A Comparative Study of Infranomic Far-infrared heating panels with existing heating systems

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Summary

Direct Savings requested the services of Verco to investigate the energy, carbon and associated cost saving potential of Infranomic infrared heating panels in comparison to other existing heating systems. The study is intended to be a pre-cursor to full empirical in-situ trials, some of which are currently underway. Verco brings a recognised track record of leadership in low carbon refurbishment of existing homes and low carbon development of new buildings.

Verco requested ESRU (Energy Systems Research Unit, University of Strathclyde) to provide support for the comparative study of performance of Infranomic infrared heating panels against LTHW (low temperature hot water) radiators and storage heating with overnight charging using ESP-r software. Verco then used data gathered from ESP-r to make a savings assumption to apply to the outputs from Design Builder models.

The data from ESP-r showed a 368.6 kWh saving by using Infranomic far infrared panels when compared with *correctly sized electric storage heating* (typical of this size of room), this saving still equates to a 41% reduction in energy usage (so a greater saving would be expected in rooms with incorrectly sized storage heating). The savings associated with ASHP vary but overall Infranomic infrared panel system showed as a lower carbon and lower cost option.

For UK, the target is to meet 15% of the energy demand from renewable sources by 2020. Using the methodology required by the EU Renewable Energy Directive, only 3.8% of UK energy consumption in 2011 came from renewable sources.

For Scotland, the target is to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as the target of 11% renewable heat. In 2011, the equivalent of 36.3% of gross electricity consumption was from renewable sources, up from 24.1% in 2010.

This study also showed that the incorporation of a 1.5kW PV system producing 800kWh per year in conjunction with the Infranomic infrared heating panels achieved on average an additional 4% carbon saving per annum – but also a significant cost saving based on the production of own electricity, return on investment from Government generation tariff, and subsequent further income if supplying the national grid.

The ambiguity and variables surrounding tariffs is a challenge but one without a definitive route in how to address. Tariffs vary on a property by property basis which also affected (along with modelling of individual geographic locations) the potential returns on investment when Infranomic systems are coupled with PV systems.

The study overall shows that the Infranomic infrared panel system is a low carbon option which offers greater thermal comfort to home occupants in line with the objectives of a number of Scottish Government heating and energy reduction strategies and obligations currently being implemented.

1. Introduction

1.1 Why carry out this study

Direct Savings requested the services of Verco to investigate the energy, carbon and associated cost saving potential of the Infranomic infrared heating panels in comparison to other existing heating systems.

By modelling representative buildings for use as the base for modelling representative heating and insulation types, the aim was to then determine the energy consumptions and subsequent carbon emissions for each option.

1.2 Our Experience

Verco has been providing consultancy services on energy, carbon and climate change for over 20 years. Our advice and analysis is informed by first-hand experience of pioneering in an expanding market. We have an unmatched pedigree in applying a mixture of technical and financial skills to both inform policy and develop clean energy and carbon reduction projects.

Verco brings a recognised track record of leadership in low carbon refurbishment of existing homes. We are founding members of the Existing Homes Alliance, which brings together over 100 public and private organisations to drive the agenda on CO2 reductions from existing housing stock. We established the national ‘Refurbishment Pioneers Network’ in 2008, bringing together leading social housing practitioners in the sector, and have authored the Housing Corporation’s ‘Fit for the Future’ manual and EST’s updated ‘Energy Efficiency Guide for Managed Social Housing’.

We have worked on leading policy and strategy development for DECC and CLG, have developed low carbon strategies covering over 60 local authorities and housing associations, and are implementing some of the most innovative low carbon refurbishment projects in the country.

With our rich and deep experience comes an in-depth understanding of the incentives and barriers as well as technical and financial risks to delivering energy reduction in existing housing stock and the implications of these for a range of stakeholders.

Further details of Verco projects can be found in Appendix 3.

1.3 Background

Infranomic Infrared (IR) heating panels operate in the far infrared spectrum as an electro-magnetic radiation with longer wavelengths than those of visible light. IR light is electromagnetic radiation with longer wavelengths than those of visible light, extending from the nominal red edge of the visible spectrum at 0.74nm to 0.3mm. Much of the energy from the Sun arrives on Earth in the form of infrared radiation - IR heating panels produce sun-like heat tuned to between 9 – 14 micron meters[1].

Infranomic far-infrared heating panels are toughen glass fronted, with carbon matting inside and an aluminium or wooden frame. They contain no moving parts and are therefore maintenance free for their lifetime.

Compared to traditional heating systems, Infranomic panels can provide human thermal comfort at lower ambient temperatures, meaning less energy is required to reach comfort levels. By heating occupants directly, such systems reduce the amount of heat wasted through infiltration and air movement. Infranomic infrared systems can also result in less vertical temperature gradients within a room space further improving energy efficiency by requiring less electricity to reach required levels.

1.4 Thermal and Infrared radiation

The existence of infrared radiation was first discovered in 1800 and describes most of the thermal radiation emitted by objects near room temperature. Infrared light is emitted or absorbed by molecules when they change their rotational-vibrational movements.

IR panels have the quickest response time of any heating technology and -- because the panels can be individually controlled for each room—the quick response feature can result in cost and energy savings compared with other systems when rooms are infrequently occupied, if controlled correctly. When entering a room, the occupant can increase the temperature setting and be comfortable within minutes. With this in mind, there is a particular benefit for this type of heating system to be used in off-grid (not connected to mains gas network) homes, and those requiring retrofitted heating systems.

The principle advantage of the Infranomic infrared heating system is that it should be able to provide occupants with comfortable homes at a lower air temperature than a convective system, and thus achieve good economies in energy used. The reduction of energy required should result in lower running costs when compared to other electric heating systems. The reduced energy requirement can be expected to result in carbon improvements when compared to other forms of electric heating, and when compared to other forms of energy efficiency investments. That being so, Infranomic infrared heating panels should be treated as a lower carbon heating option towards meeting UK carbon and renewable targets (for its compatibility with photo voltaic panels).

[1] A micron meter is an SI unit of length equalling 1×10^{-6}; The micrometre is a common unit of measurement for wavelengths of infrared radiation

1.5 Modelling contrasting systems

Verco requested ESRU (Energy Systems Research Unit, University of Strathclyde) to provide support for the comparative study of performance of Infranomic infrared heating panels against LTHW (low temperature hot water) radiators and storage heating with overnight charging using ESP-r software. The comparison with LTHW can be reviewed further in Appendix 1.

A typical in-situ storage heater size will generally be 3.4kw but the overheating shown in the modelling of this meant that unlike in most real life housing situations, the storage heater has been sized specifically for the room in which it was modelled. The overheating displayed in the initial modelling at Strathclyde marries with the anecdotal evidence available which suggests homes heated with storage heaters can be extremely warm in the morning and cold in the evening.

Verco then used data gathered from ESP-r to make a savings assumption to apply to the outputs from Design Builder models.

As Design Builder is unable to model Infranomic far infrared as a specific system, Verco have applied the difference in the kWh output for the various modelled archetypes with electric storage heating to produce a comparison of the energy used for Infranomic far infrared panels and also compared this with Air source heat pumps (ASHP), and Natural Gas boilers.

2. Modelling Representative Heating Systems – ESP-r

2.1 Overview

This initial study was based on a single room. The initial calibrations of performance were carried out to assess whether the model was representative of the input and response characteristics of these types of heating devices with a simple room topology.

The form, size and capacity of each heating system were adjusted for the demands of the room. Initially a 3.4kW storage heater was modelled but this was reduced to 2.5kW after overheating was observed, and the initial IR panel was increased to reach the set point.

The model includes sensors for radiant comfort in the centre of each room. It also includes a wooden desk in each room so that the impact of differing heating types on furniture can be tracked.

The performance of the heaters and the rooms match expectations. For example the storage heater has noticeable standby losses and loose temperature control. The radiator TRV being more sensitive to radiant temperatures than air temperature results in an initial overshoot of room air temperature until the room surfaces have warmed.

2.2 Parameters

The initial model was designed to be used for further analysis (this was carried out by Verco and is discussed in section 3). The size of the room was adjusted to be close to that of the living room in the Scotstarvit Cottage - a traditional cottage recently renovated – and extended to include three otherwise identical rooms of 20m2 with a south and west window (see figure 1).

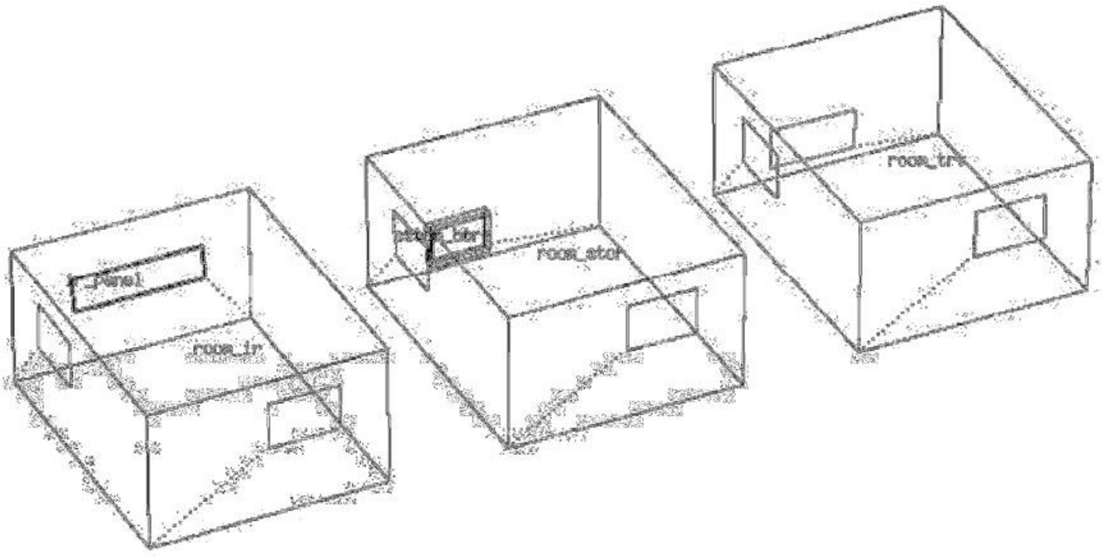

Figure 1 Wireframe view of rooms in ESP-r model

To allow the sensitivity of different types of partition wall to radiant heating, each room includes one traditional plaster rendered wall. The rooms are sensitive to wind speed and direction. Infiltration rate is calculated at each time-step based on the solution of pressure and velocity on the façade and defined cracks in the façade.

ESRU sourced information about the composition of the IR panel and adapted the size and characteristics of the initial model to reflect the literature available. The IR panel is explicitly represented as a separate zone with heat injection into the IR face of the panel but with additional heat losses via the side frame and to the wall face behind the panel.

2.2.1 Storage Heaters

The temporal response of storage heaters is complex and other work in ESRU indicated that an explicit approach within ESP-r was necessary to capture the response characteristics of such heaters. The core feolite is heated from midnight to 7h00 to ~400C and heat is transferred to the interior of the casing.

Mass flow of air between the inside of the storage unit case and the room is evaluated at each time-step of the assessment and controlled via a timed damper. The damper is closed during the charge cycle, slightly open from 7h00 – 17h00 and then further opened for the evening. The casing of the storage is warm and contributes to the heating of the room whether or not heating is required.

A 3.4kW storage heater resulted in poor control and overheating (see green line room temperature in figure 1)

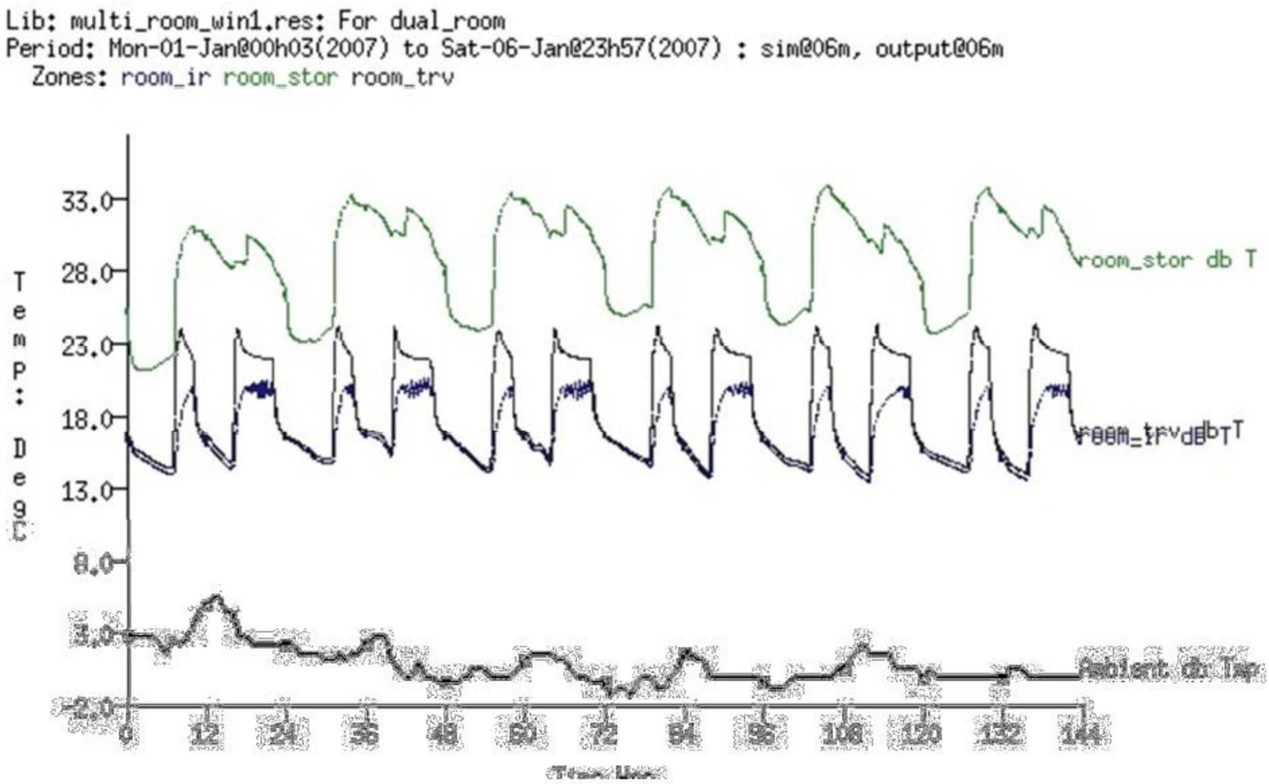

Figure 2 Poor control with initial 3.4kW storage heater

A smaller unit results in expected core/case/room temperatures during typical winter days and is included in model.

2.2.2 IR Panels

The temperature in the IR room is in blue and in the latter part of the day is seen to switch on and off as the room set-point is reached during the scheduled operating times.

After the initial portion of each of the heating-on periods the traditional radiator (which was also being modelled using ESP-r) and the IR heater showed similar patterns of resultant temperatures in the rooms. The IR panel has a lower capacity than the radiator and the room responds more slowly.

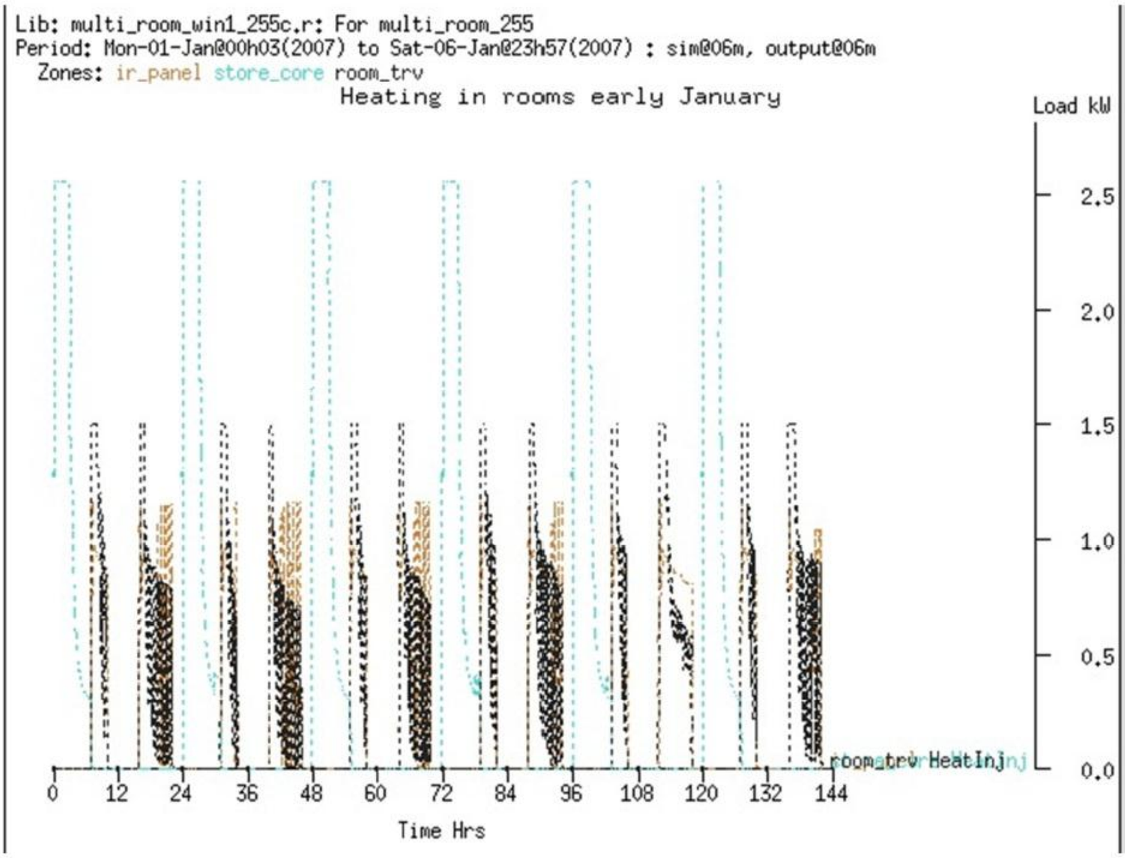

Figure 3 Heat delivered for each system

Figure 3 shows the heat input to each system green is storage, brown is IR, black is traditional radiator). The latter are seen to cycle in the latter part of each day.

The IR panel temperature and the room temperature are shown in figure 4. The rapid on-off cycling is seen in the latter portion of the heating period. The IR panel is seen to warm the wall it is attached to and thus it remains somewhat above the room temperature when it is off.

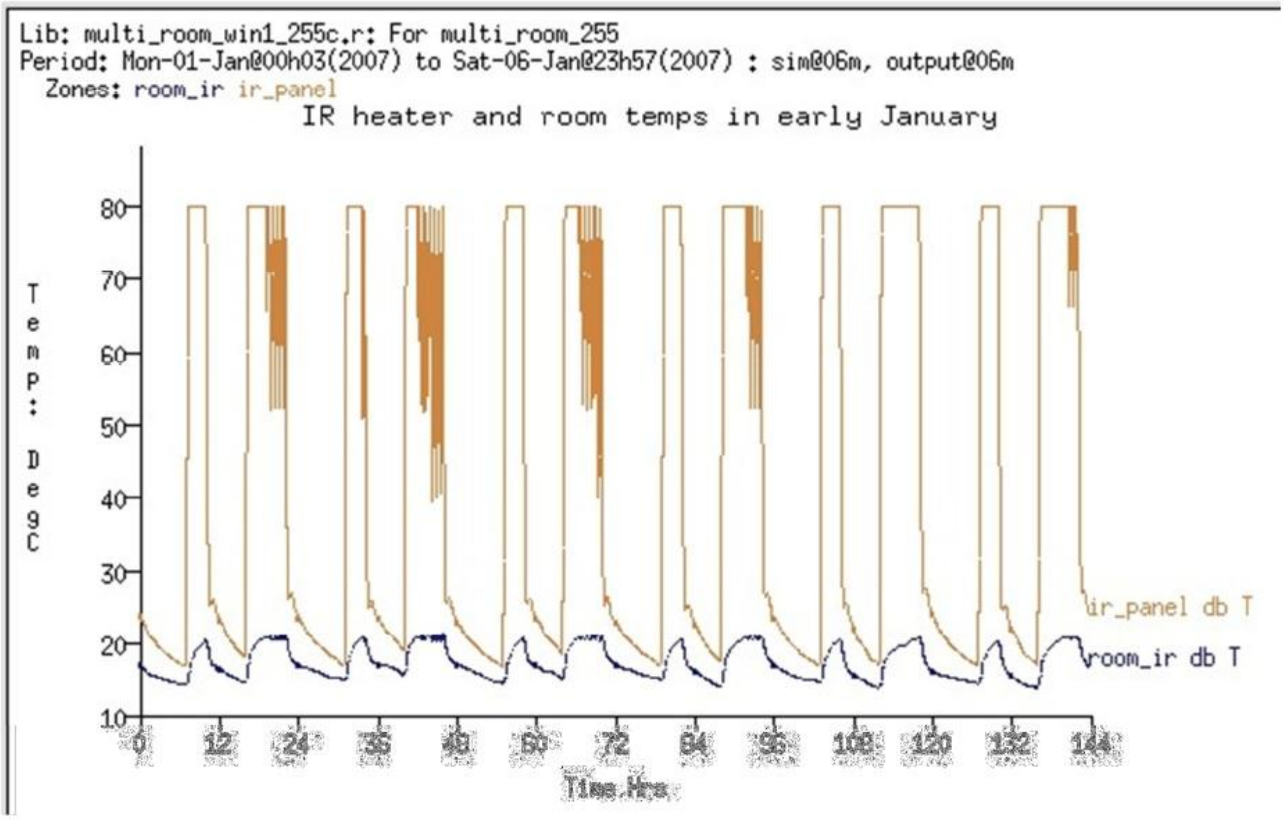

Figure 4 IR panel and room temperature

2.3 Analysis

The model details were input into ESP-r and model contents report reviewed. A score of calibration runs were made to adapt the system capacity, control logic and flow network (e.g. damper position). The short period assessments from which the above graphs were produced (more graphs in full report, Appendix 1) indicate that the model reflects the characteristics of each of the systems.

2.4 Results

The main outcomes from the ESP-r study are a calibrated ESP-r model. The storage heater exhibits the poor control consistent with the technology. The assessment indicates IR panel remain somewhat under capacity given the heat period and the assumption that the panel is limited to 80 degrees centigrade.

3. Modelling Representative Heating Systems – Design Builder

3.1 Overview

It was necessary for Verco to be able to find a way to compare the different heating systems, as Design Builder did not allow for far infrared panels to be modelled. Therefore Verco have used data gathered from ESP-r to make a savings assumption to apply to the outputs from Design Builder.

The data from ESP-r (see table) shows that there is a 368.6 kWh saving by using far infrared panels, as opposed to electric storage heating, this saving equates to a 41% reduction in energy usage. The data from the ESP-r model was measured over a 3 month period dated 1st January to 31st March 2007. The model takes into account the local, Glasgow weather during that period, so as to be truly representative of the single room that was modelled.

As Design Builder is unable to model far infrared panels, Verco have applied this 41% saving to the kWh output for the various modelled archetypes with electric storage heating to produce an estimation of the energy used for far infrared panels.

Heating type	Energy (kWh)	No. of hours required
Far infrared panel	525.78	658.3
Electric storage heater	894.41	639.0

Table 1 Outputs from IR and Electric Storage

3.2 Archetypes

The design builder models were based on four different dwelling types with average floor areas[2] (shown in brackets):

- A bungalow (123 m^2)
- A semi-detached house (101 m^2)
- A mid-terraced property (180 m^2)
- A flat (68m^2)

The definitions of these archetypes are shown in table 1 below.

Dwelling	# Floors	No Bedrooms	Living Areas	Bathrooms/ Ensuites	Floor area (m^2)
Detached bungalow	1	3	2	1	123
Semi-detached villa	1	2	2	2	101
Flat	1	2	2	1	68
Mid terrace	2	3	1	1	180

Table 2 Definitions of archetypes used in design Builder models

[2] Floor areas taken from representative properties for sale on ESPC (website http://www.espc.com/)

3.3 Construction

Verco have modelled the dwelling types with three different fabrications; a heavy weight moderate insulation brick/block wall, a typical timber frame and a Part L2 2010 Notional lightweight fabric.

These fabrics have different u-values and are set to different building regulations, to reflect the nature of the housing stock throughout the country.

The u-values of the different material types are shown below:

Main external wall structure	U-value
U Value of block	0.351
U Value of timber frame	0.375
U Value of Lightweight (Part L 2010)	0.26

Table 3 Main external wall fabric u-values

3.3.1 Heavy-weight, moderate insulation

This fabric consists of a brick/block wall that has been insulated to 1995 regulations, with 100mm brickwork, 79mm of insulation, 100mm concrete block and 15 mm of gypsum plasterboard. The walls have an infiltration rate of 50 Pa at $10m^3/hr -m^2$. The fabric has a u-value of 0.351, which is of typical standards, for a solid wall property.

3.3.2 Timber-frame

The building materials consist of a lightweight cladding, 83mm of XPS extruded polystyrene, and 13mm gypsum plasterboard, this fabric has a u-value of 0.375 and is consistent with buildings of this nature.

3.3.3 Part L2 2010 Notional, lightweight

This building fabric, is in line with the most current building regulations, and is therefore applicable to new builds, and those that have been recently refurbished to current standards. Due to the high standards, this fabric has the best u-value rating of 0.260.

3.4 Heating Appliances

The report has used three main types of heating sources; electric storage heating, far infrared panels, and air source heat pumps (ASHP).

3.4.1 Electric Storage Heaters

The electric storage heaters have been modelled with natural ventilation, and a fan coil unit. Design Builder uses a model that has been sourced from BRE, with a CoP of 1.00. Verco have made assumptions that the storage heater will be in charging mode between midnight and 7am.

3.4.2 Far Infrared Panels

Infranomic panels are a modern far-infrared technology system which is programmable for each individual panel within a dwelling. Due to this infranomic panels provide a far greater thermal comfort and air quality than that compared to traditional gas boilers and electric storage heaters. Infranomic panels are low maintenance and easy to retro-fit.

The results for the Far infrared panels have been calculated, with the help of ESRU, at Strathclyde University, using their ESP-r building software. They modelled a far infrared panel and a storage heater, and the analysis from this was that far infrared panels use 41% less kWh to heat a room than the electric storage heater, to the same temperatures. The far infrared panels were modelled on an operational time of between 07:00 to 10:00 and 16:00 and 22:00.

3.4.3 Efficiencies for ASHP, LPG and Oil

The Efficiencies for ASHP, LPG and Oil, based on the heating system are shown below:

ASHP

Seasonal energy efficiency ratio (SEER) = 2.00

Heat generator radiant efficiency = -1.00

The ASHP used in the Design builder models has been sourced from BRE

LPG

Seasonal energy efficiency ratio (SEER) = 0.810

Heat generator radiant efficiency = -1.00

Oil

Seasonal energy efficiency ratio (SEER) = 0.810

Heat generator radiant efficiency = -1.00

3.5 Analysis

The following diagrams and tables show the layouts and subsequently the results from the design builder models. As mentioned previously this is was calculated using the difference found in the ESP-r modelling.

3.5.1 Detached Bungalow

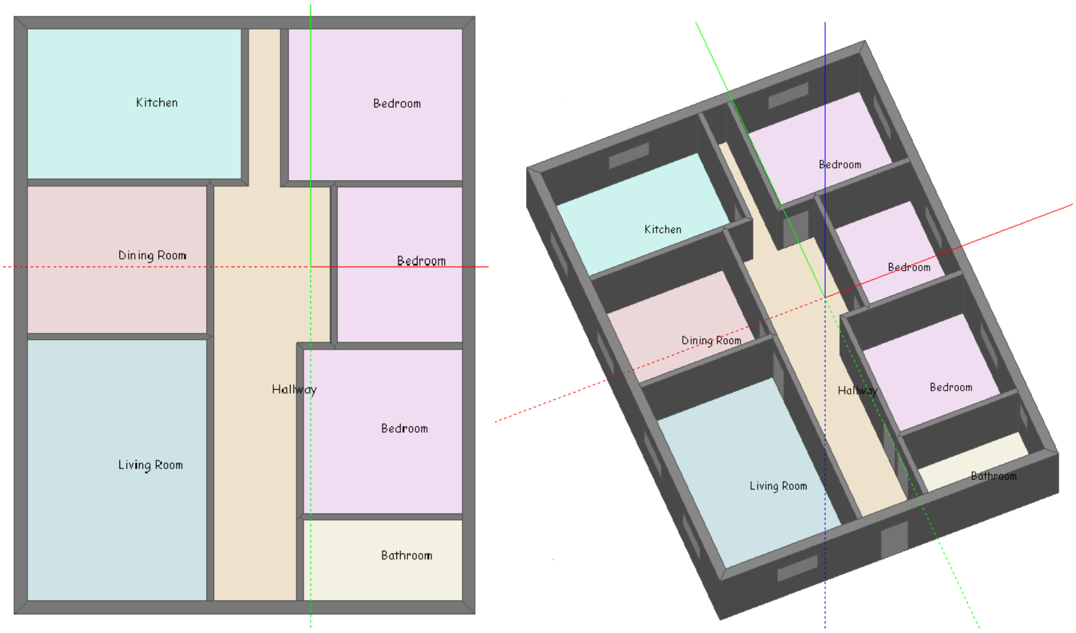

Figure 5 Floor plan of Bungalow Model (and view with doors and windows)

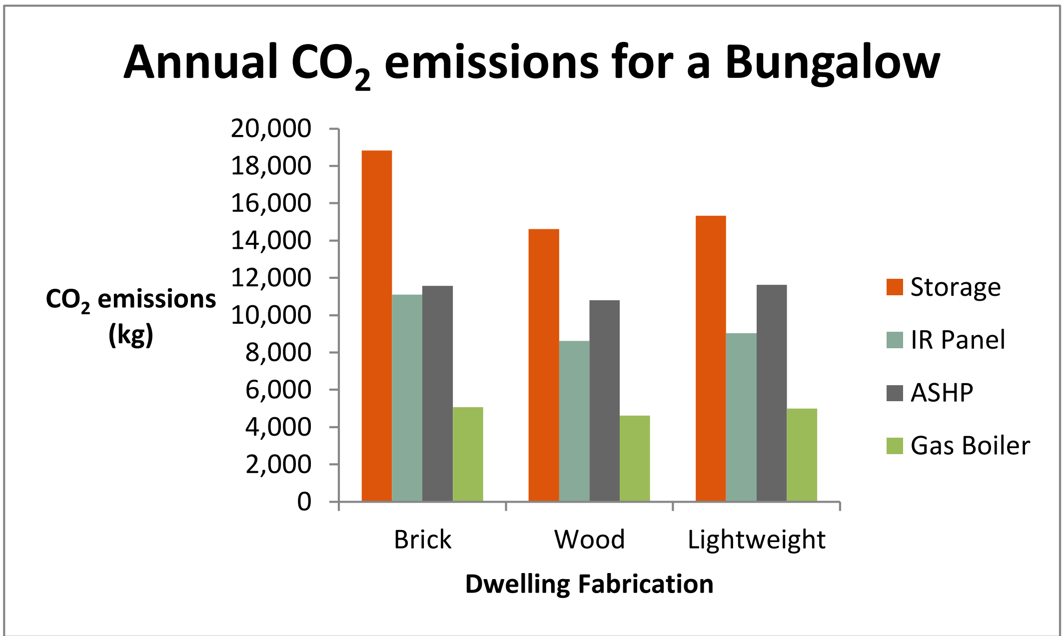

Figure 6 Bungalow - Annual CO_2 emissions

3.5.2 Semi-detached villa

Figure 7 Floor plan of Semi-detached Model (and view with doors and windows)

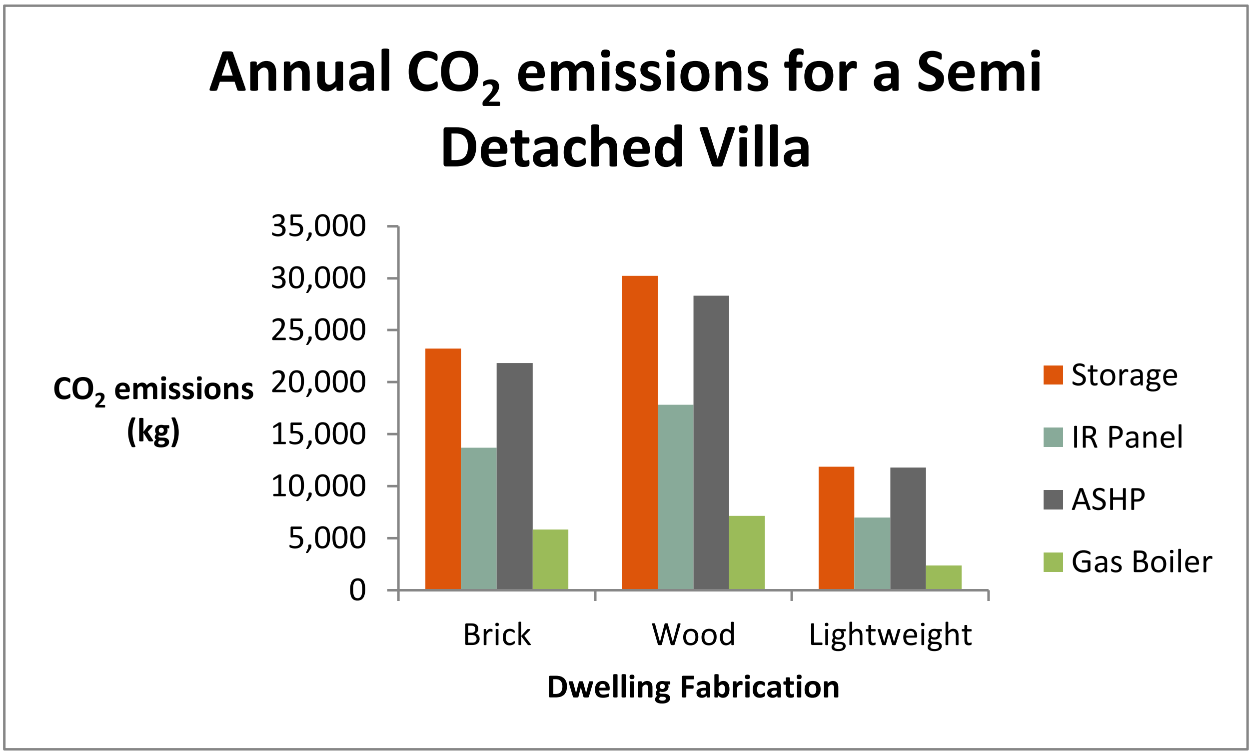

Figure 8 Semi-detached - - Annual CO_2 emissions

3.5.3 Mid-terrace house

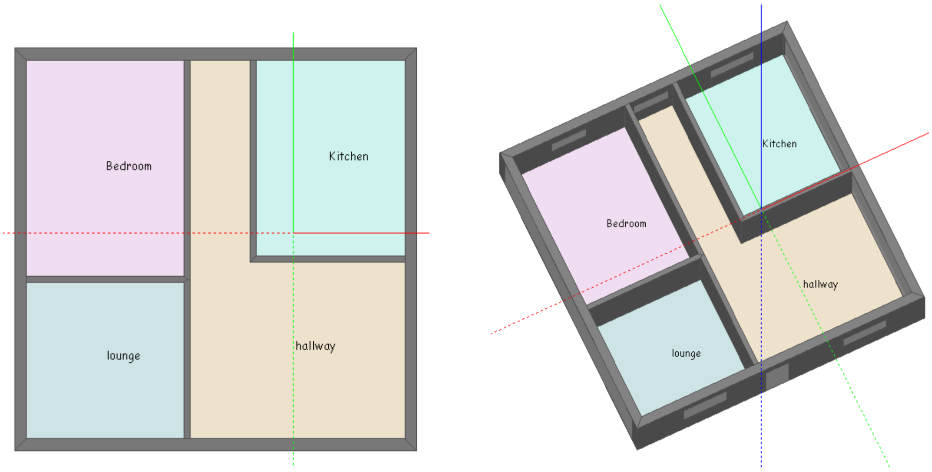

Figure 9 Floor plan of Ground floor Mid-terrace Model (and view with doors and windows)

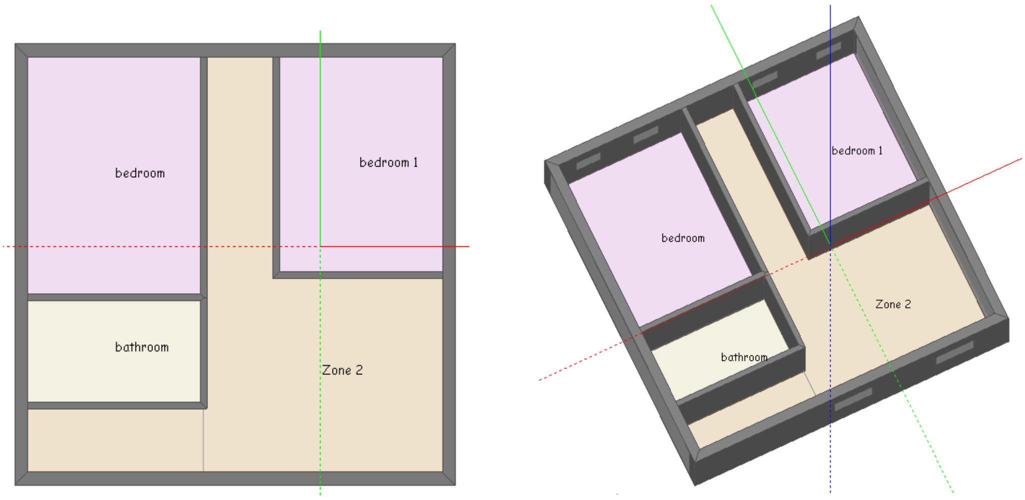

Figure 10 Floor plan of first floor Mid-terrace Model (and view with doors and windows)

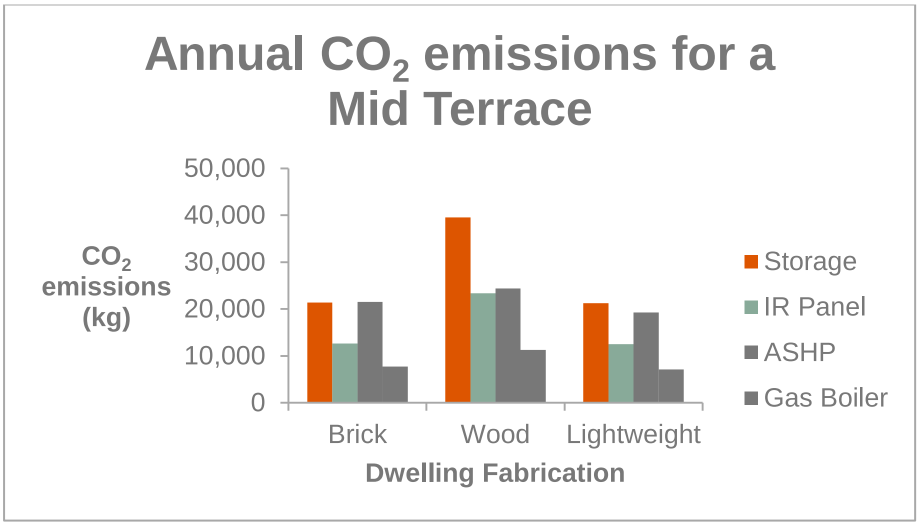

Figure 11 Mid-terrace - Annual CO_2 emissions

3.5.4 Flat

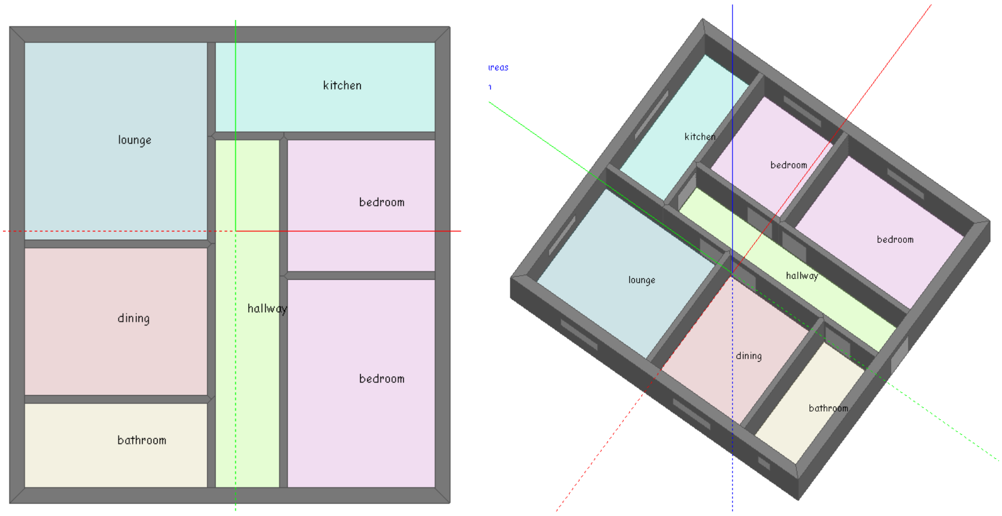

Figure 12 Floor plan of Flat Model (and view with doors and windows)

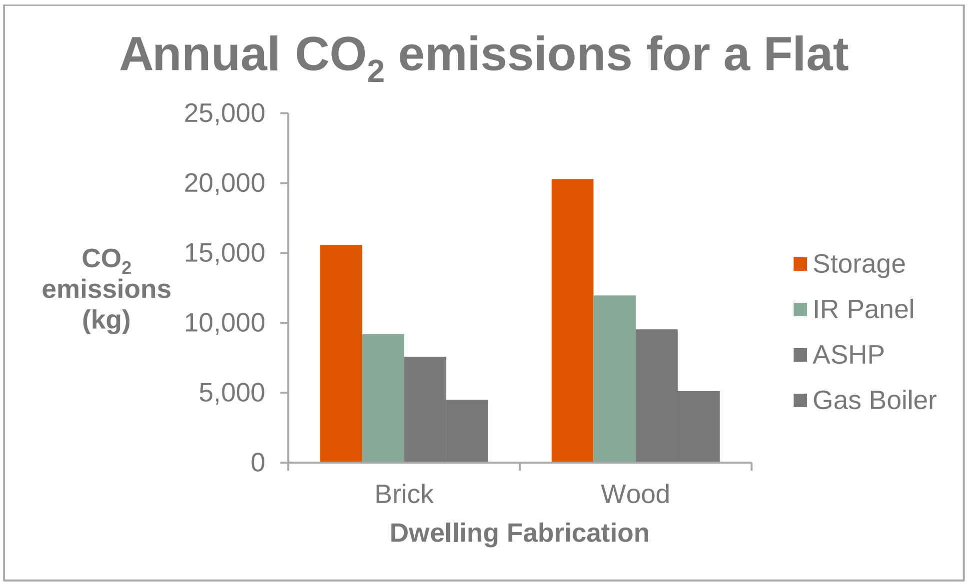

Figure 13 Flat - Annual CO_2 emissions

3.6 Results from Design Builder modelling

Dwelling Type	Fabric		Floor area (m2)	kWh/m2	Total annual kWh	Annual CO2 Emissions (kg)
Bungalow	Brick	Storage	123	296	**36,408**	**18,821**
Bungalow	Brick	IR panel	123	175	**21,481**	**11,104**
Bungalow	Brick	ASHP	123	182	**22,386**	**11,572**
Bungalow	Brick	Oil	123	229	**28,167**	**8,009**
Bungalow	Brick	LPG	123	229	**28,167**	**6,471**
Bungalow	Brick	Gas	123	201	**24,723**	**5,070**
Bungalow	Wood	Storage	123	230	**28,290**	**14,624**
Bungalow	Wood	IR panel	123	136	**16,691**	**8,628**
Bungalow	Wood	ASHP	123	170	**20,910**	**10,809**
Bungalow	Wood	Oil	123	189	**23,247**	**6,610**
Bungalow	Wood	LPG	123	189	**23,247**	**5,341**
Bungalow	Wood	Gas	123	183	**22,509**	**4,616**
Bungalow	Lightweight	Storage	123	241	**29,643**	**15,324**
Bungalow	Lightweight	IR panel	123	142	**17,489**	**9,041**
Bungalow	Lightweight	ASHP	123	183	**22,509**	**11,636**
Bungalow	Lightweight	Oil	123	206	**25,338**	**7,205**
Bungalow	Lightweight	LPG	123	206	**25,338**	**5,821**
Bungalow	Lightweight	Gas	123	198	**24,354**	**4,995**
Semi-detached villa	Brick	Storage	101	445	**44,945**	**23,234**
Semi-detached villa	Brick	IR panel	101	263	**26,518**	**13,708**
Semi-detached villa	Brick	ASHP	101	418	**42,218**	**21,824**
Semi-detached villa	Brick	Oil	101	282	**28,482**	**8,099**
Semi-detached villa	Brick	LPG	101	282	**28,482**	**6,543**
Semi-detached villa	Brick	Gas	101	282	**28,482**	**5,841**
Semi-detached villa	Wood	Storage	101	579	**58,479**	**30,230**
Semi-detached villa	Wood	IR panel	101	342	**34,503**	**17,836**
Semi-detached villa	Wood	ASHP	101	542	**54,742**	**28,298**
Semi-detached villa	Wood	Oil	101	345	**34,845**	**9,908**
Semi-detached villa	Wood	LPG	101	345	**34,845**	**8,005**
Semi-detached villa	Wood	Gas	101	345	**34,845**	**7,146**
Semi-detached villa	Lightweight	Storage	101	227	**22,927**	**11,852**
Semi-detached villa	Lightweight	IR panel	101	134	**13,527**	**6,993**
Semi-detached villa	Lightweight	ASHP	101	226	**22,826**	**11,800**
Semi-detached villa	Lightweight	Oil	101	114	**11,514**	**3,274**
Semi-detached villa	Lightweight	LPG	101	114	**11,514**	**2,645**
Semi-detached villa	Lightweight	Gas	101	114	**11,514**	**2,361**
Flat	Brick	Storage	68	443	**30,124**	**15,572**
Flat	Brick	IR panel	68	261	**17,773**	**9,188**

Flat	Brick	ASHP	68	215	**14,620**	**7,558**
Flat	Brick	Oil	68	323	**21,964**	**6,245**
Flat	Brick	LPG	68	323	**21,964**	**5,046**
Flat	Brick	Gas	68	323	**21,964**	**4,504**
Flat	Wood	Storage	68	577	**39,236**	**20,283**
Flat	Wood	IR panel	68	340	**23,149**	**11,967**
Flat	Wood	ASHP	68	271	**18,428**	**9,526**
Flat	Wood	Oil	68	400	**27,200**	**7,734**
Flat	Wood	LPG	68	400	**27,200**	**6,249**
Flat	Wood	Gas	68	367	**24,956**	**5,118**
Mid terrace	Brick	Storage	180	230	**41,400**	**21,401**
Mid terrace	Brick	IR panel	180	136	**24,426**	**12,627**
Mid terrace	Brick	ASHP	180	231	**41,580**	**21,494**
Mid terrace	Brick	Oil	180	256	**46,080**	**13,103**
Mid terrace	Brick	LPG	180	256	**46,080**	**10,586**
Mid terrace	Brick	Gas	180	209	**37,620**	**7,715**
Mid terrace	Wood	Storage	180	221	**39,780**	**20,564**
Mid terrace	Wood	IR panel	180	130	**23,470**	**12,133**
Mid terrace	Wood	ASHP	180	262	**47,160**	**24,379**
Mid terrace	Wood	Oil	180	305	**54,900**	**15,611**
Mid terrace	Wood	LPG	180	305	**54,900**	**12,613**
Mid terrace	Wood	Gas	180	305	**54,900**	**11,259**
Mid terrace	Lightweight	Storage	180	228	**41,040**	**21,215**
Mid terrace	Lightweight	IR panel	180	135	**24,214**	**12,517**
Mid terrace	Lightweight	ASHP	180	207	**37,260**	**19,261**
Mid terrace	Lightweight	Oil	180	192	**34,560**	**9,827**
Mid terrace	Lightweight	LPG	180	192	**34,560**	**7,940**
Mid terrace	Lightweight	Gas	180	192	**34,560**	**7,088**

Table 4 Results from design builder modelling of archetypes

3.6.1 Description of Results

The results across the combined ESP-r and Design Builder models show a 41% carbon saving across the year when compared with storage heating based on the parameters set out earlier. The savings associated with ASHP vary but overall Infranomic panels are a lower carbon and cost option.

As expected the emissions associated with LPG, Oil and Gas are lower than the systems using electricity (storage, Infranomic panels, and ASHP) but also don't offer the security of supply associated with electricity which can be produced by domestic homes in conjunction with solar panels and/or other renewable technologies.

3.7 Cost savings

This study is intended as a pre-cursor to a full empirical in-situ study. The cost savings have not been included due to the variations in tariffs and due to the variation in lifecycle costs.

Whilst the initial savings from LPG, oil and gas heated boilers may be less, the installation, lifecycle and maintenance costs are far greater than those of Infranomic panels.

The cost savings due to the reduction in electricity in comparison with storage heating, and the costs compared with the other heating types will be greatly different when lifecycles costs are included.

3.7.1 Gas boiler life cycle costs

Whilst the emissions savings and running costs associated with natural gas heated boilers may be lower than Infranomic panels, the life cycle costs associated with gas boilers must be considered.

The life cycle costs for a gas boiler include the following:

- Capital cost of the boiler and ancillary equipment (radiators, pipework, controls, etc.)
- Installation costs
- Incoming utility cost (gas connection)
- Annual maintenance costs
- Repair / replacement costs
- Landlords gas safety certification (if required)
- Annual fuel cost (gas for combustion + electricity for pump / flue fan, etc.)

The expected life cycle of a gas boiler can be taken as being 15-20 years for domestic combi boilers. The typical circulating pumps used in domestic systems can be expected to have a life cycle of 10-15 years. Over a 25 year period, therefore, it is necessary to include for replacement of the boiler once and for the replacement of the pump at least once. The rest of the system should be expected to last for the full 25 years.

The capital cost of a domestic gas boiler system depends on many factors including the size and age of the property, however a typical cost of about £4,000 can be expected where there is an existing gas supply already installed. It should be noted a new gas supply can cost several thousand pounds.

4. UK Renewable Targets

UK

For UK, the target is to meet 15% of the energy demand from renewable sources by 2020. Using the methodology required by the EU Renewable Energy Directive, only 3.8% of UK energy consumption in 2011 came from renewable sources.

Progress is illustrated in the figure and table below.

	2007	2008	2009	2010	2011
Percentage of capped gross final energy consumption (ie the basis proposed by Eurostat for the Renewable Energy Directive)	1.8	2.4	3	3.2	3.8
Percentage of primary energy demand (ie the basis previously quoted in this Digest)	2.2	2.6	3.1	3.3	4.1

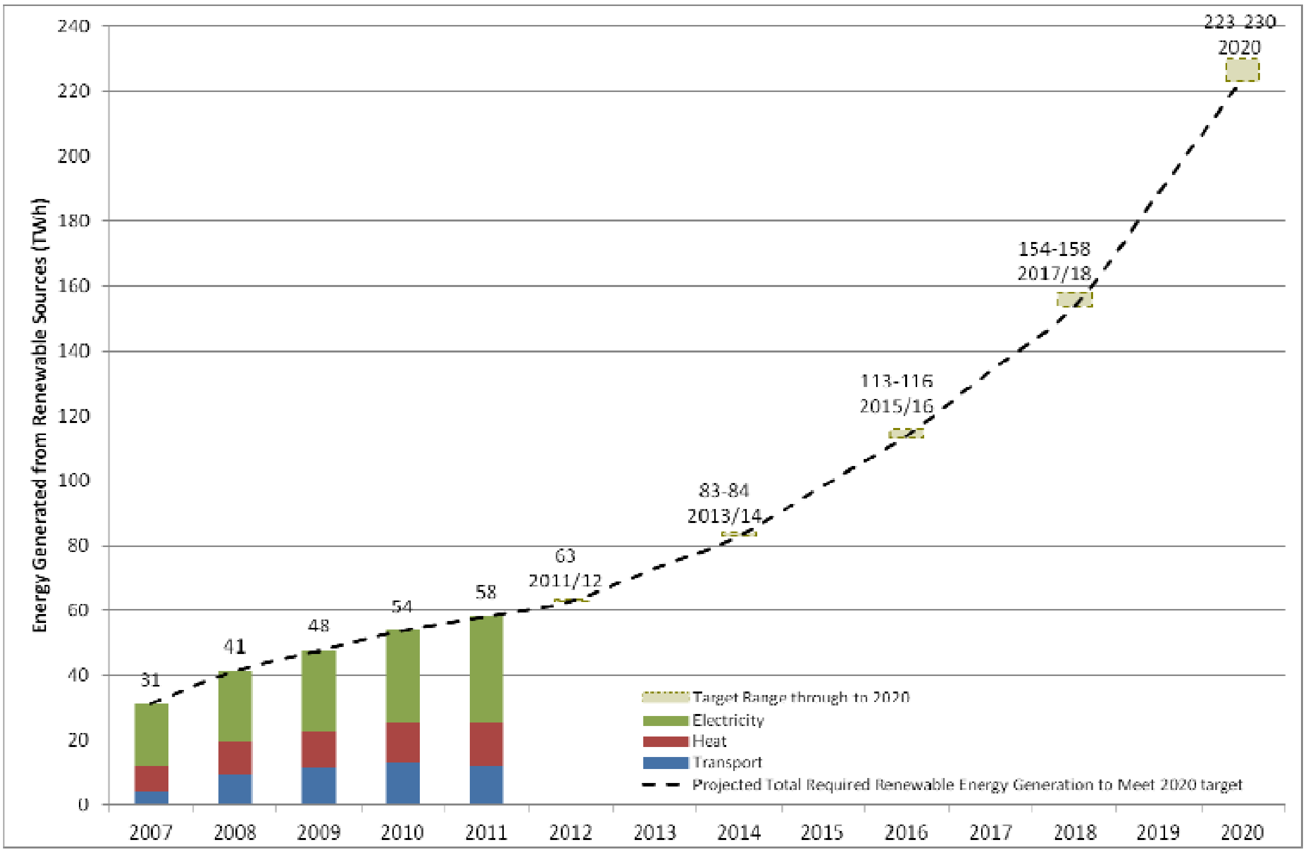

Figure 14 Progress in Renewable Electricity, Heat and Transport

The table below presents the source breakdown for renewable energy generation in UK and the share of each technology in the intermediate renewable target for 2011. [3]

Thousand tonnes of oil equivalent	2011	Percentages
Electricity generation component:		
Normalised hydro generation *(1) (2)*	431	9%
Normalised wind generation *(3)*	1,213	24%
Electricity generation from renewables other than wind, hydro, and compliant biofuels	1,137	23%
Electricity generation from compliant biofuels	-	
Total renewable generation from all compliant sources	2,782	56%
Total Gross Electricity Consumption *(2)*	31,911	
Percentage of electricity from renewable sources	8.7%	
Heat component:		
Renewable energy for heating and cooling	1,162	23%
Total Gross energy consumption for heating and cooling	52,110	
Percentage of heating and cooling energy from renewable sources	2.2%	
Transport component (excluding air transport):		
Road transport renewable electricity	-	
Non-road transport renewable electricity	59	1%
Biofuels	1,063	21%
Total electricity consumption in transport	351	
Total petrol and diesel consumption in transport	37,835	
Percentage of transport energy from renewable sources	2.9%	
Overall directive target:		
Renewables used for:		
Electricity generation	2,782	56%
Heating and Cooling	1,162	23%
Transport (Biofuels only)	1,063	21%
Total Final Consumption of Renewable Energy ["Row A"]	5,007	
Final Electricity Consumption *(4)*	27,344	
Transport Final Energy Consumption (including air transport) *(5)*	51,831	
Heating and Cooling Final Energy Consumption	52,110	
Total Final Energy Consumption *(6)*	131,286	

[3] Source: https://www.gov.uk/government/publications/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

Thousand tonnes of oil equivalent	2011	Percentages
plus Distribution losses for electricity	2,396	
plus Distribution losses for heat	0	
plus Consumption of electricity in the electricity and heat generation sectors	1,415	
plus Consumption of heat in the electricity and heat generation sectors	-	
Gross Final Energy Consumption (GFEC)	135,096	
of which Air transport	12,162	
Air transport as a proportion of GFEC	9.00%	
Air transport cap specified in Directive	6.18%	
Capped air transport	8,349	
Capped Gross Final Energy Consumption (CGFEC) ["Row B"] *(7)*	131,283	
Headline Directive percentage : Renewable Energy Consumption as a percentage of Capped Gross Final Energy Consumption ["Row A" divided by "Row B"]	3.8%	

(1) Based on a 15 year average hydro load factor.
(2) Excludes generation from pumped storage.
(3) Based on a 5 year average wind load factor.
(4) Final Electricity Consumption is Gross Electricity Consumption minus generators' own use of electricity and losses.
(5) Includes consumption of petrol and diesel, biofuels, other oil products, and coal.
(6) Total final consumption less non-energy use, as shown in Annex I, Table I.1, available on the DECC website.
(7) This row includes adjustments for loses, and generators own use of electricity, combined with the capping mechanism for air transport as specified in the Directive.

4.1 Scotland

The target is to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as the target of 11% renewable heat.

In 2011, the equivalent of 36.3% of gross electricity consumption was from renewable sources, up from 24.1% in 2010. This surpassed the interim target of 31% by 2011. A target of 50 per cent by 2015 is set up.

In 2011, it was estimated that the equivalent of 3.8% of projected 2020 heat demand was met from renewable sources. [4]

Fuel Source	**2010**	**2011**
Hydro	3,313	5,332
Wind, wave, tidal and solar	4,862	6,992
Landfill Gas	534	507
Other biofuels	882	898
Total renewables	**9,591**	**13,728**
% of gross consumption	24.2%	36.3%

4 2020 Routemap for Renewable Energy in Scotland, The Scottish Government, link: http://www.scotland.gov.uk/Resource/Doc/917/0118802.pdf
Energy in Scotland, January 2013, link: http://www.scotland.gov.uk/Resource/0041/00415880.pdf

5.1 Calculating annual costs

The rates below are taken from Scottish Power. This rate was chosen for two reasons. (i) Verco has discussed with Scottish Power the process of implementing a special tariff rate for infrared panels, and (ii) as they currently have over 5 million customers within the UK (the Scottish population is 5,295,400 million[5]). The tariffs rates are separate for electric storage heating, and one tariff heating.

This difference in tariff cost is highlighted to show the possible obstacle to moving to a lower carbon system such as Infranomic infrared panels. With the introduction of a reduced tariff for low carbon technologies however, the running costs associated with Infranomic panels would be significantly lower, in addition to achieving a 41% reduction in carbon emissions.

Tariff	Night/Off Peak (p/kWh)	Standard/Day tariff (p/kWh)
Scottish Power Standard (dual tariff)	6.883	14.181
Scottish Power Standard	n/a	12.331

Table 5 Breakdown of Scottish Power Tariffs

5.2 Electricity Suppliers

British Gas, Scottish & Southern, and Scottish Power were contacted over the duration of this study to enquire about the potential for a reduced tariff for infrared heating due to the potential to help meet UK targets especially in conjunction with solar power.

British Gas and SSE did not respond. Scottish Power provided a negative response due in part to a misunderstanding of the technology in question. It may be very beneficial to bring representatives from the key energy companies together and explain the concept to them.

This reports sets out to highlight the potentially large savings that could be achieved with the use of Infranomic infrared heating and in particular the potential to 'make' electricity unlike the lower carbon alternative of natural gas. A low carbon electric system has the security of supply as well as the simplicity of installing such a system.

The results below also show the potential reduction in carbon emissions when combined with photovoltaic panels. Typically Scotland get about 800-900 kwh per 1kw panel, so Verco have erred on the side of caution and assumed that our 1.5kw panel could make a minimum of 800kwh/year [6]

[5] Scottish census 2011 http://www.scotlandscensus.gov.uk/en/

[6] http://www.spssolar.co.uk/ReturnOnInvestment/ArraySize.asp http://www.solarecopanels.co.uk/solarinfo.html

Dwelling	Fabric	Heating	Floor Area (m2)	kWh/m2	Total Annual kWh	Annual CO2 emissions (kg)	Annual CO2 saving compared to storage	Annual KWh with PV installed	Annual CO2 emissions (kg) incl. PV reduction	Annual CO2 saving including PV (%)
Bungalow	Brick	Storage	123	296	**36,408**	**18,821**	-	**35,608**	**18,407**	2%
Bungalow	Brick	IR Panel	123	175	**21,481**	**11,104**	41%	**20,681**	**10,691**	4%
Bungalow	Brick	ASHP	123	182	**22,386**	**11,572**	39%	**21,586**	**11,159**	4%
Bungalow	Wood	Storage	123	230	**28,290**	**14,624**	-	**27,490**	**14,211**	3%
Bungalow	Wood	IR Panel	123	136	**16,691**	**8,628**	41%	**15,891**	**8,215**	5%
Bungalow	Wood	ASHP	123	170	**20,910**	**10,809**	26%	**20,110**	**10,396**	4%
Bungalow	Lightweight	Storage	123	241	**29,643**	**15,324**	-	**28,843**	**14,910**	3%
Bungalow	Lightweight	IR Panel	123	142	**17,489**	**9,041**	41%	**16,689**	**8,627**	5%
Bungalow	Lightweight	ASHP	123	183	**22,509**	**11,636**	24%	**21,709**	**11,222**	4%
Semi detache	Brick	Storage	101	445	**44,945**	**23,234**	-	**44,145**	**22,820**	2%
Semi detache	Brick	IR Panel	101	263	**26,518**	**13,708**	41%	**25,718**	**13,294**	3%
Semi detache	Brick	ASHP	101	418	**42,218**	**21,824**	6%	**41,418**	**21,411**	2%
Semi detache	Wood	Storage	101	579	**58,479**	**30,230**	-	**57,679**	**29,817**	1%
Semi detache	Wood	IR Panel	101	342	**34,503**	**17,836**	41%	**33,703**	**17,422**	2%
Semi detache	Wood	ASHP	101	542	**54,742**	**28,298**	6%	**53,942**	**27,885**	1%
Semi detache	Lightweight	Storage	101	227	**22,927**	**11,852**	-	**22,127**	**11,438**	3%
Semi detache	Lightweight	IR Panel	101	134	**13,527**	**6,993**	41%	**12,727**	**6,579**	6%
Semi detache	Lightweight	ASHP	101	226	**22,826**	**11,800**	0.4%	**22,026**	**11,386**	4%
Flat	Brick	Storage	68	443	**30,124**	**15,572**	-	**29,324**	**15,159**	3%
Flat	Brick	IR Panel	68	261	**17,773**	**9,188**	41%	**16,973**	**8,774**	5%
Flat	Brick	ASHP	68	215	**14,620**	**7,558**	51%	**13,820**	**7,144**	5%
Flat	Wood	Storage	68	577	**39,236**	**20,283**	-	**38,436**	**19,869**	2%
Flat	Wood	IR Panel	68	340	**23,149**	**11,967**	41%	**22,349**	**11,553**	3%
Flat	Wood	ASHP	68	271	**18,428**	**9,526**	53%	**17,628**	**9,113**	4%
Mid terrace	Brick	Storage	180	230	**41,400**	**21,401**	-	**40,600**	**20,988**	2%
Mid terrace	Brick	IR Panel	180	136	**24,426**	**12,627**	41%	**23,626**	**12,213**	3%
Mid terrace	Brick	ASHP	180	231	**41,580**	**21,494**	-0.4%	**40,780**	**21,081**	2%
Mid terrace	Wood	Storage	180	425	**76,500**	**39,546**	-	**75,700**	**39,132**	1%
Mid terrace	Wood	IR Panel	180	251	**45,135**	**23,332**	41%	**44,335**	**22,919**	2%
Mid terrace	Wood	ASHP	180	262	**47,160**	**24,379**	38%	**46,360**	**23,965**	2%
Mid terrace	Lightweight	Storage	180	228	**41,040**	**21,215**	-	**40,240**	**20,802**	2%
Mid terrace	Lightweight	IR Panel	180	135	**24,214**	**12,517**	41%	**23,414**	**12,103**	3%
Mid terrace	Lightweight	ASHP	180	207	**37,260**	**19,261**	9%	**36,460**	**18,848**	2%

Table 6 Results from design builder modelling of archetypes including PV

5.3 Scotlands Smart Grid Strategy

Scotlands Smart Grid Strategy aims to make Scotland a low-carbon economy, generating all of it's own electricity from renewable resources by 2020.

Smart Grids offer many interrelated benefits such as the integration of large-scale and micro-renewables without the need for extensive infrastructure upgrades, reduced need for peak power plants, improved grid asset utilisation and operational efficiency, improved reliability of service and accommodation of future demand. In addition, Smart Grids are important enablers for the transition towards the low carbon economy.

The Power Networks Demonstration Centre is a venture between the University of Strathclyde, Scottish Enterprise, the Scottish Funding Council, Scottish Power and Scottish and Southern Energy aimed at accelerating the adoption of novel research and technologies into the electricity industry.[7]

Their vision, to provide a purpose built platform for researching and developing state of the art electrical transmission, distribution and generation innovation. They aim to provide a realistic and controllable test bed for the development of emerging technologies that will support the realisation of a de-carbonised grid. And to create a rapid technology pipeline accelerating the proving and deployment of integrated solutions. They will play a key role in Scotlands Smart Grid Strategy.

Smart Grids are a worldwide development. Globally there are currently more than one hundred Smart Grid pilot projects under way, with roughly the same number planned. In Europe, the target has been set for all meters to be converted to smart meters by 2022. The UK Government has mandated a roll-out of smart meters to all UK homes and small businesses.

The start of the mass roll-out has been scheduled for the second quarter of 2014, with the aim of completing the roll-out by 2020. Scotland faces particular challenges due to the increasing capacity of large-scale renewables connected to relatively low voltage transmission lines and the distribution network. Apart from the opportunities in the Scottish market, there is a large global market opportunity for exporting Smart Grid technologies and services. However, in order to be successful Scotland will need to act quickly as there are already many Smart Grid initiatives under way globally.

Infranomic infrared heating panels could play a significant role in this development and the overall decarbonising of the grid, reducing the demand on supply, thereby increasing the security of supply, and playing a pivotal role in reaching renewable targets by becoming an integrated electric – renewable system.

[7] http://www.strath.ac.uk/pndc/

6. Overview of domestic homes – the Scottish Perspective

Scottish Housing Condition Survey

According to the Scottish Housing Condition Survey, 24% of Scottish homes are solid wall constructions –these are wide spread and include tenement flats in cities as well as the stone cottages in the countryside. The characteristics of solid walls differ from modern properties as they tend to be less airtight and are also permeable, allowing for movement of air and moisture through the properties themselves.

Homes Fit for the 21st Century[8] outlines the Scottish Governments strategy towards providing better homes and creating a housing system which provides affordable homes for everyone, this will include retrofitting efficient heating systems.

The Scottish Housing Survey has identified 197,000 dwellings that are off-grid, assuming that these dwellings are all fuelled with electric storage heating they would therefore emit an average of 19.4 t/CO_2 per year per dwelling. This equates to 3,821,800 t/CO_2 each year. By retro-fitting these heating systems with Infranomic panels, the total yearly emissions for off grid dwellings would be 2,2,51,907 t/CO_2.

6.1 Existing policies for domestic energy efficiency

In 2011-12 the Scottish Government allocated over £55 million to support its energy efficiency and fuel poverty programmes. More than £13 million of this was made available for local authorities through the Scottish Government's Universal Home Insulation Scheme (UHIS), enabling them to offer energy efficiency advice and free insulation to more than 200,000 households in Scotland. The scheme also drew in significant funding through the Carbon Emissions Reduction Target (CERT) – around £0.5m for every £1m of available Scottish Government funding. UHIS is area specific, with areas that need the greatest support being selected and put forward by the local authorities themselves. In 2012-13 the Scottish Government is investing over £16 million to fund UHIS.

A National Retrofit Programme is being designed to build on the work achieved in the previous programmes and to be the overarching structure for both proposed and future programmes, with a view to use available Government funding and to leverage significant levels of additional funding. The programme aims to make Scotland the ideal place in Britain for Energy Companies to use their obligations to support energy efficiency. At the core of this strategy will be area based schemes run by Local Authorities. The focus will be on fuel poor areas first and the programme will work alongside the Warm Homes Fund. It is projected that this will cover all areas in the next ten years, based on the rate of progress of existing area based programmes.

The report on proposals and policies (the RPP) sets out the action needed by government, business, individuals and communities. The government then aims to encourage and facilitate Local Authorities in to using available Green Deal and ECO funding through the NRP.

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[8] 'Homes Fit for the 21st Century: The Scottish Government's Strategy and Action Plan for Housing in the Next Decade: 2011-2020' published by the Scottish Government, 2011.

6.2 Scottish Renewables Targets

The Routemap for Renewable Energy in Scotland 2011 is an update and extension to the Scottish Renewables Action Plan 2009. This updated and expanded Routemap reflects the challenge of the newer target to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as the target of 11% renewable heat.

6.3 HEEPS

HEEPS (Home Energy Efficiency Programmes for Scotland) is the new Scottish Government initiative to tackle fuel poverty and increase energy efficiency in homes.

It was launched in April 2013 to take over from the Energy Assistance Package, Universal Home Insulation Scheme and Boiler Scrappage Scheme.

HEEPS is a cluster of programmes currently including:

- Affordable Warmth
- Area Based Schemes (ABS)
- Energy Assistance Scheme
- Gas Infill

Most elements are being managed by The Energy Saving Trust (except ABS) through the 'Home Energy Scotland hotline' on behalf of the Scottish Government. This is being carried out in partnership with a range of advice providers and the energy companies. They offer energy efficiency advice, information on low cost energy tariffs, and advice on income maximisation, as well as a wide range of energy efficiency measures.

Under the Affordable Warmth Scheme energy efficiency measures are installed and paid for by energy companies who may offer different measures ranging from heating to insulation.

6.4 Green Deal

The Green Deal is the UK government's flagship energy policy intended to improve the energy efficiency of the existing building stock. It is a market led approach to facilitate investment in energy efficiency measures within buildings.

Under this policy, Green Deal providers will finance and install energy efficiency improvements from autumn 2012. They recoup their investment through a charge on the electricity bill for the duration of the Green Deal plan. The charge remains with the improved home even if the person living there moves.

6.4.1 Green Deal Measures

Green Deal Measures are 'improvements' made to a property which has been financed through the Green deal. This can include part financing where a customer chooses to pay for some of the work themselves.

"The Energy Bill sets out that the Green Deal may cover measures which generate energy as well as those termed "energy efficiency" measures. If a measure is capable of paying for itself self because occupiers use less energy as result of the installation – then it can potentially qualify. Energy efficiency will often be used as short-hand for the types of measures which can attract finance even if this is not technically correct for all cases."[9]

The Green Deal measures now included post-consultation are shown in Table 9 and are found in 'The Green Deal (Qualifying Energy Improvements) Order 2012:

The Green Deal Order specifies descriptions of energy efficiency improvements for the purposes of section 1(4)(b) of the Act.

Under article 3, the energy efficiency improvements in the Schedule to this Order are specified for the purposes of section 1(4)(b) of the Act as qualifying energy improvements. Subject to the other requirements of section 1(4) of the Act, an energy plan will be a green deal plan under the Act where qualifying energy improvements are installed under the plan at an eligible property within the meaning given by section 1(9) of the Act.

A full regulatory impact assessment of the effect that this instrument will have on the costs of business and the voluntary sector is available from the Green Deal Legislation Team, Department of Energy and Climate Change, 3 Whitehall Place, London SW1A 2HH and is published with the Explanatory Memorandum alongside the instrument on www.legislation.gov.uk. [10]

Since the consultation has been passed this now includes radiant heating. The availability of Green Deal Finance significantly improves the viability of IR panels compared with other systems. The actual costs associated with Green Deal funding will need to be researched. The IR panels will also need to fall within the Golden Rule.

6.4.1 Green Deal – Golden Rule

The Green Deal Golden Rule refers to the estimated savings on a customer's energy bill due to the energy efficiency improvements made to the property. In most cases repayment levels will be based on heating bills for the property or the typical energy bills of a similar property. The Green Deal is designed to save the customer as least as much money as they will have to repay. The actual level of savings will depend on how much energy is used and the future cost of energy.

Green Deal providers described as being near Direct Savings are shown in Appendix 4.

6.5 ECO

The Energy Company Obligation (ECO) puts on obligation on energy suppliers to meet specific CO_2 reduction and affordable warmth targets through energy efficiency upgrades in domestic properties. ECO will replace the existing Carbon Emissions Reduction Target (CERT) and Community Energy Saving Programme (CESP) supplier obligation schemes in December 2012. In the early years, while customer awareness and take up of Green Deal is low and the market is still becoming established, finance delivered through ECO is likely to dominate the market with the expected value of ECO exceeding Green Deal by several times. It is estimated that ECO funding will be worth around £1.3 billion annually across the UK which translates into a pro rata share of

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48088/1734-what-measures-does-the-green-deal-cover.pdf pg4
[10] http://www.legislation.gov.uk/uksi/2012/2105/note/made

around £141m per annum for the Scottish housing sector. ECO will be delivered in one of three ways: Affordable Warmth Obligation, Carbon Saving Obligation and the Carbon Saving Communities Obligation.

1. **Affordable Warmth Obligation.** Low income households in the private rented and owner occupied sectors will be eligible for potentially free measures under this stream of ECO. Measures that reduce the notional cost of heating the property will be supported with loft insulation, cavity wall insulation, and heating systems expected to be the most common measures.
2. **Carbon Saving Obligation.** This will target hard to treat homes (i.e. those with solid walls or hard to treat cavities) across all tenures.
3. **Carbon Saving Communities Obligation.** Households in all tenures located in the bottom 15% of Lower Super Output Areas based on the Index of Multiple Deprivation (and equivalent index in Scotland) will be eligible for loft, cavity and solid wall insulation. The requirement for 15% of the overall target to be delivered to rural, low income households in settlements with a population size under 10,000 is likely to drive uplift in the value energy companies are prepared to pay for homes in these areas.

The carbon savings and carbon saving communities obligation within ECO can work in conjunction with the Green Deal, or as a standalone funding option.

7. Conclusion

The study shows that Infranomic infrared heating panels offer a valid alternative to other heating solutions as IR panels can produce human comfort conditions in a heated space at lower air temperatures and with less thermal gradient within the space and less infiltration heat loss. These factors combine to allow IR panels to offer lower energy consumption, lower carbon emissions and lower running costs than either storage heaters or air-source heat pumps.

The Scottish Housing Survey has identified 197,000 dwellings that are off-grid, assuming these dwellings were fuelled with electric storage heating they would emit an average of 19.4 t/CO_2 per year per dwelling. This equates to 3,821,800 t/CO_2 each year. By retro-fitting these heating systems with Infra-nomic panels, the total yearly emissions for off grid dwellings would be 2,2,51,907 t/CO_2 – **a potential annual carbon saving from home heating of 1,569,893 t/CO_2.**

In conjunction with this, solar PV can be included to produce the electricity required. The savings from this vary widely based on suitability of homes for PV panels, but assuming a relatively low production of 800kWh per annum a home could achieve an additional 4% carbon reduction.

Detailed modelling of the annual thermal performance of an infrared panel system compared to storage heating and air-source heat pumps showed that the infrared panels performed best in terms of control, comfort, energy consumption and carbon emissions.

Typically, the Infranomic infrared panel consumed 41% less energy required to heat the space compared with electric storage heaters.

There appears to be little opportunity for Infranomic panels to attract a specific and attractive tariff from Scottish Power or other providers. However, the government has put in place a series of measures to encourage the uptake of energy efficiency measures in housing. Chief among these is the “Green Deal”, to which radiant heating has recently been added as a supported technology.

Radiant heating is a generic term for heating systems that would be expected to include Infranomic panels however this will need to researched further - the application of Green Deal funding to Infranomic panels will depend on the ability of a proposal to satisfy the “Golden Rule” that all investment can pay for themselves from the savings made. In order to ensure this rule is satisfied it is imperative that the energy suppliers and/or the Government consider a special rate for electricity consumption from national grid by Infrared panels if they are serious about achieving their high carbon reduction targets.

Appendix 1 - ESRU ESP-r Report

The Green Deal

Standard Note: SN/SC/5763
Last updated: 15 March 2013
Author: Patsy Richards
Section Science and Environment Section

The Green Deal is the Government's "flagship piece of legislation, which will deliver energy efficiency to homes and buildings across the land".

The Green Deal went 'fully live' on 28 January 2013 in England and Wales and on 25 February 2013 in Scotland. In March 2013 the first in a series of monthly uptake statistics was released.

Through the Green Deal, energy customers in England, Wales and Scotland will receive loans to make energy efficiency improvements. The repayments will attach to the electricity bill at a property, rather than to an individual, passing to any new occupier or bill payer.

The "golden rule" is that the instalment payments should not exceed the savings on an average bill, but because this is on an *average* bill, there is the chance that in some cases, a household's energy savings may not cover the cost of the Green Deal package.

This, together with concerns about Green Deal being basically a loan with interest, rather than a grant scheme, has led to concern about Green Deal take up.

A new energy company obligation (ECO) will underpin the Green Deal for 'those most in need' and for hard to treat homes where measures do not fit the golden rule. This will take over from former energy supplier obligations (CERT and CESP) which ended in 2012. It will have three elements, "Affordable Warmth", the "Carbon Saving Obligation" and the "Carbon Saving Communities Obligation". ECO started on 1 January 2013 for Great Britain.

The Library standard notes on fuel poverty and Energy Efficiency Schemes are related to this issue, while the Library Research Paper on the *Energy Bill 2011* gives more background.

8 Annex 2 Green Deal qualifying energy improvements

The Green Deal (Qualifying Energy Improvements) Order 2012 SI 2012/2105 has a longer schedule, showing which measures are qualifying energy improvements under section 1(4)(b) of the Act:

The energy efficiency improvements specified by article 3 are—
(a)air source heat pumps;
(b)biomass boilers;
(c)biomass room heaters (with radiators);
(d)cavity wall insulation;
(e)chillers;
(f)cylinder thermostats;
(g)draught proofing;
(h)duct insulation;
(i)gas-fired condensing boilers;
(j)ground source heat pumps;
(k)hot water showers;
(l)hot water systems;
(m)hot water taps;
(n)external wall insulation systems;
(o)fan-assisted storage heaters;
(p)flue gas heat recovery devices;
(q)heating controls for wet central heating systems or warm air systems;
(r)heating ventilation and air-conditioning controls (including zoning controls);
(s)high performance external doors;
(t)hot water controls (including timers and temperature controls);
(u)hot water cylinder insulation;
(v)internal wall insulation systems (for external walls);
(w)lighting systems, fittings and controls (including rooflights, lamps and luminaires);
(x)loft or rafter insulation (including loft hatch insulation);
(y)mechanical ventilation with heat recovery systems;
(z)micro combined heat and power;
(aa)micro wind generation;
(bb)oil-fired condensing boilers;
(cc)photovoltaics;
(dd)pipework insulation;
(ee)radiant heating;
(ff)replacement glazing;
(gg)roof insulation;
(hh)room in roof insulation;
(ii)sealing improvements (including duct sealing);
(jj)secondary glazing;
(kk)solar blinds, shutters and shading devices;
(ll)solar water heating;
(mm)transpired solar collectors;
(nn)under-floor heating;
(oo)under-floor insulation;
(pp)variable speed drives for fans and pumps;
(qq)warm-air units;
(rr)waste water heat recovery devices attached to showers;
(ss)water source heat pumps.

Verco are involved in a wide and varied range of projects across the UK and the world, a selection of which are detailed below:

Scottish Fuel Poverty Funding Study

Client: WWF

This research has been commissioned by WWF Scotland to assess the level of investment expected in domestic energy efficiency under both current and proposed programmes, and whether this would be sufficient to meet Scotland's fuel poverty eradication and medium-term CO2 emissions reduction target from the housing sector.

For the analysis, the Scottish housing stock was classified into archetypes based on the dwelling form, wall construction and heating fuel. For each archetype, sub-archetypes were defined to cover a range of starting energy efficiency performance levels or SAP scores. The 2008-2010 Scottish Housing Condition Survey (SHCS) data was used as the basis of the analysis.

As part of this project Verco identified packages of measures that would satisfy the Green Deal 'Golden Rule' for each of the archetypes and sub-archetypes. The 'Golden Rule' requires that the Green Deal annual payment should not exceed the projected associated cost savings from energy efficiency measures for the duration of the Green Deal Finance arrangement.

North London sub-regional housing stock analysis and business plan (2011)

Client: LB of Haringey and other north London boroughs (funded under DECC's Low Carbon Framework pilot)

Verco was commissioned on behalf of six North London boroughs to develop a finance and delivery model for low carbon investment in housing. As part of the study, we developed an address-level housing tool for 580,000 homes across the six boroughs to help assess the technical potential for energy efficiency improvements and Green Deal investment at address and COA (Census Output Area) level. The tool was intended for use by non-technical staff to help define programmes and monitor progress and was accompanied by a simple user guide.

We also identified archetype properties and produced household-level financial models for each archetype, showing what an optimum Green Deal and Advanced ECO package might look like. We then produced a portfolio financial model for an 80,000 home, 10 year refurbishment programme, examined four primary finance and delivery models and extensively tested these both within and outside the local authority groups. This is arguably the most thorough piece of analysis to date on Green Deal opportunities, including the range of risks, values and delivery options for Local Authorities.

Public sector carbon reduction potential (PVP) & analysis of DEC results (2010 -2011)

Client: Carbon Trust/ DECC

Verco was contracted by the Carbon Trust on behalf of the Department of Energy and Climate Change (DECC) and HM Treasury (HMT) to undertake a high level review, based on existing information, of the total greenhouse gas (GHG) emissions footprint of the public sector in England, the potential size of carbon savings achievable, and the likely impact of existing and proposed policies and incentives on achieving those emissions reductions.

As part of a separate project for DECC, Verco analysed data available from the DECs (Display Energy Certificates) lodged on the Landmark register to yield information about the low carbon potential of the Public Sector. This was combined with Verco's previous work analysing the Carbon Trust's public sector carbon management programme closeout database and a range of other datasets to provide a best estimate of baseline energy use in buildings in 2008-09 and projected cost-effective carbon savings. The analysis of the DEC data supplements the previous work with quality-assured information at the individual building level.

Green Deal potential in social housing (2010-2011)

Client: National Housing Federation

This study analysed the potential for Green Deal to deliver viable CO2 reductions in the social housing sector. As part of this study, Verco modelled appropriate Green Deal packages for all relevant social housing property types, calculated the scale of investment required for cost-effective packages and quantified carbon reductions taking into account the impact of grid decarbonisation. This analysis supported discussions of the Green Deal Working Group which, in turn, helped inform government policy in this important area.

New Finance mechanisms for Housing Refurbishment

Client: Energy Efficiency Partnership for Homes, EST

This work builds on the preliminary study for EEPfH and NHF that involved modelling the financial barriers and incentives to whole house refurbishment and liaising with key stakeholders including financial institutions, economists and housing associations. It uses the EST Housing Model to assess the national potential for commercially viable carbon reduction opportunities in existing housing through alternative finance mechanisms such as PAYS and ESCo approaches. We presented the results to key policymakers including DECC and CLG, as well as HCA's Housing Finance Group.