# Enabling Technologies & Innovation Competences Challenge Project (ETICC)

Project Number: 01R18P02312

## Characterisation of Infrared Heating Source

**Solutions by Jigsaw Limited**

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**ETICC Road Map and Summary**

In this report, we provide technical details and information about the

1. Characterisation of the IR panels in 8 $m^2$ open and closed room.
2. Characterisation of 1700-2000W convection heating system (System A).
3. Characterisation of the storage heating system (System B).
4. Calculate the electrical power consumption, efficiency and the cost per hour for all three heating systems.

## 1. Characterisation of the IR panels in an open and closed room.

**IR heating system electrical cable and thermostat connections.**

The first step is connecting the Genius room thermostat with both the electrical switch and Infrared radiator (panel). The Blue colour wire has been connected to both N mark letters in the thermostat and electrical switch devices. The same for the Brown wire which has been connected to both L mark letters, while the earth wire (yellow and green) connects both devices together via the earth mark. Then the panel wires have been connected to the thermostat (Brown wire to L heating mark and Blue wire to both N heating mark).

After that, Genius Hub is connected to the internet via internet cable to control the system operation. The controlling between the Genius Hub and the electrical switch has been done via a wireless connection and this step was followed step by step based on the instructions in the manual. The schematic diagram of the connection is illustrated in Fig. 1.

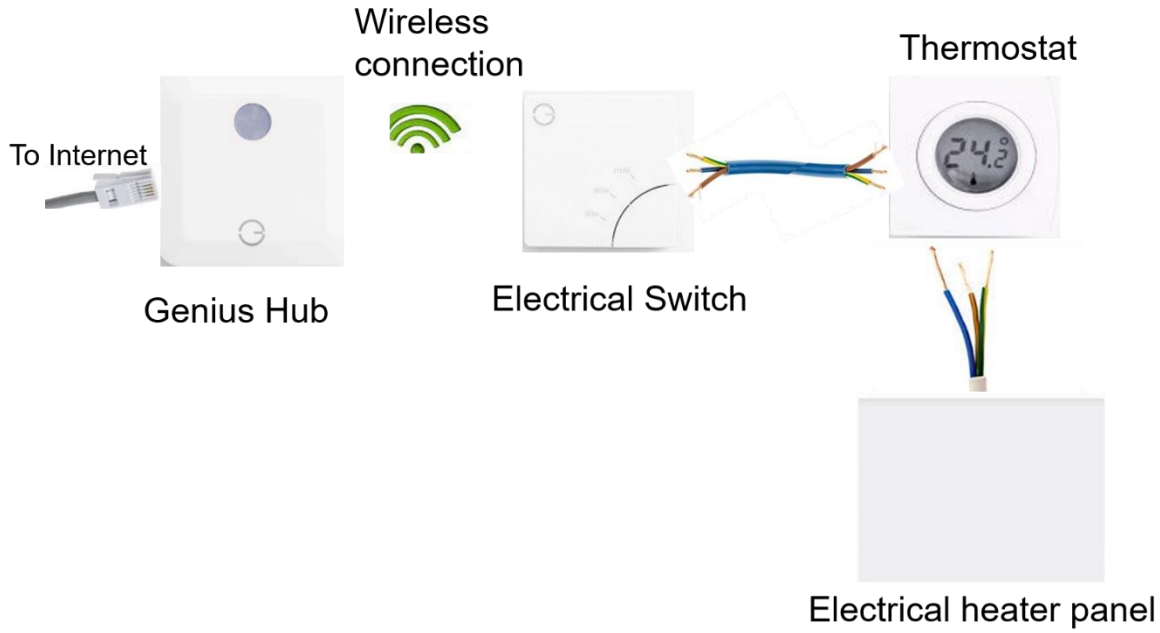


Fig. 1: The schematic diagram of the heating system connection.

**The Experimental Results**

The first step here is to log in to the system through https://www.geniushub.co.uk and activated all three zones and then turned on the system from the laptop. After that, the process of collecting data has been started directly by measuring the temperature on the top surface of the panel using a wireless laser thermometer and also measuring the room temperature using the system thermostat. Fig. 2 shows the measured temperature on the middle area of the panel for 20 min. The data has been collected at 10-second intervals for the first two minutes and then at one-minute intervals. The temperature has been increased dramatically from 20 C to 80 C within the first 8 minutes as shown in Fig. 1(a). The slope efficiency in Fig. 1(b) shows that the temperature is increased at a rate of 8C/min. Then the temperature increased slowly from 80 C to 90 C at the second 8 minutes (from 8-16) with a rate of 1.25 C/min. After that, the panel temperature dropped down because the thermostat has been switched off automatically. The temperature has also been measured at the 4 corners of the panel and it was found to be 10 C less than the temperature measured at the centre of the panel.

The room temperature has also been measured simultaneously as shown in Fig. 3 (a). The room temperature started at 18.5 C and has unchanged for the first two minutes. After that, it increased from 18.5C to around 23.5 C within 14 min with a slope efficiency of 0.4 C/min (Fig 3(b)). When the room temperature reached 23.5 C, the thermostat has switched off automatically and the room temperature decreased to 22C and within 1 min, the thermostat switched on automatically and the temperature increased to 22.5 C and again switched off and so on as shown in Fig. 3 (a).

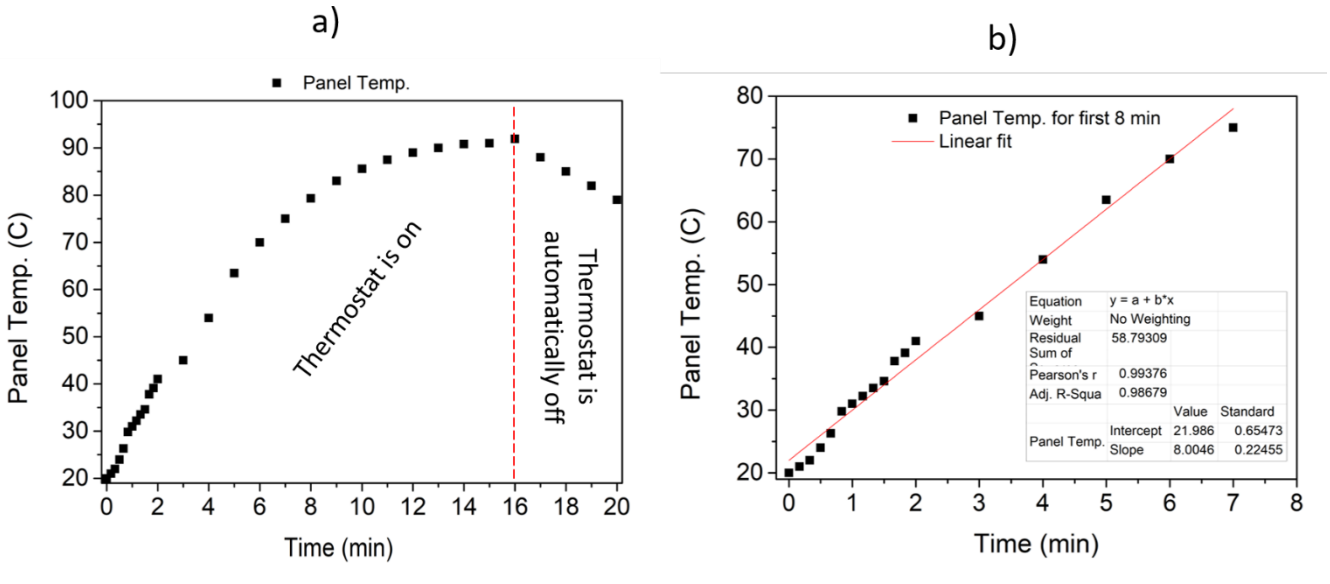


Fig. 2: (a)The measured temperature on the middle area of the panel; (b) the slope efficiency calculations for the first 8 min.

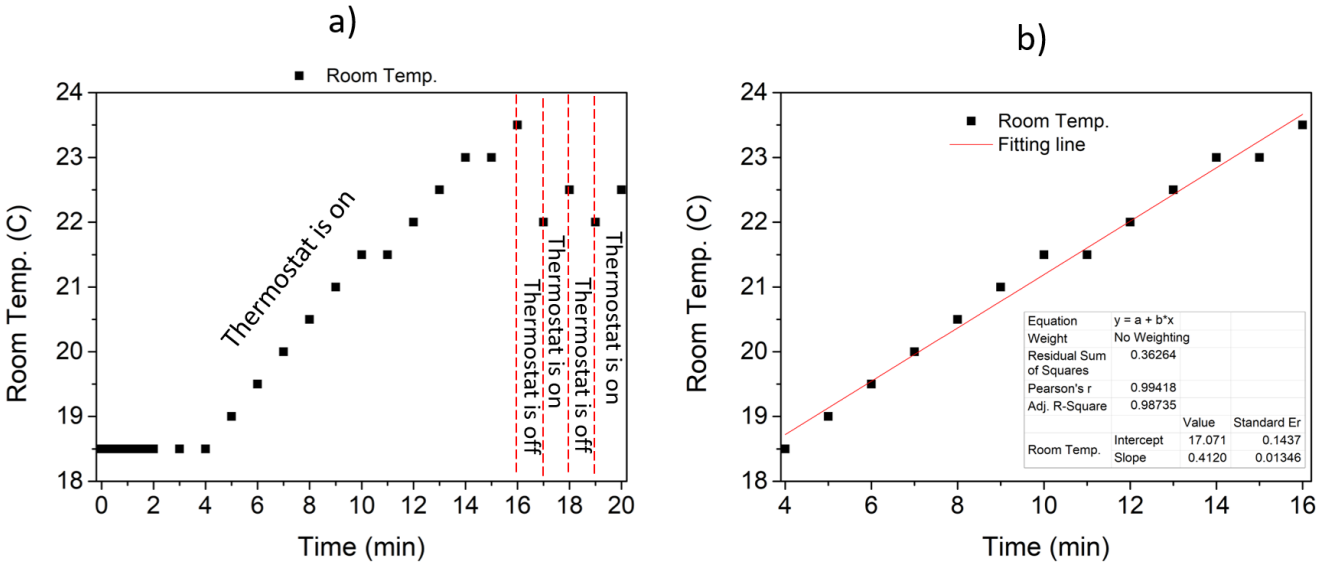


Fig. 3: (a)The room temperature measured and (b) the slope efficiency calculations for the time between 4-16 min.

The panel temperature decay has also been measured when the Genius hub is switched off (thermostat is also off). The temperature decayed exponentially from 88 C to 30 C for 15 min and then dropped down from 30C to 25 C during another 15 min as shown in Fig. 3.

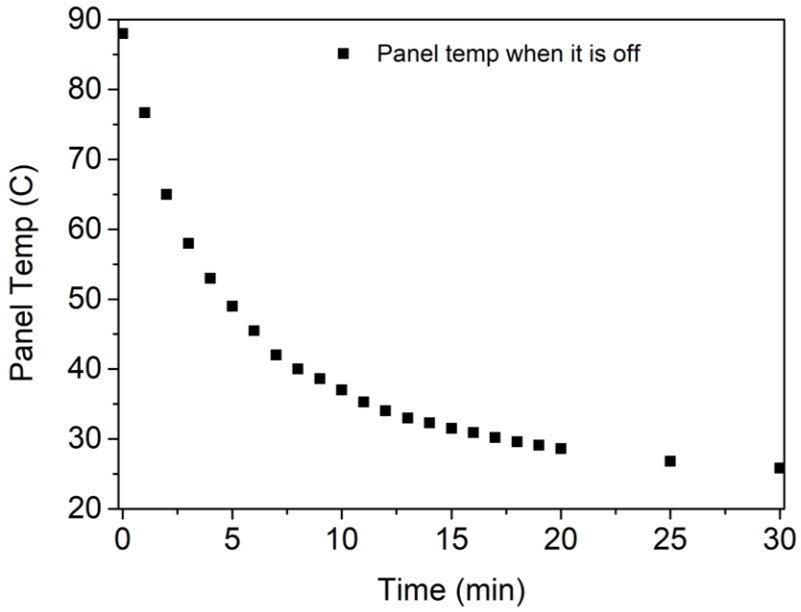


Fig. 3: The panel temperature decay when the Genius hup is switched off.

The next step was examining the IR heating panel system and room temperature at opened and closed room to see the degree of heat loss. The thermal insulation information (from the Aston University estate) of the examination room has been provided to Jigsaw IR Ltd. From Panel results. I can see there is no difference in the panel temperature when we open the lab door as the panel temperature is about 90 C for both cases and the results are exactly similar to the results in Fig. 1. While the room temperature drops down to 0.5C in the case of an open lab door compared to a closed-door (Fig. 4) which means the heating loss of almost 0.5 C. The IR heating system efficiency is 0.5 C/min 9 (temperature rise during time) which is calculated from the slop of the figure. So, the room heated up from about 14 to 21 within 14 min and when the temperature increased to 22.5 (lab closed), the thermostat is off automatically, and a message says the setup is override even when zones set it up to 28 C. (PRT currently has no valid temp. and unable to fetch the weather data and also ESW off similar to PRT). While in the case of opened room, the override is shifted to 24 C because the heat flow to the outside.

The power consumption is 0.8kWh (IR power is 800W x time (1 h)) to heat the room from 14 to 21 and then it will consume 0.2KWh. This will cost 13 pence/h and 3.25 pence/h respectively. This calculation is based on the assumption of an electrical cost of 16.3 pence/KWh (0.8 x16.3=13 pence).

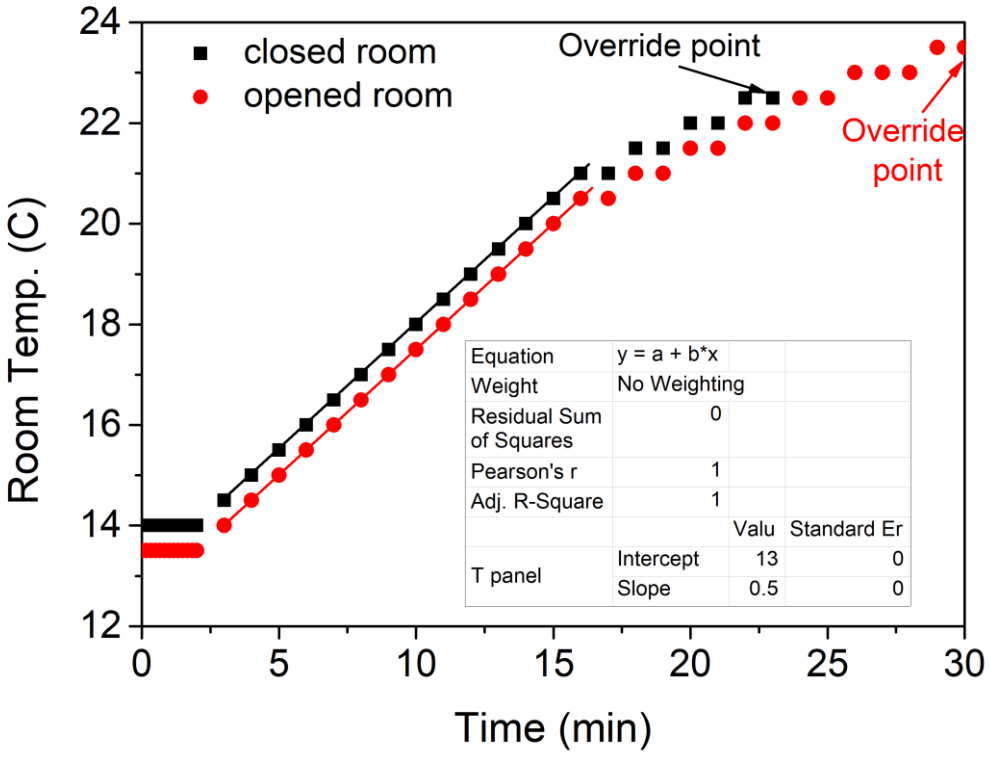


Fig. 4: The measured room temperature in 8 $m^2$ room in open and closed door.

## 2. Characterisation of the 1700-2000W convection heating system (System A).

In this experiment, we used the same electrical cabling and thermostat connections (the Genius hub) between the main power switch and the convection heating system, which means we used the same thermostat and other equipment in the room and heating system measurement in all of three provided systems.

Similar to the previous data collection, we first activated all three zones and record the surface heating system (using wireless laser thermometer) and room temperature (using Genius thermostat). The results in Fig. 5 show the measured temperature on the bottom area of the radiator for 20 min which increased from 15 C to 70 C. The data has been collected at 10-second intervals for the first two minutes and then at one-minute intervals. The temperature has been increased dramatically from 15C to 65C within the first 6 minutes with a slope efficiency of 21 C/min. Then the temperature increased only 5C during the rest of the operation time with a slope efficiency of less than 0.5 C/min.

The temperature has also been measured at centre and top corners of the radiator and it was found to be more than 10 C less than the temperature measured at the bottom of the panel.

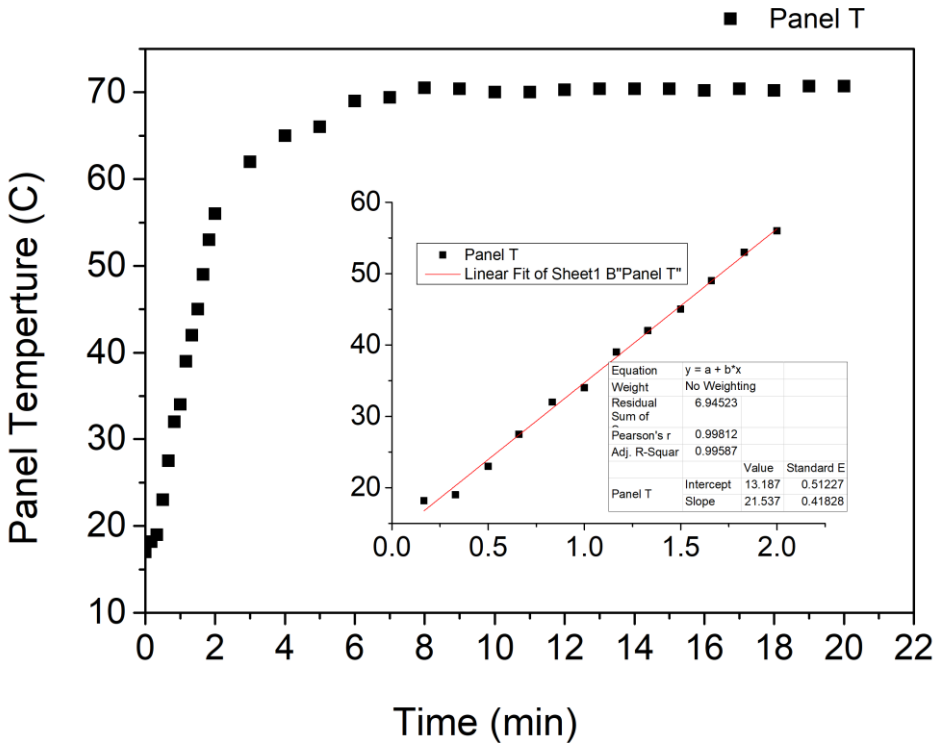


Fig. 5: 1700-2000W surface temperature.

The room temperature has also been measured simultaneously as shown in Fig. 6. The room temperature started at 15.5 C and has unchanged for the first minute. After that, it increased from 15.5C to around 16C within 2 min and from 16 C to 18.5 C with a slope efficiency of 0.25 C/min (temperature increased 0.5C in 2min) and has not changed after that. This means this heating system

can make a temperature difference with 3 C only. The power consumption is 2 kWh to heat the room from 15.5 to 18.5 C and this will cost 32.6 pence/h which is 2.5 times higher than the cost of the Jigsaw IR heating system. Furthermore, the Jigsaw IR heating system made more than 8 C variation in the room temperature and the efficiency is 2 times higher.

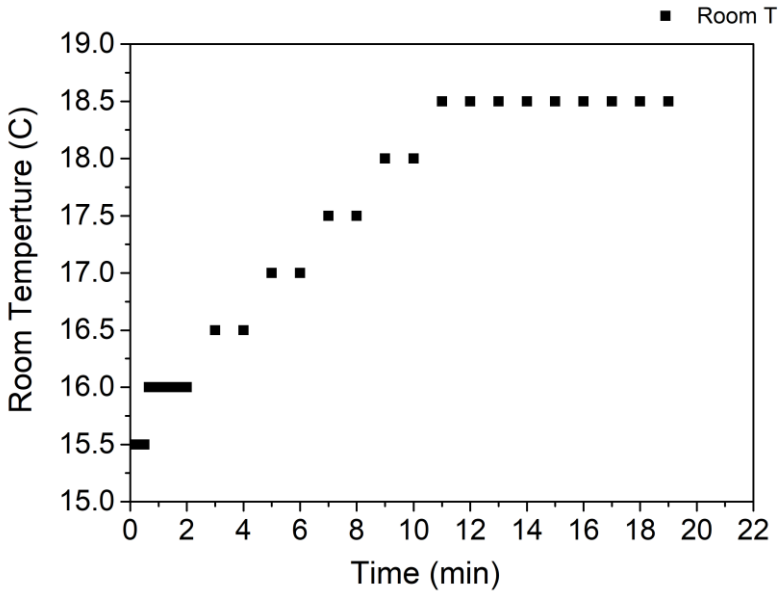


Fig. 6: The measured room temperature using a 1700-2000W heating system.

The heating system temperature decay has also been measured when the Genius hub is switched off. The temperature decayed exponentially from 72 C to 2 0C for 15 min as shown in Fig. 7. While the room temperature decreased from 18.5 C to 16 C in 11 min (Figure 8).

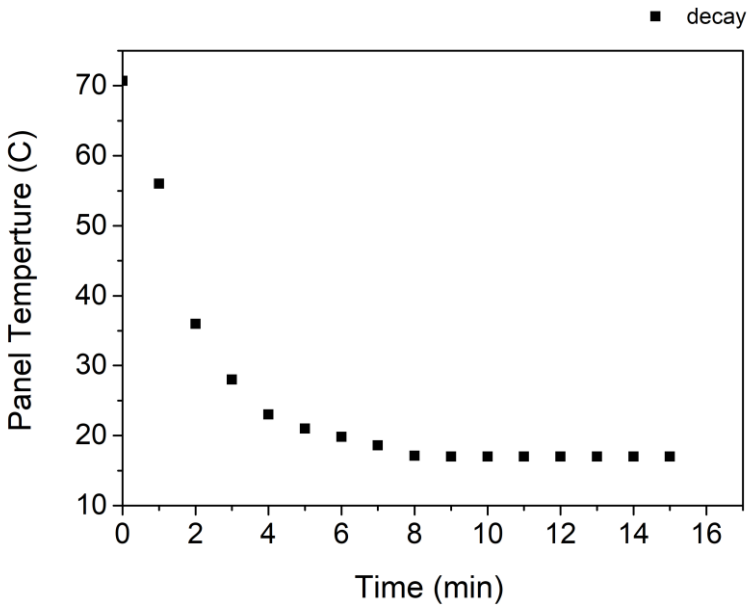


Fig. 7: Heater temperature decay when the 1700-2000W heating system switched off.

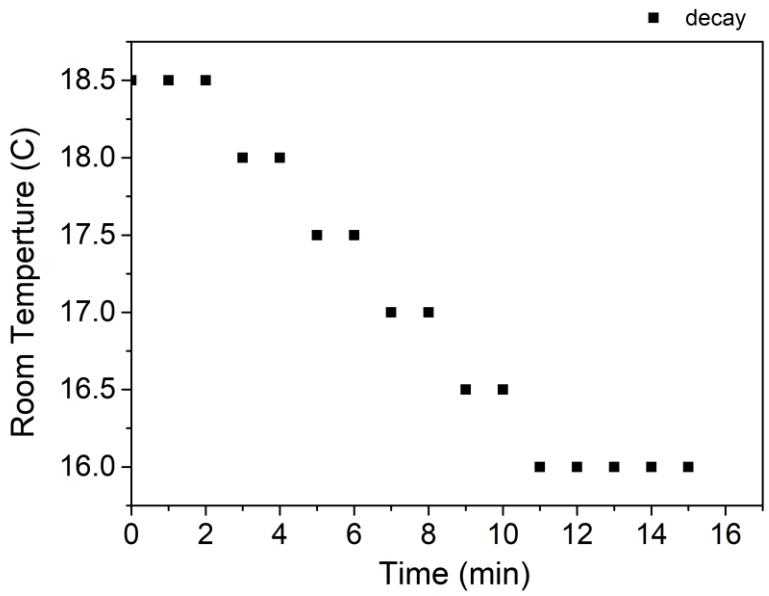


Fig. 8: Room temperature decay when the 1700-2000W heating system switched off.

### 3. Characterisation of the storage heating system 87kgm (System B).

After, connecting the electrical cables and inserted the bricks into the heating system, we also used a Genius hub in the measurement of the surface and room temperature for characterisation of this quite heavy heating system.

The results in Fig. 9 show the measured temperature on the bottom area of the radiator for 22 min which increased from 15 C to 45 C in the first 2 mins with a slop efficiency of 11 C/min. Then the temperature increased only 15 C during the rest of the operation time with a slope efficiency of about 0.6 C/min. Whereas the room temperature has increased from 15. 5 C to 18.5 C over 20 minutes (Fig. 10) with a slop efficiency of 0.25 C/min for the first 12 minutes and less than 0.1 C/min for the rest of the time. The temperature heater and room decay (Figs 11 and 12 respectively) shows the temperature has decreased from 64 C to 25 C and from 18 C to 17 C in 16 min respectively. Very slow decay in the room temperature because of the high thermal coefficient of the bricks inside the heating system.

This also means this heating system can make a temperature difference with 3 C only. The power consumption is 1.56 kWh to heat the room from 15.5 to 18.5 C and this will cost 25.4 pence/h which is near to the double cost of the Jigsaw IR heating system. Furthermore, the Jigsaw IR heating system made more than 8 C variation in the room temperature, the efficiency is 2 times higher and low weight compared to 87Kgm storage heating system.

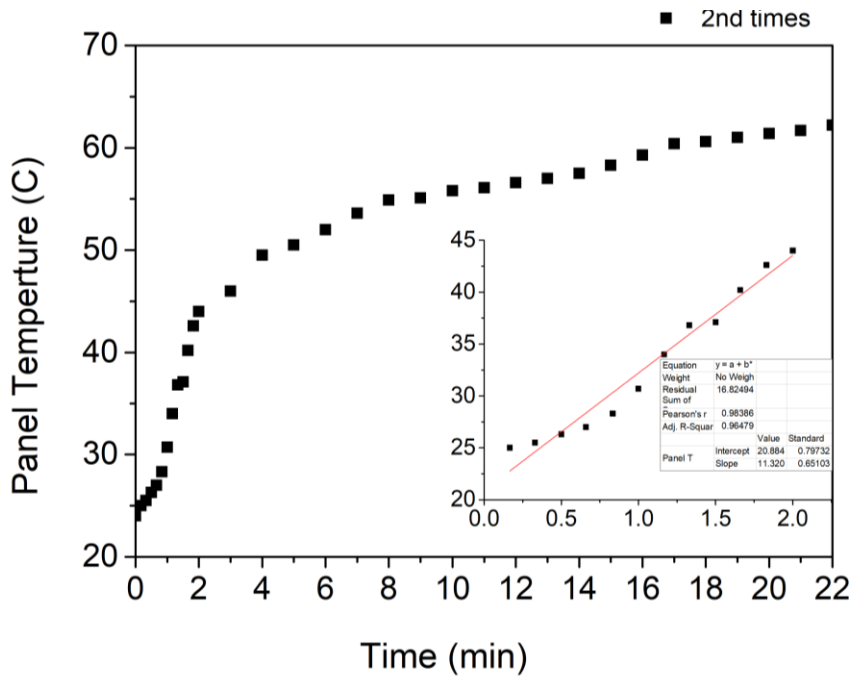


Fig. 9: Storage and convection surface temperature.

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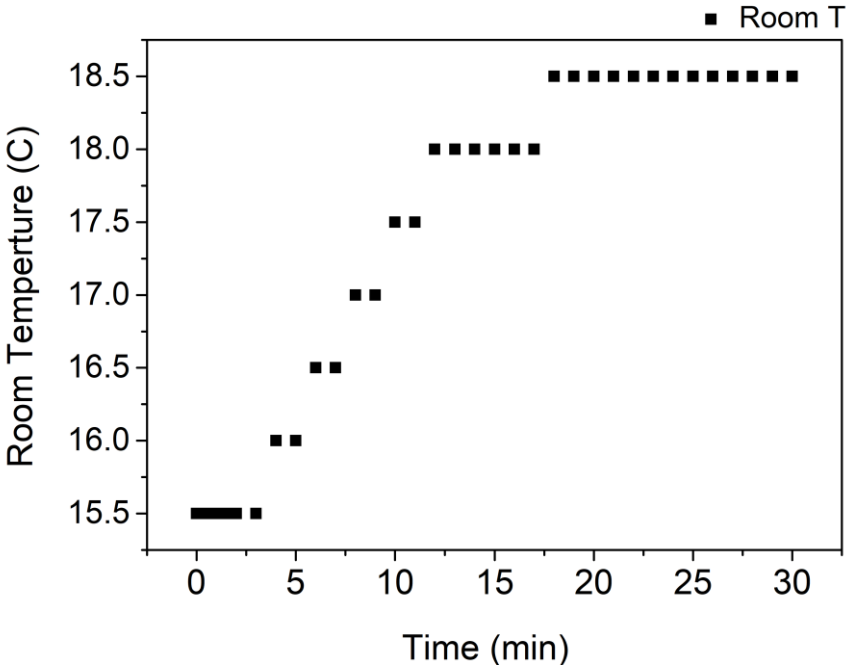


Fig. 10: The measured room temperature of the storage and convection heating system.

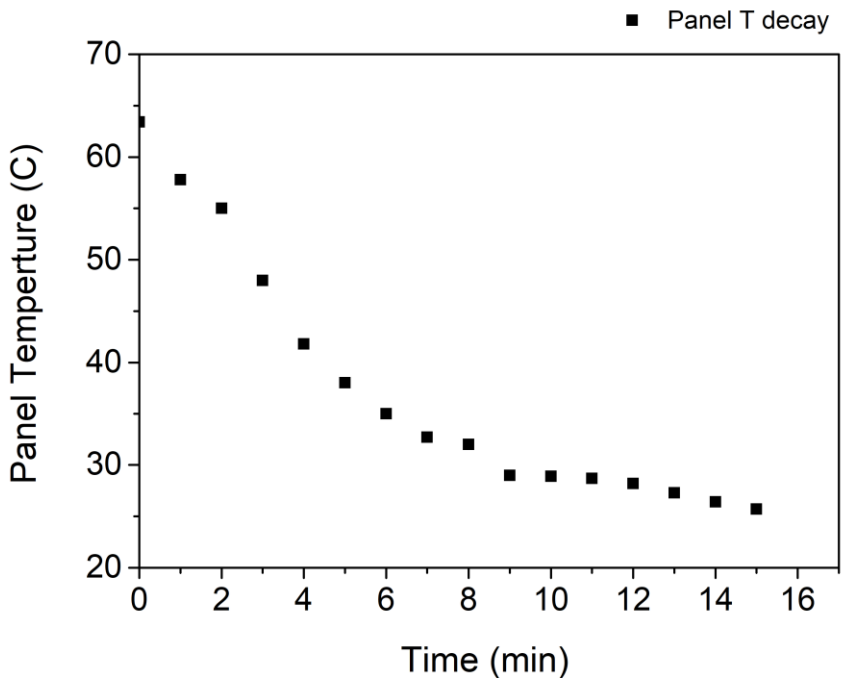


Fig. 11: Heater temperature decay when the heating system switched off.

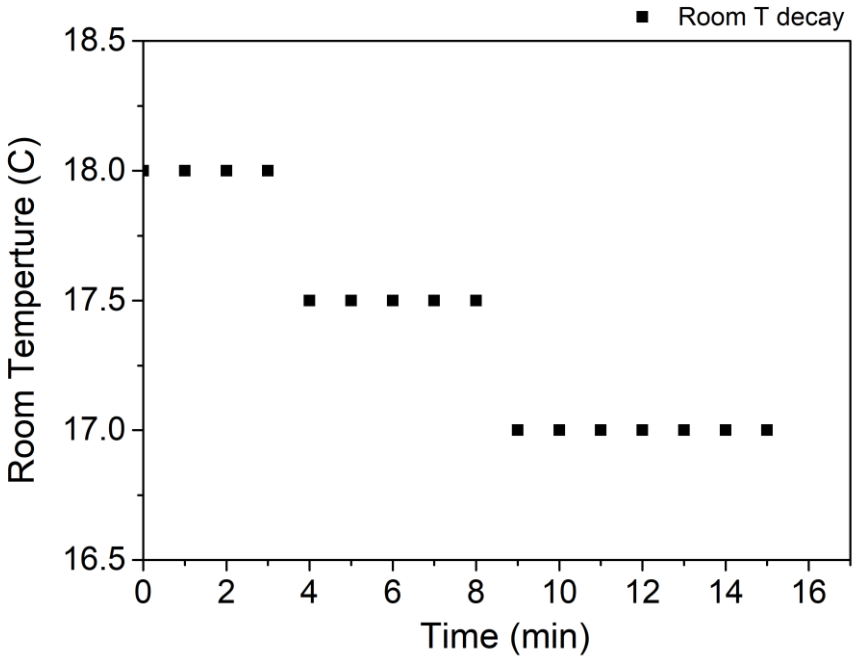


Fig. 12: Room temperature decay when the heating system switched off.

**Technical examination laboratory room information**

- The thickness of insulation specified has been calculated based upon information available to achieve an overall U- VALUE OF 0.18W/sqm K.
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- More information about the insulation is below:
- 670B LAYING THERMICALLY-ACTIVATED VAPOUR CONTROL LAYER

  • Attachment: Securely bond to the substrate.

  • Install thermically-activated vapour control layer to the prepared substrate by removing the peel -off backing sheet.

  • Laps - fully sealed Side laps to be 75mm minimum. End laps to be 100mm minimum.

  All side laps must be fully supported.

  Edges of insulation at roof edges, abutments, upstands, kerbs, penetrations and the like: fully bonded at all details and turned up to encapsulate the thermal insulation, in accordance with current instructions.

  In colder weather, the adhesion can be enhanced by activating the thermically-activated adhesive underside using hot-air welding equipment.

**Summary**

In this report, we provided technical information and characterisation for three different heating systems. IR heating system can increase the room temperature to 18 C in 10 mins which are less than the other two heating systems (2000 W and storage and convection) which take 15 and 17 min respectively. Also, the IR heating system can heat the room temperature to 22-23 C compared to up to 18.5 C for the other two systems. Moreover, the IR heating system has an efficiency 2 times higher than the 2000 W and storage and convection heating system. Therefore, the IR panel used half the energy (50% less) of the storage heater and reached room temp in almost half the time. The other advantages are low weight, small size, and no need for thermal bricks.