Ecotrip Heating Control Field Trial

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By: School of Engineering and Built Environment
Glasgow Caledonian University
4th Floor, Buchanan House
Cowcaddens Road
Glasgow G4 0BA
T: 0141 273 1416

Contact: Dr Charles Russell

Email: Charles.Russell@gcal.ac.uk
T: 0141 331 8427

The School of Engineering and Built Environment, Glasgow Caledonian University supports environmental research and policy development.

Executive Summary

Corrour Concepts have developed an energy use reduction device called “Ecotrip” which is a timer and thermostat that switches off a heating, ventilating or cooling system for a specified period of time. The device is easy-to use and has a simple to understand design that can supplement existing domestic central heating controls. A prototype device has been produced and theoretical studies carried out by ESRU at the University of Strathclyde for potential carbon savings that could be possible in different types of housing.

Glasgow Caledonian University was commissioned to undertake a feasibility study of the device by domestic users. The field study was carried out in conjunction with West of Scotland Housing Association who had been approached by Corrour Concepts to run a trial of the devices with Social Housing Tenants.

The pilot study, “a field trial” assessed the use of the device in 5 Cumbernauld homes that had been recently upgraded with gas central heating systems, and 5 homes without the device which had also undergone the heating upgrade.

Various measurement parameters were undertaken with a data logger installed at the inception of the trial to assess actual usage of Eco-trip by the residents, temperature and humidity readings were captured by Tiny Tag data loggers, and Gas and Electricity readings were gathered for households over the duration of the project. Householder surveys were carried out to understand the type of energy use and socio-demographic and lifestyle variations within the trial participants.
This study was beset with delays with the installation and original running times of the trial and finally ran from the end of March until May which was not the optimal period for the assessment (December to February); however, it was clear that in a small sample size, the device was used by at least 1 of the 5 properties for heating control as per the design, which would make a saving of 8 hours over a 14 day period.

The field trial shows no significant difference in gas or electricity usage between the control households and those with Eco-trip installed and that there is a spectrum of energy use by the householders in the survey, with no obvious trends evident, such as more use by elderly participants. However the experience of the householders of their homes with new heating systems was entirely positive and may have skewed any benefits, actual or perceived by the installation of the energy saving device “Eco-trip”.

Contents

1. Introduction

1.1. Corrour Concepts and Ecotrip

Corrour Concepts have developed an energy use reduction device called “Eco-trip” which is a timer and thermostat that switches off a heating, ventilating or cooling system for a specified period of time (see Figure 1).
It is a simple easy-to use and understand design that can supplement existing domestic central heating controls a prototype had been produced and theoretical studies carried out by ESRU at the University of Strathclyde.

Figure 1: Photograph of the Eco-trip Device

1.2. Corrour Concept’s Rationale for developing the Eco-trip Device

Although the majority of people turn unwanted lights off, most people tend to leave their heating on when they go out[1]. However, shutting off heating saves much more energy than turning lights out[2]. The main reason for this type of wasteful behaviour is convenience. Lights can be turned off and on at the flick of a switch; however, people’s perceptions and ability to switch off their heating in the same with is not so straight forward.
The Ecotrip heating control is designed to make the turning off and on of the heating as easy as possible. The device combines a countdown timer with a standard room thermostat. Operated by simply turning a dial, the timer overrides other controls and shuts off the heating for the period selected. For example, the user, about to

[1] See SEABS ’08 - 67% say they always or mostly turn lights off; 43% say the same about their heating.
[2] See DEMScot distribution of energy use in existing homes.

leave the home for 3 hours, can instantly stop the heating for 2 1/2 hours, so ensuring it is warm for their return.
Certainly a similar countdown feature is incorporated in some programmable room thermostats, but even the simplest of these are lacking in user friendliness – see Table 1 for a comparison between the Ecotrip and the Honeywell 'homexpert' - one of the most basic of its type.
There are a number of reasons for combining the countdown timer with the room thermostat. Essentially the standard room thermostat is a passive, self acting device - passive because it does not require any sort of power source such as batteries, and self acting in that the mechanism operates directly to control the heating. Employing a spring driven countdown timer in the Ecotrip (itself a passive, self acting mechanism) means that it works in the same way as the thermostat so that when it is retrofitted as a replacement for an existing room thermostat the same connections and cabling can be used.

The Ecotrip is designed to be easy to operate and maintenance free. Its design can also be developed for use by the blind and disabled and it has the potential to play a role in coping with fuel poverty.

1.3. Ecotrip operation

There are two dials on the Eco-trip box. The thermostat is the right hand dial on the box and is used as a conventional thermostat to control overall room temperatures. In the field study the devices were fitted in the hall ways of the flats. The left hand dial is a timer which is used to pause the heating for the interval required by the householder. The design of the Eco-trip requires that the user turn the control to 3 hours and then back to the time wanted if less than 2 hours. The timer can run for up to 12 hours and also can be over-ridden by switching the dial back to 0 which effectively switches on the heating again.

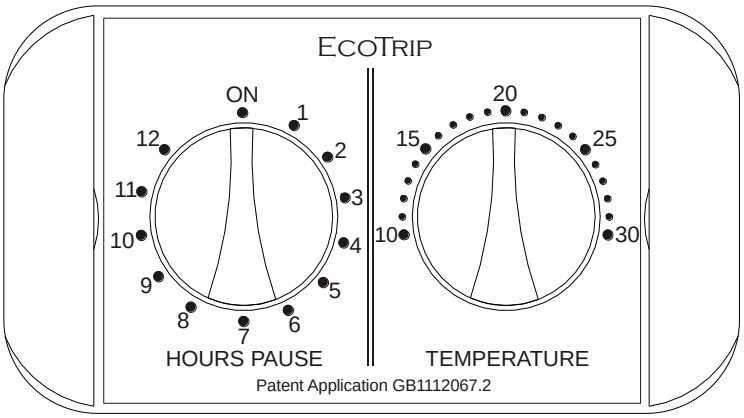


Figure 2: Ecotrip Design Drawing

1.4. The Ecotrip and the 'homexpert' – A Comparison

Devices that switch of the heating are not a new concept, and are part of a series of control devices that are meant to empower householder energy use reduction or efficiency. The main market competitor is Honeywell's "homexpert" which is a digital device and has certain features that are quite distinctly different from Eco-trip that are demonstrated in table 1 below:

Table 1: Comparison between Eco-trip and "homexpert"

Feature	Ecotrip	'homexpert'
Battery free	Yes	No
Single action to set	Yes	No[3]
Intuitive to operate	Yes	No
Instant readjustment	Yes	No[4]
Set to quarter hour	Yes	No[5]
Sight impaired/disabled operable	Yes	No
Current setting immediately apparent	Yes	No
Inexpensive	Yes	Yes
Very compact	No	Yes
Extra features	No	Yes[6]

1.5. ESRU Study Findings

The University of Strathclyde's Energy Systems Research Unit carried out a simulation on two models that were built using "Dynamic building and Plant

[3] Requires one button press and then a button hold depending on length of time being set
[4] Requires two button presses and then a button hold depending on length of time being reset
[5] Can only be set to whole hours
[6] For example, can be used as for temperature setback

modelling software ESP-r". Two different house types were simulated – a turn of the previous century property and a "UK Stock Average House". The model predicted that potential savings from 0.1% 10% could be made in the c.1919 house and from 0.14% to 7.6% in for a UK stock average house.[7]

1.6. West of Scotland Housing Association (WSHA)

The device has several features which are designed for ease of use and therefore as a field trial, Corrour Concepts engaged West of Scotland Housing Association because the savings available from the device would suggest that it would be favoured by people in Social Housing and at risk or in Fuel Poverty.

1.7. Hillcrest

Hillcrest is a development of 101 units that were built 1991 by Cumbernauld Development Corporation and subsequently transferred to West of Scotland Housing Association Ltd. After the transfer 18 units (all flats) were sold as "sharing owner units". The remaining properties are let as social rented units.

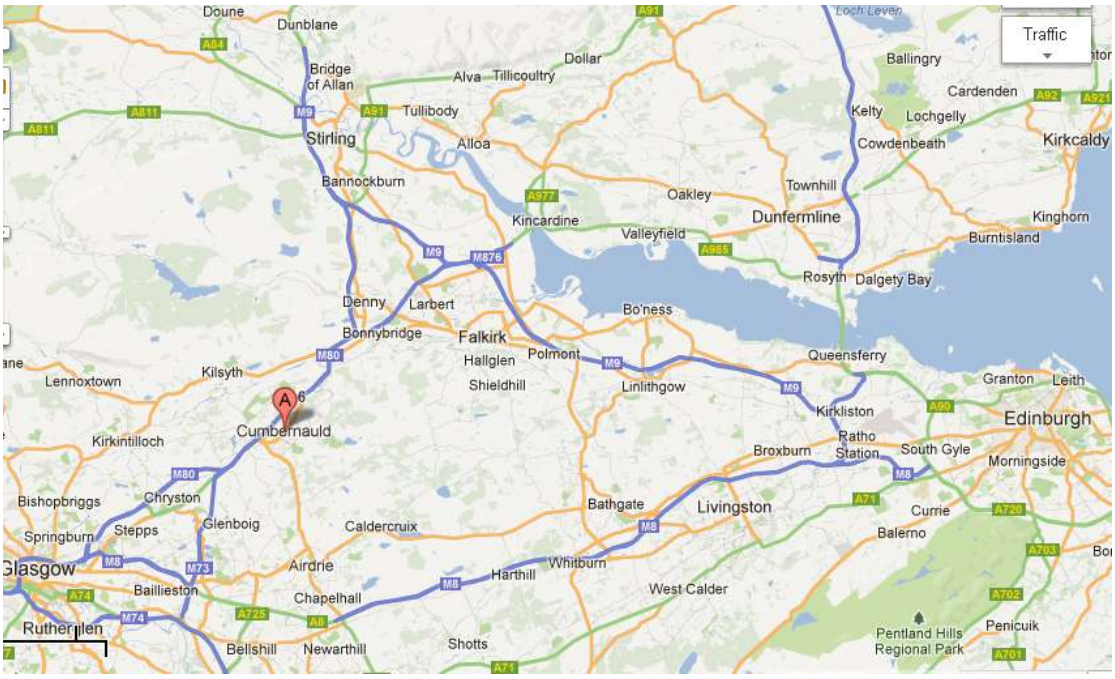


Figure 3: Map of the location of Cumbernauld

[7] Energy Saving Potential of Ecotrip Technology in UK Domestic Buildings, Jeremy Cockroft, Aizaz Samuel, Energy Systems Research Unit, University of Strathclyde, April 2010

Figure 4: Hillcrest Development, Cumbernauld

The properties are traditional brick and block build. Terraced houses contain a mixture of end terrace and mid terrace cottage flats (main door flat on ground or upper level) and 2 storey houses.

The property mix is as follows: -

- Houses - 22 units
- Mid terraced or end terraced flats - 32 units
- Flats in point blocks - 47 units

All the properties are 1 or 2 bedrooms and all the houses have 2 bedrooms.

Figure 5: Hillcrest - Point blocks of flats (left) and mid terraced flats included in the study

The upper flats have concrete slabs with floating timber floor over separating them from lower flat as fire precaution. The lower flats have suspended timber floors. The mid-terraced houses have suspended timber floors at ground and upper levels.

The 4 point blocks have solid concrete floor slabs with floating timber floor over. Each block has 12 flats 2 of which are maisonettes, with the exception of the block sitting at the entry to the site which has 11 flats only.

Roofs to all the properties are concrete tiled over timber trusses and, unusually, there are no sarking boards underneath the tiles.

1.8. Heating provision and upgrade

All the properties were originally fitted with electric night storage heating or electric panel heaters consisting of a night store heater in hallway and lounge and also kitchen if separated from lounge. All the bathrooms had a wall mounted fan heater and bedrooms had electric panel heaters with timer control.

Gas central heating was proposed in 2008 with a start date mooted for 2009. Due to issues in obtaining a gas governor located on the site, the actual installation works did not commence till early 2012.

Figure 6: The new Sime boilers installed at the Hillcrest properties.

All the properties were built to the building standards applicable at the time and have since had the following works carried out.

- Renewal of all windows with high performance, double glazed timber windows between 2001 and 2007.
- Renewal of most of the external doors with high performance composite doors 2008-2010.
- Upgrade of loft insulation where access was allowed by tenants to around 250/300mm 2009/10
- Cavity fill insulation all properties approx. 2007/8.

Many of the tenants are elderly who moved to Hillcrest as the original tenants.

2. Field Study Methodology

2.1. Site selection process

An equal number of "Ecotrip" installed households to control households were agreed and provided by Gordon Dowie of West of Scotland Housing Association. The Ecotrip devices were installed at the same time as the heating upgrades were being carried out and on meeting with the householders, a short survey was undertaken to gauge lifestyle and use of the property. At the same time, a data logger was installed to record temperature and humidity and a data logger recording on and off function of the Ecotrip was also installed. The householders were previously invited to take part in the Ecotrip study.

2.2. Monitoring - Data-logger for Eco-trip device

A major part of this study was to determine the use of the Ecotrip device. Whilst a general survey asking householders if they used the device or not was included as a part of the survey – checked when collecting the device, it was decided to take an empirical approach to measure actual use.

This involved a slight modification to the heating system, whereby a connection to the new Gas Boilers was made with an Easylog data logger. This worked such that every time the heating switched on and off, the data logger registered the time and duration.

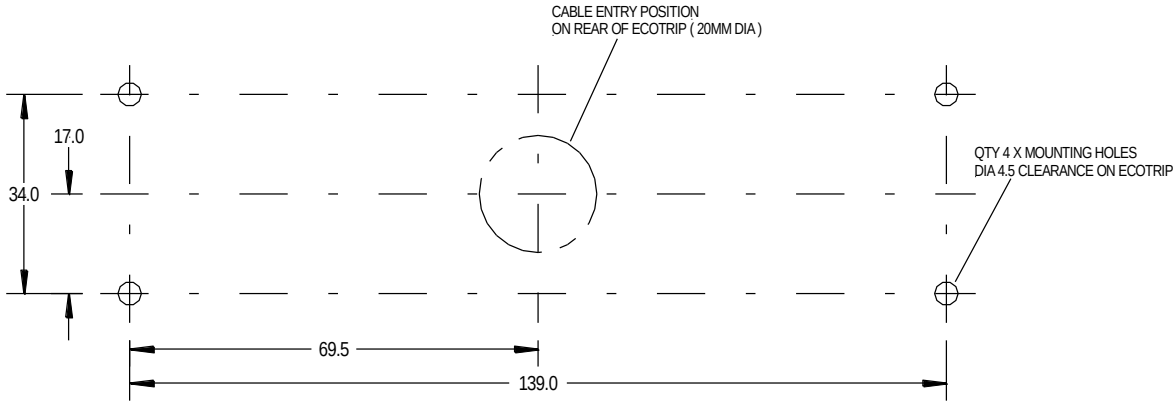
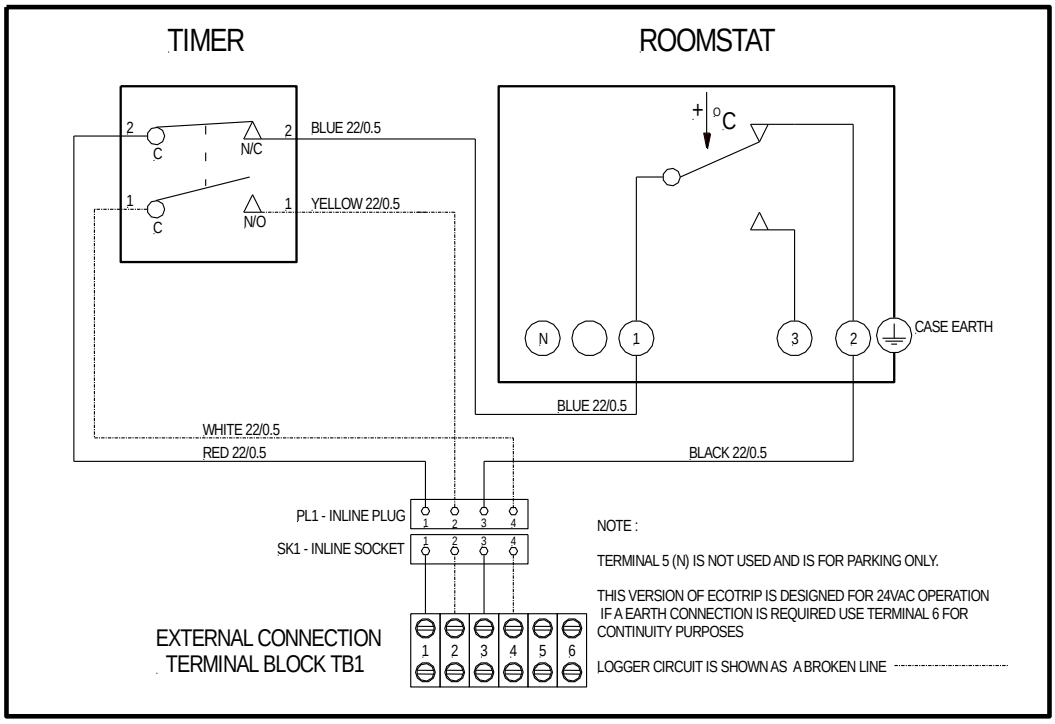


Figure 7: A schematic of the Ecotrip/Sime boiler and data logger circuit.



EXTERNAL CONNECTION DETAILS (TB1)

TERMINAL 1 : LIVE IN
TERMINAL 2 : LOGGER RETURN
TERMINAL 3 : DEMAND
TERMINAL 4 : LOGGER
TERMINAL 5 : NEUTRAL
TERMINAL 6 : EARTH

Figure 8: A schematic of the Ecotrip device and the connections for the data logger

2.3. Tinytag data loggers

Tintag data loggers are robust and reliable units and have been used in previous household comfort studies. The units used in the field trial were the Tinytags Ultra 2 were set up to take a temperature and relative humidity reading for every minute in the majority of the assessments.

Figure 9: Tinytag unit.

2.4. Meter readings

Meter readings were taken at the start of the field trial period and at the end, when collecting the data-loggers at the end of the 6 week trial.

2.5. Householder survey

The householder was carried out to understand the type of householder participating in the study. The information gathered included, number of householders, age, occupation, house use periods, number of rooms, appliances and the experience of living in the house – comfort levels, drafts, damp etc. The survey allowed some insight into the different drivers for people in the way they use their heating and electricity.

3. Field Study Findings

3.1. Eco-trip Usage

Data loggers were installed into 4 of the 6 properties that had the Eco-trip device installed. Of these 4 properties, 1 property abandoned their participation in the study after their Eco-trip device failed to operate due to a design weakness. Of the other 3 properties with the Device installed, one consistently used the device and the two other others said they used the device, but this was not substantiated by the data-loggers, which provided unclear short and infrequent data. Whilst the householders reported using the Eco-trip to control heating, with the unsubstantiated data, we believe that this element of the field trial may have been flawed and resulted from insufficient trial testing with the loggers and the household boiler.

From the householder that used the Ecotrip and the data-logger data that is consistent with that the following results were collected:

3.2. Household comfort data

Household comfort levels were assessed by taking frequent temperature and humidity readings using Tinytag data loggers. The graphs below show differences between householders and are split into two groups – those households with the Ecotrip installed.

3.3. Ecotrip Installed Households

West of Scotland Housing Association had pre-selected 6 households originally for Ecotrip installation, however one of the households was vacant during the period of the field trial and the other did not have a cable installed to connect the data logger.

What we can tell from these data sets is that there is enormous variation and that it seems that the Ecotrip was installed in households with higher overall energy use. It is difficult to distinguish any changes or efficiency savings as we do not have before and after installation of the device.

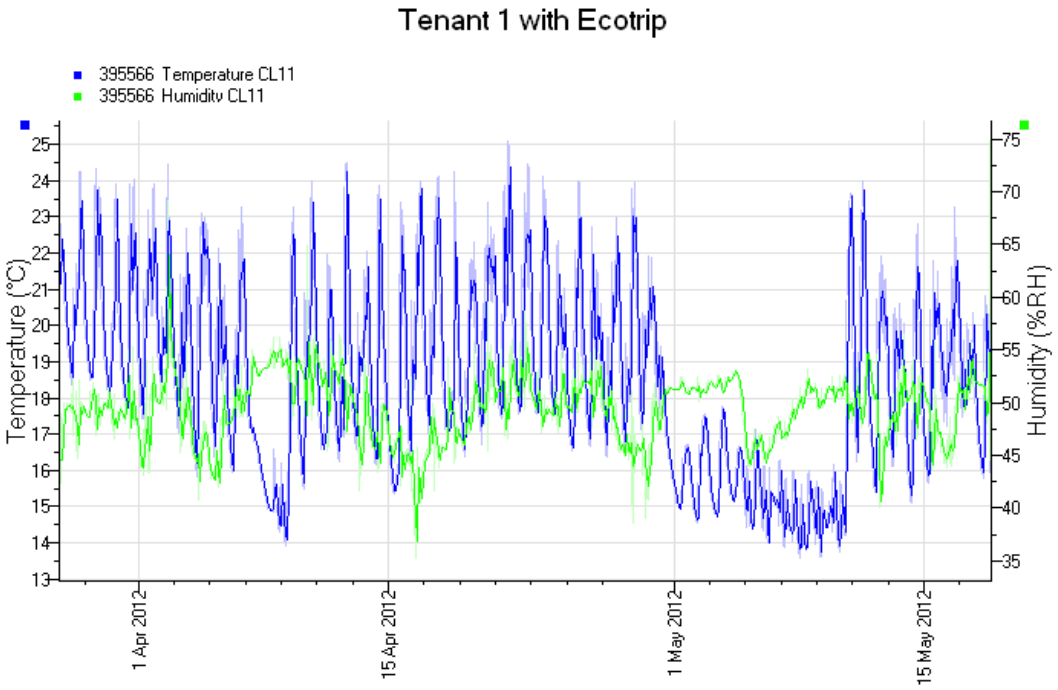


Figure 10: Tenant 1 (with Ecotrip)

Tenant 1 with the Ecotrip installed was a 2 bedroom ground floor flat with a garden door exit from the lounge with a single female tenant over the age of 60. In this case, data was recorded for the entire period at a recording frequency of 5 minutes.

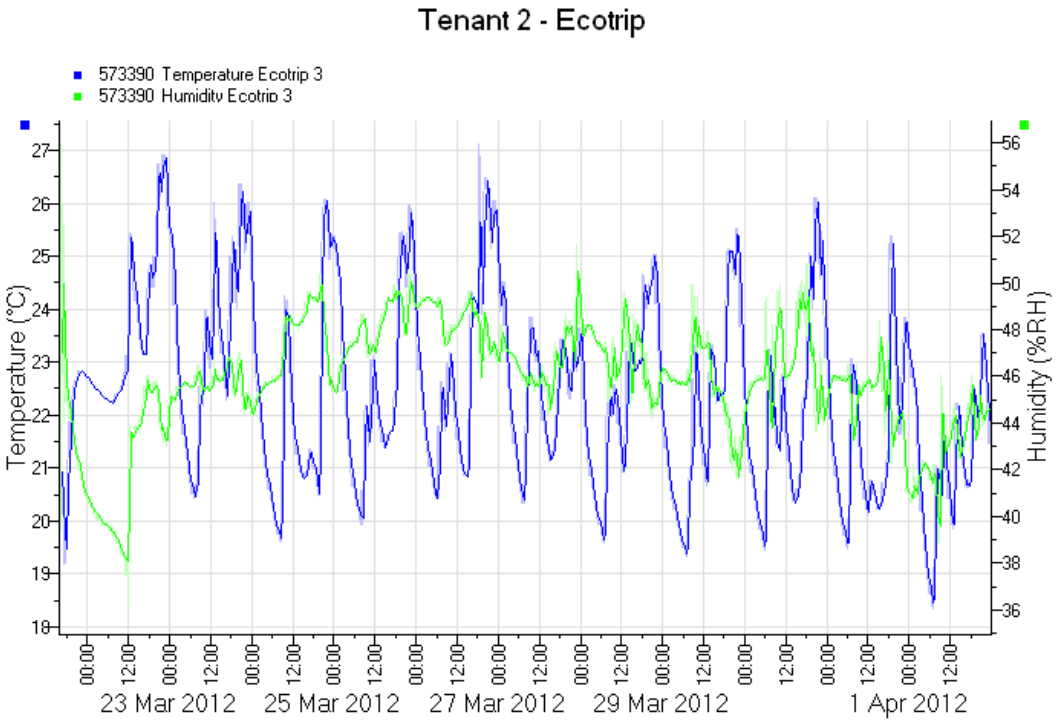


Figure 11: Tenant 2 (with Ecotrip)

Tenant 2 with Ecotrip was a 1 bedroom ground floor flat with a single female tenant over the age of 60. In this case readings were taken at a frequency of every minute for the period of 8 days.

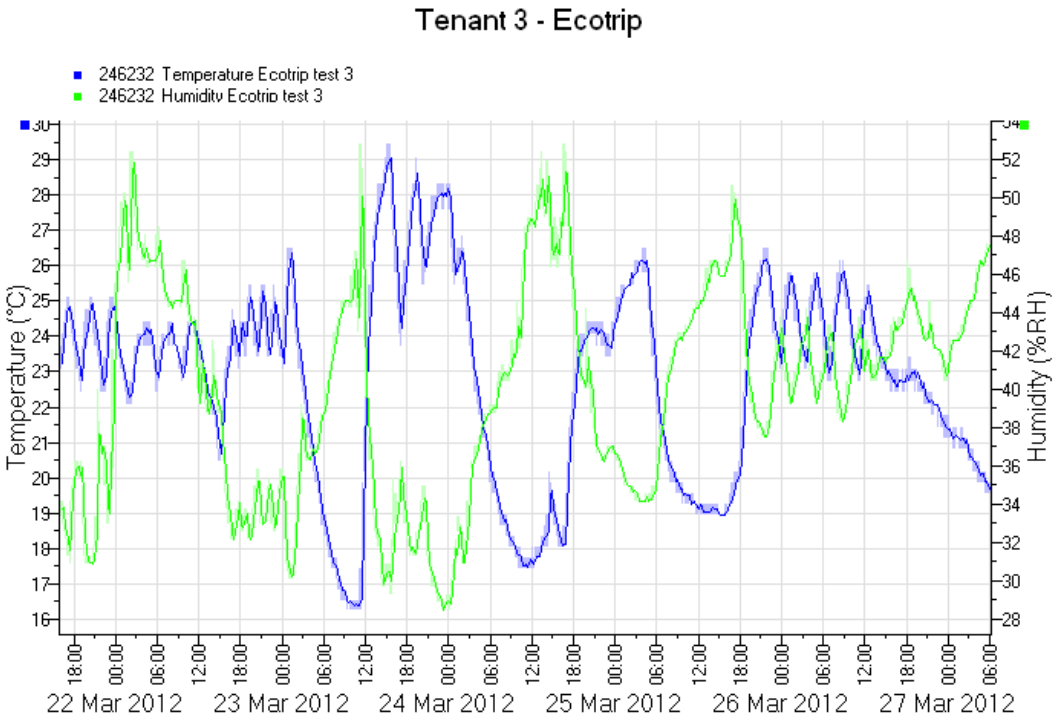


Figure 12: Tenant 3 (with Ecotrip)

Tenant 3 with Ecotrip installed, was a second floor two bedroom flat occupied by a 16-25 year old female and her child (under 5). Readings were recorded at a frequency of 1 minute for 8 days.

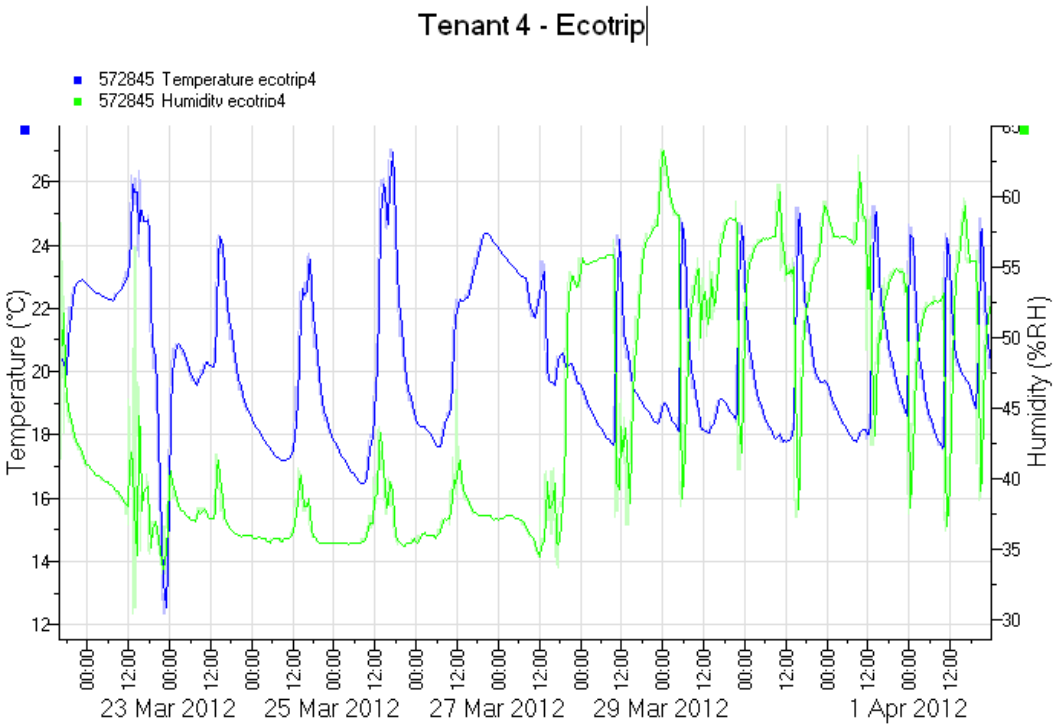


Figure 13: Tenant 4 (with Ecotrip)

Tenant 4 with Ecotrip installed was a ground floor flat in the terraced townhouse block, occupied by a single "56-65" years male. Readings were recorded at a frequency of 1 minute for 8 days.

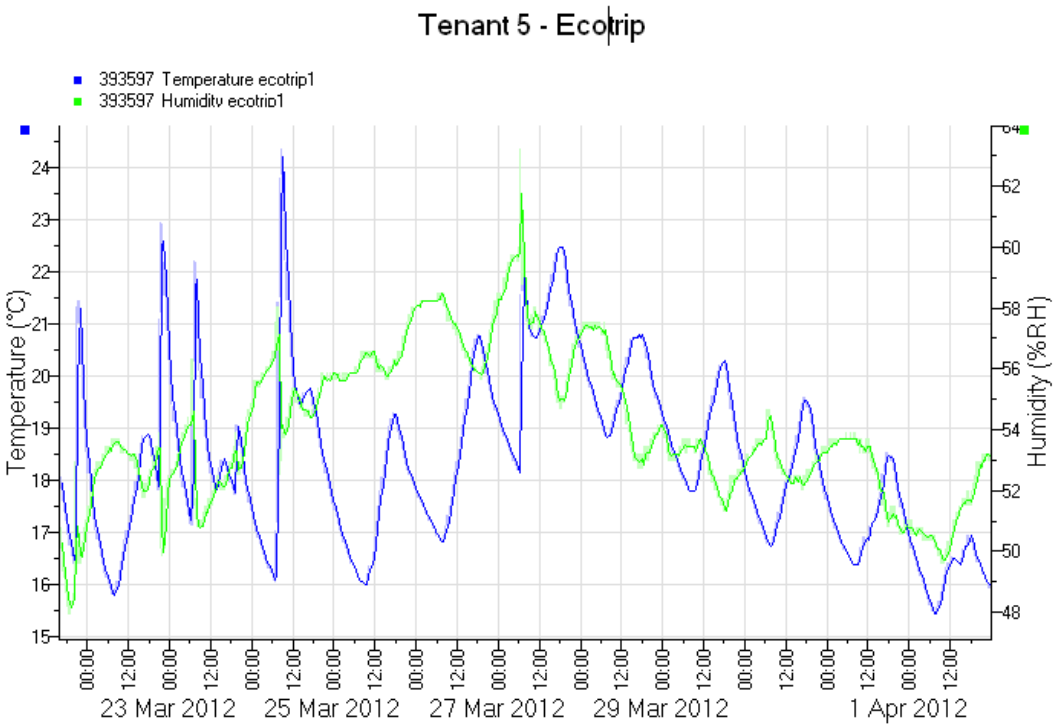


Figure 14: Tenant 5 (with Ecotrip)

Tenant 5 with Ecotrip installed a top floor (3rd floor) flat, occupied by a single "36-45" year male. Readings were recorded at a frequency of 1 minute for 8 days.

3.4. Control Households

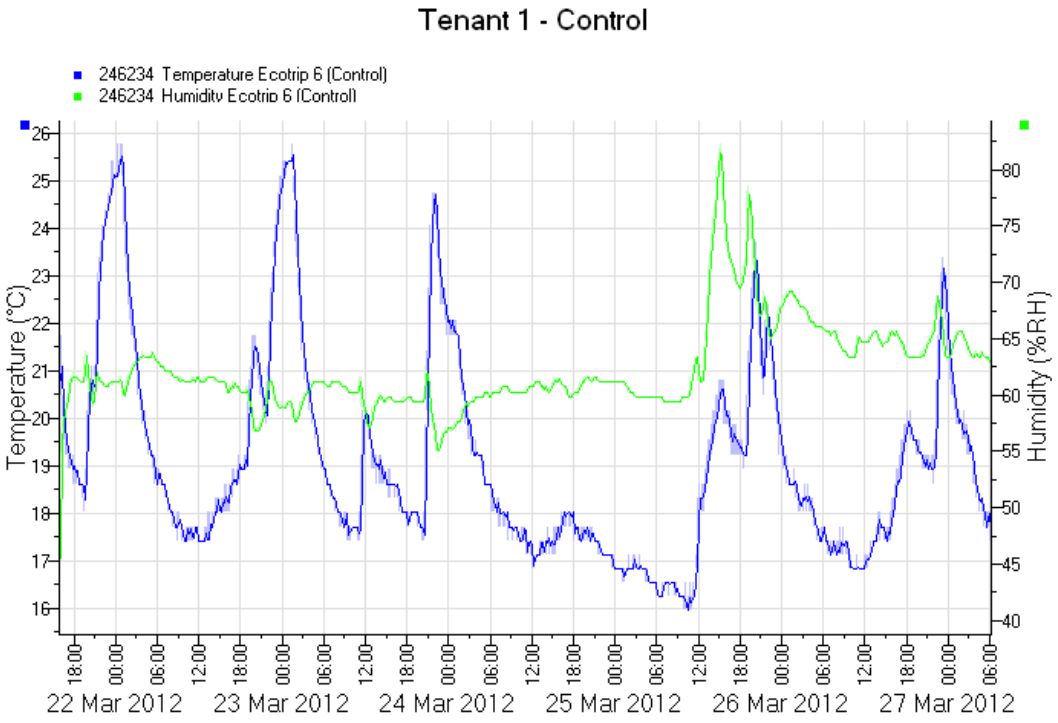


Figure 15: Tenant 1 (Control)

Tenant 1 of the control set (no Ecotrip) was a ground floor flat in a block occupied by a single "46-55" male. Readings were recorded at a frequency of 1 minute for 6 days.

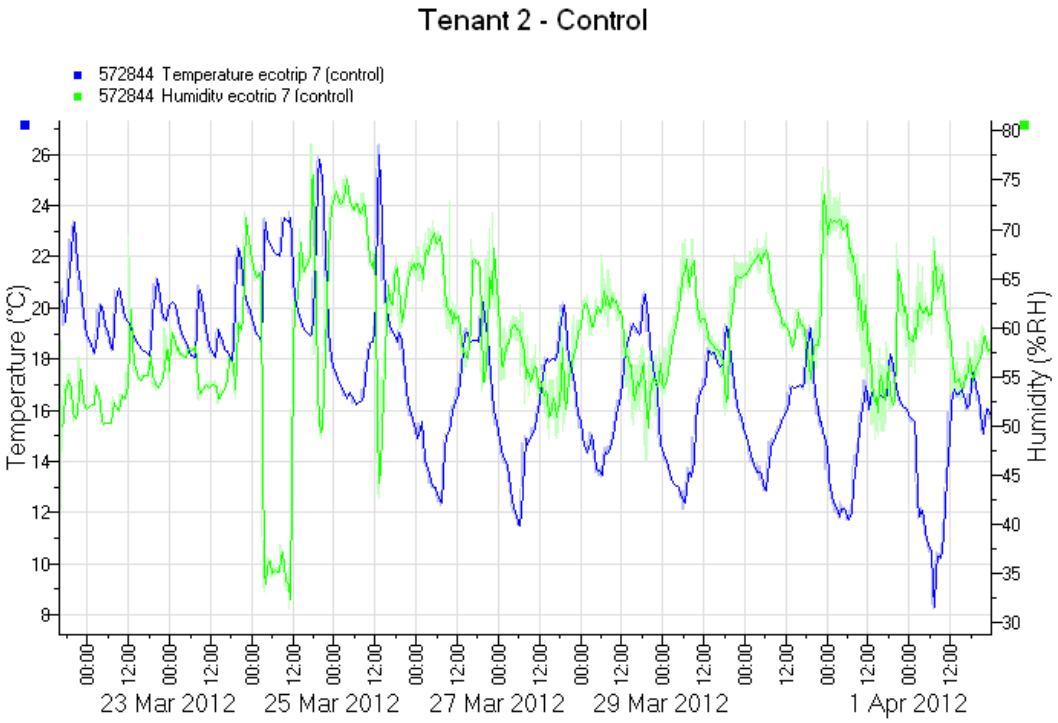


Figure 16: Tenant 2 (Control)

Tenant 2 of the control set (no Ecotrip) was a 1 bedroom ground floor flat occupied by 2 "36-45" male and female. Readings were recorded at a frequency of 1 minute for 8 days.

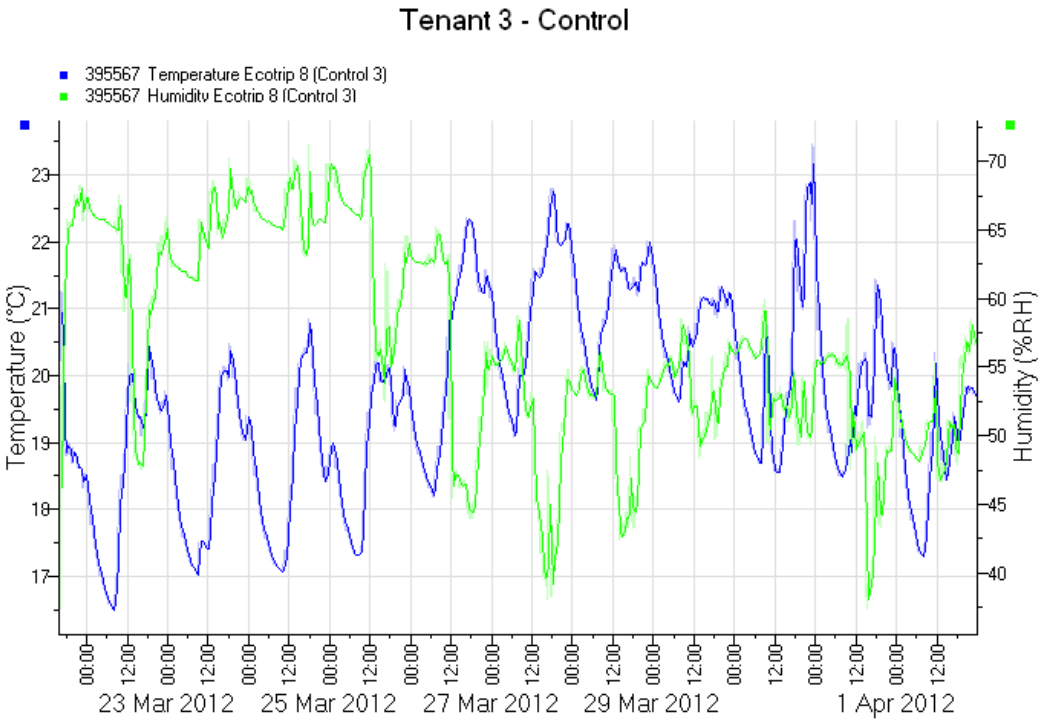


Figure 16: Tenant 3 (Control)

Tenant 3 of the control set (no Ecotrip) was a 2 bedroom first floor flat occupied by 1 "46-55" female and one "56-65" male. Readings were recorded at a frequency of 1 minute for 8 days.

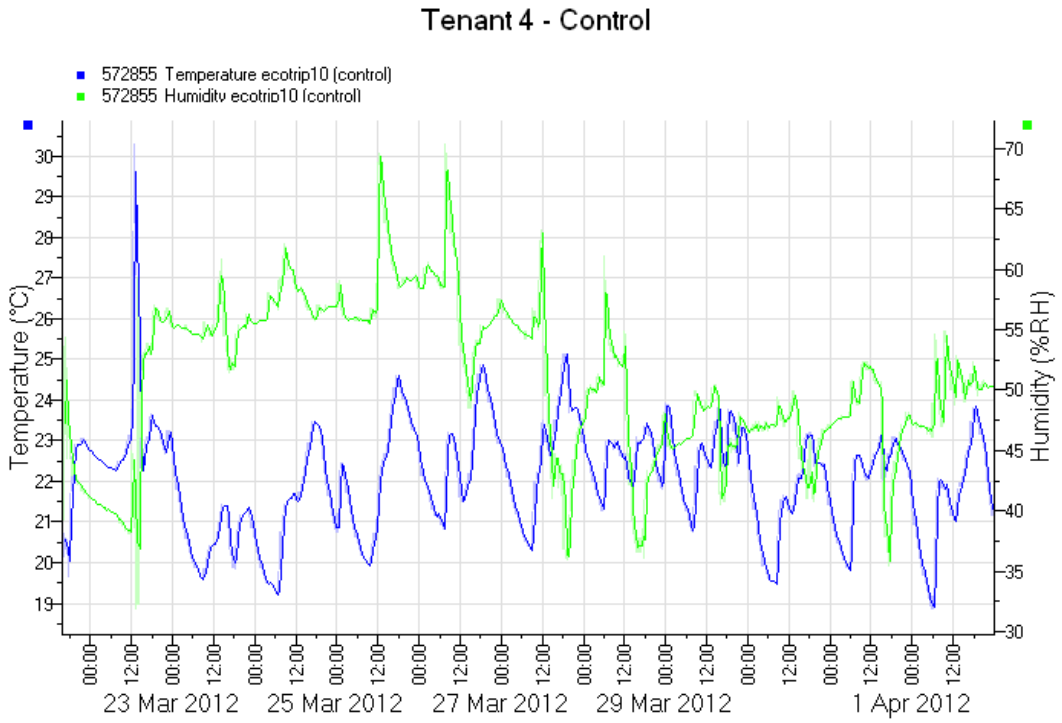


Figure 17: Tenant 4 (Control)

Tenant 4 of the control set (no Ecotrip) was a 1 bedroom second floor flat occupied by 1 “over 65” male. Readings were recorded at a frequency of 1 minute for 8 days.

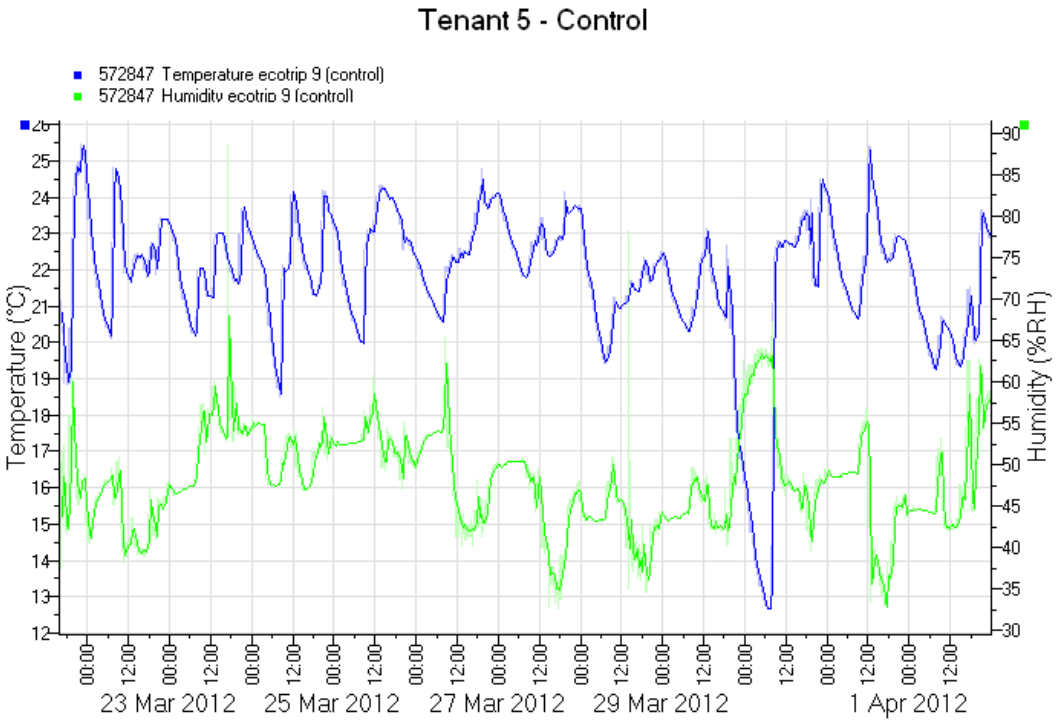


Figure 18: Tenant 5 (Control)

Tenant 5 was a family (2 adults and 3 Children) living in a 2 bedroom top floor fat. Readings were recorded at a frequency of 1 minute for 8 days.

3.5. Energy Use

Table 2 below shows the energy used by the various tenants in the study. On average the households chosen for the Ecotrip installation used 93.2 m3 gas over the trial compared with 52.8 m3 gas by the Control set. This seems to be part of the selection process where high energy users were preselected to take advantage of the Ecotrips. This is consistent with the electricity use being higher 452.5 kWh in the Ecotrip households versus 383 in the Control households.

Table 2: Energy use in all properties (Eco-trip and Control) over the field study period

No in Property	Ecotrip/Control	Gas Use (m^3)	Electricity Use (kWh)
1	E	148	491
1	E	106	576
1	E	19	260.7
1	E	59	348
2	E	134	587
1	C	63	532
1	C	62	200
2	C	46	348
2	C	21	326
5	C	72	509

There was no significant correlation in this small data set between householder numbers and gas and electricity use. The sample size was too small and what this really points to is the large variation in individual energy use, mainly dictated by lifestyle prerequisites and needs.

3.6. Householder Survey Insights

The households were chosen for ease in participation and a reasonable comparator control was selected.

- Ecotrip Participants
  - 2 bed – Single female over 65 yrs
  - 1 bed – Single female over 65 yrs
  - 2 bed – Single female (16-25 yrs) and Child < 5 yrs
  - 1 bed – Single male (56-65 yrs)
  - 1 bed – Single male (36-45 yrs)
- Control Participants
  - 1 bed – Single male (46-56yrs)
  - 1 bed flat – Male and Female (35-45 yrs)
  - 2 bed – Male and Female (46- 55 and 56- 65yrs)
  - 1 bed – Single male over 65 yrs
  - 2 bed – 2 Adults and 3 Children

4. Conclusions and Recommendations

The methodology for the assessment was robust and both interviewing the householders and taking meter readings was both fairly easy to do and effective (accurate). The Tinytag assessment was only for the main living room; however this provides insight into the range of temperatures that are "comfortable". There were no real surprises, for example the working people have a lower energy use than the mother with child at home most of the time.

Because the trial was very limited in terms of scope (only five participants) and timing (March to May) it was not perhaps surprising, that no reliable evidence was produced of the effectiveness of the Ecotrip in saving fuel. However, subjective experience with participants in the course of the exercise did support the claim that the device was simple to operate and potentially useful in reducing energy wastage in the home.

The methodology for assessing the use of the Ecotrip did not give and effective result. The householders all claimed to use the device however for the most part the data logger readings were erratic and in some cases only for a few seconds.

It could be possible that installing a new heating system with additional instructions for the Ecotrip devise may have been confusing for the householders who may have simply used the thermostat instead of the time. Several units failed and it was the thermostat element which was defective, suggesting over use of that rather than the timer.

Only 5 properties had an Ecotrip installed and it was only possible to assess 4 of these properties. Unfortunately the trial was a short period of time running in the late spring (late March to End of April) due to installation of the new boilers being delayed. However there was a mini "cold snap" in the middle of the trial. The trial was much shorter than intended and further more the briefing given to the householders on the use of the device was limited.

The recommendations are that a longer trial be conducted over the winter period with a wider group and that a test trial is conducted on the data logger to ensure that it works over a period of time and that it is completely accurate on what is being measure – i.e. the switching on and off of the heating. This could be done in a control or laboratory mock up.