GREEN HOME FESTIVAL

BROUGHT TO YOU BY THE CICV

Debunking Heat Pump Myths in Pre-1919 Homes

With Barry Sharp,
Renewable Heat

Wednesday 14 August
@ 11.00am

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

greenhomefestival.co.uk

#GHF24

Introduction

- What we mean by Pre 1919 Homes
- Why it's more of a problem for Scotland
- Why is it perceived to be bad
- How we are getting it wrong
- Why its isn't actually a problem and we should just really get on with.

- We are going also Chat to Bruce who lives in semi-detached pre 1919 house and has had a heat pump for 5 years about his experiences

Introduction

- Trading for nearly 10 years, but designing, installing and maintaining heat pump systems for over 20 year
- Designed & Installed over 1000 heat pumps
- 20 directly employed staff
- Including 5 apprentices

What is pre-1919?

The definition as per a google search!

Traditional buildings are usually defined as those constructed before 1919 using solid wall construction methods and materials, including wood and stone. Construction changed rapidly after this time as new materials and faster methods of construction were introduced.

In Edinburgh we may refer to them as Georgian or Victorian homes

What is pre-1919?


WWF

AFFORDABLE WARMTH

NEXT STEPS FOR CLEAN HEAT IN SCOTLAND

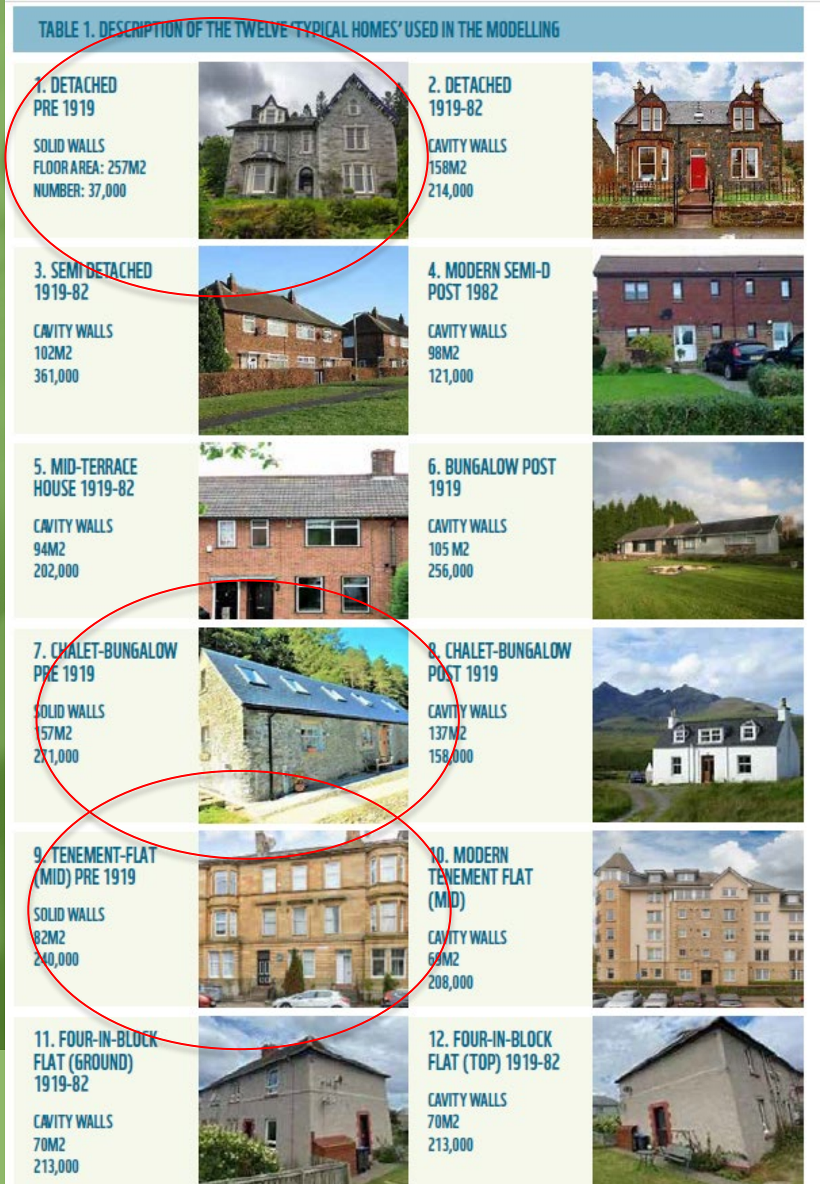


TABLE 1. DESCRIPTION OF THE TWELVE 'TYPICAL HOMES' USED IN THE MODELLING

1. DETACHED PRE 1919 SOLID WALLS FLOOR AREA: 257M2 NUMBER: 37,000	2. DETACHED 1919-82 CAVITY WALLS 158M2 214,000
3. SEMI DETACHED 1919-82 CAVITY WALLS 102M2 361,000	4. MODERN SEMI-D POST 1982 CAVITY WALLS 98M2 121,000
5. MID-TERRACE HOUSE 1919-82 CAVITY WALLS 94M2 202,000	6. BUNGALOW POST 1919 CAVITY WALLS 105 M2 256,000
7. CHALET-BUNGALOW PRE 1919 SOLID WALLS 157M2 271,000	8. CHALET-BUNGALOW POST 1919 CAVITY WALLS 137M2 158,000
9. TENEMENT-FLAT (MID) PRE 1919 SOLID WALLS 82M2 240,000	10. MODERN TENEMENT FLAT (MID) CAVITY WALLS 69M2 208,000
11. FOUR-IN-BLOCK FLAT (GROUND) 1919-82 CAVITY WALLS 70M2 213,000	12. FOUR-IN-BLOCK FLAT (TOP) 1919-82 CAVITY WALLS 70M2 213,000

What is pre-1919?

SCOTTISH HOUSING FACTS

Total Scottish homes: 2,496,000

Detached - **576,000** (built pre-1919 = 122,000)

Semi-detached **494,000** (built pre-1919 =52,000)

Terraced **525,000** (built pre-1919 =64,000)

Tenement **587,000** (built pre-1919 =184,000)

Other flats **315,000** (built pre-1919 =58,000)

- Pre-1919 total: 479,000
- 1919-44: 273,000
- 1945-64: 518,000
- 1965-82: 548,000
- Since 1982: 677,000

Source: Scottish government, 2019

19.19% of Scottish homes

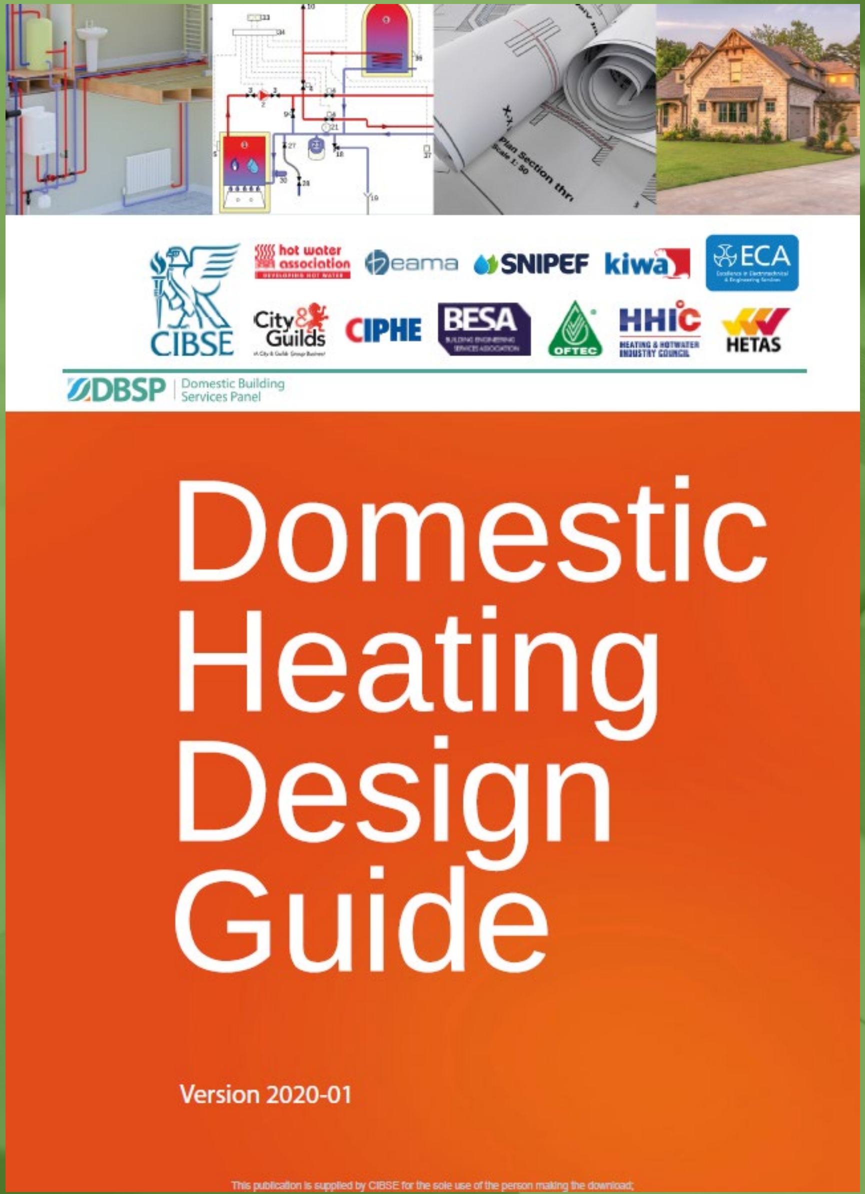
Bad Perceptions

- No insulation
- Big draughty windows
- Cold
- Open fireplaces
- Hard to heat

kW is always kW*

*Except when you measure it wrong

kW is a kW


hot water association
eama
SNIPEF
kiwa
ECA
CIBSE
City & Guilds
CIPHE
BESA
OFTEC
HHIC
HETAS
DBSP Domestic Building Services Panel
Domestic Heating Design Guide
Version 2020-01
This publication is supplied by CIBSE for the sole use of the person making the download;

Dalrymple Crescent

- **4-bedroom, 3 Public rooms**
- **172m2, c. 1860**
- **19.1kW (as per CIBSE)**
- **Not suitable for a heat pump**
- ***(For refence, roughly speaking, the maximum we can do with one heat pump on single phase is 12kW~)***

Why do I believe this is wrong?

Stone Cold

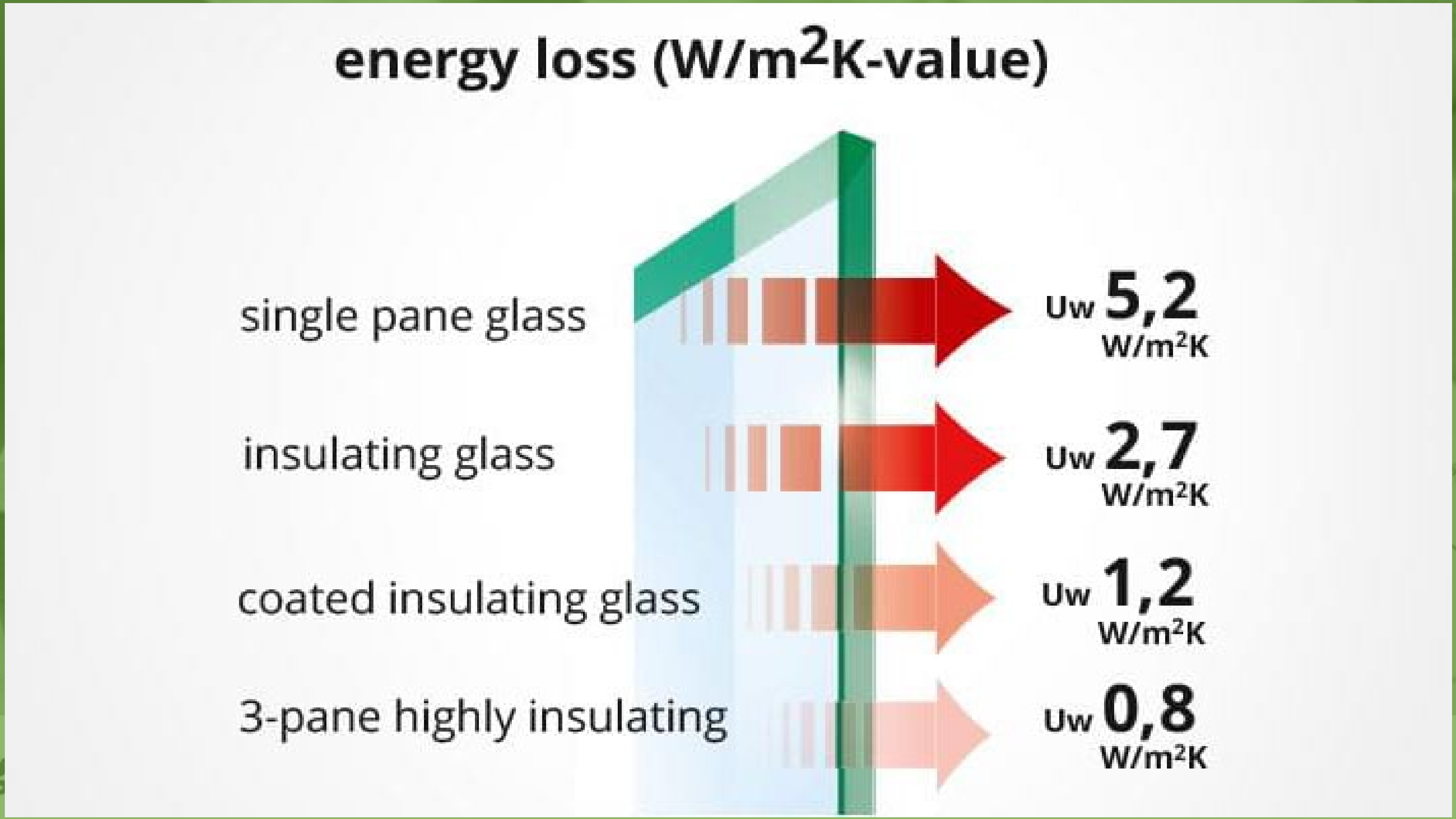
GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

- 600mm thick sandstone walls

Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

U Value measures the rate of heat transfer through a specific material (roof, walls, door, window, etc)



Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

EXTERNAL WALLS	U-value W/m²K	
Solid brick wall, dense plaster		
Brick 102 mm, plaster	2.97	
Brick 228 mm, plaster	2.11	
Brick 343 mm, plaster	1.64	
Solid stone wall, unplastered		
Stone 305mm (12in)	2.78	
Stone 457mm (18in)	2.23	
Stone 610mm (24in)	1.68	
Solid concrete wall, dense plaster		
Concrete 102mm, plaster	3.51	
Concrete 152mm, plaster	3.12	
Concrete 204mm, plaster	2.80	
Concrete 254 mm, plaster	2.54	
Cavity wall, (Open cavity or mineral wool slab), lightweight plaster	**Open Cavity**	**Mineral Wool Slab**

Property assumed U Values

Ground Floor | Mid-floor | Upper Floor | Single Storey

Mid-Floor	***U' Value***	***Construction***
Floor	*0.32*	Intermediate floors, boarding 19mm, airspace 100mm insulation between joists, 9.5mm plasterboard heat flow upward
Windows	*1.60*	*Wood/PVC Double Glazed, low-E glass, argon filled*
Door	*3.00*	*solid wood door (external)*
External Wall	*1.86*	*Stone 610mm (24in)*
Ceiling	*0.32*	*Intermediate floors, boarding 19mm, airspace 100mm insulation between joists, 9.5mm plasterboard heat flow upward*
Pitched Roof	*0.12*	*Pitched roof - Slates or tiles, , ventilated air space, 300mm insulation between joists, 9.5 mm plasterboard*
Internal Wall	*0.00*	
Party Wall	*0.50*	
Roof Glazing	*0.00*	
Upper-Floor	***U' Value***	***Construction***

Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

HISTORIC SCOTLAND

Technical Conservation Group

Technical Paper

In situ U-value measurments in traditional buildings – preliminary results

Prepared for Historic Scotland

Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Lauriston Place, Edinburgh

19th Century tenement
Stone - Craigleith

Five measurement locations with various wall finishes and thicknesses.
Additional test on basement floor

Figure 8: Lauriston Place
Front elevation (S), ground floor.

Wall thickness: 600mm
External face: Ashlar
Internal face: lath and plaster

Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

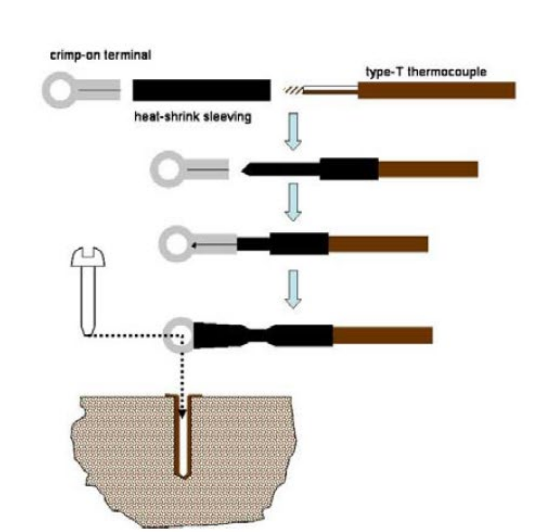
4 The buildings

Figure 6: Victorian Villa, Cathcart, Glasgow

N-W facing bedroom
Blonde sandstone
Wall thickness: 600mm
External face: rubble
Internal face: lath and plaster

Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV



Stone Cold

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Thus far, indicative U-values for 600mm masonry walls are as follows:

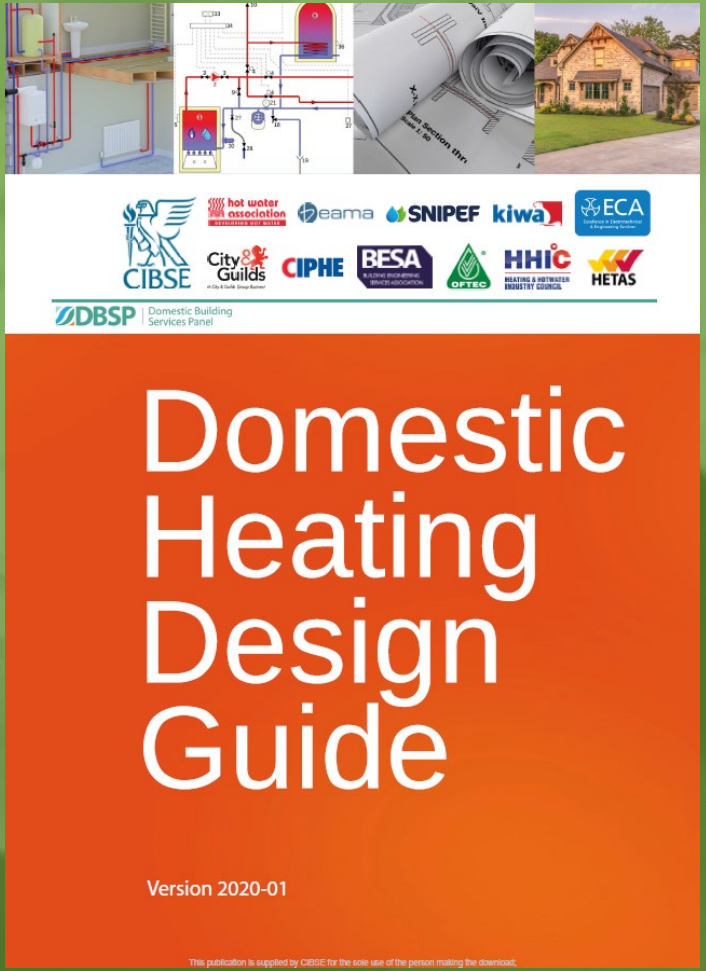
- Wall plastered on the hard: 1.5 ±0.4 W/m^2K
- Wall with lath and plaster: 1.0 ±0.3 W/m^2K
- Wall with plasterboard: 0.9 ±0.1 W/m^2K

Dalrymple Crescent

- 172m2, c. 1860
- 4-bedroom, 3 Public rooms
- ~~19.1kW (as per CIBSE)~~
- 15.1kW (Walls corrected)
- ***Still* not suitable for a heat pump**

Blowing in the Wind

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV



Blowing in the Wind

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Table 3.8 Recommended room design number of air changes per hour

Room	Category			Room	Category		
	A	B	C		A	B	C
Lounge/sitting room	1.5†	1.0†	0.5	Games room	1.5	1.0	0.5
Living room	1.5†	1.0†	0.5	Bedroom	1.0	1.0	0.5
Breakfast room	1.5	1.0	0.5	Bedsitting room	1.5	1.0	0.5
Dining room	1.5	1.0	0.5	Bedroom, including en suite bathroom	2.0	1.5	1.0
Kitchen	2.0*	1.5*	0.5*	Internal room or corridor	0.0	0.0	0.0
Family/breakfast room	2.0*	1.5*	0.5*	Bedroom/study	1.5	1.5	0.5
Hall	2.0	1.0	0.5	Landing	2.0	1.0	0.5
Cloakroom/WC	2.0*	1.5*	1.5*	Bathroom	3.0*	1.5*	0.5*
Toilet	3.0*	1.5*	1.5*	Shower room	3.0*	1.5*	0.5*
Utility room	3.0*	2.0*	0.5*	Dressing room	1.5	1.0	0.5
Study	1.5	1.5	0.5	Store room	1.0	0.5	0.5

Note:

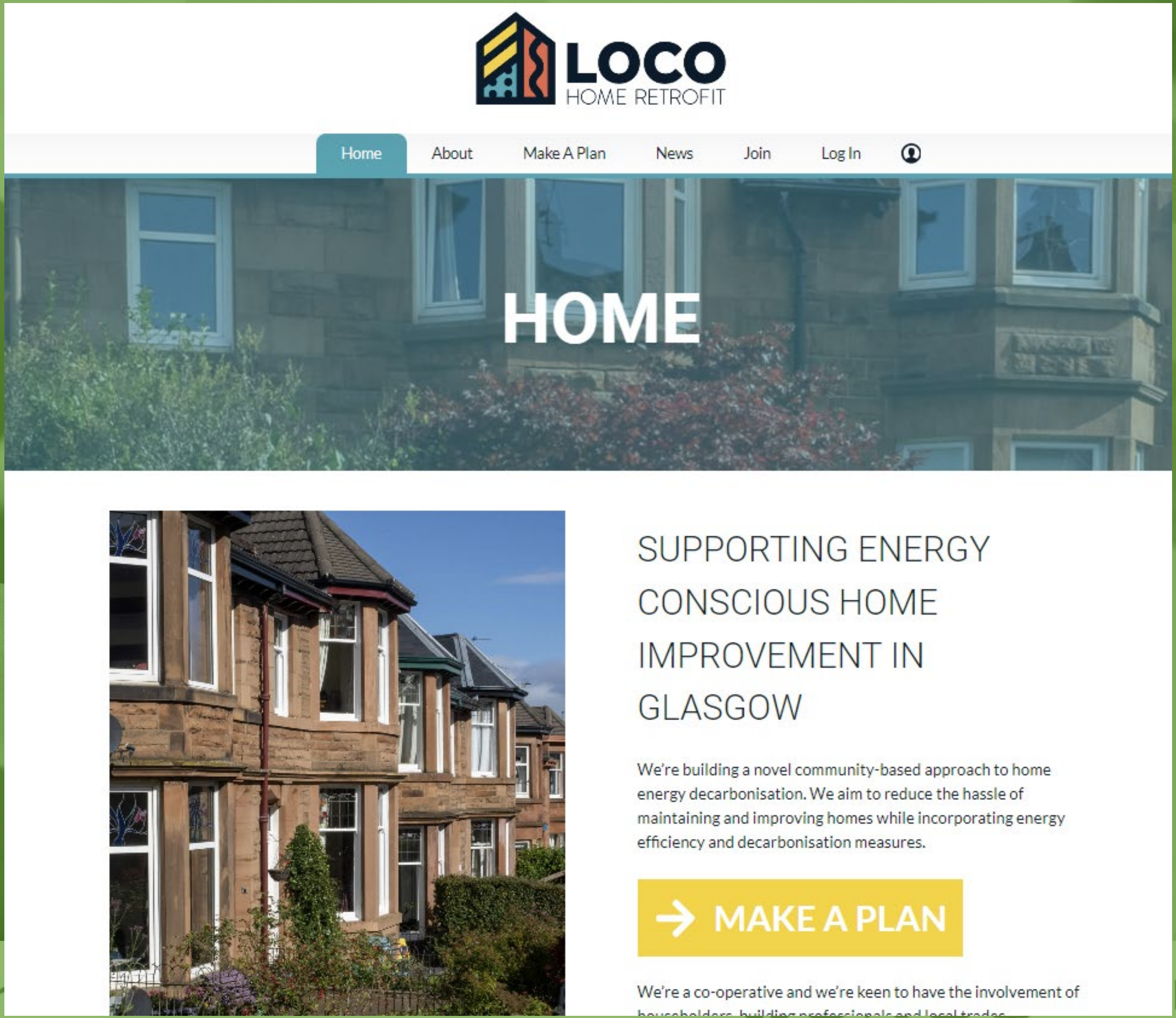
Category A: Air change rates for older existing buildings (pre-2000). Those with several chimneys and/or subject to preservation orders may require greater infiltration allowance than shown above.

Category B: Air change rates for modern buildings (2000 or later) with double glazing and regulatory minimum insulation.

Category C: New (or existing) buildings constructed after 2006 and complying with all current building regulations.

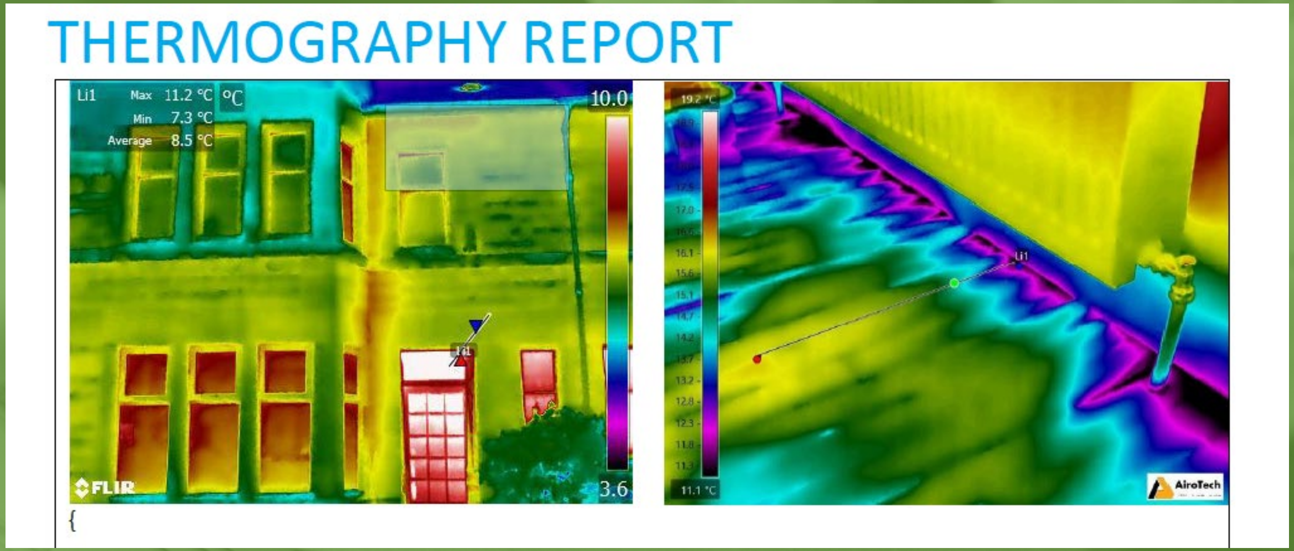
Blowing in the Wind

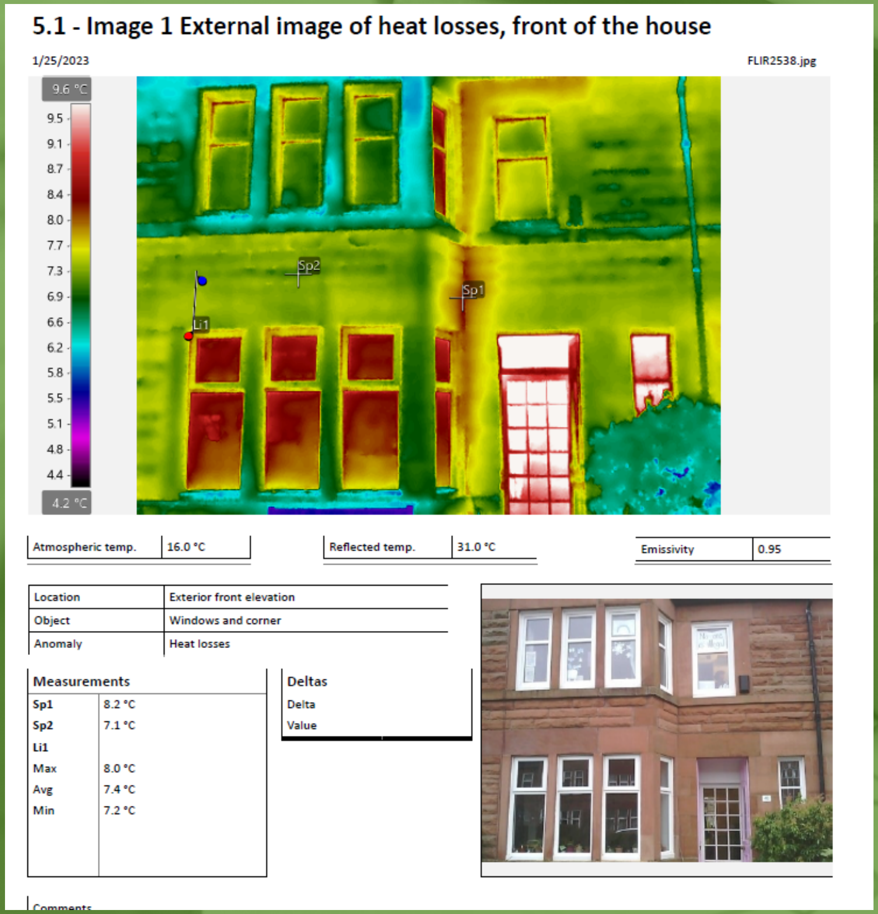
GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV



Blowing in the Wind

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV





Blowing in the Wind

Air tightness testing, also known as an air leakage, air infiltration or air permeability testing is a test to indicate the cubic metres of air leakage per hour per square metre of external area of the building – (m3/hr. m2) – as per Part L of Building Regulations.

Blowing in the Wind

To convert the n50 number to Air Changes Per Hour roughly divide by 19 or 20

= 15.45 / 20 = 0.77ACH

Air leakage rate at 0 Pa, q_0, [m³/h]	
Specific leakage rate (envelope) at 50 Pa, q_{E50}, [m³/h/m²]	15.45
Specific leakage rate (floor) at 50 Pa, q_{F50}, [m³/h/m²]	36.05

Blowing in the Wind

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Table 3.8 Recommended room design number of air changes per hour

Room	Category			Room	Category		
	A	B	C		A	B	C
Lounge/sitting room	$1.5^{\dagger}$	$1.0^{\dagger}$	0.5	Games room	1.5	1.0	0.5
Living room	$1.5^{\dagger}$	$1.0^{\dagger}$	0.5	Bedroom	1.0	1.0	0.5
Breakfast room	1.5	1.0	0.5	Bedsitting room	1.5	1.0	0.5
Dining room	1.5	1.0	0.5	Bedroom, including en suite bathroom	2.0	1.5	1.0
Kitchen	2.0*	1.5*	0.5*	Internal room or corridor	0.0	0.0	0.0
Family/breakfast room	2.0*	1.5*	0.5*	Bedroom/study	1.5	1.5	0.5
Hall	2.0	1.0	0.5	Landing	2.0	1.0	0.5
Cloakroom/WC	2.0*	1.5*	1.5*	Bathroom	3.0*	1.5*	0.5*
Toilet	3.0*	1.5*	1.5*	Shower room	3.0*	1.5*	0.5*
Utility room	3.0*	2.0*	0.5*	Dressing room	1.5	1.0	0.5
Study	1.5	1.5	0.5	Store room	1.0	0.5	0.5

Dalrymple Crescent

- **4-bedroom, 3 Public rooms**
- **172m2, c. 1860**
- ~~**19.1kW (as per CIBSE)**~~
- ~~**15.1kW (U Value Walls corrected)**~~
- **13.1kW (Ventilation rate corrected)**
- ***Almost* suitable for a heat pump**

Multiplying Margins

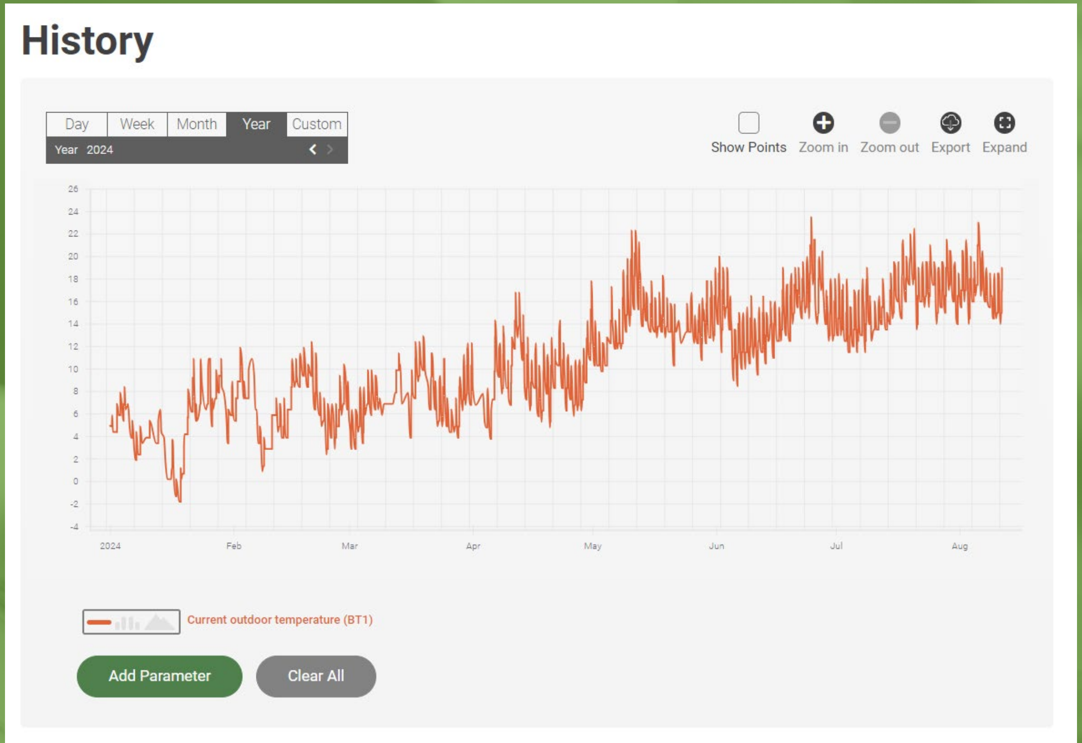
- Heat loss calculators were design for gas boilers
  - Gas was design for intermitting heating (on/off) so to allow for cold start 20% was added to the heat loss
- Ventilation loss are a factor of the total heat loss
- By using the wrong numbers at the start, we multiply out the error in the ventilation calculation. Twice.

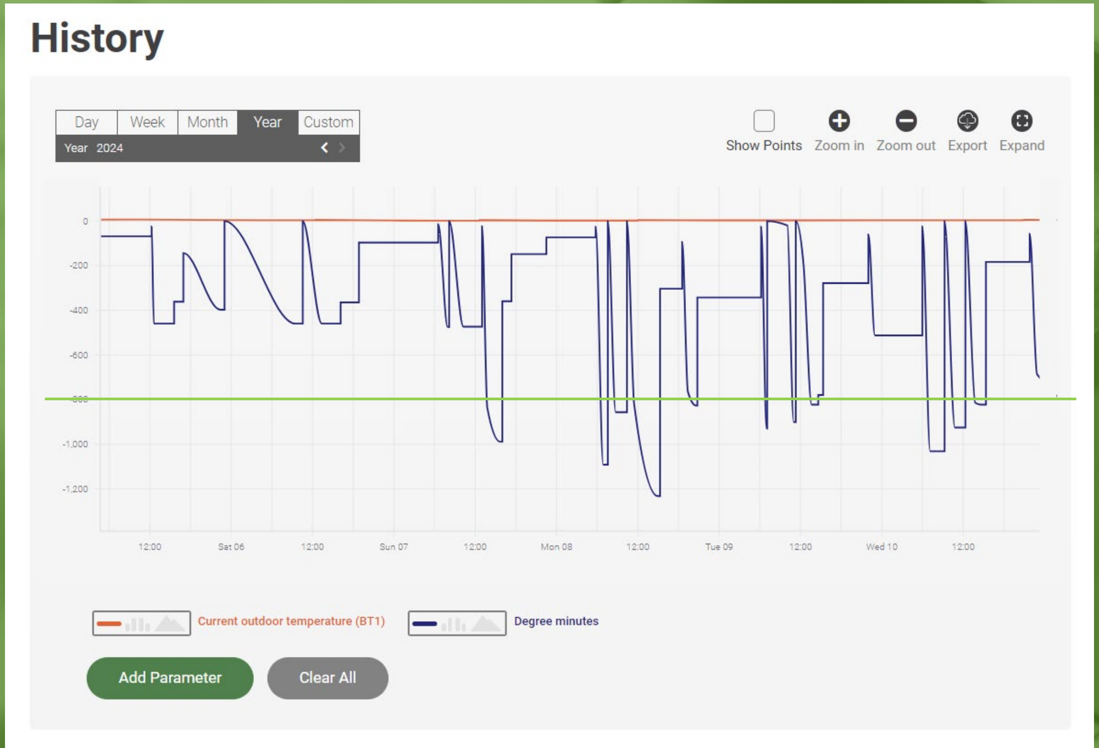
GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Dalrymple Crescent

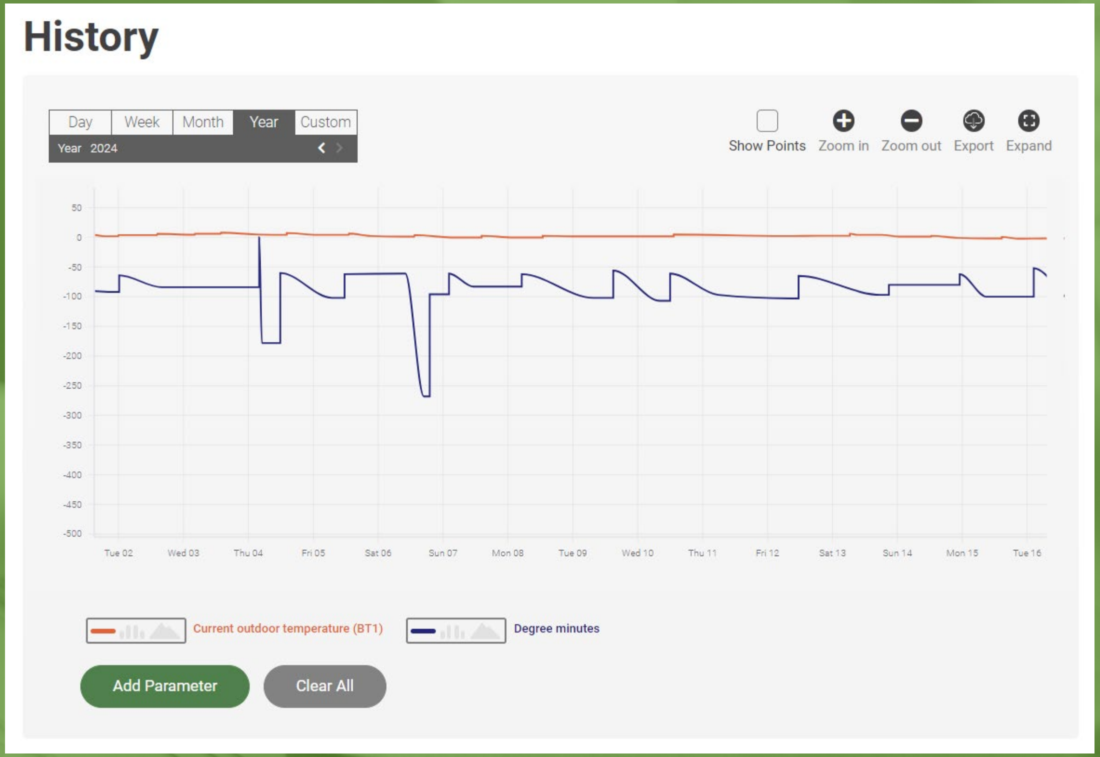
- **4-bedroom, 3 Public rooms**
- **172m2, c. 1860**
- ~~**19.1kW (as per CIBSE)**~~
- ~~**15.1kW (U Value Walls corrected)**~~
- ~~**13.1kW (Ventilation rate corrected)**~~
- **11.6kW (Removing margins and uplift)**

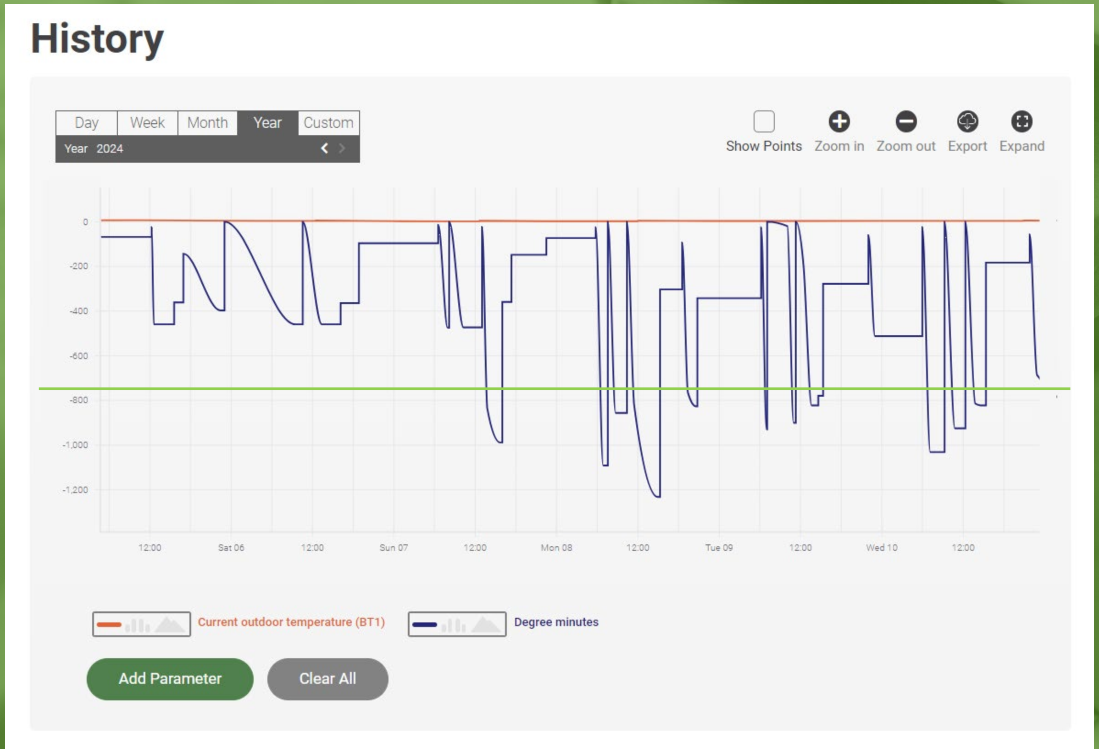
The Proof


History
Day
Week
Month
Year
Custom
Year 2024
Show Points
Zoom in
Zoom out
Export
Expand
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
2024
Feb
Mar
Apr
May
Jun
Jul
Aug
Current outdoor temperature (BT1)
Add Parameter
Clear All

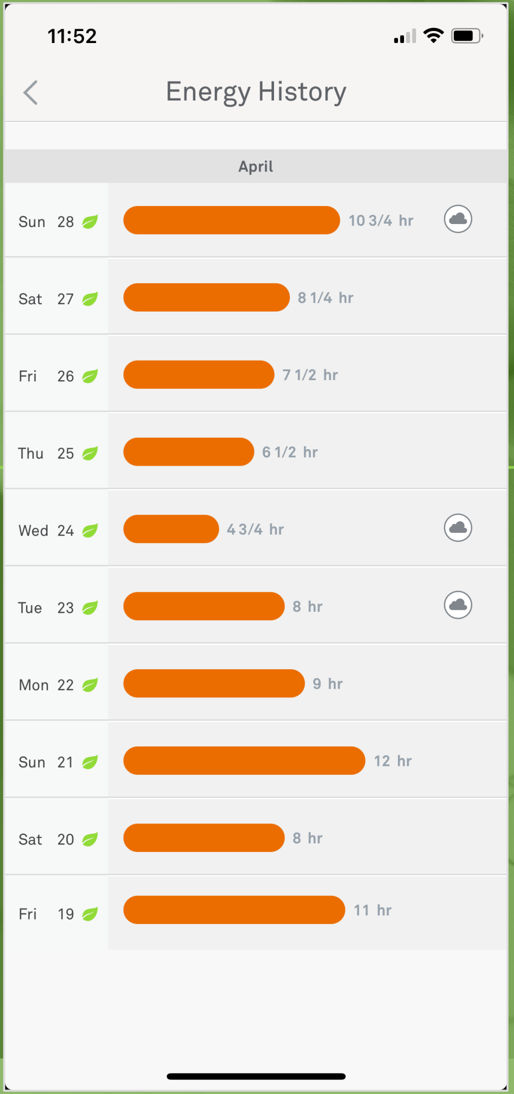

History
Day
Week
Month
Year
Custom
Year 2024
Show Points
Zoom in
Zoom out
Export
Expand
0
-200
-400
-600
-1,000
-1,200
12:00
Sat 06
12:00
Sun 07
12:00
Mon 08
12:00
Tue 09
12:00
Wed 10
12:00
Current outdoor temperature (BT1)
Degree minutes
Add Parameter
Clear All

The disclaimer..





The disclaimer..



GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Cardross, Dumbarton

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Cardross, Dumbarton

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

HeatpumpMonitor.org An open source initiative to share and compare heat pump performance data.

Here you can see a variety of installations monitored with OpenEnergyMonitor, and compare detailed statistics to see how performance can vary.

If you're monitoring a heat pump with **Emoncms** and the MyHeatPump app, login to add your system.

To join in with discussion of the results, or for support please use the OpenEnergyMonitor community forum.

Stats time period: Last 90 days

Filter | Min days: 72

- Top of the SCOPs
- Heatpump + Fabric
- Costs

Add fields

Show systems with

- [x] MID metering (125)
- [x] Other metering (26)
- [ ] Metering errors (11)

Location	Installer	Training	Source	Make & Model	Rating	Data length	COP	DHW	Hx	MID	View
Sheffield	Damon Blakemore		Air	Viessmann Vitocal 150A	10 kW	90 days	5.3		H4		
Bristol	Rickman Heat		Air	Nibe F2050	9 kW	90 days	5.2		H3		
Aylesbury	Custom Renewables		Air	Viessmann Vitocal 150A	16 kW	90 days	5.0		H4		
Cambridgeshire	TS		Air	Grant Aerona 3	13 kW	85 days	4.9	4.1	H2		
Cairngorms National Park, Scotland	Tony Lake		Air	Panasonic J Series	7 kW	84 days	4.9	3.7	H4		
Hitchin, Hertfordshire	Libtek		Air	Vaillant Arotherm+	5 kW	83 days	4.8		H4		
Market Drayton, Shropshire			Air	Samsung Gen 6	8 kW	90 days	4.8	2.5	H4		
Aberdeenshire	Aberdeen Air Source Heating Ltd.		Air	Vaillant Arotherm+	10 kW	90 days	4.7		H4		
Gwynedd	Bespoke Energy Solutions		Air	Vaillant Arotherm+	10 kW	85 days	4.7		H4		
Leicester	Jason Holme		Air	Vaillant Arotherm+	5 kW	90 days	4.7		H4		
Foveran, Aberdeenshire	Aberdeen Air Source Heating Ltd		Air	Vaillant Arotherm+	12 kW	90 days	4.6	3.5	H4		
Cadross, Dumbarton	Renewable Heat		Air	Nibe S2050	10 kW	89 days	4.6		H4		

greenhomefestival.co.uk #GHF24

Bragging rights.

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

HeatpumpMonitor.org An open source initiative to share and compare heat pump performance data.

Here you can see a variety of installations monitored with OpenEnergyMonitor, and compare detailed statistics to see how performance can vary.

If you're monitoring a heat pump with **Emoncms** and the MyHeatPump app, login to add your system.

To join in with discussion of the results, or for support please use the OpenEnergyMonitor community forum.

Stats time period: Last 365 days

Filter | Min days: 290

- Top of the SCOPs
- Heatpump + Fabric
- £ Costs

Add fields

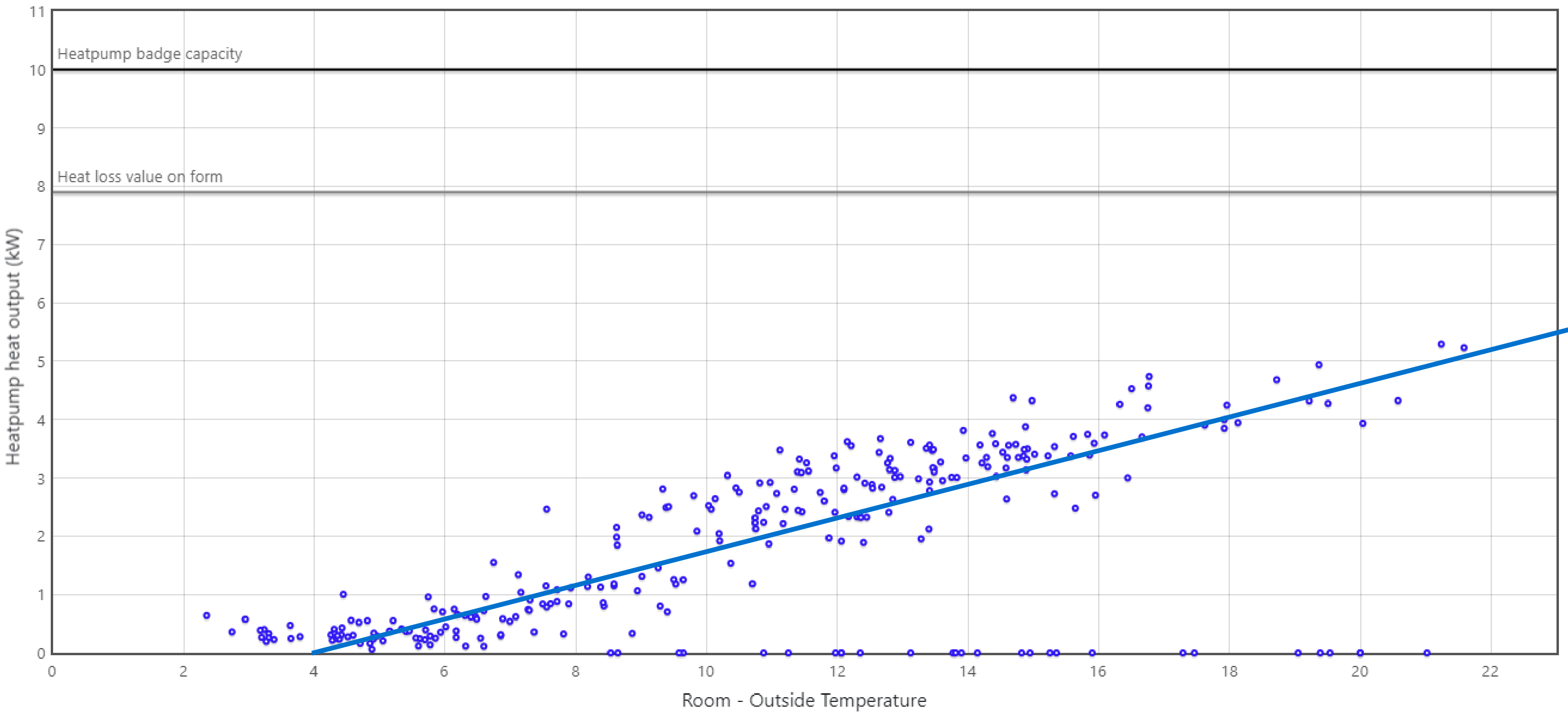
Show systems with

- MID metering (49)
- Other metering (7)

Location	Installer	Training	Source	Make & Model	Rating	Data length	COP ↓	DHW	Hx	MID	View
Broxburn, West Lothian	Renewable Heat (Barry Sharp)		Ground	Nibe S1155 PVT	12 kW	320 days	5.0	4.9	H4		
Sheffield	Damon Blakemore		Air	Viessmann Vitocal 150A	10 kW	319 days	5.0		H4		
Bristol	Rickman Heat		Air	Nibe F2050	9 kW	319 days	4.7		H3		
Mytchett, Surrey	Heat Geek		Air	Vaillant Arotherm+	7 kW	354 days	4.6	4.2	H4		
Stroud	Rickman Heat		Air	Vaillant Arotherm+	5 kW	335 days	4.5	2.4	H4		
Leicester	Jason Holme		Air	Vaillant Arotherm+	5 kW	297 days	4.5		H4		
North Yorkshire	Gavin Raitt		Air	Grant Aerona3	6 kW	361 days	4.4		H2		

Cardross, Dumbarton

Select system	Cadross, Dumbarton, Nibe S2050 , 10 kW	< >	Elec	2945	kWh	Heat	11739	kWh	COP	3.99

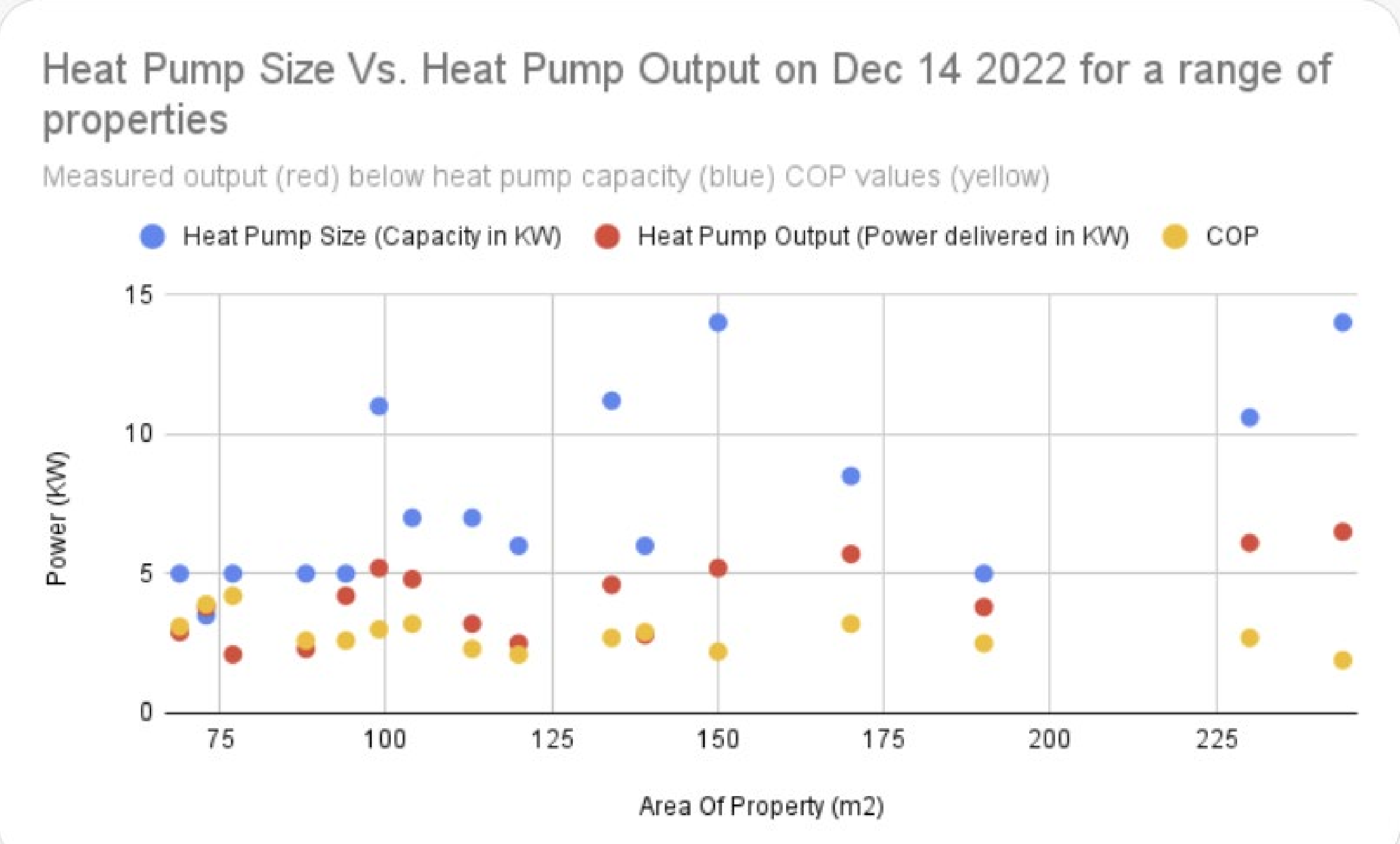


It's not just old homes...

The Suburban Pirate @suburbanpirate · Jul 20, 2023

Replying to @suburbanpirate and @Openenergymon

I added COP values on. Notice that COP is fairly flat with a slight uptick in the small heat pump cluster on the left.



Fabric First?

Scottish Housing News

About Advertise SUBSCRIBE

News Insight Jobs Events Podcast

LATEST | APPOINTMENTS | FUEL POVERTY | HOMELESSNESS | PRS | WELFARE

The Housing & Social Care Accessibility Summit 2024 TICKETS AVAILABLE NOW

THE SOCIAL HOUSING SAFETY NETWORK SCOTLAND We're shining a light on tenant and re safety in social housing in Scotlan Click this banner to find out mor

Why 'fabric-first' may be the wrong approach for retrofitting - podcast transcript

22 MAR 2024 | Reading time: 37 minutes

Home About Contact Content Research Integrity B&C Community Site

BUILDINGS & CITIES

Start Submission

Reading: Fabric first: is it still the right approach?

Download A+ A−

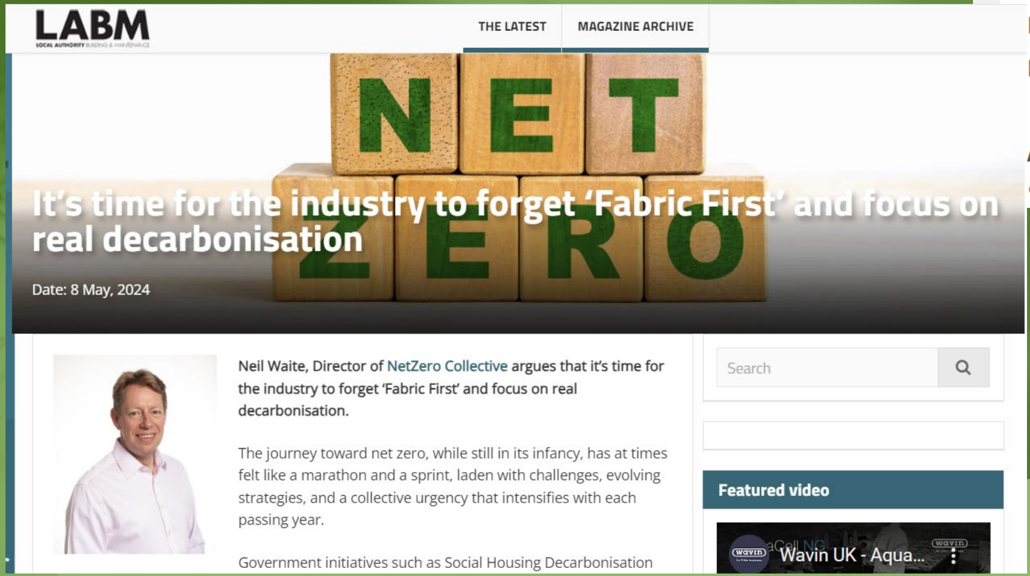
Briefing Notes

Fabric first: is it still the right approach?

Nick Eyre, Tina Fawcett, Marina Topouzi, Gavin Killip, Tadj Oreszczyn, Kay Jenkinson, Jan Rosenow

Abstract

'Fabric first' describes an approach to improving the thermal performance of



LABM

THE LATEST MAGAZINE ARCHIVE

It's time for the industry to forget 'Fabric First' and focus on real decarbonisation

Date: 8 May, 2024

Neil Waite, Director of NetZero Collective argues that it's time for the industry to forget 'Fabric First' and focus on real decarbonisation.

The journey toward net zero, while still in its infancy, has at times felt like a marathon and a sprint, laden with challenges, evolving strategies, and a collective urgency that intensifies with each passing year.

Government initiatives such as Social Housing Decarbonisation

Search

Featured video

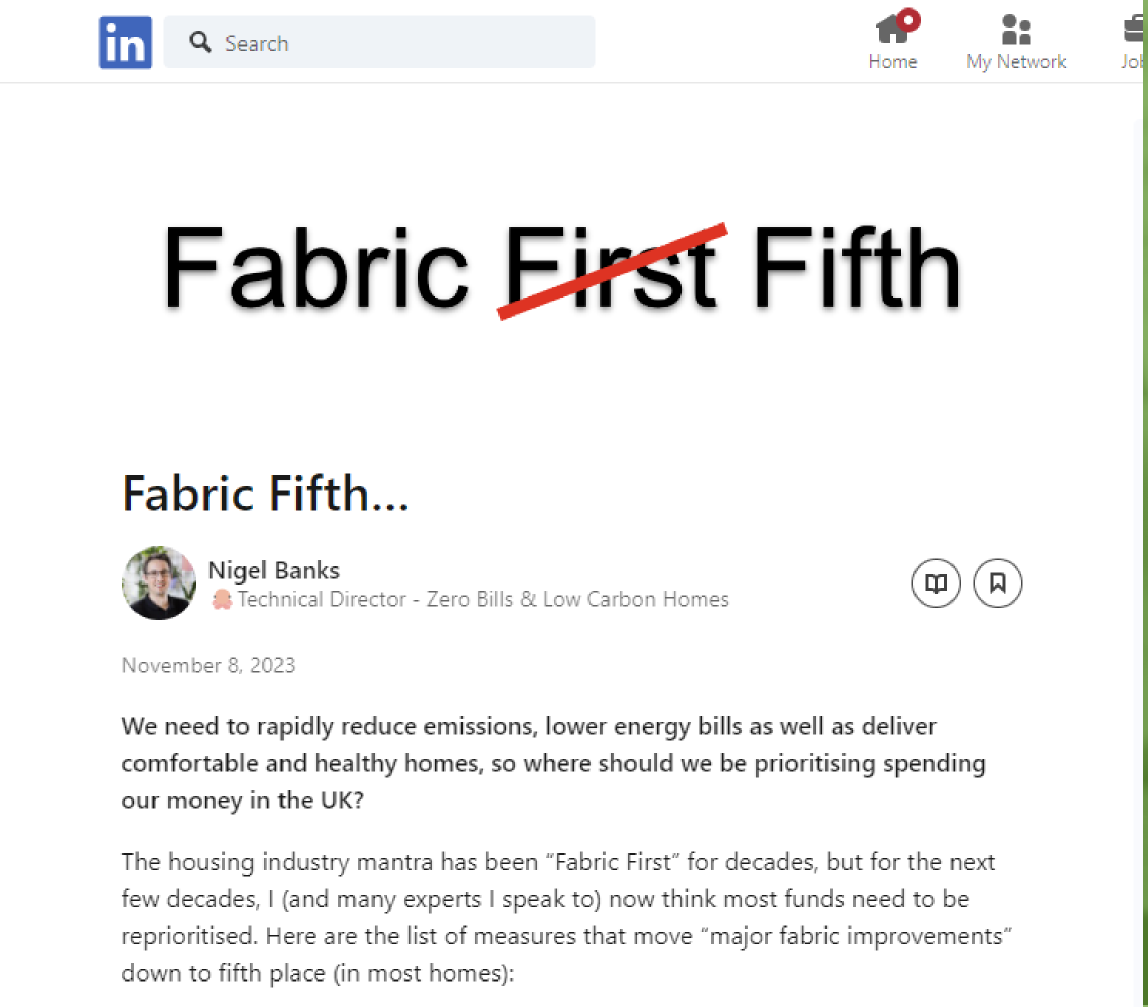
Wavin UK - Aqua...

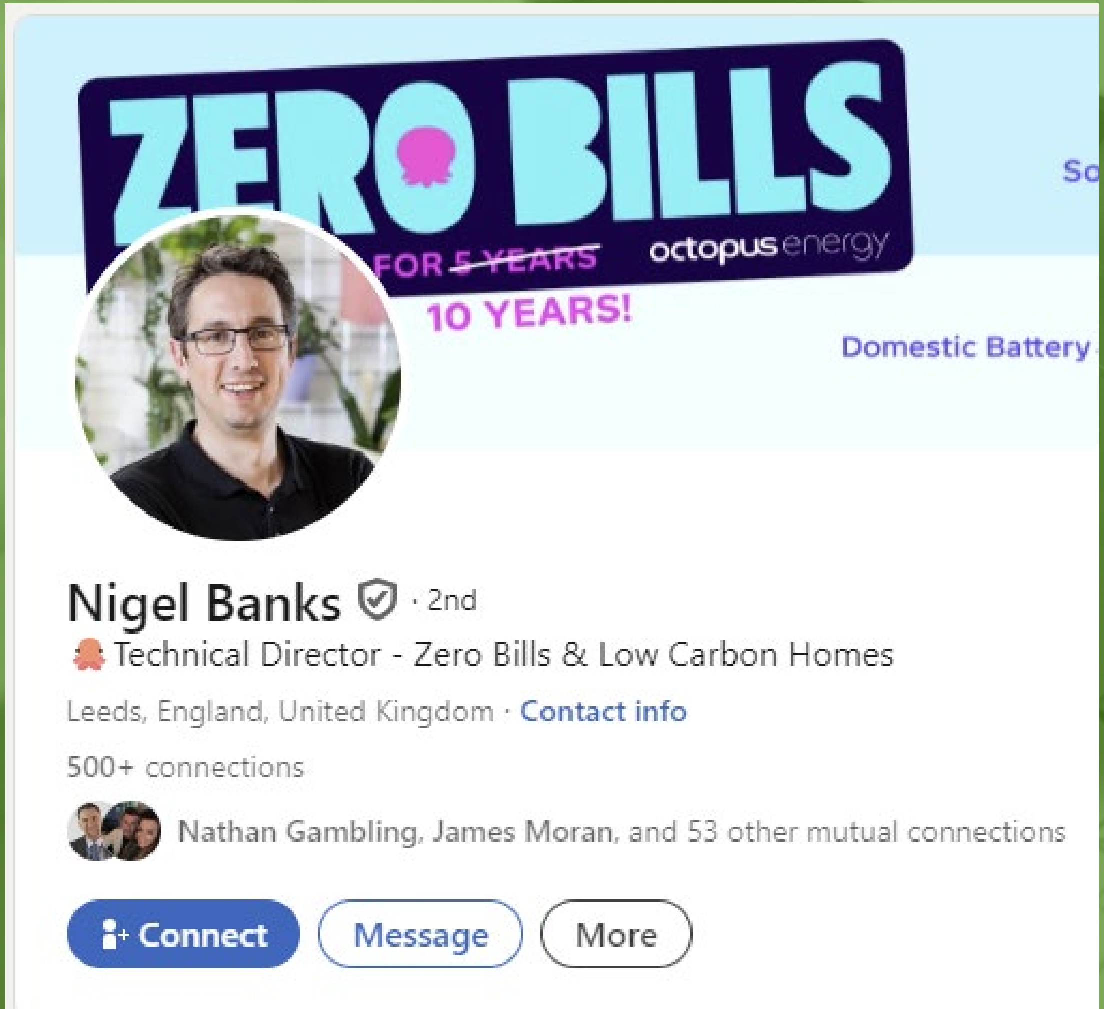
GREEN HOME FESTIVAL

BROUGHT TO YOU BY THE CICV

#GHF24

Fabric Fifth





Fabric 5th

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

BetaTalk - The Renewable Energy and Low Carbon Heating Podcast

Fabric Fifth - has SHDF Mismanagement Wasted Tax Payers Money?

JUNE 06, 2024 NATHAN GAMBLING BETATEACH SEASON 9 EPISODE 14

Fabric Fifth - has SHDF Mismanagement Wasted Tax Payers Money?

BetaTalk - The Renewable Energy and Low Carbon Heating Podcast

00:00:00 | 01:08:46

15 30 1x More Info Share

Fabric 5th

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

1. ASHP ASAP
2. Get Smart
3. Get Comfy and Measure
4. Solar and Storage
5. Fabric

Green Homes Festival's Fabric 5th Approach

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

3. Get Comfy and Measure
2. Get Smart
1. ASHP ASAP
4. Solar and Storage
5. Fabric

43 Slides to make one point

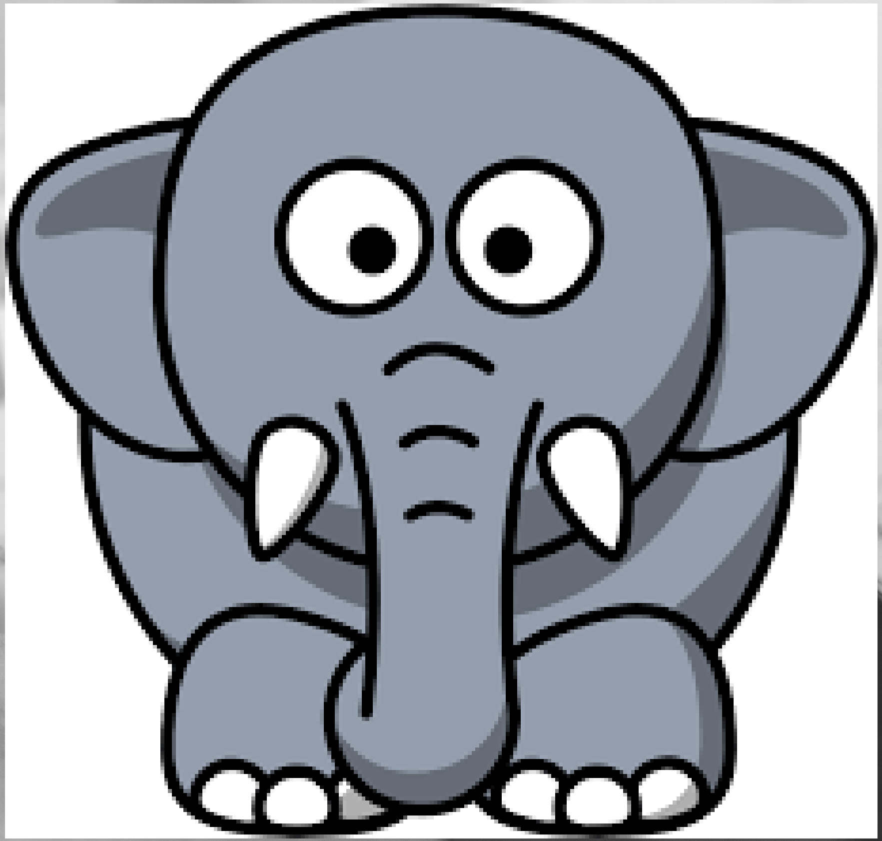
- Old homes are **not hard to heat** as long as you tackle the low hanging fruit

  - Upgrade the window (if they are single glazed)
  - Draft proof the house
  - Insulated the loft

- We are probably overestimating the heat requirements of most homes

GREEN HOME FESTIVAL

BROUGHT TO YOU BY THE CICV



Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

SCOTTISH HOUSING FACTS

Total Scottish homes: 2,496,000

Detached - **576,000** (built pre-1919 = 122,000)

Semi-detached **494,000** (built pre-1919 =52,000)

Terraced **525,000** (built pre-1919 =64,000)

Tenement **587,000** (built pre-1919 =184,000)

Other flats **315,000** (built pre-1919 =58,000)

- Pre-1919 total: 479,000
- 1919-44: 273,000
- 1945-64: 518,000
- 1965-82: 548,000
- Since 1982: 677,000

Source: Scottish government, 2019

35% of Scottish housing stock is Tenement or Flat

9.7% of Scottish housing stock is Tenement or Flat (pre-1919)

Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Tenement flats are not hard to heat, just hard to heat without gas.

Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

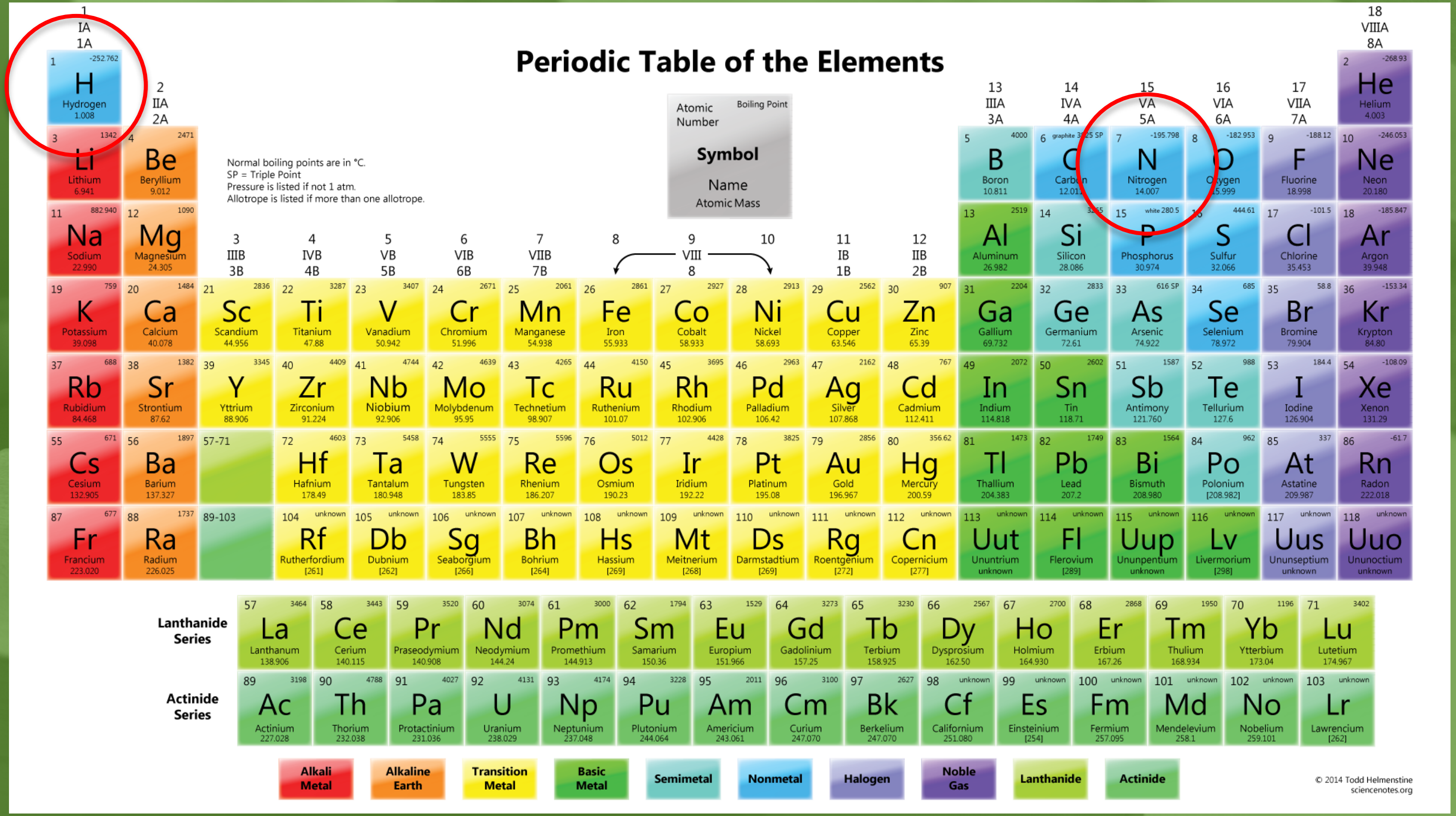
Heat pumps might not be the solution, where do you fit the outdoor unit?

- The garden is communal
- They are too heavy to hang off walls at height
- Planning, building control
- On the roof? But who owns the roof?

Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

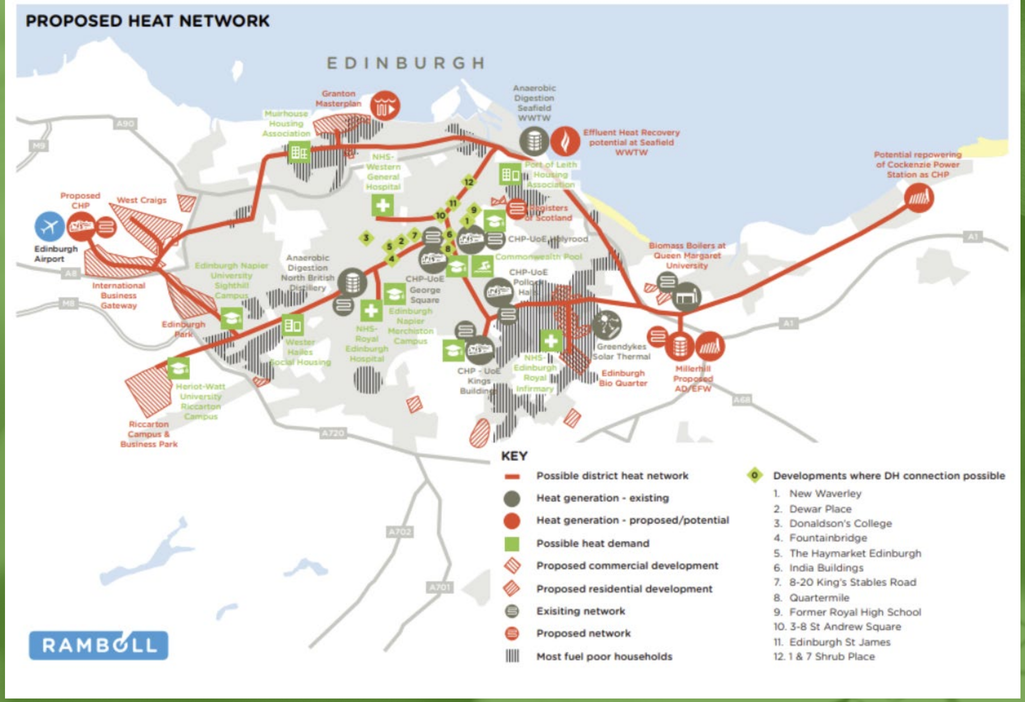
Hydrogen?



Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Heat Network?



Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

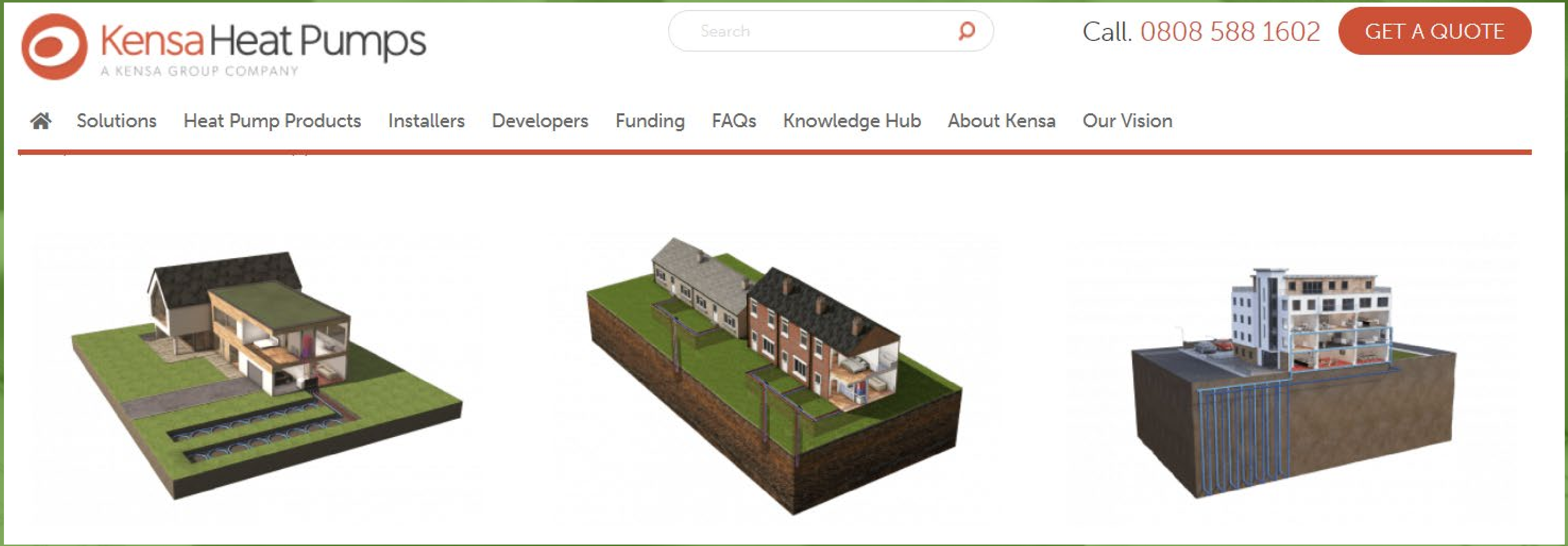
Heat Network with a heat pump?

Table 1: Classification of heat networks, adapted from [1].

Network type	Temperatures supply/return	Features
Ice network	0 °C / 12 °C	little widespread, more efficient than conventional cooling network
Cooling network	6 °C / 12 °C	large volume flows
Source network	6 °C - 15 °C / 3 °C - 6 °C	"classic" **5GDHC network**, little heat losses (but heat gains!)
Alternating-warm heat network	25 °C - 45 °C / 10 °C - 25 °C	is operated in winter as a normal heat network, in summer also cold supply
Low-temperature heat network (4th generation district heating)	70 °C - 90 °C / 50 °C - 70 °C	often in combination with solar thermal or central heat pump, "modern" heat network
High-temperature heat network (3rd generation district heating)	> 100 °C	currently (still) most widespread type of heat network, inefficient, difficult to decarbonize
Steam network (1st generation district heating)	< 200 °C	obsolete technology, but still in use in some cases, inefficient

Elephants in Tenement Flats

Heat Network with a heat pump?

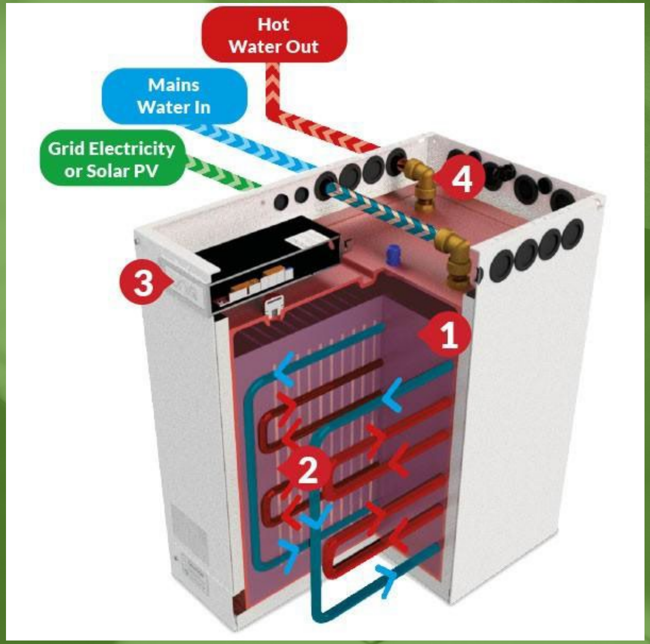


Elephants in Tenement Flats

Storage Heaters / SunAmp?

Failures in the past because of;

- **Uncontrollable heat**
- **Running cost**



Elephants in Tenement Flats

GREEN HOME FESTIVAL
BROUGHT TO YOU BY THE CICV

Solar power + Add to myFT

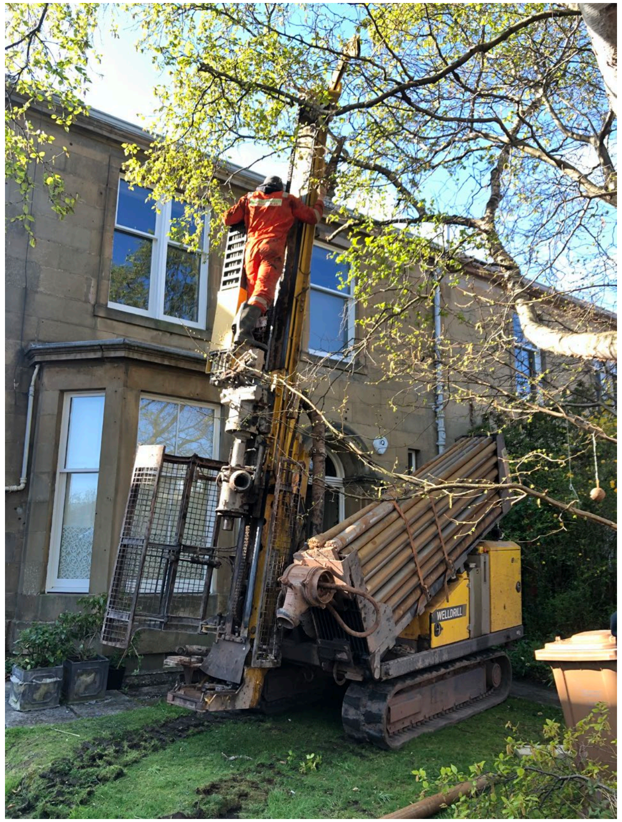
Global glut turns solar panels into garden fencing option

Europeans find alternative location for cheap green technology with cost of rooftop installation so high

Dalrymple Crescent

Bruce Crawford

Dalrymple Crescent



Dalrymple Crescent

Any Questions?