

ECO STOVE – PERFORMANCE EVALUATION

By

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1. Summary

The main aim of this project is to investigate the performance of the ECO Stove developed by Landy Vent in comparison with the metal stove commonly used. Of particular interest is the temperature distribution in the cottage where the stove is installed. The investigation was conducted by logging the temperature in the cottage at various positions and levels within the different volumes in the two-story cottage namely; first floor living room, kitchen, second floor living room, bathroom and bedroom. The temperatures were logged every 10 minutes over a period of three days. First the ECO stove was tested and then the metal stove. The results indicated that the Eco stove produced uniform temperature throughout the cottage with the difference in the middle level temperature of the various volumes being within 2⁰C. For the metal stove, the difference in the middle level temperatures of the various volumes was within 5⁰C.

2. Temperature Measurements:

In the first floor living room, seven thermocouples were installed at two planes at varying distance from the ECO Stove. At each plane, the temperature was measured at a level close to the roof and another level close to the middle of the plane. In the kitchen, four thermocouples were installed at a plane at the centre of the kitchen with two installed at the top level and two installed at the middle level. On the second floor, a total of thirteen thermocouples were installed; namely four in the bed room, eight in the living room and one in the bathroom. One thermocouple was installed outside the house to measure the ambient temperature. Appendix 1 shows the temperature variation of the various volumes in the cottage using the ECO stove and appendix 2 is for temperature variation of the various volumes using the metal stove. Table 1 shows the rate of feeding the metal stove with woods.

3. ECO Stove:

Figures 1-3 present the variation of the average temperatures of the various volumes in the cottage with time. Figure 1 compares the average middle level temperature of the various volumes namely; the first floor living room, kitchen, second floor living room, bed room and bathroom. It can be seen that the average middle level temperatures of the various volumes are in close agreement with maximum difference of 2⁰C. Figure 2 compares the average top level temperatures of the various volumes and figure 3 compares the overall average of the various volumes. While the difference between the average top level temperatures can be as high as 10⁰C at the point of maximum when the fire is at its highest rate, the difference between the overall average temperatures of the various volumes is about 5⁰C at the same point of maximum fire rate.

Table 1: Rate of feeding the metal stove with wood.

<i>Time & Date</i>	<i>Metal stove wood mass kg</i>
<i>20.1.2011</i>	
<i>12:00 PM</i>	<i>7</i>
<i>03:15 PM</i>	<i>3.5</i>
<i>04:30 PM</i>	<i>3</i>
<i>08:00 PM</i>	<i>4</i>
<i>09:30 PM</i>	<i>2</i>
<i>21.1.2011</i>	
<i>07:30 AM</i>	<i>2</i>
<i>08:00 AM</i>	<i>2</i>
<i>09:30 AM</i>	<i>3</i>
<i>11:30 AM</i>	<i>2</i>
<i>12:30 PM</i>	<i>2</i>
<i>02:30 PM</i>	<i>4</i>
<i>04:00 PM</i>	<i>3</i>
<i>06:00 PM</i>	<i>2</i>
<i>07:00 PM</i>	<i>1</i>
<i>22.1.2011</i>	
<i>8:15 AM</i>	<i>3.5</i>
<i>11:30AM</i>	<i>3.5</i>
<i>01:00 PM</i>	<i>4</i>
<i>03:45 PM</i>	<i>2</i>
<i>04:45 PM</i>	<i>3</i>
<i>07:45 PM</i>	<i>4</i>
<i>23.1.2011</i>	
<i>06:00 AM</i>	<i>2</i>
<i>07:00 AM</i>	<i>2</i>

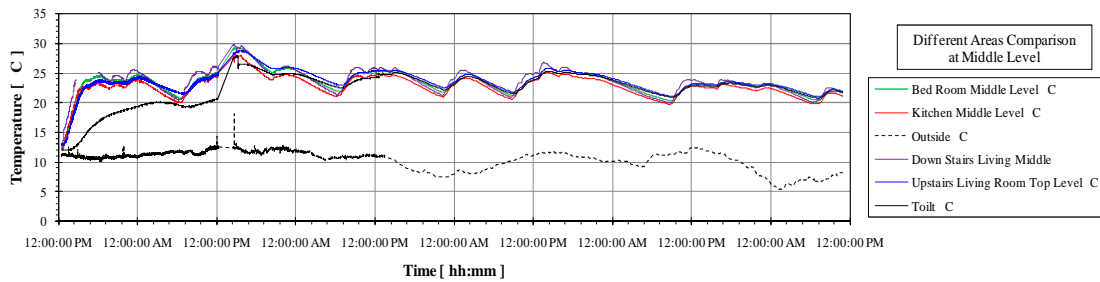


Fig. 1 Comparison of the average middle level temperature in the various volumes (ECO Stove)

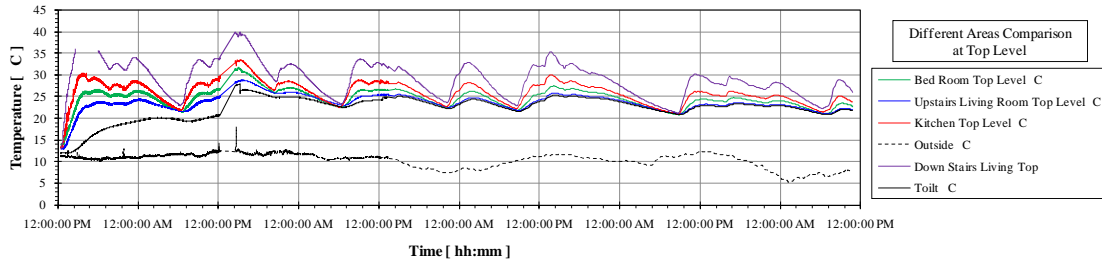


Figure 2 Comparison of the average top level temperature in the various volumes (ECO stove)

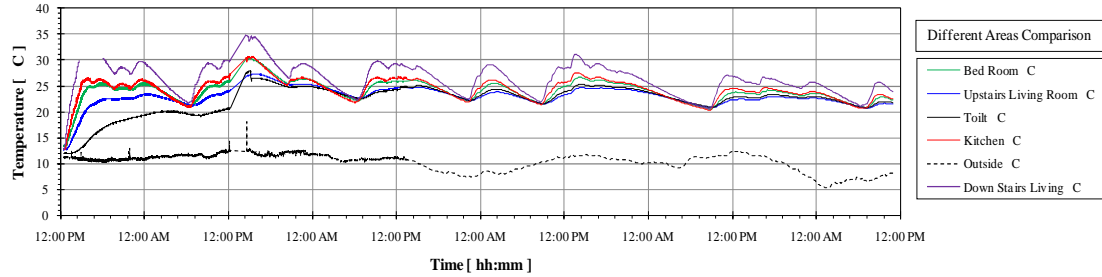


Figure 3 Comparison of the average temperature in the various volumes (ECO Stove)

4. Metal Stove

Figures 4-6 compares the average temperatures of the various volumes for the middle level, top level and overall average for the metal stove. Figure 4 shows that the difference between the average middle level temperatures of the various volumes ranges from 3^oC to 6^oC with the highest temperature being in the kitchen and lowest one being in the first floor living room. Figure 5 shows the difference between the average top level temperatures of the various volumes ranges from 3^oC to 15^oC. Figure 6 indicates that the difference between the overall average temperatures of the various volumes ranges from 3^oC to 8^oC at the points of maximum fire rate. These differences shown in figures 4-6 are significantly higher than those shown in figures 1-3.

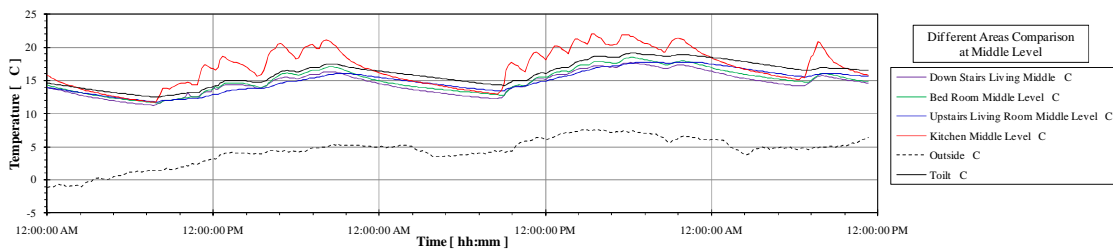


Figure 4 Comparison of the average temperatures at middle level in the various volumes (Metal Stove)

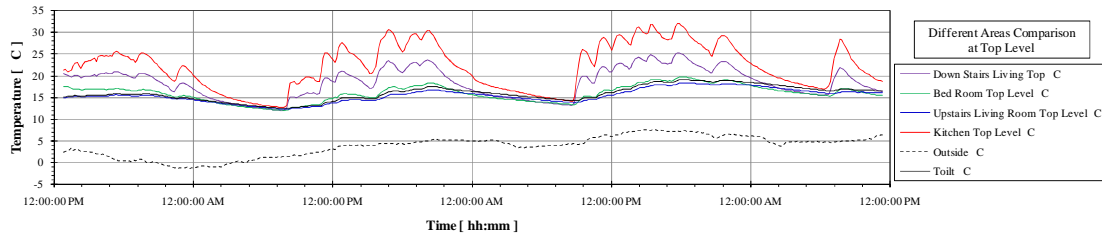


Figure 5 Comparison of the average temperatures at top level in the various volumes (Metal Stove)

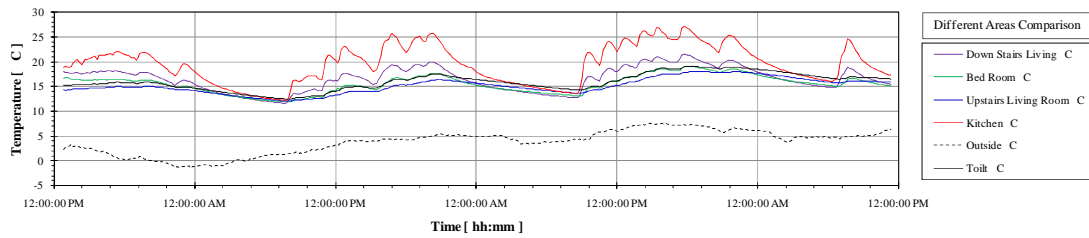


Figure 6 Comparison of the overall average temperatures of the various volumes (Metal Stove)

Figure 7 compares the average temperature over 24 hrs with distance from any of the stoves. Here the temperature difference relative to the ambient temperature was presented to take into account the variation in the ambient temperature when using any of the two stoves. For the metal stove, the average middle level temperature difference decreases sharply with distance from the stove with overall reduction of 3°C . For the ECO stove, the average middle level temperature difference decreases slightly with distance from the stove with overall reduction of less than 0.5°C . For the top level average temperature difference, the metal stove and the ECO stove gave a comparable overall reduction of 3.7°C and 2.8°C respectively. The reduction in the overall average of the temperature difference with distance is 2.8°C for the metal stove and 1.2°C for the Eco stove. The larger reduction in the temperature difference with distance from the metal stove indicates that the effect of the metal stove decreases with distance. This could be due to the lower thermal capacity of the metal stove. The larger thermal mass of the Eco stove allows heat to be released at a rate adequate to maintaining the temperature in the various volumes uniform.

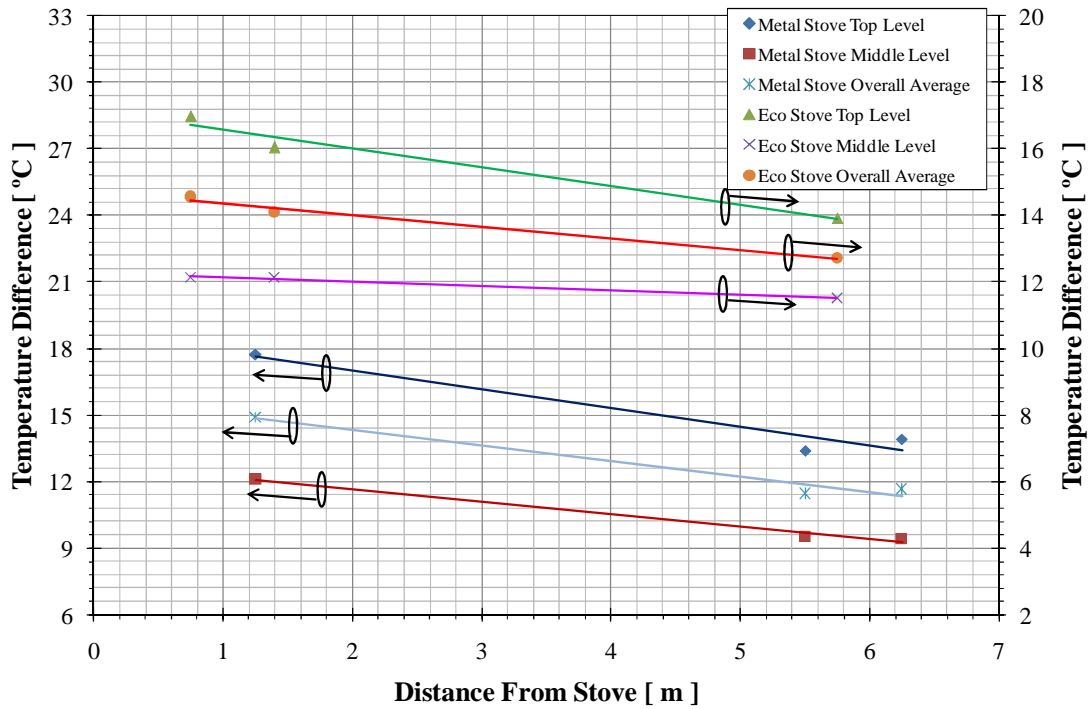


Figure 7 Temperature difference versus distance from stove or fireplace (averaged over 24 hrs)

Conclusions:

From the extensive data collected we can conclude the following:

- 1- For the Eco stove, the average middle level temperatures of the various volumes of the cottage are close to each other (within 2°C).
- 2- At levels close to the ceiling, the temperatures of the of the first floor living room are higher than the rest of the cottage by 5°C. This is mainly due to the radiation effect of the Eco stove and to the lower height of the ceiling.
- 3- Mid plane temperatures are the sensed temperatures by people using the cottage therefore, it can be concluded that the Eco stove provide a uniform temperature across the cottage.
- 4- As for the metal stove, it is clear that its thermal effects are limited due to its limited thermal capacity (mass x specific heat constant).

Appendix 1 Eco Stove Performance

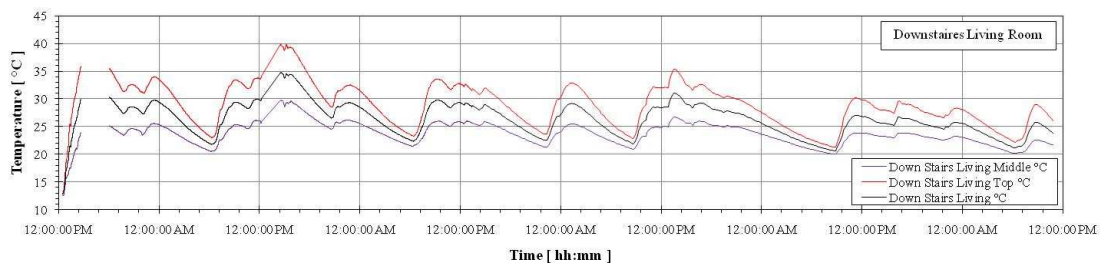


Figure 1.1 First floor living room

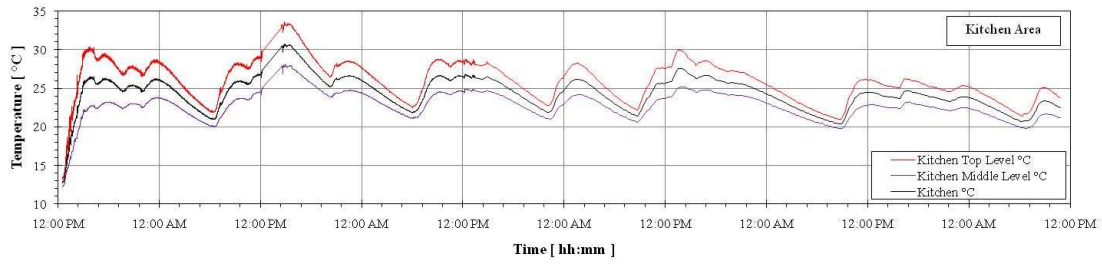


Figure 1.2 Kitchen

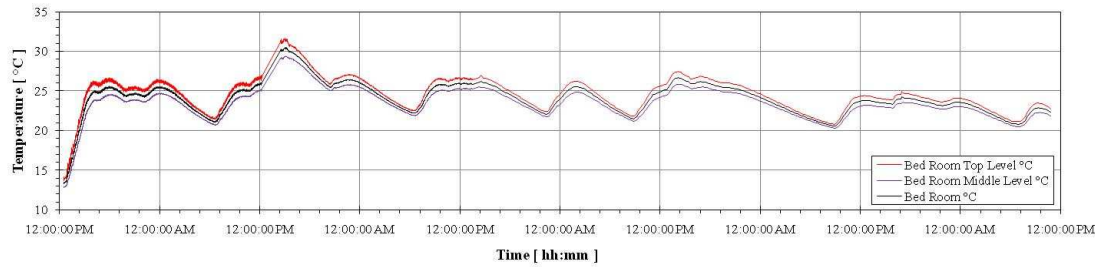


Figure 1.3 Bed Room

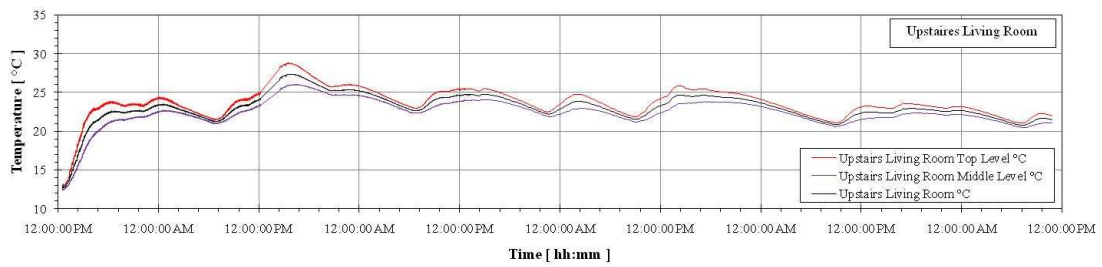


Figure 1.4 Second floor living room

Appendix 2 Metal Stove

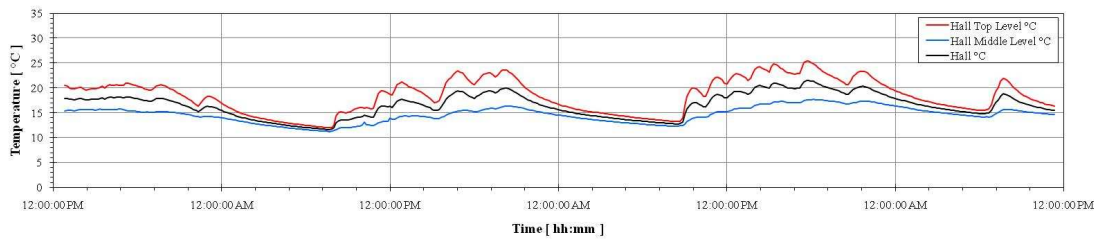


Figure 2.1 First floor living room

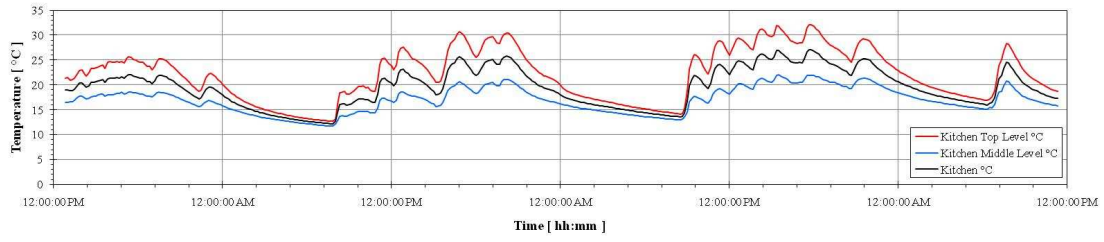


Figure 2.2 Kitchen

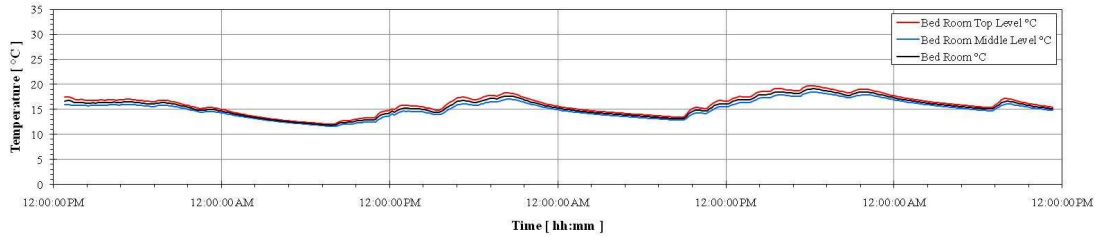


Figure 2.3 Bed Room

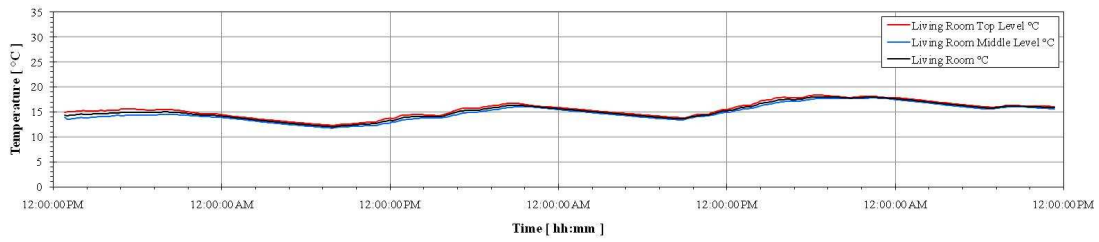


Figure 2.4 Second floor living room