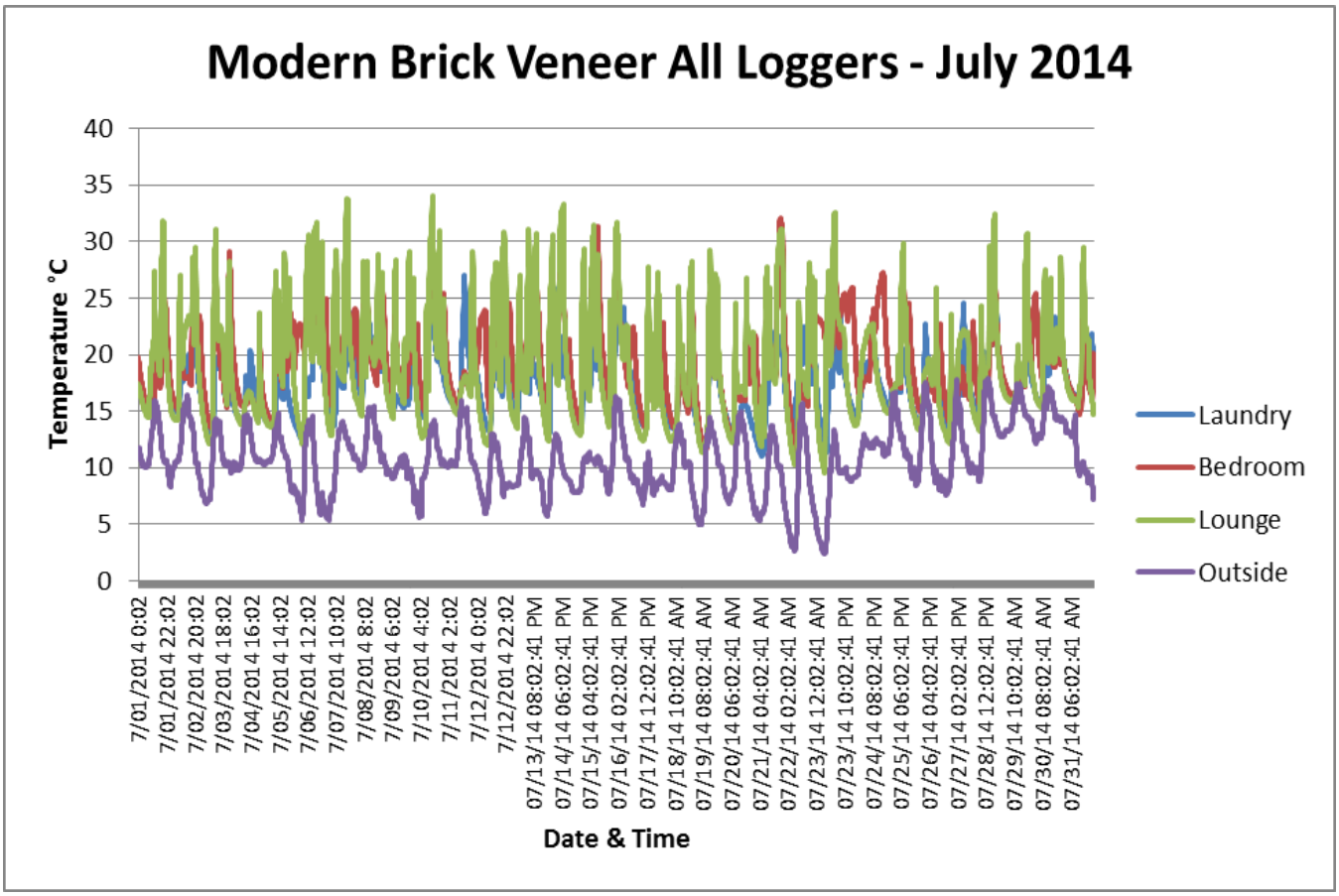
02/18/15 02:07:24 AM
02/18/15 10:37:24 PM
02/19/15 07:07:24 PM
02/20/15 03:37:24 PM
02/21/15 12:07:24 PM
02/22/15 08:37:24 AM
02/23/15 05:07:24 AM
02/24/15 01:37:24 AM
02/24/15 10:07:24 PM
02/25/15 06:37:24 PM
02/26/15 03:07:24 PM
02/27/15 11:37:24 AM
02/28/15 08:07:24 AM
Date & Time
Lounge
Play Room
Studio
Outside


Modern Brick Veneer All Loggers - July 2014
Temperature °C
40
35
30
25
20
15
10
5
0
7/01/2014 0:02
7/01/2014 22:02
7/02/2014 20:02
7/03/2014 18:02
7/04/2014 16:02
7/05/2014 14:02
7/06/2014 12:02
7/07/2014 10:02
7/08/2014 8:02
7/09/2014 6:02
7/10/2014 4:02
7/11/2014 2:02
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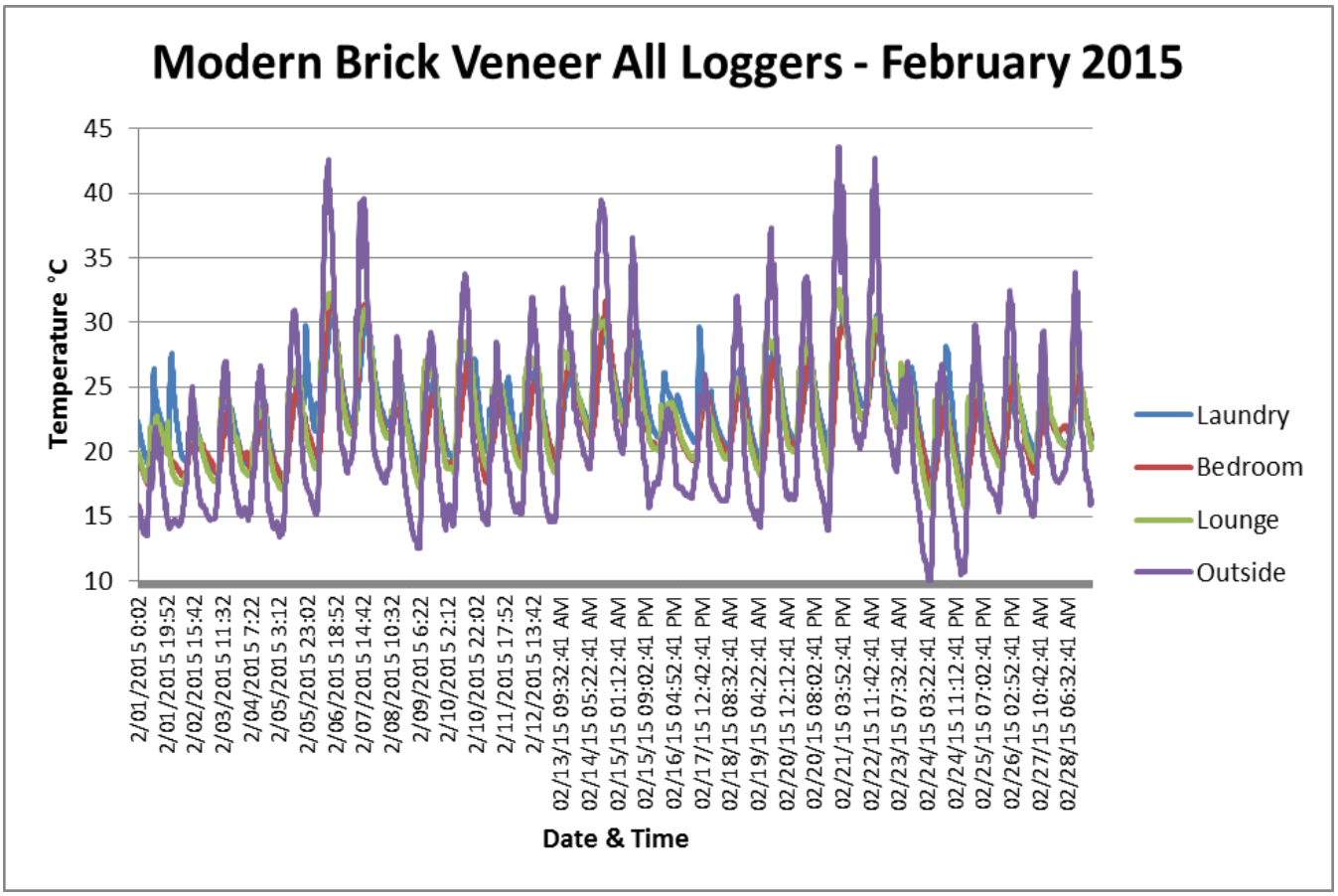
7/12/2014 22:02
07/13/14 08:02:41 PM
07/14/14 06:02:41 PM
07/15/14 04:02:41 PM
07/16/14 02:02:41 PM
07/17/14 12:02:41 PM
07/18/14 10:02:41 AM
07/19/14 08:02:41 AM
07/20/14 06:02:41 AM
07/21/14 04:02:41 AM
07/22/14 02:02:41 AM
07/23/14 12:02:41 AM
07/23/14 10:02:41 PM
07/24/14 08:02:41 PM
07/25/14 06:02:41 PM
07/26/14 04:02:41 PM
07/27/14 02:02:41 PM
07/28/14 12:02:41 PM
07/29/14 10:02:41 AM
07/30/14 08:02:41 AM
07/31/14 06:02:41 AM
Date & Time
Laundry
Bedroom
Lounge
Outside


Modern Brick Veneer All Loggers - February 2015
Temperature °C
45
40
35
30
25
20
15
10
2/01/2015 0:02
2/01/2015 19:52
2/02/2015 15:42
2/03/2015 11:32
2/04/2015 7:22
2/05/2015 3:12
2/05/2015 23:02
2/06/2015 18:52
2/07/2015 14:42
2/08/2015 10:32
2/09/2015 6:22
2/10/2015 2:12
2/10/2015 22:02
2/11/2015 17:52
2/12/2015 13:42
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02/20/15 12:12:41 AM
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02/21/15 03:52:41 PM
02/22/15 11:42:41 AM
02/23/15 07:32:41 AM
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02/24/15 11:12:41 PM
02/25/15 07:02:41 PM
02/26/15 02:52:41 PM
02/27/15 10:42:41 AM
02/28/15 06:32:41 AM
Date & Time
Laundry
Bedroom
Lounge
Outside