Energy House 2.0

Final Report

Description:
Test report on various heating systems to meet Future Homes Standard

Client:
Barratt Developments PLC, Bellway Homes, Saint Gobain and Salford University Energy House

Heating System:
Vaillant and Panasonic Air Source Heat Pump

Emitters:
Radiators, UFH and Radiators, ThermaSkirt (BM2 & BM3)

Synopsis by Discrete Heat

DiscreteHeat™ ThermaSkirt™ University of Salford MANCHESTER

Future Homes Standard

Salford's Energy House can create snow, rain, winds and temperatures from -20°C to +40°C to test full size house

The future homes standards (FHS) will require a new approach and predicates the elimination of gas boilers from all new properties. For some market sectors, this means all-electric heating such as radiant panels or space heaters, but the vast majority of developers, air source heat pumps (ASHP) will be the de facto heat generator, providing low temperature hot water (LTHW) to radiators or similar.

As of 2022, regulations under Part L mandate that all newbuild heating systems operate at a boiler flow temperature of **55°C**. This measure aims to reduce gas consumption by up to **12%**, resulting in a corresponding decrease in CO_2 emissions.

A reduction in boiler flow to **55°C** results in a radiator correction factor of approximately **0.5**, or, in layman's terms, roughly double the size. A further reduction to a flow temperature of **45°C** requires a correction factor of approximately **0.3**; the radiators must increase by two thirds to compensate for the drop in output.

Testing Protocol

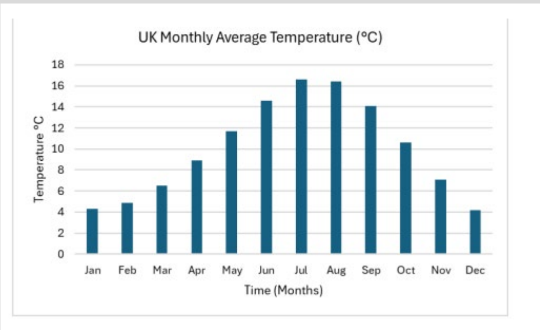
Barratt Homes and Bellway homes constructed two typical detached properties in the £16m Energy House 2 facility at Salford University, which can control the climate to enable heating systems to be tested under laboratory conditions.

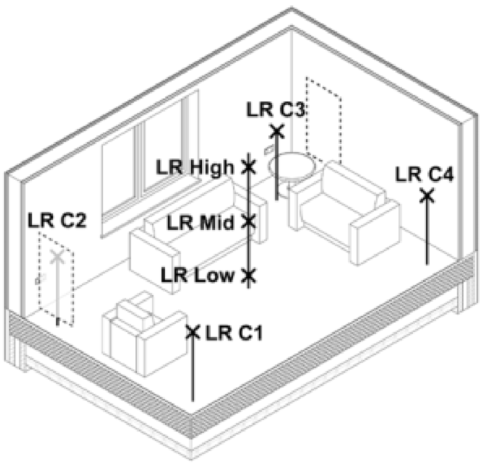
This includes creating temperatures as low as -20°C, rain, snow, wind etc and holding those conditions for a defined period.

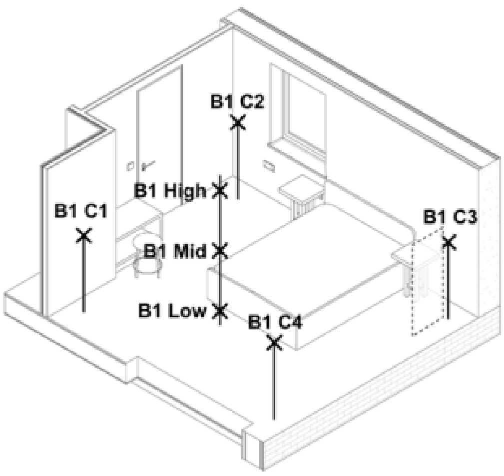
In both houses, ASHPs were deployed, with Bellway opting for either radiators only or UFH and radiators at first floor, and in bathrooms etc. Barratts opted to test the ThermaSkirt on both floors, with only towel radiators in bathrooms and en suites.

The two houses were then tested at -5°C and +5°C ambient outside temperatures and with both a continuous 24–hour running cycle and a more onerous (for a heat pump) stop/start 'SAP' cycle over a 24–hour period. This was to replicate the average winter UK temperatures (+5°C) and a more serious cold snap (-5°C).

The living room was set a target temperature of 21°C, with the kitchen and bedrooms set to the current building standard design temperature of 18°C. Both Panasonic and Vaillant ASHPs were tested.







Each room was fitted with a sophisticated series of sensors to measure room temperature and heat distribution (comfort or operative temperature).

Comparative Emitter Sizes

A) Radiator Sizes

Installed Radiators				
Location	Height(mm)	Length(mm)	Type	Quantity
Living	600	700	K2	2
Kitchen/Dining	700	900	K2	1
Kitchen/Dining	700	500	K2	1
WC	700	600	K1	1
Hall	600	700	K1	1
Bedroom 1	450	700	K2	1
Ensuite	600	500	K2	1
Bedroom 2	450	600	K2	1
Bedroom 3	450	600	K2	1
Landing	600	400	K1	1
Bathroom	700	800	K1	1

B) ThermaSkirt Sizes

Table 7. Thermaskirt Specification (sized at 45 °C flow -3 °C design temperature)

Room Type	Emitter length	Heat Output (according to design)	Model Reference
Living Room	11.74 m x 115 mm	693 Watts	BM2
Kitchen/Dining (wall)	5.96 m x 170 mm	604 Watts	BM3
Kitchen/Dining (plinth)	4.35 m x 115 mm	257 Watts	BM2
Bedroom 1	6.41 m x 115 mm	378 Watts	BM2
Bedroom 2	5.86 m x 115 mm	346 Watts	BM2
Bedroom 3	4.55 m x 115 mm	268 Watts	BM2

The BM3 profile was used in the kitchen and the smaller BM2 everywhere else; including the kitchen plinths.

Room Type	Emitter length	Heat Output (according to design)	Model Ref
Living Room	11.74 m x 115 mm	693 Watts	BM2
*Living Room**	*11.74m x 170mm*	*970 Watts **	*BM3**

*In this series of tests, BM2 was used in the living room rather than the recommended BM3

C) Underfloor Heating Design

The ground floor underfloor heating consisted of approximately 380m of 17mmØ pex pipe at 150mm centres connected to a 6 zone manifold; 2 each for the living and dining/kitchen and one each for the hall and WC. Approximately 65mm of screed was poured over the insulated pipes.

Results

The temperature in each of the rooms was measured at one minute intervals and the electrical consumption measured over the testing period.

The performance and running costs could then be determined for each heat emitting strategy or, indeed, a combination of systems.

It was concluded that at -5°C ambient outside temperature, in the intermitent (SAP) mode with two short heating cycles per day, the ASHP was not able to deliver the necessary heat energy rapidly enough to bring the rooms up to temperature. This was true of all emitters, although the UFH fared better than, most due to its high thermal mass and, therefore, slow response times to both heating and cooling.

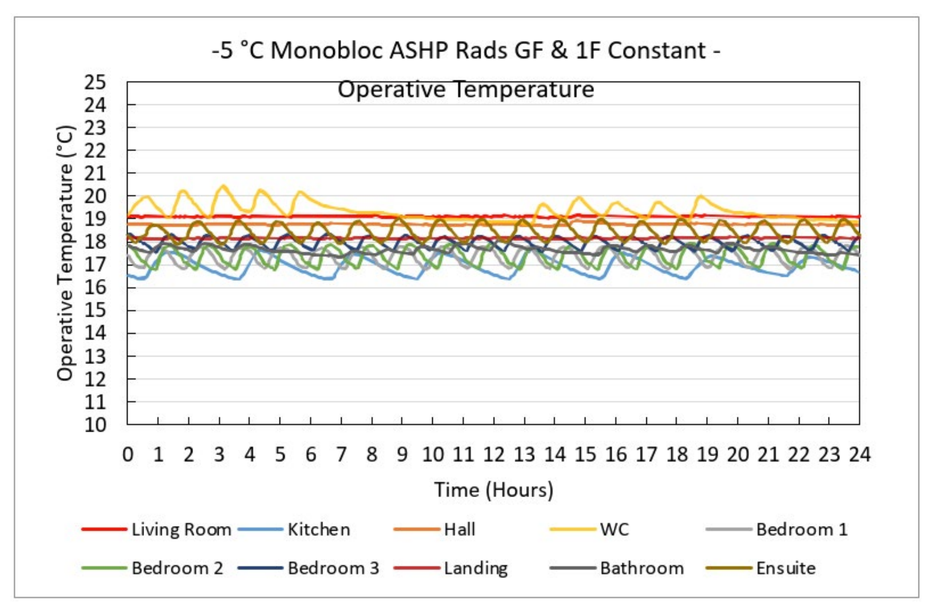
For clarity, the results here are shown for the more onerous -5°C outside temperature with the ASHP in continuous mode, which is the recommended set up according to most manufacturers and installers.

The operative temperature is shown, as this is recognised as a more appropriate measure of thermal comfort.

The results shown are for radiators at both ground and first floors, ThermaSkirt in all rooms except hallways and bathrooms, and UFH at ground floor and radiators at the first floor.

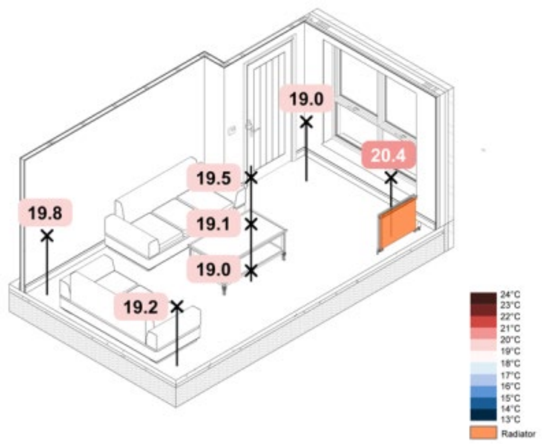
Results

A) Radiators only ground floor and first floor

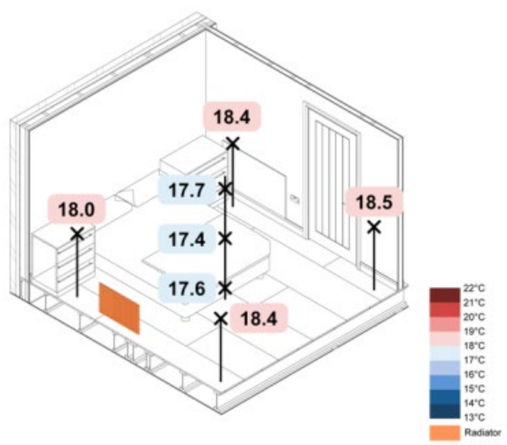


Source: Energy House 2 Systems Report by Salford University 24th Oct. 2024

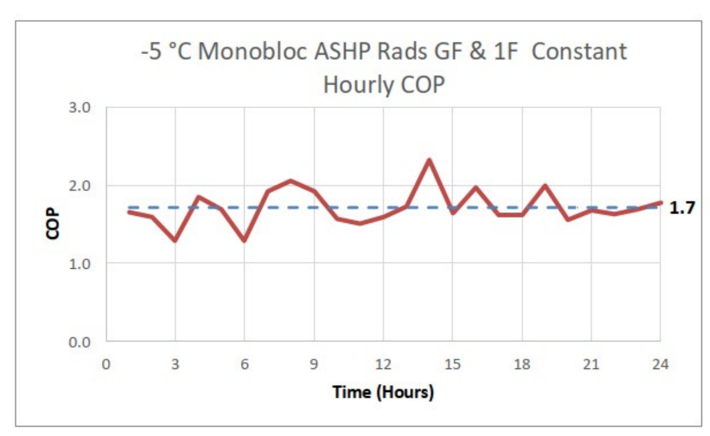
-5 °C Monobloc ASHP TFH Rads – Operative - 7h



-5 °C Monobloc ASHP TFH Rads – Operative - 7h

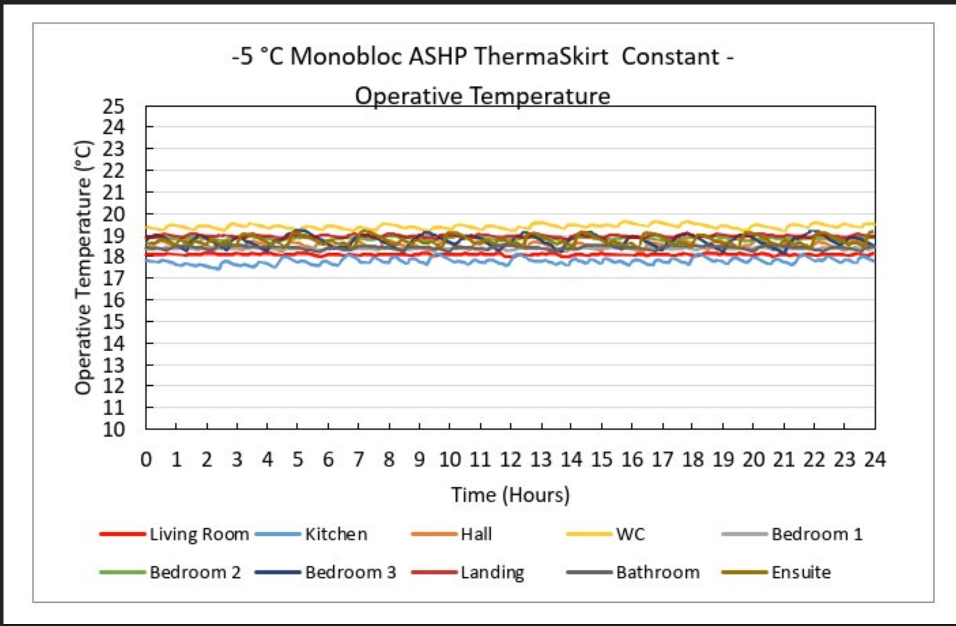


COP	SEEI (K/kWh)	24h Energy Consumption (kWh)	24h Running Cost
1.7	0.62	34.4	£8.43



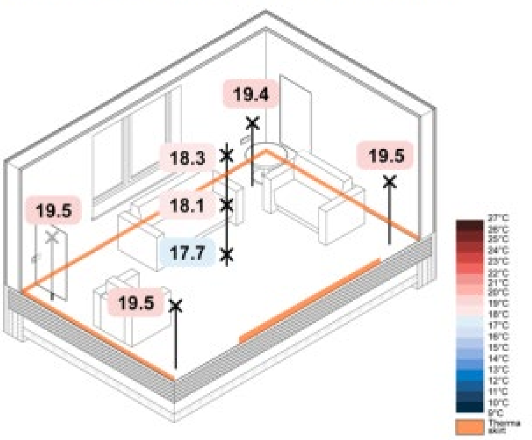
Results

B) ThermaSkirt only (towel radiators in bathrooms)

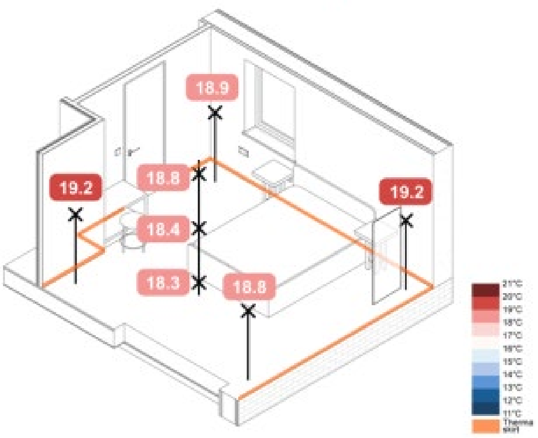


Source: Energy House 2 Systems Report by Salford University 24th Oct. 2024

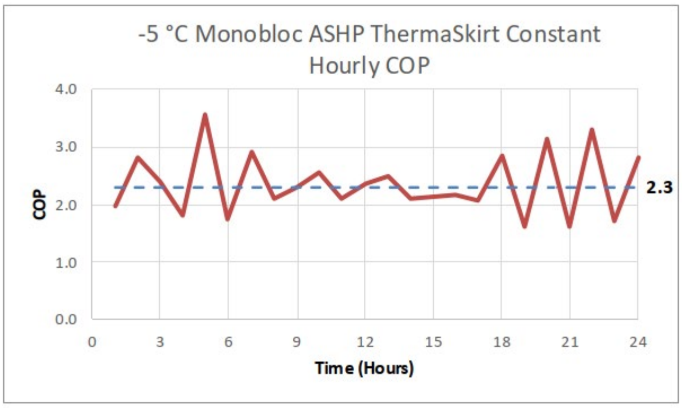
-5 °C Monobloc ASHP eHome2 Constant – Operative - 7h



-5 °C Monobloc ASHP eHome2 Constant – Operative - 7h

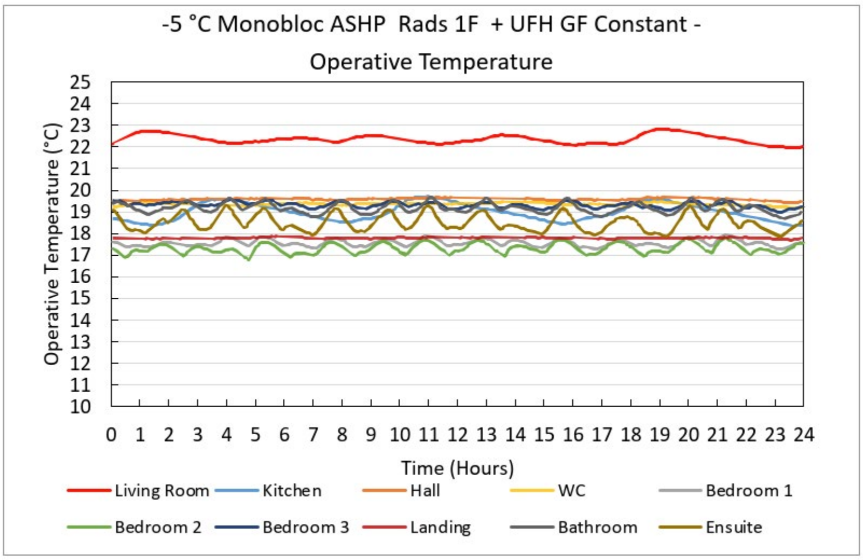


COP	SEEI (K/kWh)	24h Energy Consumption (kWh)	24h Running Cost
2.3	0.94	22.5	£5.51



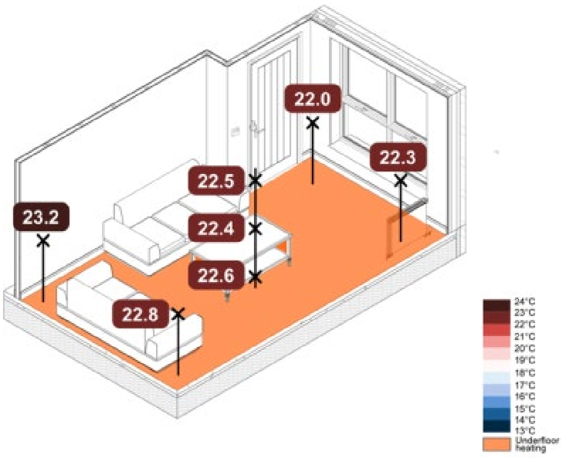
Results

C) UFH at ground floor and radiators at first floor

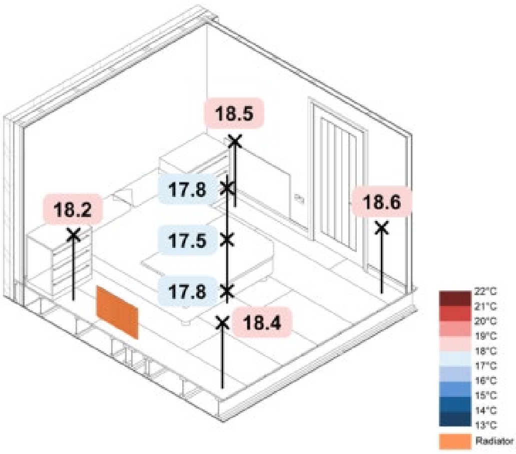


Source: Energy House 2 Systems Report by Salford University 24th Oct. 2024

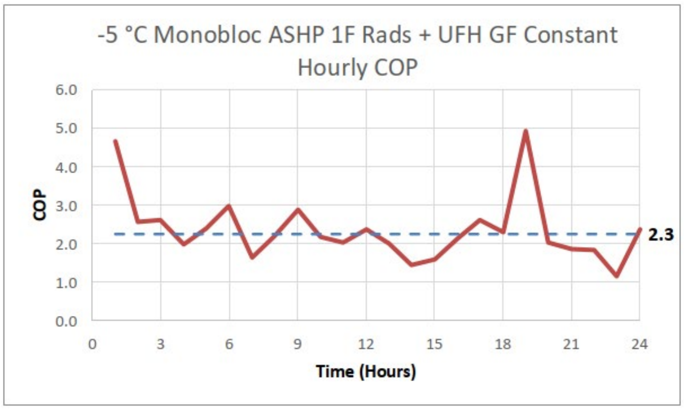
-5 °C Monobloc ASHP TFH Rads + UFH Constant – Operative - 7h

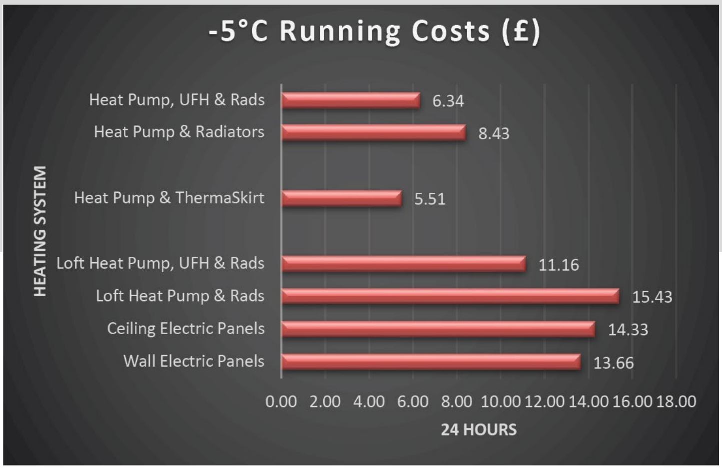


-5 °C Monobloc ASHP TFH Rads + UFH Constant – Operative - 7h



COP	SEEI (K/kWh)	24h Energy Consumption (kWh)	24h Running Cost
2.3	0.87	25.9	£6.34





Conclusion

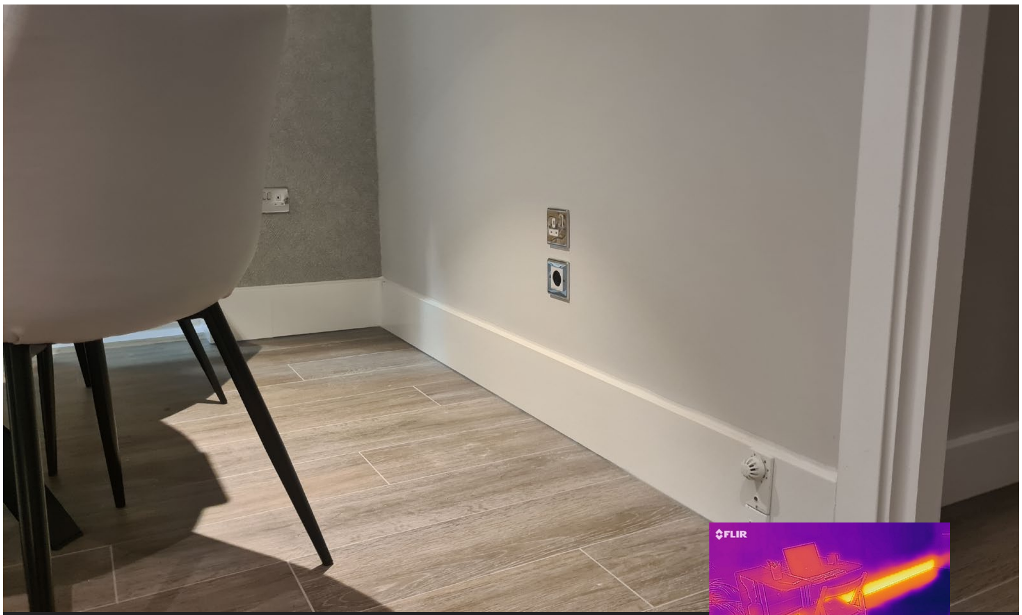
- Air source heat pumps perform best when run in continuous mode and not in intermitent mode as you would a gas boiler.
- Over zoning the controls can lead to short cycling of the ASHP and reduced CoP.
- UFH and ThermaSkirt produce the most even heating patterns.
- Radiators and ThermaSkirt have faster response times than UFH.
- The thermal mass of UFH can offset the impact of intermitent heating cycles, but requires a longer initial warm up period.
- ThermaSkirt has lower running costs compared to radiators only.
- Running costs of UFH with radiators improved compared to radiators only.
- The larger BM3 ThermaSkirt profile is required for ground floor living spaces to achieve the 21°C set point.
- Combining UFH at ground floor and ThermaSkirt at first floor would most likely provide the lowest overall running costs (this combination was not tested in this programme).

Technical & Innovations Director Oliver Novakovic, selected ThermaSkirt for tesing at EH2

"Discrete heat has been a valued partner on this project both in supporting the Z house projects and integrating with the renewable technologies, but more importantly they have looked to understand the key challenges in using their technology and the role it plays in delivering both a zero-carbon home and the future homes standard."

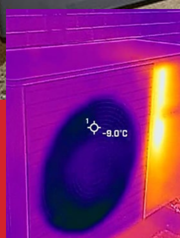
Oliver Novakovic MSc Technical & Innovation Director, Barratts Developments PLC

Conclusion



ThermaSkirt can be controlled by a simple on-board TRV like a radiator, 2 port valve or actuated manifold like UFH.

ThermaSkirt is available in a colour matched or contrasting plinth heater version for where wall space is limited.



The ASHP was tested in conditions down to -5°C in the Energy House Test Chamber

DiscreteHeat

Technical:
1 Victoria Works
Coal Pit Lane
Atherton
M46 0FY

T: 01942 880066
E: info@discreteheat.co.uk

BARRATT
DEVELOPMENTS PLC

Press & Marketing
Tim Abbott
Deputy Head of Corporate Communications
Barratt Developments PLC

T: 020 7299 4894
E: tim.abbott@barrattplc.co.uk