Retrofit: How Much Insulation for Efficient and Affordable Heat Pumps?

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AECB Standards & Certification Program Manager

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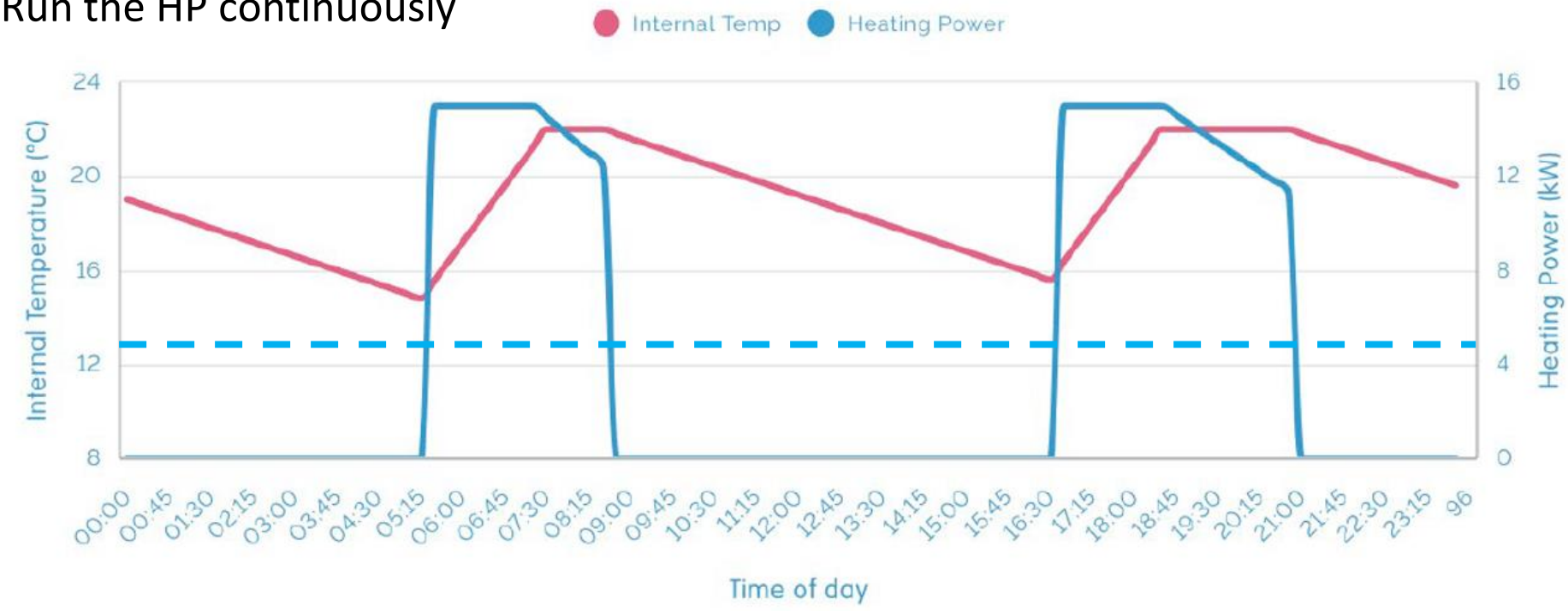
There is a range of answers depending on how you set up and run your ASHP
First maximise the efficiency of the ASHP (points 1-3)

1. Run at a low temperature, AECB says <50C acceptable, < 45C good. Lower is even better, even down to 35C.

2. Run the HP continuously



With permission from The Passivhaus Trust
by Alan Clarke, AECB Services Engineer

3. Increase the radiator size, you can double, even treble it. Or have underfloor heating.
The output of a radiator depends on its area and the temperature difference between it and the room.

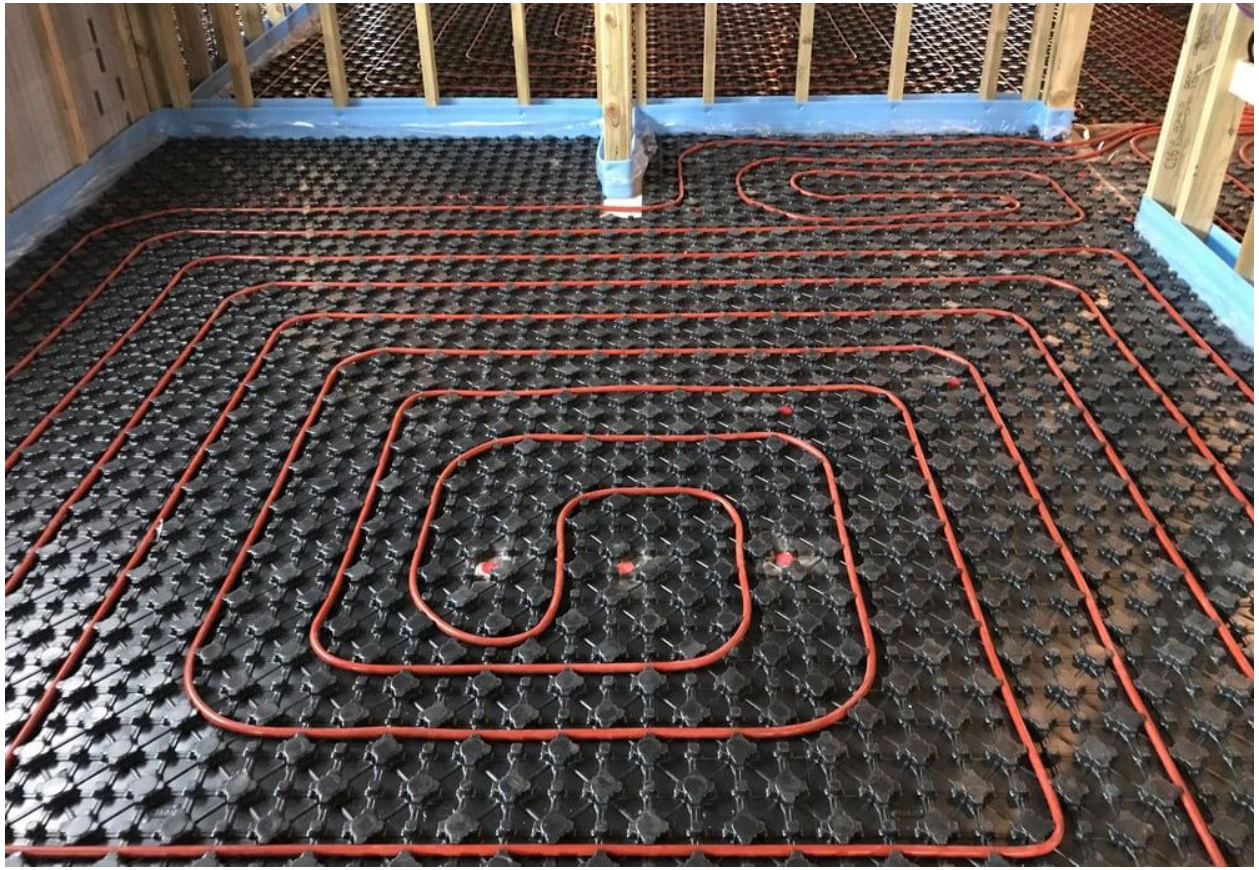
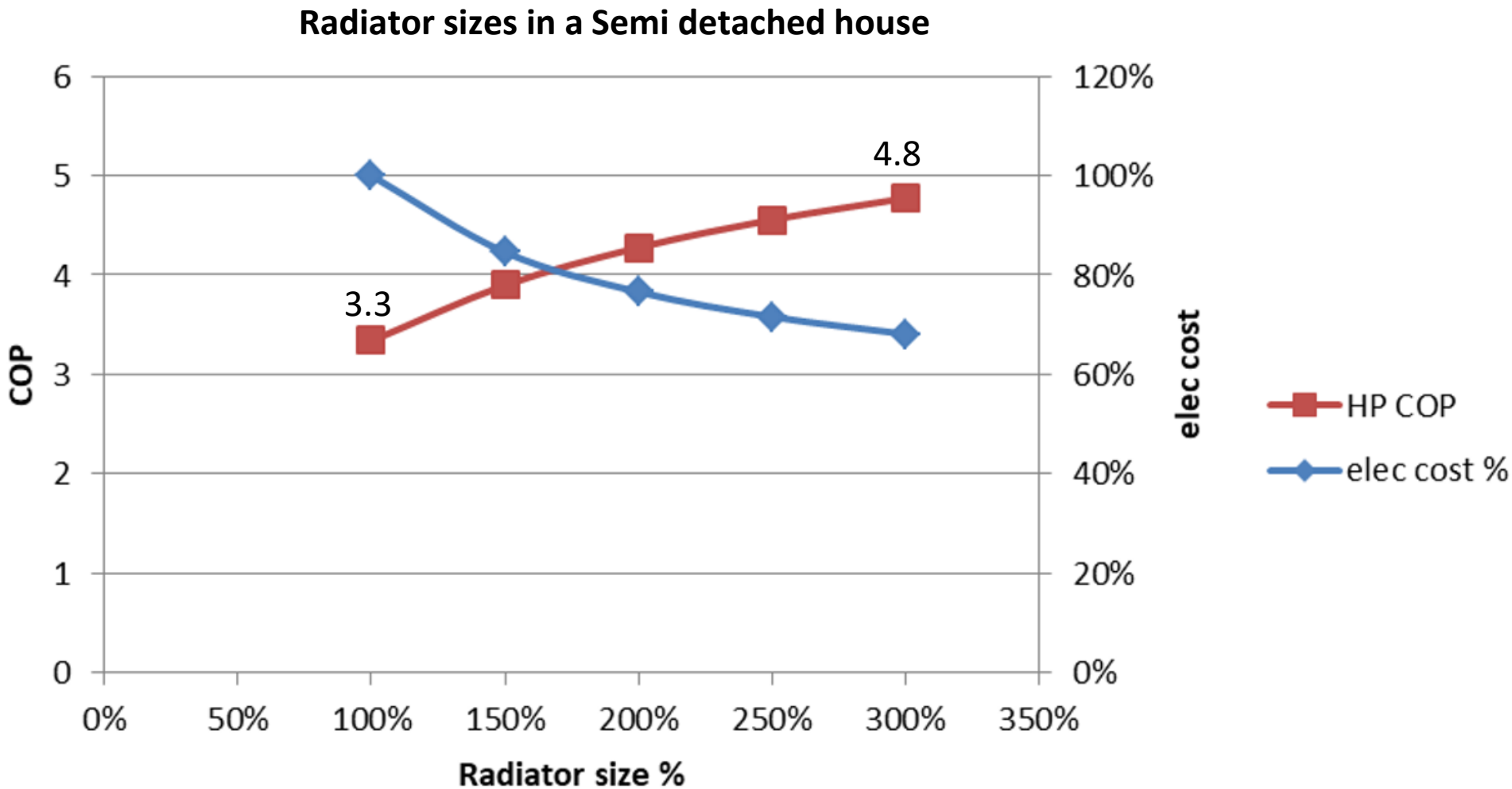


Image credit: Wavin

Image credit: Stelrad



With permission from Alan Clarke and Passivhaus Trust

4. Consider how much insulation is a sensible starting point -
- is it a good idea to have no insulation?

Step 1 does not specify any requirement for the insulation type or thickness, it is a performance standard and insulation levels required are indicated by the running cost calculation in which
The standardised Space Heating cost using OfGem prices must be less than or equal to the running cost in the original building (or equivalent part if the building extended).

To keep the running costs of a heat pump manageable in a Step 1 retrofit we imagine you would have:

- cavity wall insulation (perhaps extracted and redone if poor)
- 300-400mm loft insulation
- at least double glazed windows

and fixed Step 1 criteria of

- Airtightness 5m3/m2.hr
- MEV or MVHR ventilation system (discussed later)

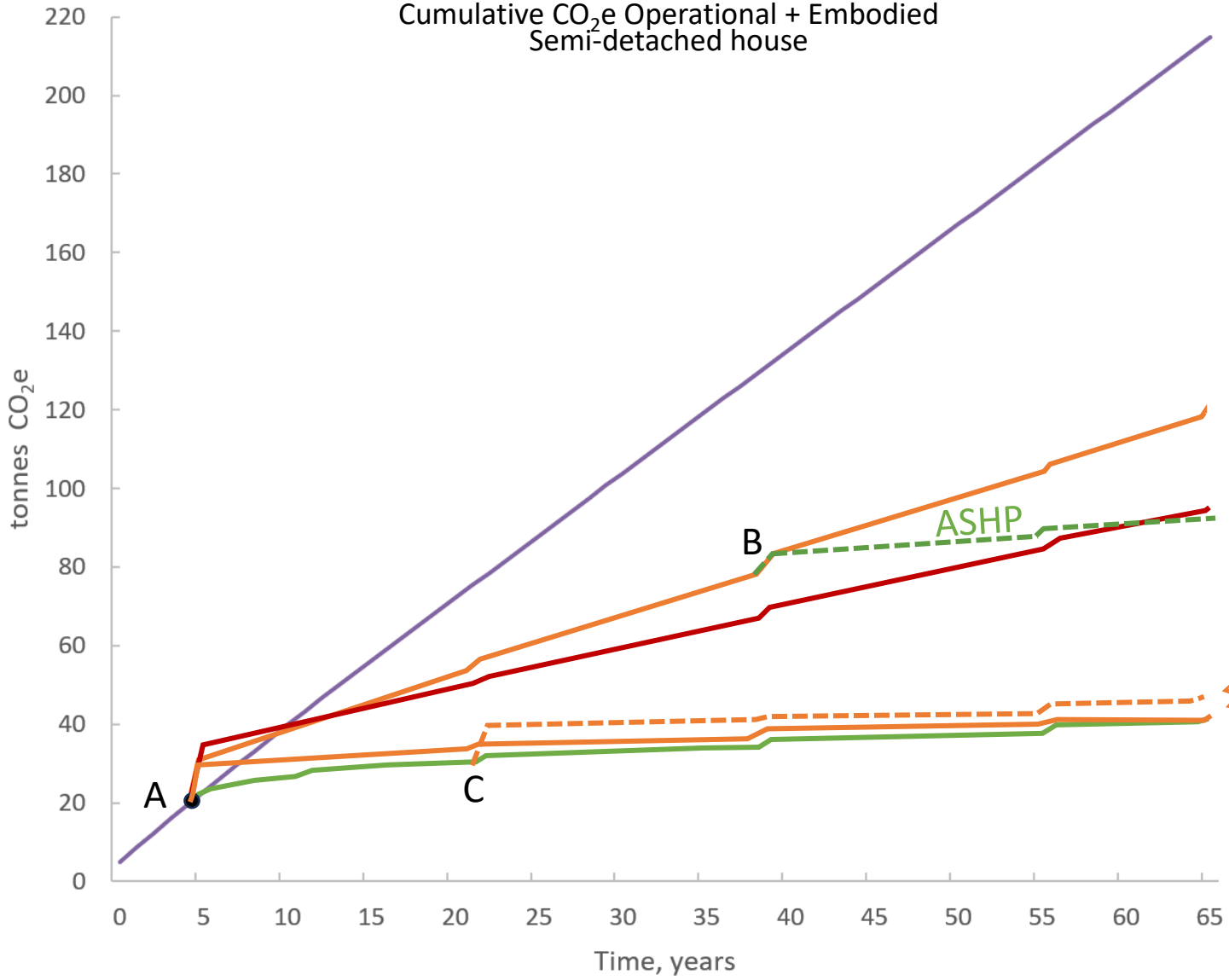
Image credit: The Green Age

Q. Step1 or Step-by-Step?

CarbonLite Retrofit has option - Step-by-Step method.
Step-by-Step allows the process to be done in stages.
Step1 is the minimum permissible step in the Carbonlite Retrofit – Step-by-Step method. (Previously “Level 1”).

Q. The AECB has been promoting fabric first retrofit for many years, why is there a Step1 which doesn’t include 'deep' fabric retrofit?

It’s a good low-carbon interim measure
- anticipate how to achieve a full Retrofit in the future
- Energy and Carbon both important – L Carb energy exp, disruptive. Not just Suppl, Demand side



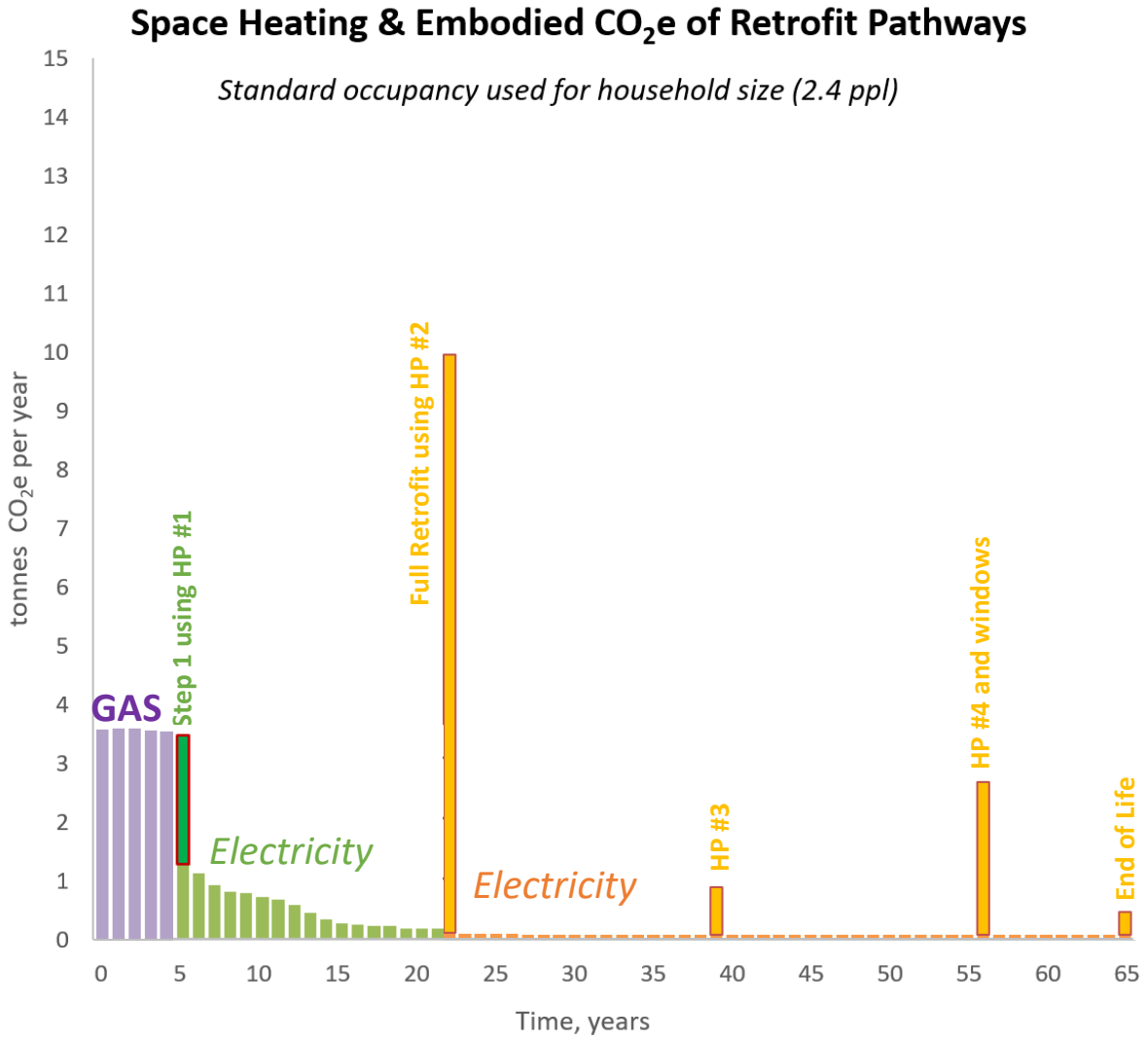
Tonnes over 60yrs since A

194t for gas boiler

99t - CarbonLite Full Retrofit (no ASHP)
Affordable warmth, "warm" measure

76t - EnerPHit at A (no ASHP)

CarbonLite Full Retrofit (with ASHP)
21t, CarbonLite Step1 Retrofit
the low carbon measure

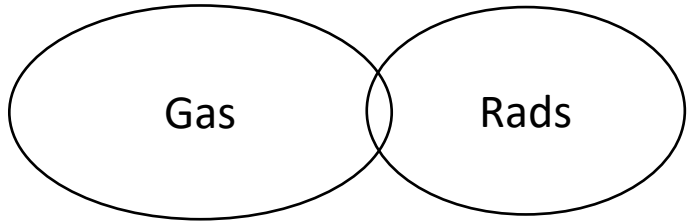


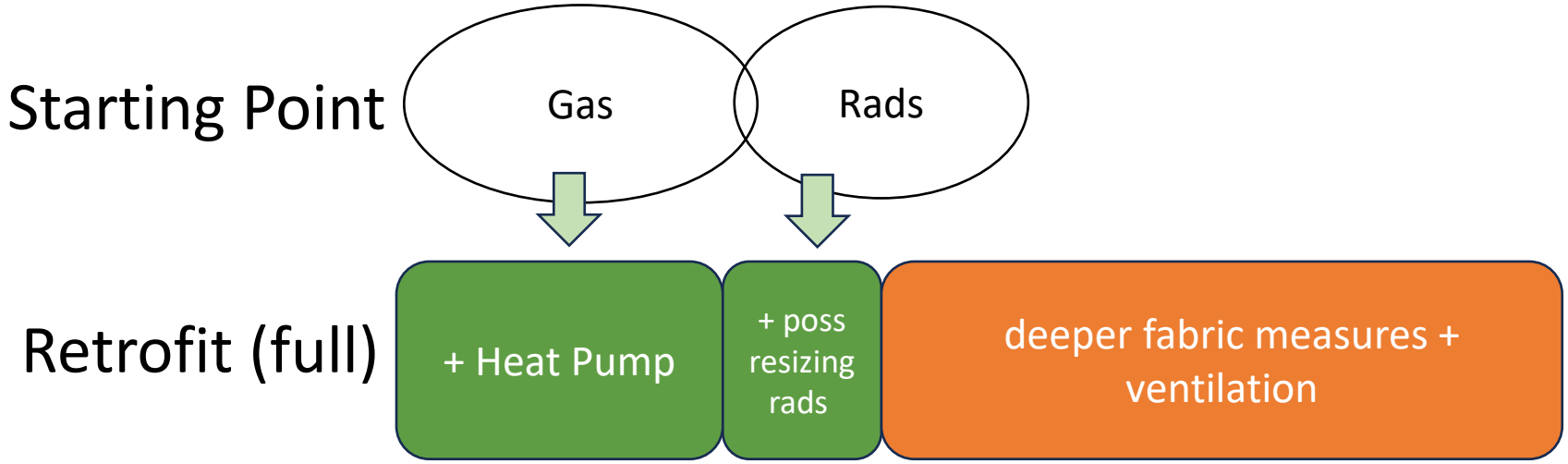
This is one scenario

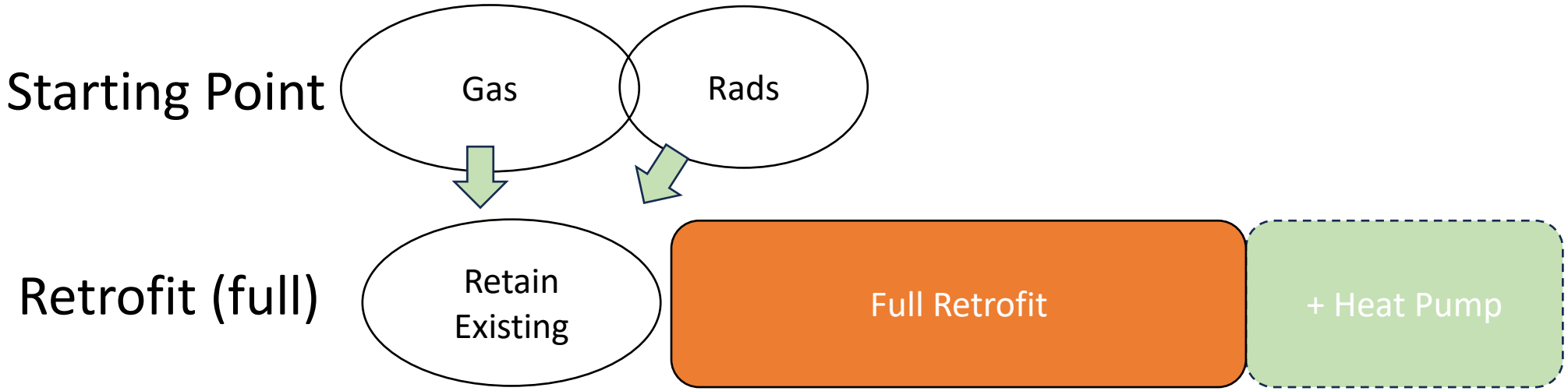
Important and useful to have the ASHP quickly

In aggregate the difference will be increasingly important

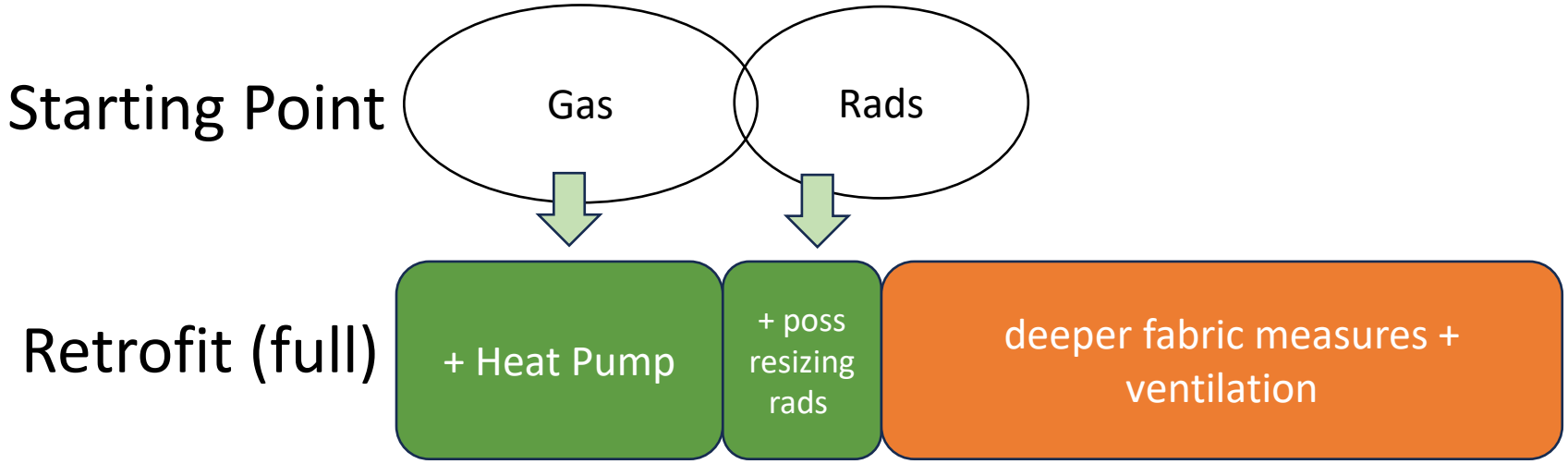
Starting Point




Starting Point
Gas
Rads
Retrofit (full)
+ Heat Pump
+ poss resizing rads
deeper fabric measures + ventilation



HP optional for EnerPHit too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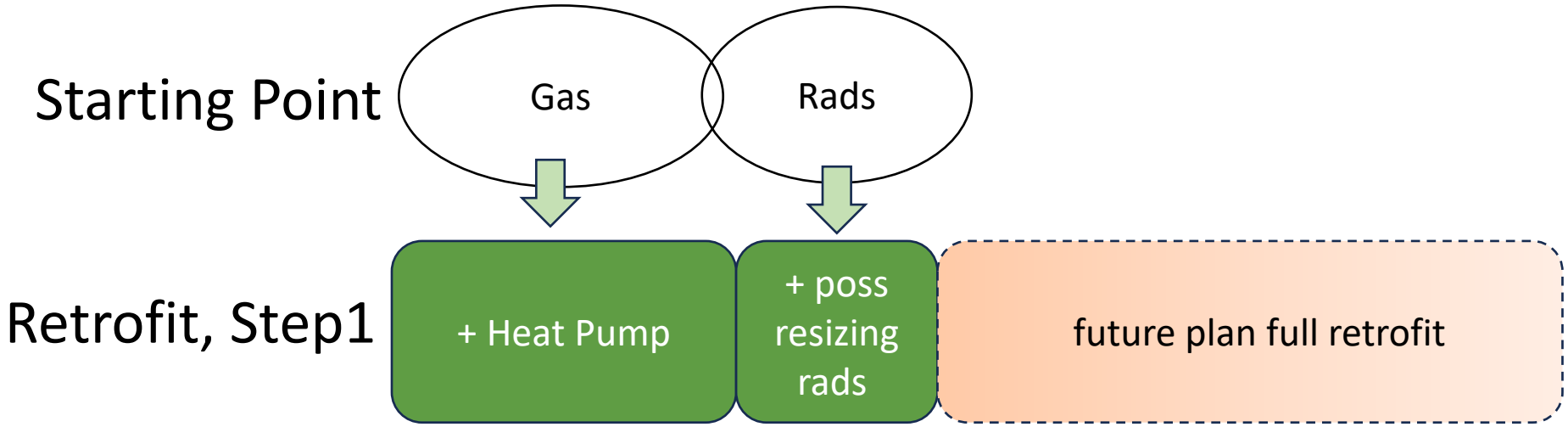
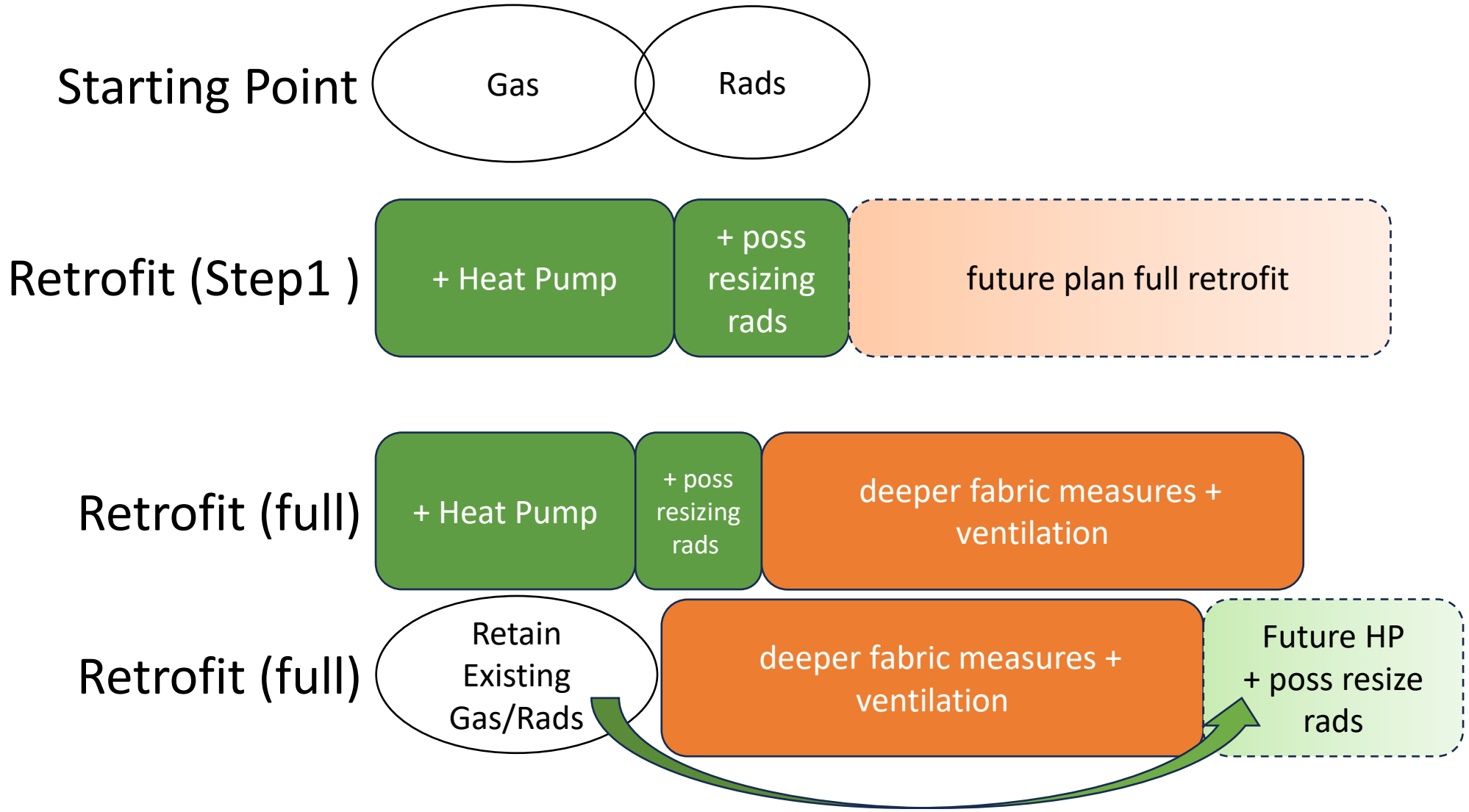
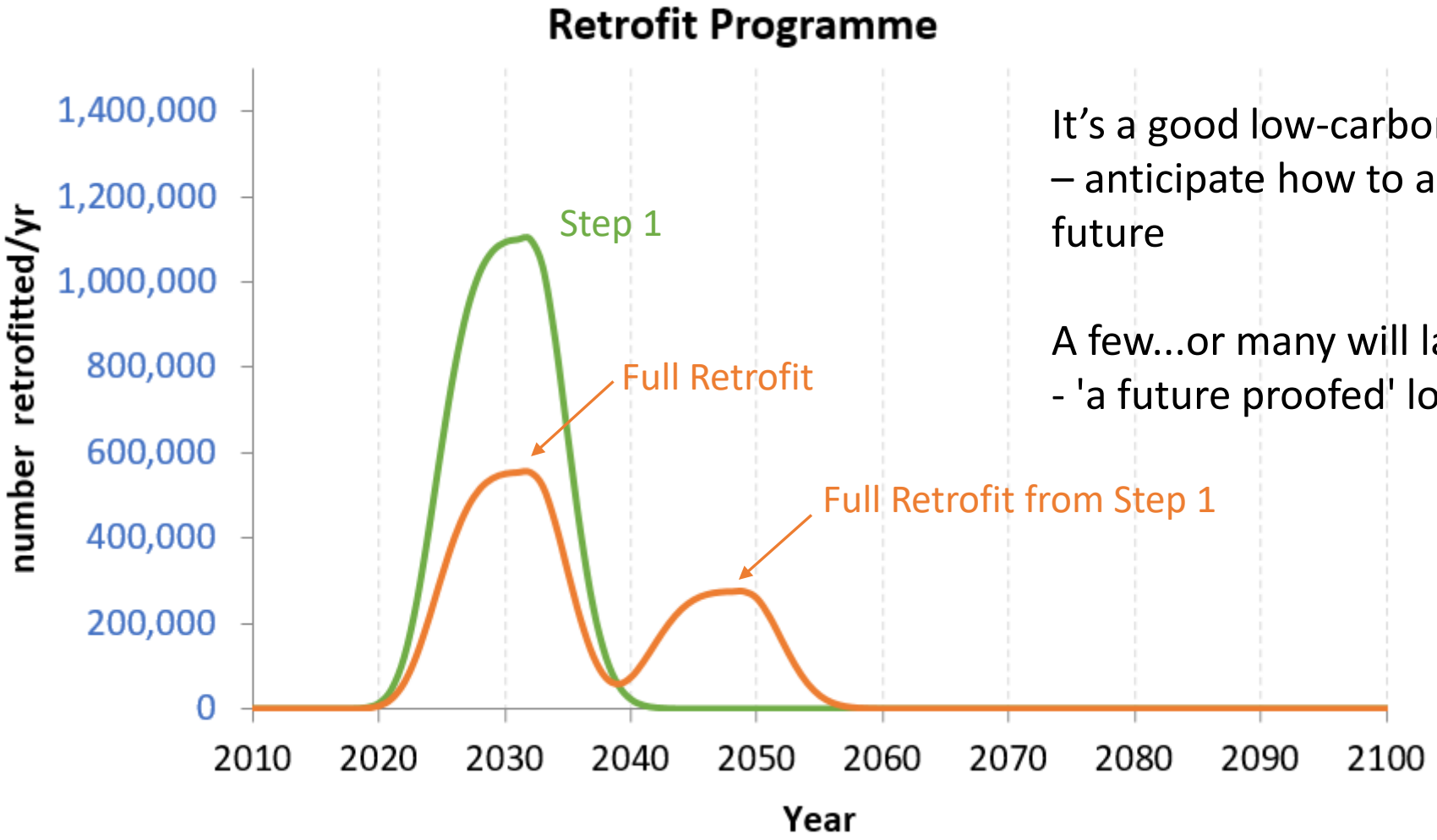

Starting Point
Gas
Rads
Retrofit, Step1
+ Heat Pump
+ poss resizing rads
future plan full retrofit


Starting Point
Gas
Rads
Retrofit (Step1)
+ Heat Pump
+ poss resizing rads
future plan full retrofit
Retrofit (full)
+ Heat Pump
+ poss resizing rads
deeper fabric measures + ventilation
Retrofit (full)
Retain Existing Gas/Rads
deeper fabric measures + ventilation
Future HP + poss resize rads

Q. With these 3 alternatives, what would a retrofit programme look like?



It's a good low-carbon interim measure – anticipate how to achieve a full Retrofit in the future

A few...or many will later go to full Retrofit - 'a future proofed' longer-term' strategy

QUESTIONS

BREAK

We’ve looked at heat pump set up, some insulation,
What other considerations?

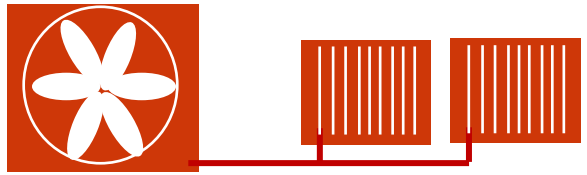
This then takes us to “What is a good design of the whole building?”

Criteria	Carbonlite Retrofit Step-by-step	Carbonlite Retrofit	Carbonlite New Build
Delivered space heating and cooling (kWh/m2/a)	report result	≤ 50 kWh/m².a (≤ 100 kWh/m².a with certifier-approved exemption)	≤ 40 kWh/m².a
EITHER Primary Energy (PE, varies) **OR** Renewable (PER) (kWh/m2/anum)	report result report result	report result report result	≤ 85 kWh/m².a ≤ 75 kWh/m².a
Ensure ventilation	Continuous MEV or MVHR must be installed : follow PAS 2035 Annexe C or as required by Part F of the Building Regulations.		
Airtightness (q50)	≤5.0 m³/m².h	≤2.0 m³/m².h	≤ 1.5 m³/m².h
Thermal Bridges	N/A. If some additional & significant fabric measures are being replaced or installed, certifiers will advise whether full Retrofit Standard requirements are applicable.	Assumed to be less than 0.01 W/mK, else accounted for in PHPP or for retrofits a default heat loss factor may be used.	Assumed to be less than 0.01 W/mK, else accounted for in PHPP
Surface Condensation (fRsi) assessed		fRsi to meet criteria in PHPP, or 0.75 (as Building Regulations/ PAS2035), or local standards - whichever is more onerous.	fRsi to meet criteria in PHPP, or 0.75 (as Building Regulations/ PAS2035), or local standards - whichever is more onerous.
Heating System	Change existing fossil fuel (or direct electric) heating system to a heat pump.	Existing heating systems may be retained, but a practical plan to allow for future low carbon heating supply must be in place.	Install a non fossil fuel system or connect to a low carbon district heating network.
Thermal Comfort	PHPP modelled overheating risk, <10% Acceptable (Guidance: <5% Good practice or <3% Best practice)		
Running cost comparison	Must be same/lower running costs than base case **	-	-

Where a heat pump is installed

Certifiers must liaise with the building owner and the MCS heating system designer in order to ensure that:

Maximum flow temperature for the designed and installed heating system (space heating only)	no greater than 50°C ; Best Practice - heating system is designed and installed for flow temp <45°C



CarbonLite Retrofit (Step 1)

What do we stand for?

Criteria	Carbonlite Retrofit Step-by-step
Heating System	Change existing fossil fuel (or direct electric) heating system to a heat pump.
Maximum flow temperature for the designed and installed heating system (space heating only)	no greater than 50°C ; Best Practice - heating system is designed and installed for flow temp <45°C
EITHER Primary Energy (PE, varies)	report result
OR Renewable (PER) (kWh/m2/anum)	report result

1: Low Carbon

Does it run efficiently? ideally 45C
but 50C aligns with Octopus Energy, main industry leader

No limit for PE/PER but concerns about peak electrified heating loads

No direct electric heating for
1 – 3 storeys detached,
semi-detached and
terraced homes

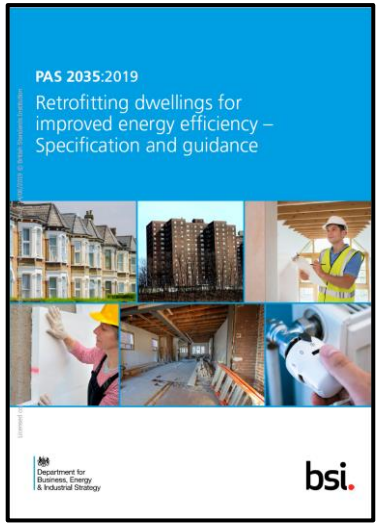
For multi-storey dwellings, certifiers may consider an exemption.

CarbonLite Retrofit (Step 1)

Some Immediate benefits to occupier

Criteria	Carbonlite Retrofit Step-by-step
Ensure ventilation	Continuous MEV or MVHR must be installed : follow PAS 2035 Annexe C or as required by Part F of the Building Regulations.
Airtightness (q50)	≤5.0 m³/m².h
Thermal Comfort	PHPP modelled overheating risk, <10% Acceptable (Guidance: <5% Good practice or <3% Best practice)

2: Healthy



Air Quality (IAQ)

PAS 2035 Annex C

Now free!

You may be using it anyway

May go beyond part F

CarbonLite Retrofit (Step 1)

Criteria	Carbonlite Retrofit Step-by-step
Ensure ventilation	Continuous MEV or MVHR must be installed : follow PAS 2035 Annexe C or as required by Part F of the Building Regulations.
Airtightness (q50)	≤5.0 m³/m².h
Thermal Comfort	PHPP modelled overheating risk, <10% Acceptable (Guidance: <5% Good practice or <3% Best practice)

2: Healthy

Airtightness to minimise energy loss and discomfort from draughts.

Notice it is a q_{50} (air permeability), **$m^3/m^2.hr$** not air changes per hour, ach

Why?
Change made to bring in line with UK practice
Allows us to concentrate on fabric quality

CarbonLite Retrofit (Step 1)

Criteria	Carbonlite Retrofit Step-by-step
Ensure ventilation	Continuous MEV or MVHR must be installed : follow PAS 2035 Annexe C or as required by Part F of the Building Regulations.
Airtightness (q50)	≤5.0 m³/m².h
Thermal Comfort	PHPP modelled overheating risk, <10% Acceptable (Guidance: <5% Good practice or <3% Best practice)

2: Healthy

Window design

Shading

Ventilation

Building Fabric

CarbonLite Retrofit (Step 1)

No barriers to future maximum benefits to occupier

Criteria	Carbonlite Retrofit Step-by-step
Delivered space heating and cooling (kWh/m2/a)	report result
Thermal Bridges	N/A. If some additional & significant fabric measures are being replaced or installed, certifiers will advise whether full Retrofit Standard requirements are applicable.
Surface Condensation (fRsi) assessed	
Running cost comparison	Must be same/lower running costs than base case **

3: Path to Energy Efficiency

Medium Term Improvement Plan Identified
(+ future airtightness measures)

HP costs must be the same or less
using standardised costs from Ofgem

More detail in Q/A

CarbonLite Retrofit

Step-by-step

AECB building knowledge

Project name: 20 Stevens Road

AECB Approved Certifier: Jack Robbins

	Actual	Required	
3 Space Heat Demand	120	-	kWh/m^2.yr
2 Summer comfort overheating risk	1%	10%	missing data
2,3 Airtightness q_{50}	4.9	5	m^3/m^2.h
1 Non Renewable PE	150	-	kWh/m^2.yr

3 Path to Energy Efficiency

- Medium Term Improvement Plan identified
- HP Running costs no more than pre-retrofit

2 Healthy

- ventilation system for reliable air quality
- Airtightness to minimise energy loss and discomfort from draughts

1 Low Carbon

- HP with efficient flow temperature

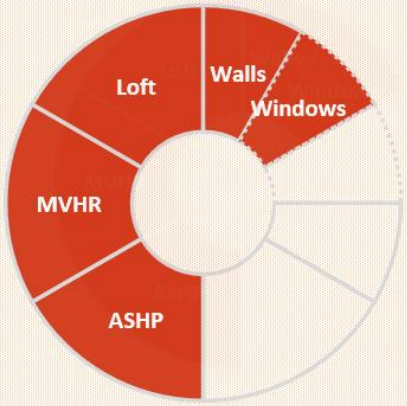
Reliable Design

- Quality assurance system
- Certified by trained professionals

Certifier Signature:

Certificate issue date: 16/08/2023

Certificate ID: MARTEL-001-N



Progress towards Full Retrofit

CarbonLite New Build

AECB building knowledge

Project name:

AECB Approved Certifier:

	Actual	Required	
Space Heat Demand	39	40	kWh/m^2.yr
Summer comfort overheating risk	1%	10%	
Airtightness q_{50}	1.49	1.5	m^3/m^2.h
Non Renewable PE	82	85	kWh/m^2.yr

Energy Efficient

Minimises space heating and cooling

Healthy

- healthy temperature in winter and summer
- ventilation system for reliable air quality
- designed out condensation and mould
- designed out draughts

Low Carbon

- minimal energy needed for heating
- HP with efficient flow temperature

building fabric multiple benefits

Reliable Design

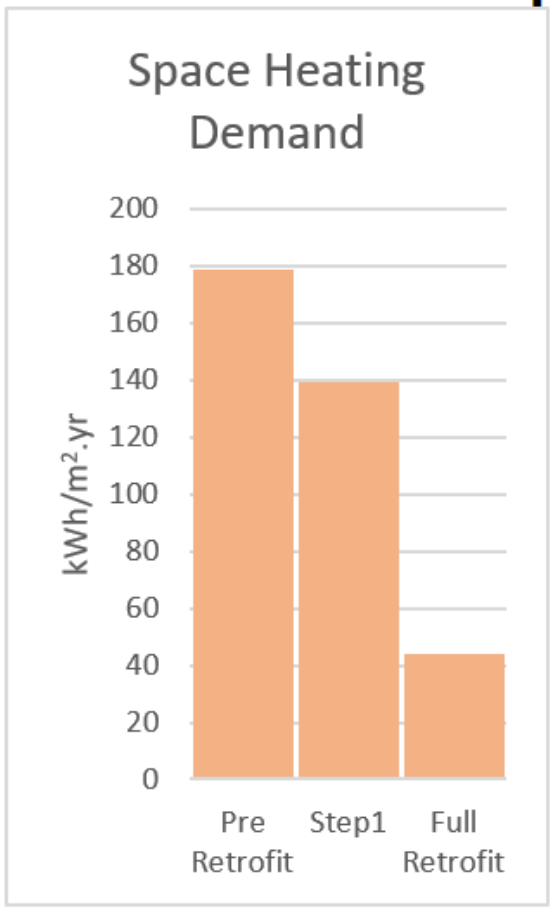
- Quality assurance system
- Certified by trained professionals

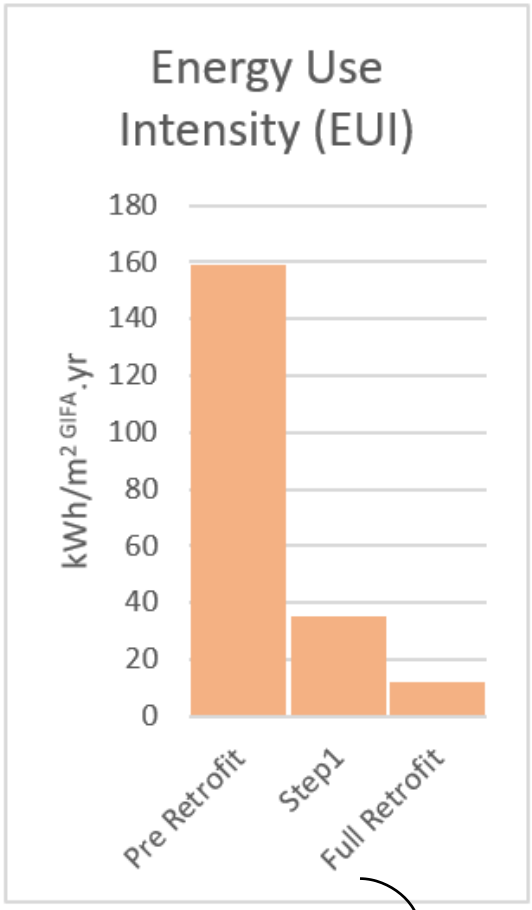
Certifier Signature:

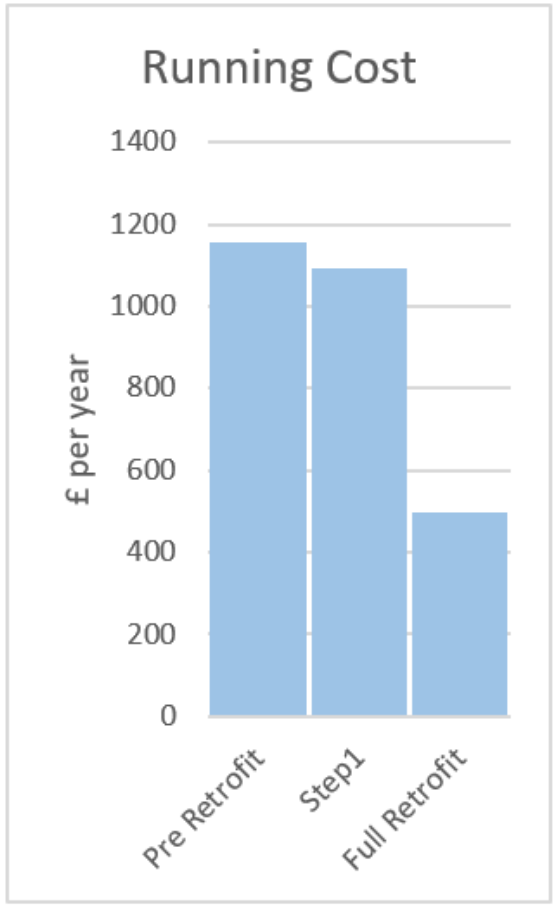
Certificate issue date: 19/12/2023

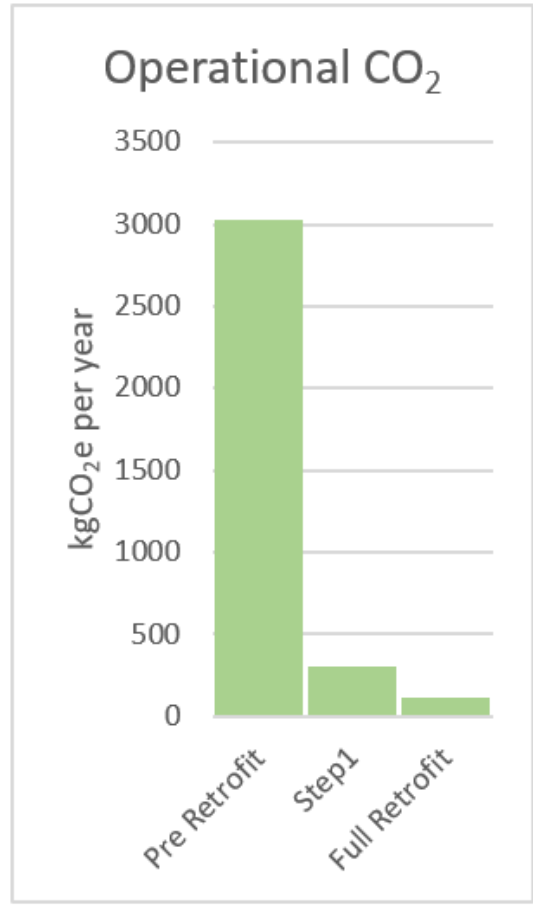
Certificate ID: MARTEL-001-N

Space Heating
Performance Comparison









have to enter GIFA
Gross Internal Floor Area

Quality Assurance

Evidence to prove built as designed

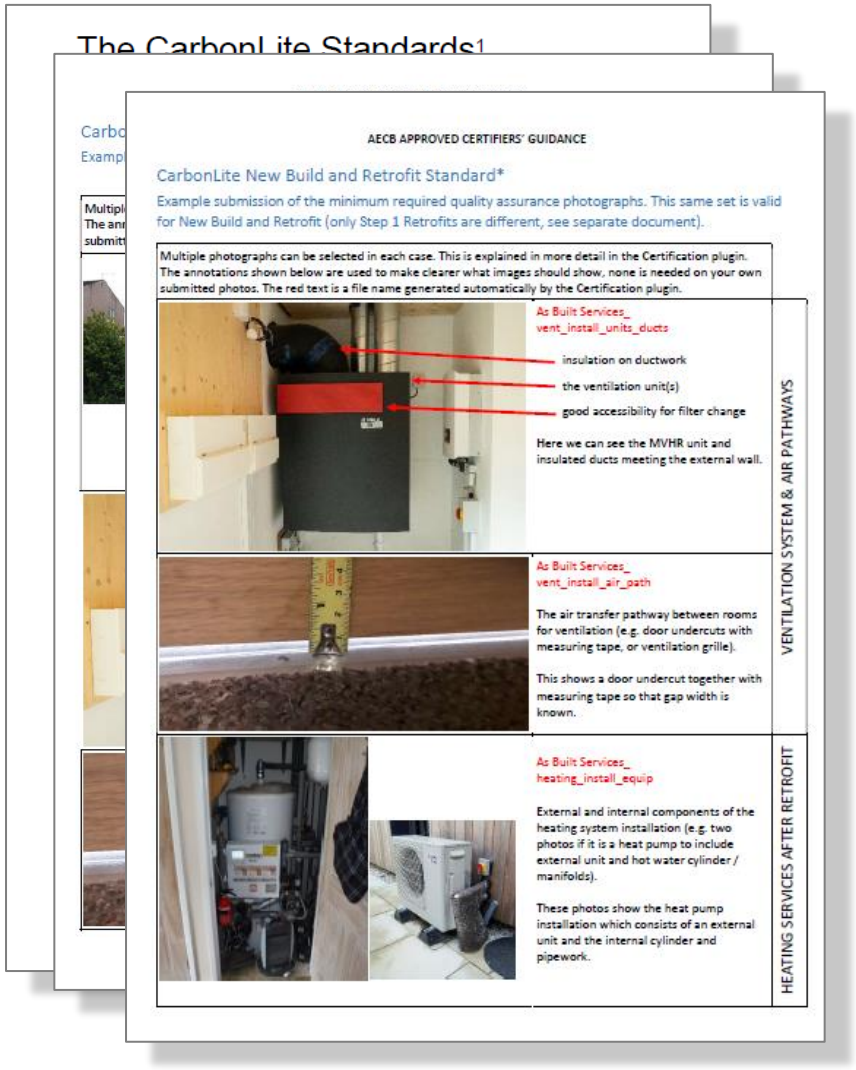
Photographs

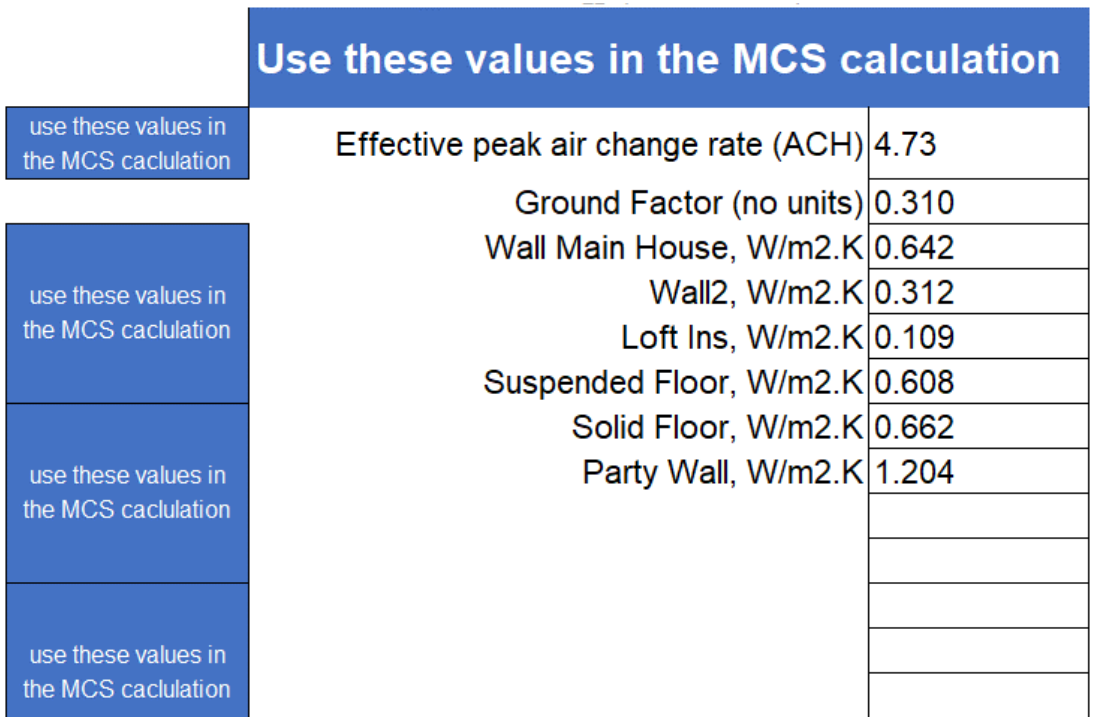
- Pre_Retrofit_
  - elev_South
  - elev_North
  - elev_West
  - elev_East
- As Built Services_
  - vent_install_units_ducts
  - vent_install_air_path
  - heating_install_equip
  - heating_install_emitters
- GA Photo_
  - as_built elev_South
  - as_built elev_North
  - as_built elev_West
  - as_built elev_East

Documents or 3rd party

- As Built Design & Calc_
  - layout_design data_ventilation
  - report_MCS
- Certificates_
  - q50 ATTMA TSL4
  - space heating_commissioning
  - hot water system_commissioning
  - vent_commissioning

Provide 3 PHPPs





	Use these values in the MCS calculation	
use these values in the MCS caclulation	Effective peak air change rate (ACH)	4.73
	Ground Factor (no units)	0.310
use these values in the MCS caclulation	Wall Main House, W/m2.K	0.642
	Wall2, W/m2.K	0.312
	Loft Ins, W/m2.K	0.109
	Suspended Floor, W/m2.K	0.608
use these values in the MCS caclulation	Solid Floor, W/m2.K	0.662
	Party Wall, W/m2.K	1.204
use these values in the MCS caclulation		

Boiler Upgrade Scheme (BUS) £7,500 off the cost of an ASHP (or GSHP) if done by MCS certified installer – further criteria

Some of the data collected feeds directly into the MCS calculation

QUESTIONS

Q. Does the large ASHP in Step1 mean you are completely stuck

Will a deep retrofit make my heat pump inefficient?
i.e. Step1 lock-in?

1) Rads
No, larger rads for Step1 allows you to reduce the temp for Full Retrofit. Properly sized rads result in an efficient system

2) ASHP
HP can modulate down to 30%/25% - so when weather is warmer a large heat pump won't become less efficient than in colder weather

Can reduce the heating hours in warmer weather, could use a tariff that gives you cheaper offpeak rates - e.g. Octopus gives you cheaper rates outside peak hours