BAILY GARNER

The Future Homes Standard

A Practical Toolkit Towards Net Zero

Revision A (June 2022)

CONTENTS

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Significant revisions made since the first version of this document are written in italics.

INTRODUCTION

The UK is required to achieve net zero by 2050 and a 78% reduction by 2035 in line with the Climate Change Act 2008 and subsequent revisions in 2019 and 2021.

The built environment and residential home heating are major contributors to the UK's emissions. This toolkit is a pragmatic guide to help build organisations' understanding of the key issues and to set out and navigate a path towards net zero new build that suits the needs and priorities of your business. It lays out the challenges, the policy context and the choices facing organisations developing new homes. *This update of the toolkit has added additional property types in multi-residential buildings, updated costs and added whole life costs.*

Many organisations will have existing homes that require retrofitting and achieving significant carbon reductions in these homes is the subject of our other toolkit: Net Zero for existing homes.

This toolkit takes real property layouts and typical construction details for different forms of construction and identifies how these must change to achieve a net zero carbon home as envisaged by the Government's Future Homes Standard.

It also identifies the broad cost impacts of the options presented for your organisation and your residents and draws together other considerations such as whole life carbon and the circular economy.

The main statutory lever the Government has at its disposal is Building Regulations for new build and in particular Part L for energy and Part F for ventilation.

Approved documents covering parts L and F were published alongside a brand new part O covering overheating in December 2021 and came into force in June 2022.

The timeline below shows the current timetable for the implementation of Building Regulations Part L and Part F up to 2025 to achieve Future Homes Standard and net zero carbon ready homes. The homes constructed under this standard are unlikely to use fossil fuels and will rely on further decarbonisation of the electricity grid to reach true net zero carbon operation.

June 22	June 2022 to June 2023	2023	2024	2025
Part L1 in force	Transitional period	Future Homes Standard technical consultation	Future Homes Standard legislation	Future Homes Standard
Part F1 in force		Part L1 and Part F1 updates		New part L1 and F1
				Future Buildings Standard
Part L2 in force		Part L2 and Part F2 updates		New Part L2 and F2
Part F2 in force				
Overheating approved document in force				

NET ZERO CARBON DEFINITIONS

For the purpose of this toolkit our definition of Net Zero Carbon in new build is:

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

> **UKGBC Zero Carbon Buildings: A Framework Definition**

The timeline here shows the journey to the Future Homes Standard using uplifts in Part L and Part F of the building regulations.

A home meeting the standard is not a net zero carbon home unless your organisation chooses to allocate some form of carbon offsets. The standard envisages these homes as net zero ready but still using some energy that is not zero carbon. The home is envisaged to reach true net zero over time as the energy from the grid de-carbonises fully. Homes are also envisaged to be designed to accept new technologies at a later date.

Definitions

Green House Gases (GHG)
The gases, including carbon dioxide and methane, which have a heating effect when released into the atmosphere.

Upfront Carbon
The total GHG emissions associated with materials and construction of the home up to practical completion.

Embodied Carbon
The total GHG emissions and removals associated with the materials and construction processes through the whole lifecycle of the home.

Operational Energy
The GHG emissions arising from all energy consumed by the home, in use, over it's lifecycle.

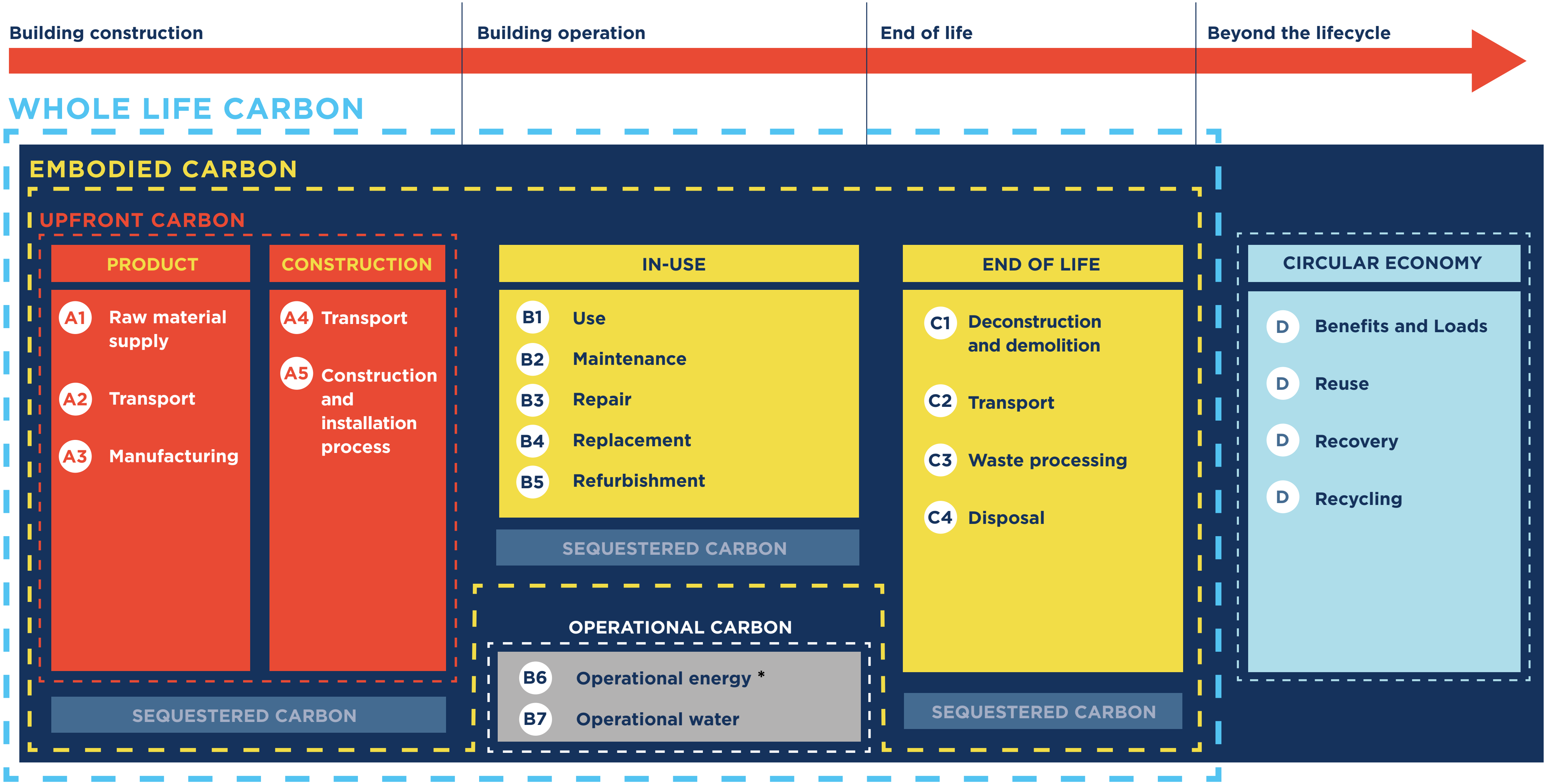
Whole Life Carbon
The total of all the GHG emissions and removals, both operational and embodied, over the life of the home, including demolition.

Sequestered Carbon
Carbon dioxide removed from the atmosphere and incorporated in biomass such as timber.

Circular Economy
A non-linear model of economic development based upon elimination of waste and pollution, keeping products and materials in use and regenerating natural systems.

One of the key issues faced by organisations is the lack of a commonly understood definition of what net zero carbon means. This is starting to be resolved through the cooperation of industry bodies.

Figure 1 – Whole life carbon assessment model



The table above, adapted from an image originally created by London Energy Transformation Initiative (LETI), illustrates the differences between the different aspects of zero carbon.

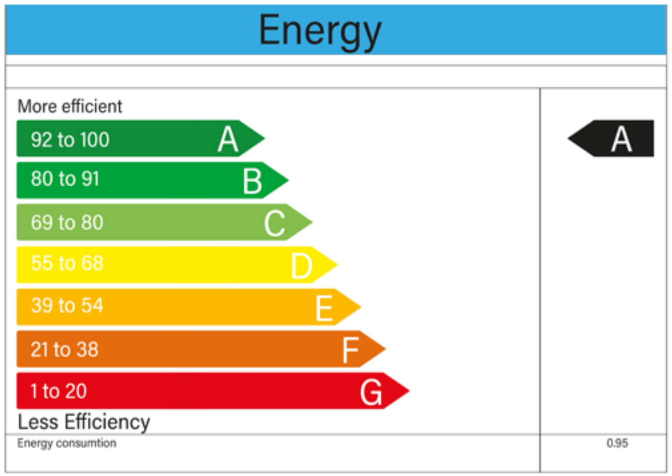
***This toolkit is concerned with B6 'operational energy' carbon following the retrofit of your homes. However, it also considers B2-B5 in relation to strategic asset management and planned investment and asset maintenance**

CALCULATION METHODOLOGIES

Building professionals generally, and in particular energy assessors, use the Government's full Standard Assessment Procedure (SAP) methodology - which is captured in industry standard software and used to calculate likely energy performance of new homes at design stage - to demonstrate compliance with Building Regulations Part L minimum standards of energy performance.

The SAP software allows energy assessors to input different fabric performance values (U-values), thermal junction values, air tightness values and building service performance and renewables efficiencies and outputs.

The software creates a notional (digital twin) building to determine compliance and a likely SAP score and EPC banding.



At completion of construction, actual values such as air tightness are input into the design stage SAP model to determine the 'as built' SAP score and the final energy performance certificate rating.

The calculation tool used for compliance with Part L 2021 is SAP 10. This will supersede the SAP 2012 tool which is currently used to demonstrate compliance with Part L 2013.

Previously there were two criteria that a home needed to comply with: an emissions rating which assessed the amount of CO_2 likely to be emitted from the building and a fabric efficiency rating which assessed how efficiently the building's thermal envelope performed. The Future Homes Standard has introduced an additional primary energy rating that needs to be met. This will mean that the running cost of the home needs to be considered to avoid a home that has low CO_2 emissions but high fuel costs for the occupier.

SAP also considers heat losses at the junctions of two thermal elements e.g. external wall and floor/windows/roof. These junctions are known as thermal bridges and the calculation of the effectiveness of these thermal bridges is known as a psi value. The new SAP 10 rewards calculation of bespoke rather than default psi values, which will be worse than the figures used in the current SAP 2012 tool.

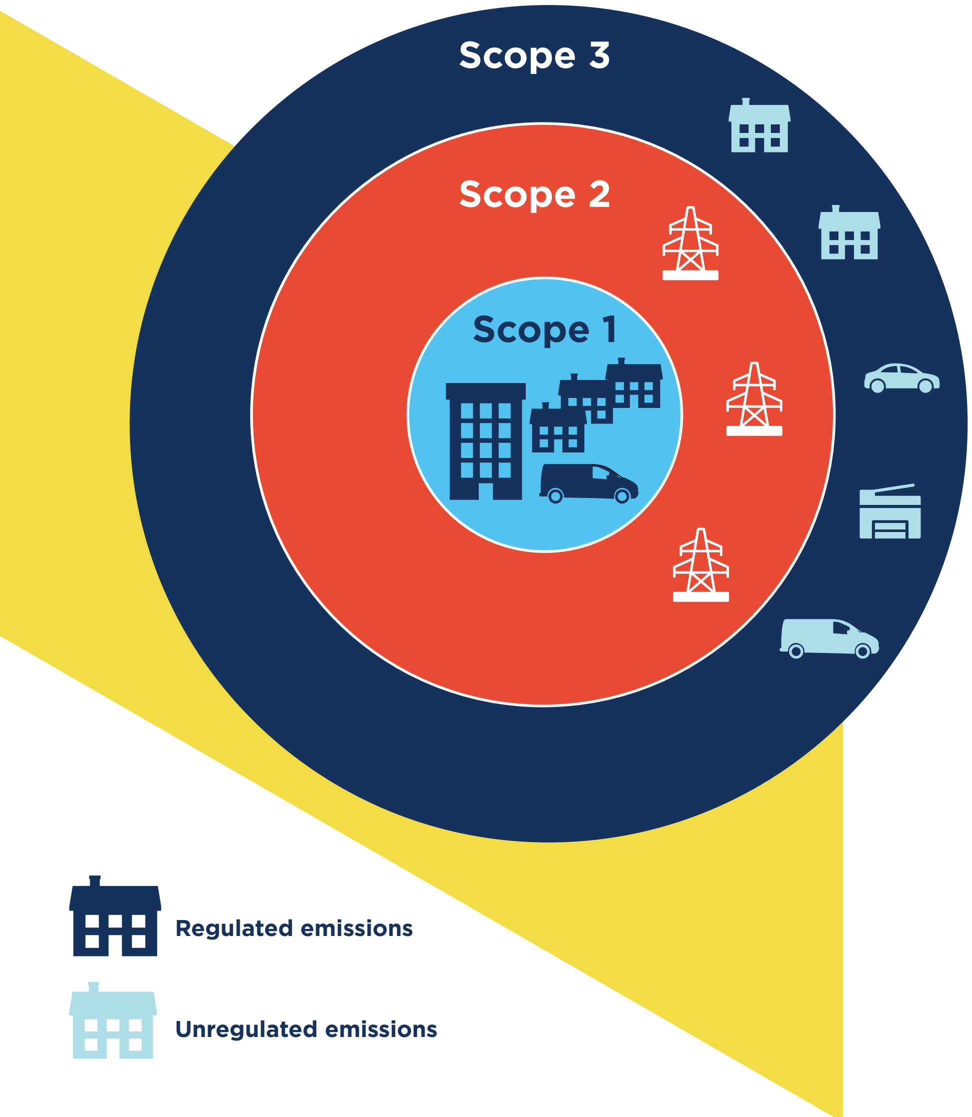
In this toolkit we have used bespoke thermal bridging psi values. Our calculation uses a minimum 30% improvement over the default values for the thermal bridging junctions.

There are alternatives. Passivhaus is a certified scheme to achieve very high performance of buildings and uses a different software to calculate performance, which is focused on a fabric first and mechanically ventilated approach. *This focuses on the operational energy and the space heating demand.*

YOUR ORGANISATION'S STRATEGY

The journey to net zero carbon new build homes for your organisation can be seen as part of a wider organisational restructuring.

Figure 2 – The scope of your organisation's carbon emissions



Your organisation's carbon footprint will sit in:

- **Scope 1** - the activities you are directly responsible for including your offices, vehicles and the emissions from residents' use of regulated energy in their homes e.g. gas boilers.
- **Scope 2** - the emissions produced by energy suppliers resulting from your residents' and your own use of energy.
- **Scope 3** – the emissions indirectly resulting from your supply chain, staff commuting and your residents' use of unregulated energy, for example in their electrical appliances.

Your organisation can directly control your Scope 1 emissions and thus influence your Scope 2 emissions. Scope 3 emissions can be managed by your procurement policies and influencing behaviour. A way of allocating emissions arising from your residents' homes might be to calculate the regulated emissions predicted by your energy data and subtract from actual emissions from sampled bill data or monitoring feedback. *Some organisations consider that only energy they directly buy or sell sits within their scope 1 emissions.*

The strategic choices facing organisations in a net zero new build future are a myriad but can essentially be summarised as:

- What are your strategy drivers?
  - > To reduce residents' fuel costs and increase comfort
  - > To lower your overall carbon footprint to avoid future new build retrofit and other costs
  - > Other metrics?
- Do you wish to deliver net zero carbon ready homes ahead of the legislative timetable?
- Can your organisation accommodate the current cost premium of early adoption?
- What technologies are your organisation and your residents likely to accept and how much risk of adoption or non-adoption are you willing to accept?
- Are you ready to maintain this type of property?

It may be useful to overlay your strategic business plan with these questions including strategic asset management, revised design briefs, procurement strategies, development pipeline activities and wider planned maintenance and strategic asset management activities.

FABRIC FIRST APPROACH AND POTENTIAL TECHNOLOGIES

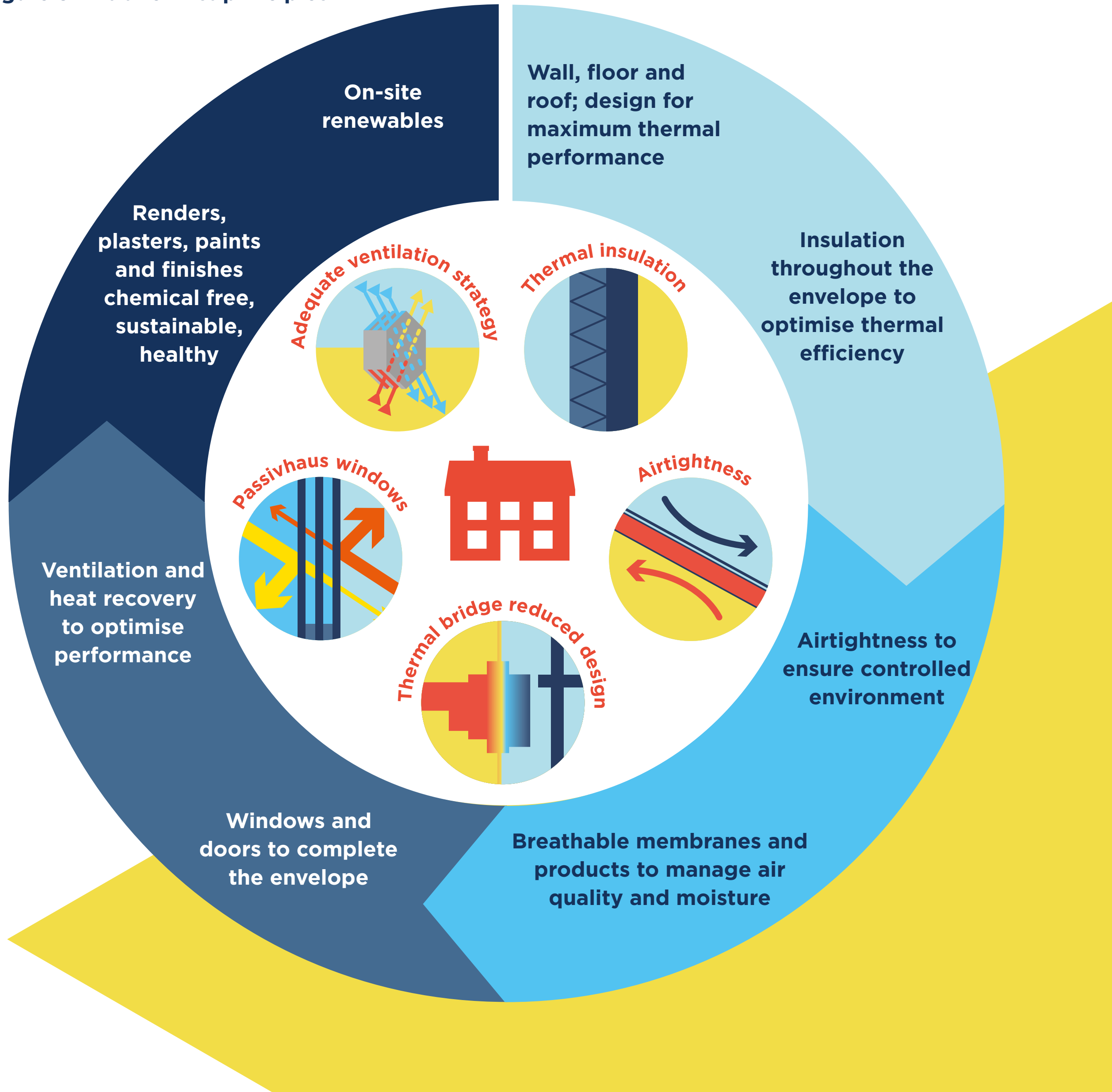
The latest Part L, Part F and Part O are predicated on a very well-insulated building envelope and building components known as 'fabric first'.

By constructing a high performing external envelope with well-insulated walls, high performance doors and windows and efficient junction detailing between them, the heat needed to keep the property comfortable is much less and building services do not need to produce as much energy.

As a result, air tightness (measured in cubic metres of air per square metre of building envelope per hour – *$m^3/(h.m^2)$@50Pa* needs to be better so that heat is not lost through a drafty building. The new building regulations require *8.0$m^3/(h.m^2)$@50Pa* but we have used $3m^3/m^2/hr$, which is a challenging target. The new regulations also allow a form of low pressure pulse testing which must achieve a value of 1.57 $m^3/(h.m^2)$@4Pa. This can lead to more complex forms of ventilation, such as mechanical ventilation with heat recovery (MVHR). Lower heat demands suit technologies such as air source and ground source heat pumps which can be run at efficiencies of more than 300% (compared to traditional gas heating). Such technologies do however require occupiers to consider how they operate their home heating systems and perhaps adapt their behaviours to maximise the potential of this approach.

One final thought as our climate warms is that overheating is a significant risk and must be considered within the design. *This aspect is addressed in Part O, which uses a simplified and standard calculation based upon a geographic distinction between London and everywhere else.* The simplified method will probably lead to smaller window openings, potentially affecting design and amenity. Clients may wish to commission overheating studies to meet criteria to allow more flexibility in design.

Figure 3 – Fabric First principles



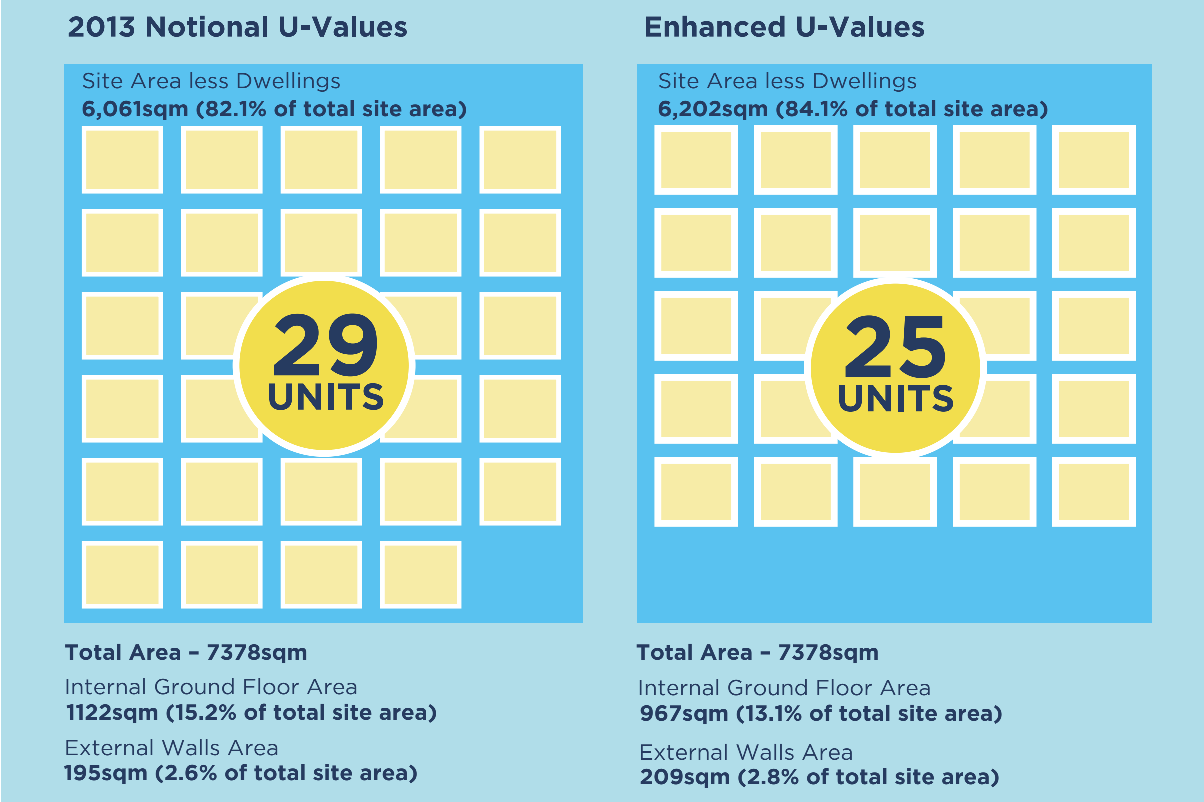
DESIGN IMPLICATIONS

A 'fabric first' approach and the inclusion of different or new technologies has implications for the layout of homes and the building footprint which may affect site capacity, and hence land values and viability.

In one sense it's 'welcome back to the airing cupboard' but not as we know it. Space is likely to be required to house hot water cylinders, which can provide hot water but also act as energy stores for other technologies like solar photovoltaics (PV). MVHR units and associated ducting can be space hungry. Space may also need to be carefully considered for the future installation of air source heat pump condensing units.

However, it is the thicker external wall build-up required to achieve the new standards which may impact on the number of units which can be planned on a given site area.

Figure 4 – Potential effect of enhanced U-values on site capacity



The diagram above graphically shows the effect on site capacity on a real site by increasing unit element build ups.

The example above is based on a real site which comprised several sets of semi-detached homes. Increasing the cavity wall sizes of the homes caused a knock-on effect to the overall external wall dimensions, ultimately resulting in the loss of four homes.

As a result of improving the u-values of external walls, the overall wall thickness and building footprint will become larger. On sites which have maximised developable area and feature semi-detached or terraced units this will likely result in the loss of units, when compared to sites which have been designed to 2013 u-values.

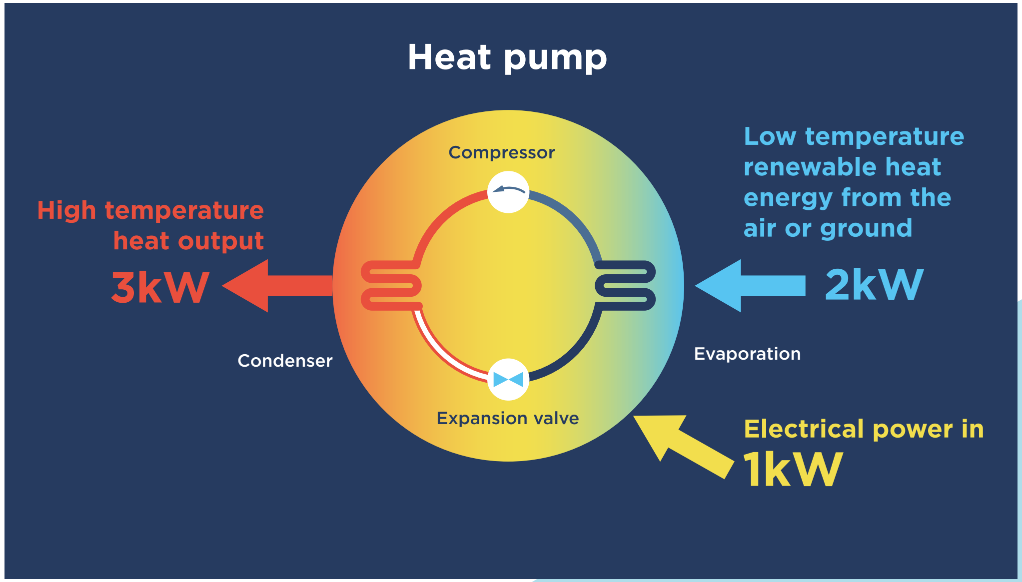
Experienced designers should be able to address this constraint to some extent, but it should be borne in mind that complex plan forms with steps, staggers and inefficient floor to wall ratios will drive up cost through buildability and make energy performance compliance more difficult.

CURRENT TECHNOLOGIES

Heat pumps

The most common are air and ground source heat pumps which use electricity to harvest energy from the air or ground into usable heat within the home. Ground source heat pumps use fluid in buried pipes laid horizontally or in vertical piles in the ground to capture ambient ground heat. Laid horizontally this can require a larger external area. Air source heat pumps capture ambient energy from the air. Both will generally transfer this using a condensing unit to a hot water cylinder from where it can be used to provide heat and hot water. Air source heat pumps are the most common heat pump but need to be correctly installed providing low temperature heat into an efficient and airtight building envelope.

Figure 5 – Heat pump efficiency



Photovoltaic (PV) panels

Another common renewable technology is photovoltaic (PV) panels, which are often roof mounted. They generate electrical power which passes through an invertor to convert it to alternating current to use in the home, store as energy via hot water or batteries, or export to the grid. Panels must be carefully sized and take account of orientation towards the sun. They will generate peak power during the day in summer which, with the right system, can be stored in the home.

Figure 6 – PV panels

Controls

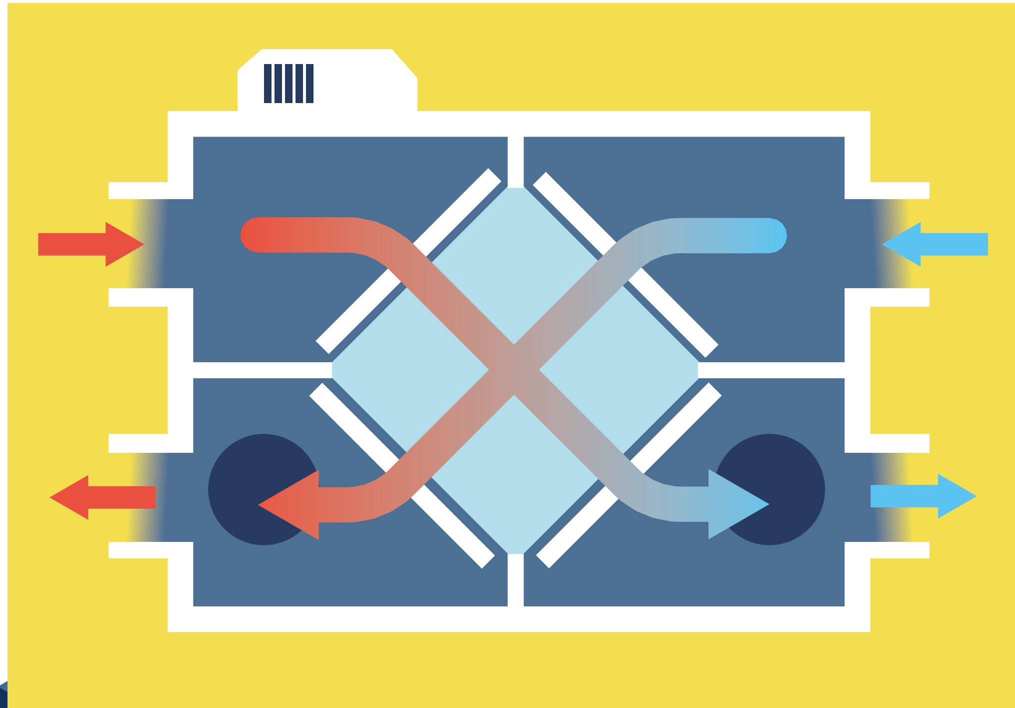
A home's heating and hot water system needs to contain controls to ensure that it is operating in the most effective and efficient way and provides occupants with the most user-friendly interface possible. If people can see the energy performance of their home and what it is costing, they are more likely to operate it as intended by its designers. There are now smart control systems available that use sensors and AI to allow the building to adapt to occupants' behaviour patterns and use time of use energy tariffs and energy storage in the home to optimise efficiency and even sell energy back to the grid.

Figure 7 – Smart home control systems

Heat recovery

Once heat has been provided into a home, it is possible to recover some of this heat and reuse it. The most common form of heat recovery is when mechanical extract systems extract warm moist air and pass it through a heat exchanger where it warms incoming fresh air as shown in figure 7. The other common form of heat recovery is from waste shower and bath water which is used to pre heat incoming cold water.

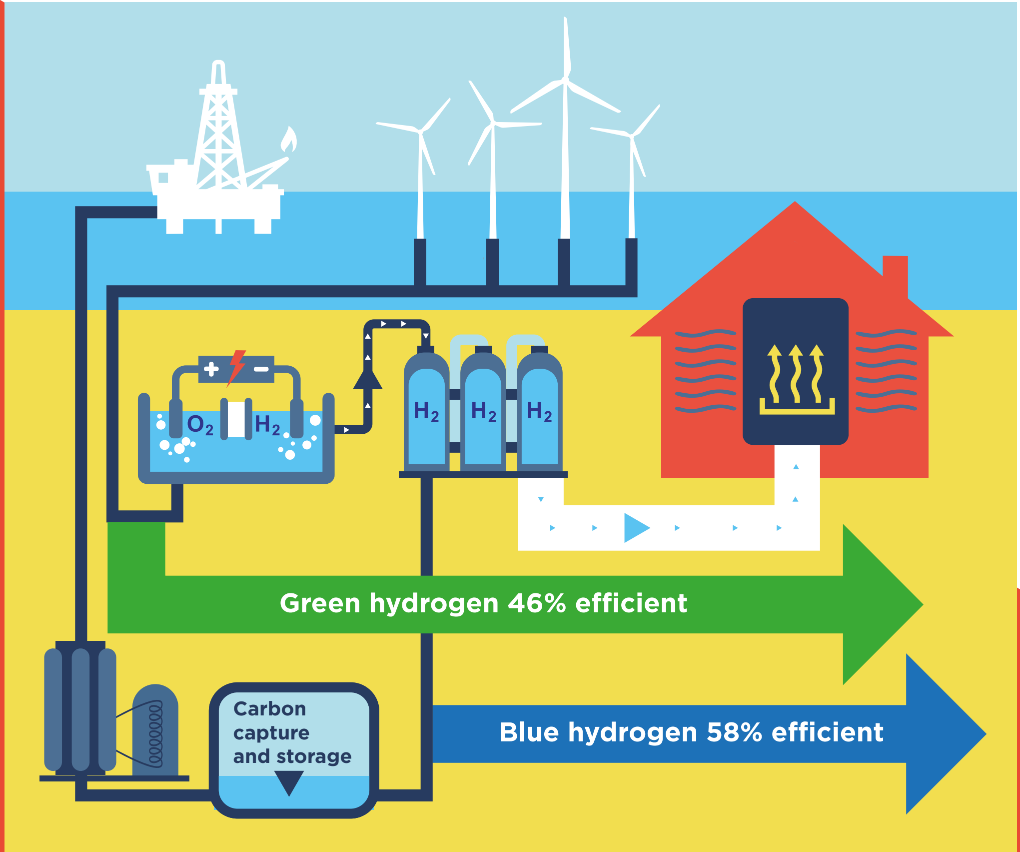
Figure 8 – Mechanical Ventilation with Heat Recovery (MVHR)



Hydrogen

Hydrogen is being promoted as a zero-carbon fuel of the future. The idea being that new homes use hydrogen-ready boilers with 'blue' and/or 'green' hydrogen being supplied via a new network or mixed into existing gas supplies to reduce their carbon intensity. Whilst this is an option, because hydrogen production is inefficient, as can be seen in figure 8, it is likely that hydrogen will be used in other industries, transport or as an energy storage medium. *This is reflected in the government's published Hydrogen Strategy and British Energy Security Strategy which also identified 'pink' electrolytic hydrogen produced by nuclear power.*

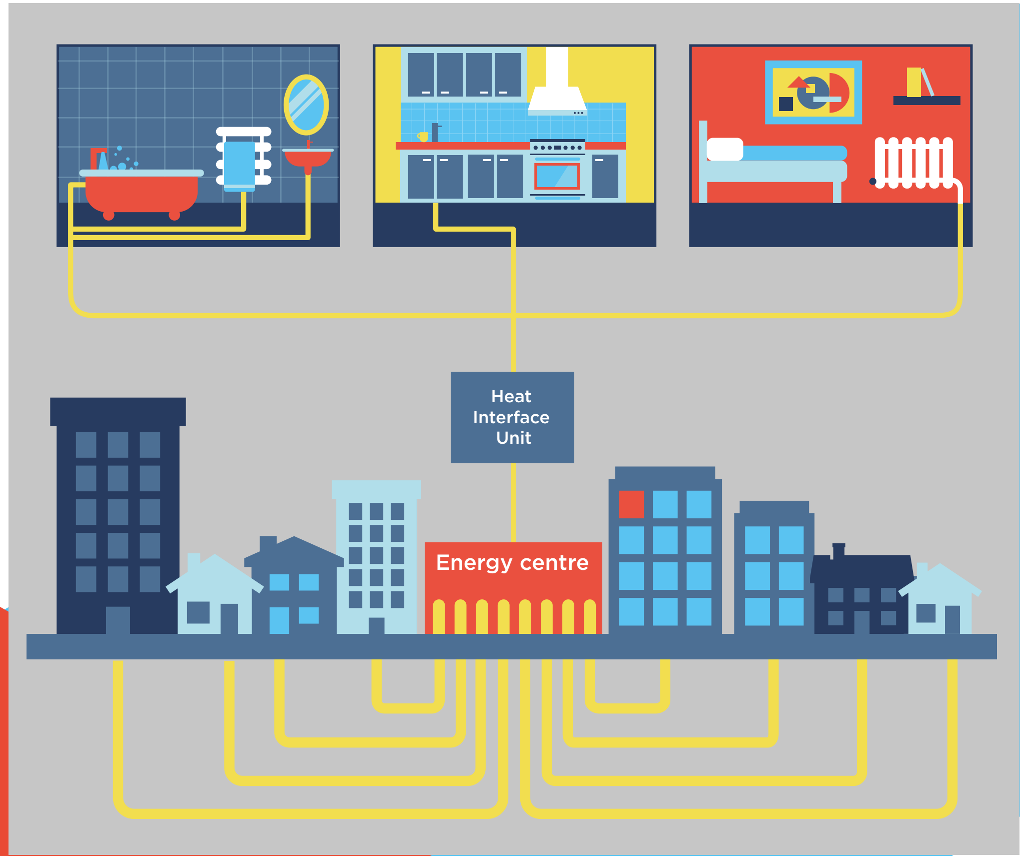
Figure 9 – Efficiency of blue and green hydrogen production



Heat networks

In some locations, heat networks are available or can be constructed so that home heating and hot water can be provided by a heat interface unit (HIU) connected to the network that is supplied by central plant. Such central plant can be very efficient in cost and carbon terms, as shown in figure 9 but heat networks require scale to spread the cost of the infrastructure among users.

Figure 10 – Energy centre heat distribution



BUILDING SERVICING OPTIONS

This revision of the toolkit has added different building services options providing space heating and hot water for apartments in multi residential blocks.

The circumstances for each block will be unique and require specialist professional design but we have selected options using energy centres with electric boilers boosted by air source heat pumps (figs 11 and 12) and ground source heat pumps boosted by micro water source heat pumps (fig 14). Individual apartment servicing options of air source heat pumps (fig 13) and electric storage heaters with hot water boosted by micro air source heat pumps (fig 15) are also included. Heat may be delivered via heaters, radiators or underfloor heating. All units will include an MVHR unit, which has been included in energy modelling and costs. Photovoltaics shown are indicative only. We consider the minimum number of units at which the energy centre options become viable is around 35 apartments.

Figure 11 – Option 1: Energy Centre - Hybrid Air Source Heat Pumps and Electric Boiler with Heat Interface Unit

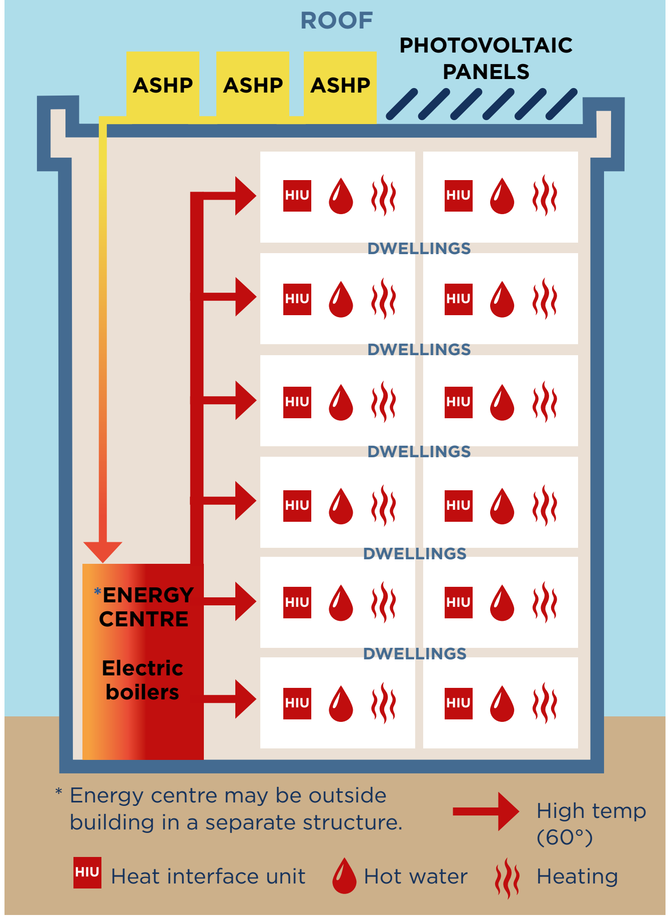


Figure 12 – Option 2: Energy Centre - Air to Water Heat Pump and Water to Water Heat Pump Cylinder

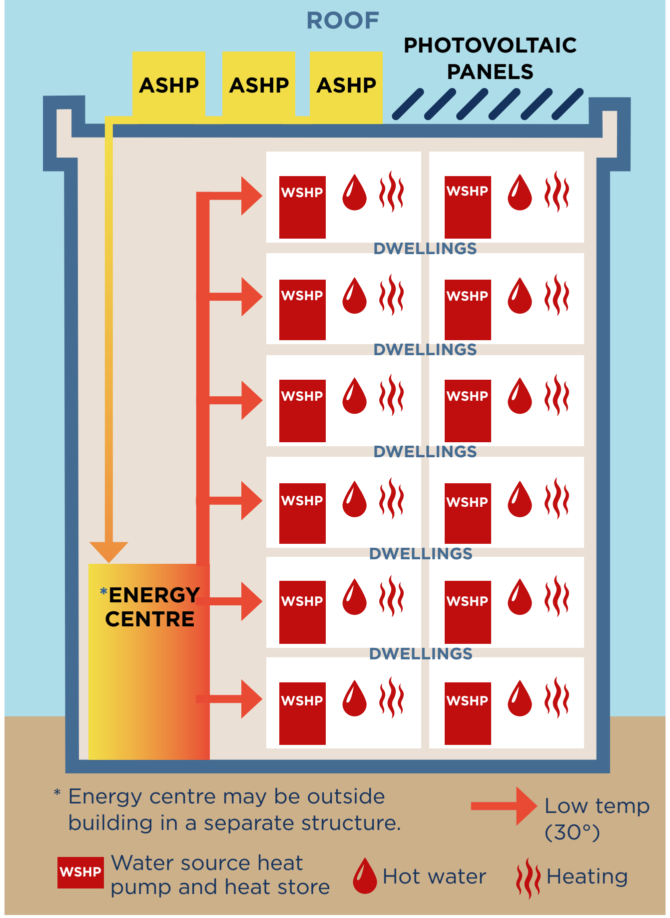


Figure 13 – Option 3: Individual Air Source Heat Pumps with Internal Hot Water Cylinder

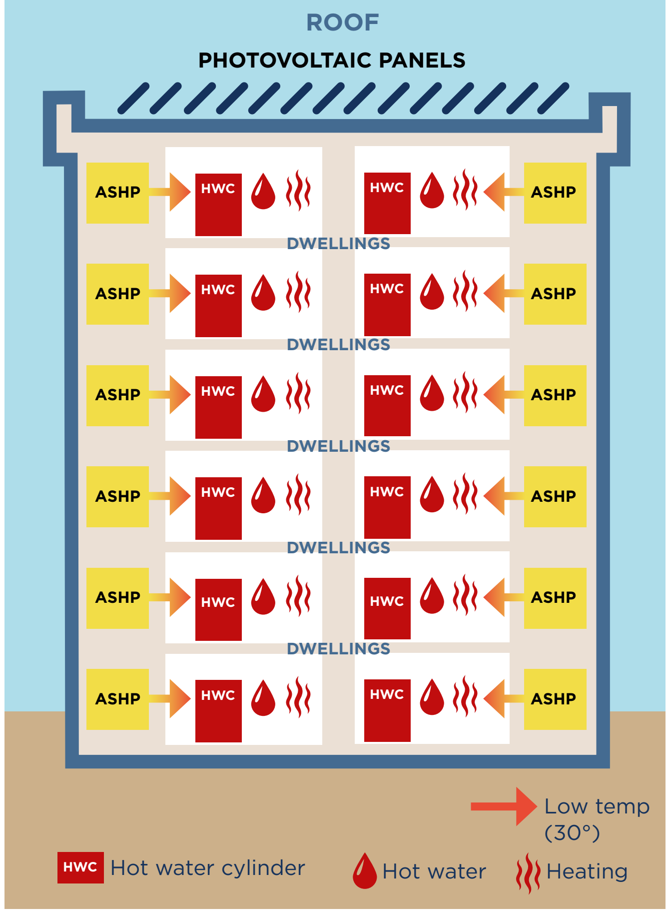


Figure 14 – Option 4: Ground Source Heat Pump with Water to Water Heat Pump and Heat Store

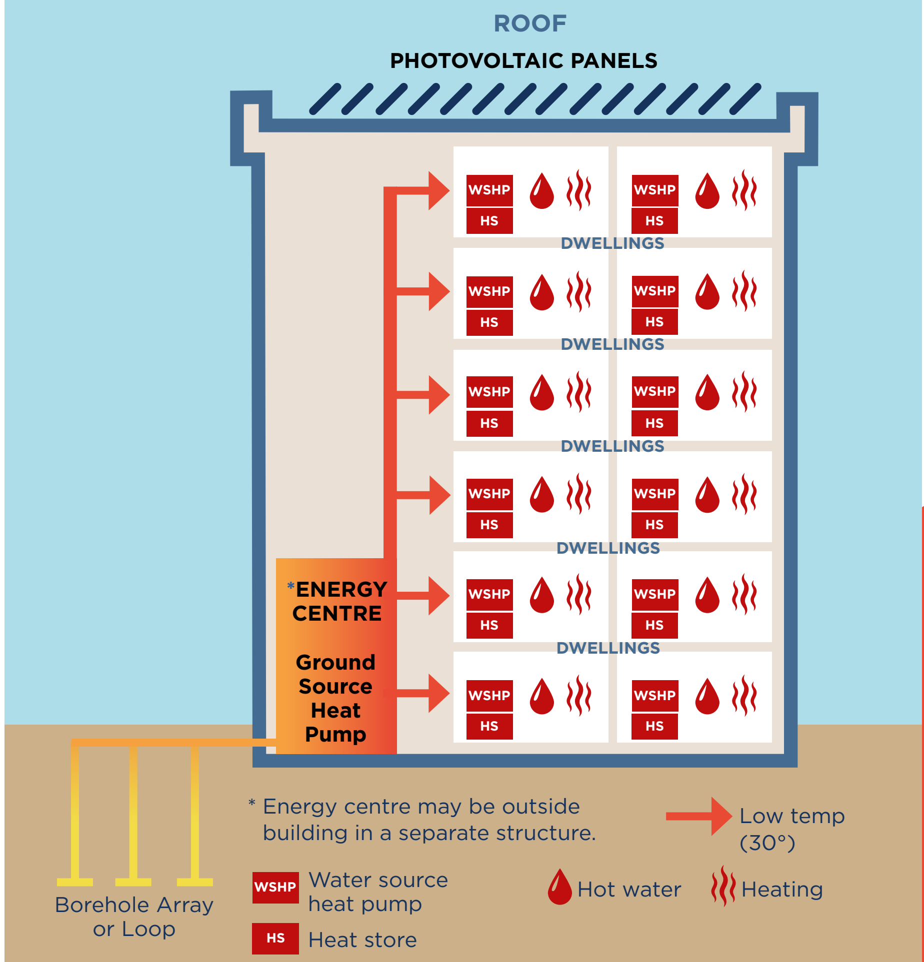
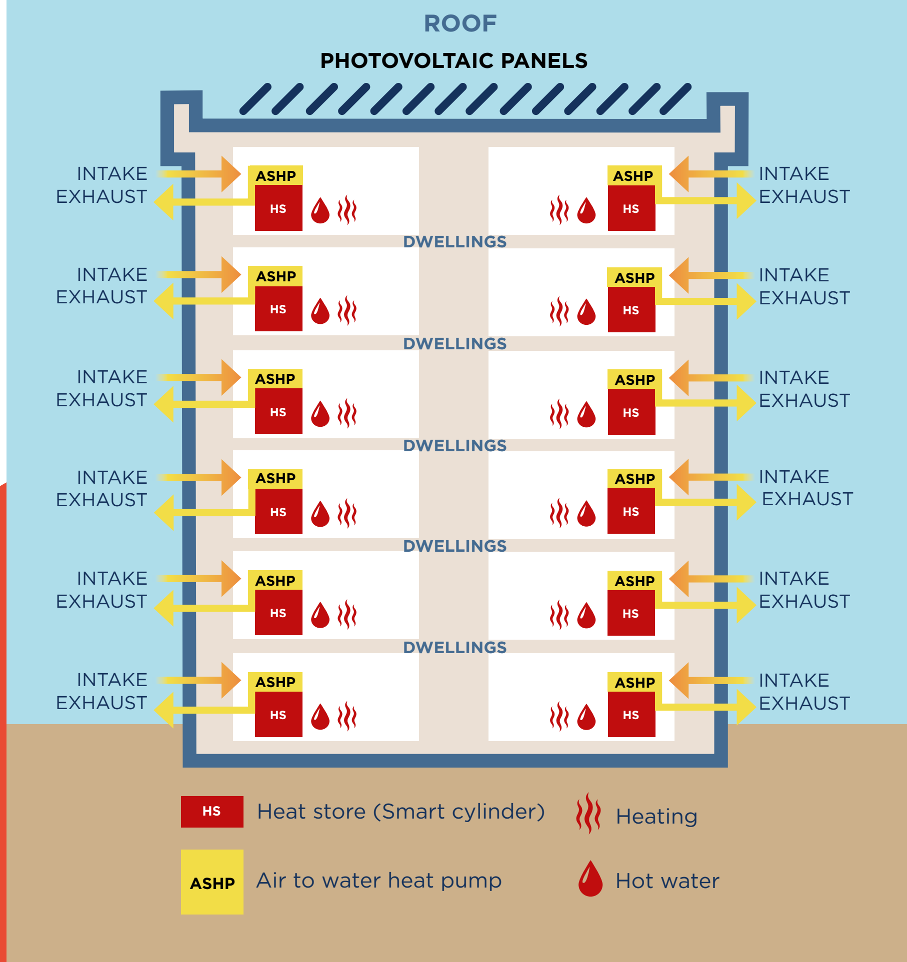


Figure 15 – Option 5: Electric Storage Heaters and Hot Water Cylinder with Air to Water Heat Pump



RESIDENTS, COMMISSIONING AND MAINTENANCE

Most organisations' key objectives are likely to include having a positive impact on their residents' quality of life through providing a low-cost comfortable living environment.

Net zero carbon homes present some advantages when compared to new homes currently offered to residents. Fabric first energy efficient homes are likely to be heated with heat pumps, have renewable technologies such as solar PV and have a hot water cylinder. In addition, they are also likely to be relatively airtight and use a mechanical extract system such as MVHR.

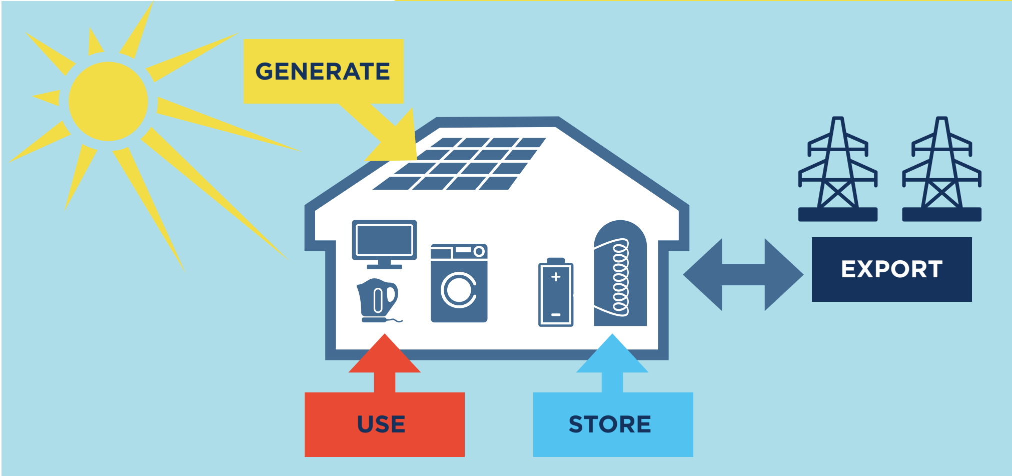
There are, however, some key considerations to ensure residents benefit from their new homes to the greatest possible extent. One of the key issues of the net zero carbon home is that the peak heat demand is lower and more consistent.

Heat is not on-demand by turning the heating on or off and this means that programmers, timers and intelligent controls are needed to ensure a comfortable living environment is maintained. Such controls can also reduce load on the grid by using time of use tariffs.

A key point for net zero carbon homes is to adopt the 'soft landings' approach which originated in commercial buildings. This should incorporate a very well explained user manual presented at property handover, videos, or other resources accessible via social media and call backs by servicing staff in the period immediately after handover to check in on residents' understanding and operation of their systems.

In phased handovers, site staff have an important role to play. Asset management staff and service contractors who will be maintaining M&E installs outside of warranty periods must be trained in maintaining equipment and could also undertake post occupancy call backs.

Figure 16 – Optimising energy use



If homes incorporate photovoltaics, the least cost-effective thing for a resident to do is allow energy to be exported to the grid.

A hierarchy of generate, use, store, export should be adopted. This leads to a balance of optimal sizing of solar PV for the available roof and size of property. Energy generated by the solar PV can then be stored in the property with the minimum exported. If residents understand when renewable electricity is being generated, then they may adapt their use of appliances to use energy before it is stored in a smart hot water cylinder or other potential energy storage devices like batteries. Smart home control systems can also optimise energy storage and interaction with the grid.

An essential element is resident energy literacy and understanding of their new home, which needs to be embedded through a non-technical home user guide, follow up visits and sign posted online resources. You may wish to support this with energy monitoring that can identify issues early and allow resident support to be provided where appropriate. As part of planning, some city authorities are starting to require evidence of monitoring strategies.

YOUR OPTIONS AND POTENTIAL STRATEGIES

What have we done?

We have undertaken scenario modelling using the standard assessment procedure version SAP 10 on some typical house and flat layouts using different details and wall build-ups adding different technologies and levels of air tightness.

The Layouts

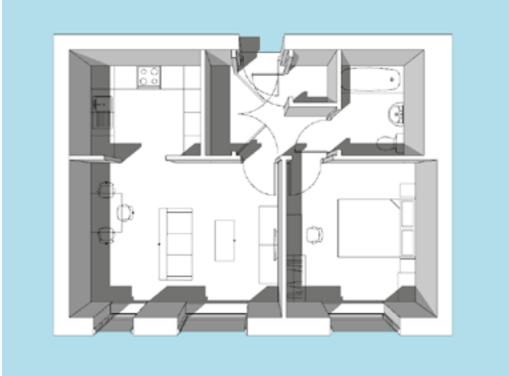
The house and low rise apartment layouts and gross internal floor areas (GIFAs) shown here meet nationally described space standards (NDSS) and are fairly typical but won't necessarily match units that your organisation uses. They should, however, give similar approximate outcomes.

Find the layouts that interest you in the tables on **pages 18-22.**

**The high rise 78m² apartment is a composite apartment type which was created from 10 different apartment types within a multi-residential block of over 120 units within Greater London. This approach allowed energy and cost outputs for this composite type to be shown in a m2 format allowing the performance of different building servicing options to be compared.*

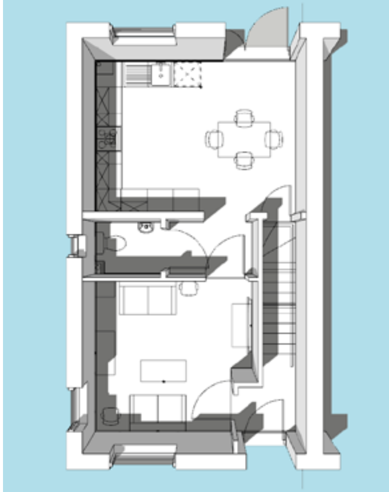
Find the servicing options that interest you in the tables on **pages 18-22.**

1B2P Low Rise Apartment Floor Plan

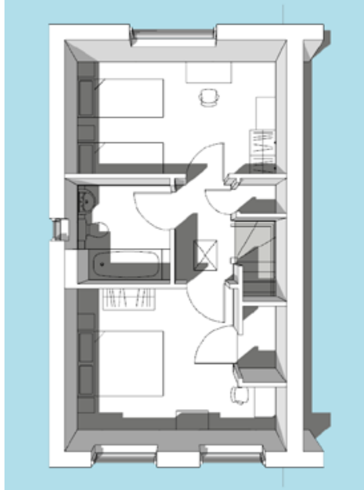


Gross Internal Floor Area 50m²

2B4P House Ground Floor Plan

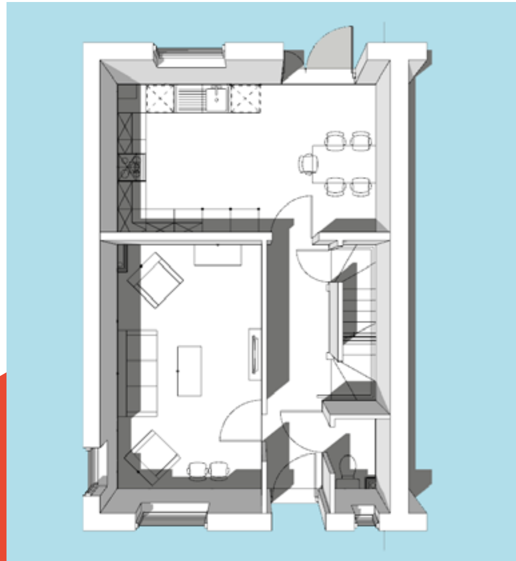


2B4P House First Floor Plan



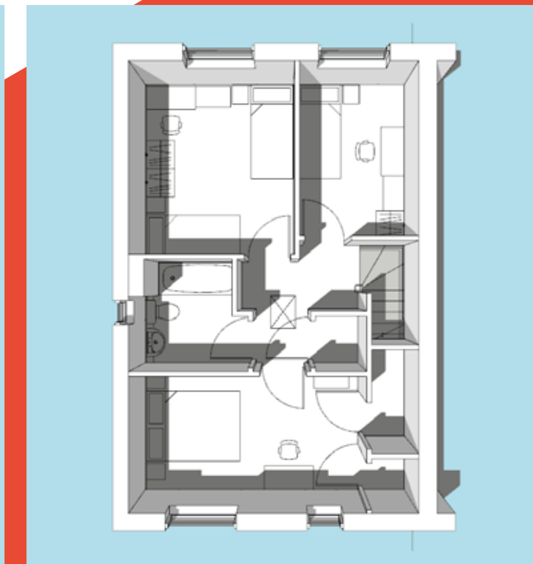
Gross Internal Floor Area 79.5m²

3B5P House Ground Floor Plan

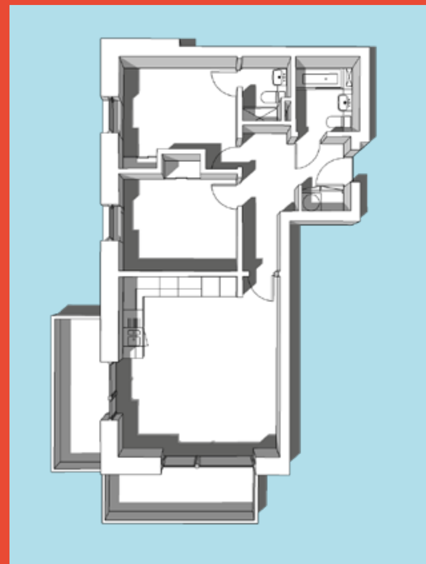


Gross Internal Floor Area 94.5m²

3B5P House First Floor Plan



2B4P Composite High Rise Apartment Floor Plan*



Gross Internal Floor Area 77.9m²

THE DETAILS

We have used the following element build-ups and values in the energy calculations with the layouts shown **on p16**. The options shown are based on current standard products which are on the market. One of the options is either the use of a mineral wool type insulation or a Polyisocyanurate (PIR) insulation. The former is an inert material, and the latter is more efficient but is not inert. The final choice of insulating material must be balanced against risk and environmental performance. *In multi-residential properties, landlords will be aware of their obligations under the Building Safety Act and material choices will be made accordingly. Wall option 6 is a typical steel framing system (SFS), mineral wool and masonry build for higher rise buildings.*

The improved fabric values shown in the table below have been selected as the lowest realistic values, to achieve maximum fabric performance, that can be attained with the products currently available in the market.

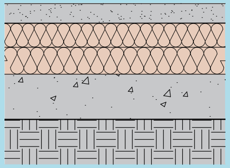
These values should enable compliance with the draft Part L 2025 Future Homes Standard values.

Improved fabric values

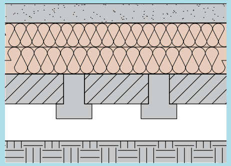
Elements	Improved U-Values (W/m^2K)
Floor	0.09
External Walls	0.13
Party Wall	0.00
Roof	0.10
Doors	1.00
Windows (Triple Glazing)	0.80

CLICK HERE to see more information on **Ground Floor Level** build-up options

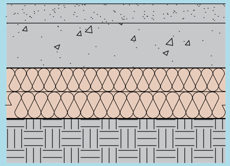
Ground Floor Level
Option 1



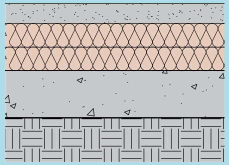
Ground Floor Level
Option 2



Ground Floor Level
Option 3

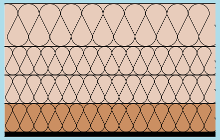


Ground Floor Level
Option 4

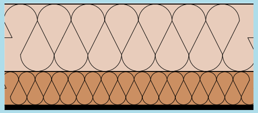


CLICK HERE to see more information on **Roof** build-up options

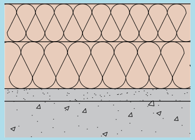
Roof
Option 1



Roof
Option 2

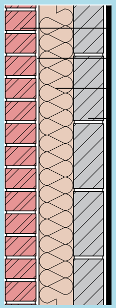


Roof
Option3

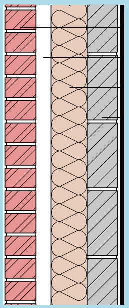


CLICK HERE to see more information on **Wall** build-up options

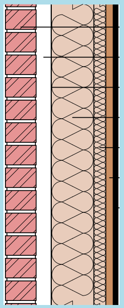
Wall
Option 1



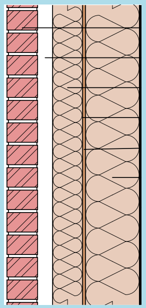
Wall
Option 2



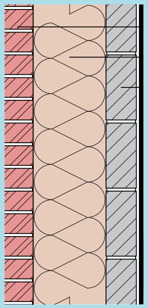
Wall
Option 3



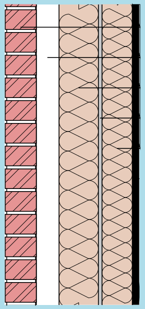
Wall
Option 4



Wall
Option 5



Wall
Option 6



THE RESULTS

The tables on pages 18 to 22 give a range of the results that can be expected for the unit layouts identified on **page 16** **to give you an idea of what inputs result in net zero carbon outputs.**

Figure 17 – Future Homes Standard houses and low rise apartments compliance tables

Gas Boiler				**Part L Compliance**					
Dwelling Type	**Improved Fabric** (as per table on page 15)	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**Compliance with Part L 2025**
2 Bed house to NDSS	✔	3	✔	✔	✘	✔	✘	✘	✘
3 Bed house to NDSS	✔	3	✔	✔	✘	✔	✘	✘	✘
1B2P Low rise apartment at ground floor	✔	3	✔	✔	✘	✔	✘	✘	✘
1B2P Low rise apartment at mid floor	✔	3	✔	✔	✘	✔	✘	✘	✘
1B2P Low rise apartment at top floor	✔	3	✔	✔	✘	✔	✘	✘	✘
Electric Panel Heaters				**Part L Compliance**					
Dwelling Type	**Improved Fabric** (as per table on page 15)	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**Compliance with Part L 2025**
2 Bed house to NDSS	✔	3	✔	✔	✔	✔	✘	✘	✘
3 Bed house to NDSS	✔	3	✔	✔	✔	✔	✘	✘	✘
1B2P Low rise apartment at ground floor	✔	3	✔	✔	✔	✔	✘	✘	✘
1B2P Low rise apartment at mid floor	✔	3	✔	✔	✔	✔	✘	✘	✘
1B2P Low rise apartment at top floor	✔	3	✔	✔	✔	✔	✘	✘	✘

Figure 17 (continued) - Future Homes Standard houses and low rise apartments compliance tables

Air Source Heat Pump				Part L Compliance					
Dwelling Type	**Improved Fabric** (as per table on page 15)	**Air Permeability $m^3/hr/m^2$**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**Compliance with Part L 2025**
2 Bed house to NDSS	✔	3	✔	✔	✔	✔	✔	✔	✔
3 Bed house to NDSS	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✔

Ground Source Heat Pump				Part L Compliance					
Dwelling Type	**Improved Fabric** (as per table on page 15)	**Air Permeability $m^3/hr/m^2$**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**Compliance with Part L 2025**
2 Bed house to NDSS	✔	3	✔	✔	✔	✔	✔	✔	✔
3 Bed house to NDSS	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✔
1B2P Low rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✔

Figure 17 – Future Homes Standard high rise apartments compliance tables

Gas Boiler				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025**	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✘	✔	✘	✘	✘	0	✘	✘	0
2B4P High rise apartment at mid floor	✔	3	✔	✔	✘	✔	✘	✘	✘	0	✘	✘	0
2B4P High rise apartment at top floor	✔	3	✔	✔	✘	✔	✘	✘	✘	0	✘	✘	0

Option 1: Energy Centre - Hybrid Air Source Heat Pumps and Electric Boiler with Heat Interface Unit (Fig 11)				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025****	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0

* The Part L 2025 values on which these results are based are published in draft and are likely to be subject to change.
** PV is not required for energy compliance but may be required for planning and clients may wish to incorporate on a scheme-specific basis.

Figure 17 (continued) - Future Homes Standard high rise apartments compliance tables

Option 2: Energy Centre - Air to Water Heat Pump and Water to Water Heat Pump Cylinder (Fig 12)				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025****	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0

Option 3: Individual Air Source Heat Pumps with Internal Hot Water Cylinder (Fig 13)				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025****	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0

* The Part L 2025 values on which these results are based are published in draft and are likely to be subject to change.
** PV is not required for energy compliance but may be required for planning and clients may wish to incorporate on a scheme-specific basis.

Figure 17 (continued) - Future Homes Standard high rise apartments compliance tables

Option 4: Ground Source Heat Pump with Water to Water Heat Pump and Heat Store (Fig 14)				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025****	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
2B4P High rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0
B4P High rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✘	0

Option 5: Electric Storage Heaters and Hot Water Cylinder with Air to Water Heat Pump (Fig 15)				**Part L 2021**							**Part L 2025***		
Dwelling Type	**Improved Fabric**	**Air Permeability m³/hr/m²**	**Bespoke Thermal Bridging Calculation**	**MVHR**	**Emissions Rating**	**Fabric Efficiency Rating**	**Primary Energy Rating**	**Compliance with Part L 2021**	**PV required for Compliance with Part L 2021**	**Amount of PV kWp**	**Compliance with Part L 2025**	**PV required for Compliance with Part L 2025**	**Amount of PV kWp**
2B4P High rise apartment at ground floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✔	0.25
2B4P High rise apartment at mid floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✔	0.25
2B4P High rise apartment at top floor	✔	3	✔	✔	✔	✔	✔	✔	✘	0	✔	✔	0.25

* The Part L 2025 values on which these results are based are published in draft and are likely to be subject to change.
** PV is not required for energy compliance but may be required for planning and clients may wish to incorporate on a scheme-specific basis.

COST IMPLICATIONS

The cost implications of delivering new homes to higher standards are a critical factor when considering standards, specifications, and performance, particularly when competing against those who are not adhering to the same standards.

This is particularly critical if an organisation is considering adopting standards ahead of the regulatory timetable, which in time will create a level playing field in the market for land and development.

There are undoubtedly capital cost implications of high performing homes, however it may be helpful to consider this in the context of whole life costs. *This revision of the toolkit has also provided whole life costs as can be seen in the revised tables.* New homes being built to current standards will require further retrofitting within the viability model period to meet our net zero commitment. The capital cost of later retrofitting is up to five times more expensive than the cost difference now between building current standards and the proposed Future Homes Standard.

It is also likely that there will be lower repairs and maintenance costs, and regulatory requirements around servicing. Skills and supply chain issues will come into play.

Crucially, the costs of occupation are likely to be lower which will hopefully lead to a reduction in fuel poverty. *In this time of a 'cost of living crisis' this aspect is likely to be weighted more highly.*

To assist in taking decisions, we have adopted a cost methodology expressed in figure 18 on **page 24** where you can see the average uplift calculations. You can also take the costs from the table for your preferred fabric and services enhancements for the layout you are evaluating and use it to get the specific uplift for your choices, as demonstrated by the example formula. If you wish, you can then apply the location factor to get a final figure. These cost figures are only approximate and you should always carry out your own specific cost evaluation on your own projects.

A final thought is that, with the UK government's push towards Modern Methods of Construction (MMC), widespread adoption of MMC compliant unit types could lead to lower capital and time related costs. The standardisation of unit types and elemental build-ups required by MMC may allow easier routes to compliance and achieving the Future Homes Standard with variant SAP calculations being produced for different orientations of each type.

The base date for the costs in this toolkit is June 2022.

House and low rise apartment cost table

Figure 18 – Cost of standards compliance

Future Homes Standard enhancements (see page 17 for details of options)	Extra over cost over base cost* Type 1 1B2P	Type 2 2B4P	Type 3 3B5P
	GIFA** 50.0 m²	GIFA 79.4 m²	GIFA 94.6 m²
External Walls Option 1	£2,432	£3,861	£4,601
External Walls Option 2	£2,357	£3,743	£4,459
External Walls Option 3	£5,143	£8,167	£9,730
External Walls Option 4	£2,450	£3,891	£4,636
External Walls Option 5	£3,441	£5,464	£6,510
Floor Option 1	£333	£529	£630
Floor Option 2	£126	£200	£238
Floor Option 3	£333	£529	£630
Roof Option 1	£481	£764	£911
Roof Option 2	£598	£950	£1,131
MVHR	£3,950	£4,773	£5,261
ASHP	£9,775	£11,213	£12,420
GSHP	£11,788	£12,363	£14,088
Electric Panel Heater	£316	£500	£598
PV***	£3,091	£4,908	£5,847

Location factor****	Multiplier
Default location	1.00
London	1.21
South East	1.11
South West	1.04
East Midlands	1.04
West Midlands	0.94
North East	0.92
North West	0.98

* Base cost is set at standard social housing specification to current regulations

** GIFA stands for gross internal floor area

*** PV (photovoltaic) measure assumed at 25% roof area

**** Location factor (information taken from the BCIS) - the extra over costs are set at the 'default location' rate. Multiply the overall cost by the required location factor

Please note these costs indicate the total extra over cost per dwelling. The costs are for the increased specification of that particular element and do not include cost for any subsequent impact that change has on the building layout.

	External Walls		Floor Option		Roof Option		MVHR		ASHP/GSHP		PV		Total	Average £/m² uplift
Type 1 Average Options Cost	£3,164	+	£264	+	£540	+	£3,950	+	£10,781	+	£3,091	=	£21,790	£436
Type 2 Average Options Cost	£5,025	+	£419	+	£857	+	£4,773	+	£11,788	+	£4,908	=	£27,769	£350
Type 3 Average Options Cost	£5,987	+	£499	+	£1,021	+	£5,261	+	£13,254	+	£5,847	=	£31,870	£337

	External Walls		Floor Option		Roof Option		MVHR		ASHP/GSHP		PV		Total		Location factor		Total for location	Average £/m² uplift
Calculate your own cost		+		+		+		+		+		=		x		=		

Composite mid and high rise apartment cost table

Figure 18 – Cost of standards compliance

	Extra over cost over base cost*	
Future Homes Standard enhancements (see page 17 for details of options)	**Composite unit extra over cost**	**Whole life cycle**
External Walls Option 6	£7,191	£8,054
Floor Option 4	£530	£593
Roof Option 3	£989	£1,108
MVHR	£5,070	£5,772
Option 1: Energy Centre - Hybrid Air Source Heat Pumps and Electric Boiler with Heat Interface Unit (Fig 11)	£9,204	£10,512
Option 2: Energy Centre - Air to Water Heat Pump and Water to Water Heat Pump Cylinder (Fig 12)	£8,658	£9,868
Option 3: Individual Air Source Heat Pumps with Internal Hot Water Cylinder (Fig 13)	£9,906	£11,321
Option 4: Ground Source Heat Pump with Water to Water Heat Pump and Heat Store (Fig 14)	£10,823	£12,570
Option 5: Electric Storage Heaters and Hot Water Cylinder with Air to Water Heat Pump* (Fig 15)**	£6,006	£7,027

GIFA**	78.0	(m^2)

Location factor*****	**Multiplier**
Default location	1.00
London	1.21
South East	1.11
South West	1.04
East Midlands	1.04
West Midlands	0.94
North East	0.92
North West	0.98

* Base cost is set at standard social housing specification to current building regulations

** GIFA stands for gross internal floor area

*** Building Servicing Option 5 includes 0.25kwp of PV (photovoltaic) per apartment

**** Location factor (information taken from the BCIS) - the extra over costs are set at the 'default location' rate. Multiply the overall cost by the required location factor

Please note these costs indicate the total extra over cost per dwelling. The costs are for the increased specification of that particular element and do not include cost for any subsequent impact that change has on the building layout. The Building Services which contain communal systems have been priced on the assumption of a block of flats containing a minimum of 35 units. Whole Life Costing element assumes a Building Life of 60 years. The cost has been valued at the Net Present Value (NPV).

Composite unit extra over per m² cost

Building fabric & MVHR		Building servicing		Total	Average £/78m² uplift
£13,779	+	Option 1: £9,204	=	£22,983	£295
£13,779	+	Option 2: £8,658	=	£22,437	£288
£13,779	+	Option 3: £9,906	=	£23,685	£304
£13,779	+	Option 4: £10,823	=	£24,602	£315
£13,779	+	Option 5: £6,006	=	£19,785	£254

SOME OTHER THINGS TO THINK ABOUT

Whole life carbon and specification

Whole life carbon of a home is comprised of upfront carbon, in use carbon and end of life carbon. This toolkit is concerned with 'in use' carbon and as can be seen from **figure 1 on page 5** specifically B6.

As the operational performance of homes improves, the proportion of whole life carbon represented by operational carbon compared to upfront carbon changes, with upfront embodied carbon intensity becoming much more important. This is a fundamental issue and is likely to be regulated in the same timeframes as the Future Homes Standard.

The Greater London Authority currently requires whole life carbon assessments for schemes which contain more than 150 units and/or which are more than 30m in height. A draft Part Z of the building regulations has been proposed and be found here: **https://part-z.uk/**.

In principle, organisations would be wise to consider this rapidly emerging consideration alongside their adoption of the Future Homes standard.

Client organisations can influence all aspects of whole life carbon through specification, procurement, partner selection, maintenance and, crucially, refurbishment, or retrofitting, which is the subject of a further toolkit.

The sequestering of carbon through material specification, in particular timber, is also important. It is likely that other materials which have a lower embodied carbon or lock up carbon are likely to come to market in the future. Many of these are likely to be more natural materials that are renewable or have a lower environmental impact.

The principles of the circular economy, in which materials are not disposed of at the end of their life but reused in a similar or changed capacity, e.g. crushed aggregate, is being adopted. The Greater London Authority currently requires that referable projects of 200 units or more produce a circular economy statement to ensure this is being considered.

Photovoltaics (PV)

The fabric values and servicing options selected mean that the Future Homes Standard can be achieved without PV. Particularly in a multi residential block, if roof area is available, PV can be added which will improve the SAP and potentially the EPC ratings of apartments but this will be on a project-specific basis.

Biodiversity

The climate emergency goes hand in hand with the ecological emergency. Consideration of biodiversity in projects is required by obligations in the forthcoming Environment Bill. However, biodiverse and well thought out landscape design can provide cooling effects and are certainly good for wellbeing and mental health.

New technologies

We have already reviewed some technologies and there will undoubtedly be new technologies in the future. It is tempting to focus on new technologies but an emphasis on passive fabric first, occupant engagement, skills and competence training, partner selection and cultural change within organisations to account for whole life carbon are probably more important.

In truth, the really important new technologies are already here. Digital design and simulation tools and modern methods of construction are capable of delivering lower whole life carbon buildings, but they need to be mandated and adopted by clients.

Summary

Each project is unique but using this toolkit should have allowed you to review options for your project and the implications of adopting the standards and construction build-ups that are likely to meet the forthcoming Future Homes Standard.

As homes become more energy efficient and produce less carbon in operation the proportion of their whole life carbon from their construction increases. This embodied and upfront carbon will be the subject of a further Baily Garner toolkit.

We are all facing a climate and ecological emergency and the time to act is now. Early adoption of higher performing homes that are zero carbon ready in their operation will mean more comfortable homes with lower costs of occupation for your residents, which is vital in the current cost of living crisis. *They are also likely to deliver lower whole life costs for your organisation.* These fabric first homes will not need to be retrofitted with more insulation and should be capable of accepting new technologies as and when they arrive.

For further information on how Baily Garner can help you achieve net zero on your new build homes, contact us.

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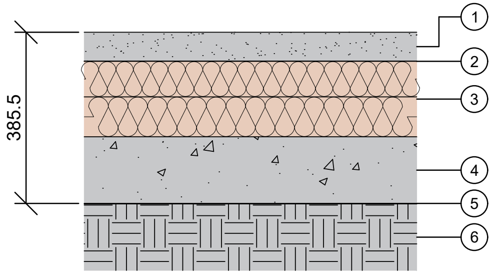
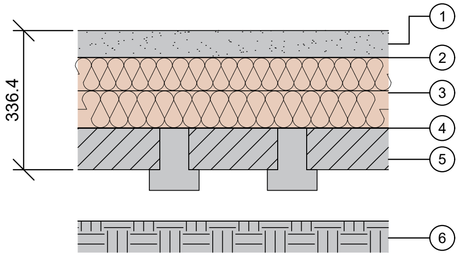
GROUND FLOOR LEVEL

Option 1
PIR insulation below screed



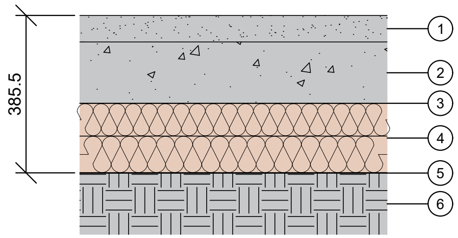
1. 65mm screed
2. Separation layer
3. 170mm PIR insulation board
4. 150mm concrete slab
5. DPM
6. Hardcore

Option 2
PIR beam and block



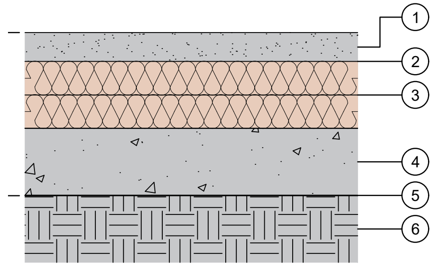
1. 65mm screed
2. Separation layer
3. 170mm PIR insulation board
4. DPM
5. Beam and block floor
6. Hardcore

Option 3
PIR insulation below slab



1. 65mm screed
2. 150mm concrete slab
3. Separation layer
4. 170mm PIR insulation board
5. DPM
6. Hardcore

Option 4
PIR Insulation above concrete



1. 65mm screed
2. Separation layer
3. 150mm PIR insulation board
4. 150mm concrete slab
5. DPM
6. Hardcore

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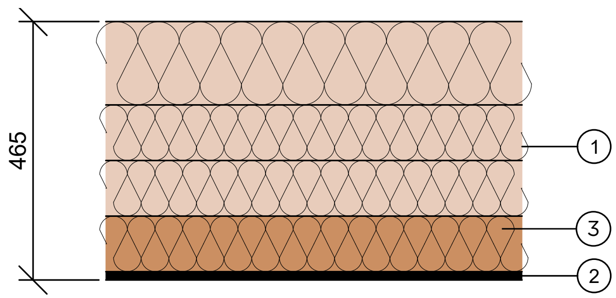
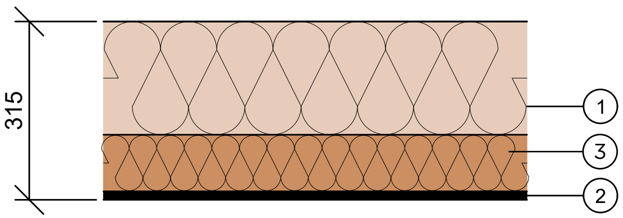
ROOF

Option 1
Mineral wool roll insulation



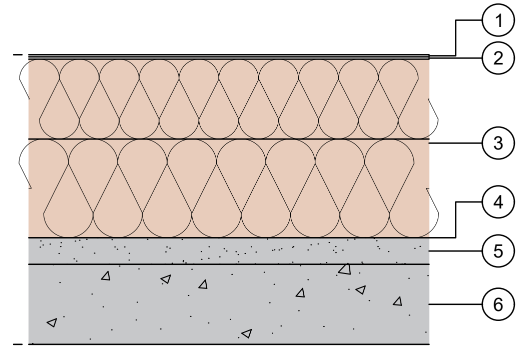
1. 450mm mineral wool insulation
2. 15mm skim coated plasterboard
3. Joists

Option 2
PIR insulation between and over joists



1. 300mm PIR insulation
2. 15mm skim coated plasterboard
3. Joists

Option 3
Hardrock insulation above concrete



1. 4mm Bitumen felt/sheet
2. 4mm Bitumen felt/sheet
3. 335mm hardrock multi-fix
4. Vapour layer
5. 50mm screed

6 150mm concrete, medium density

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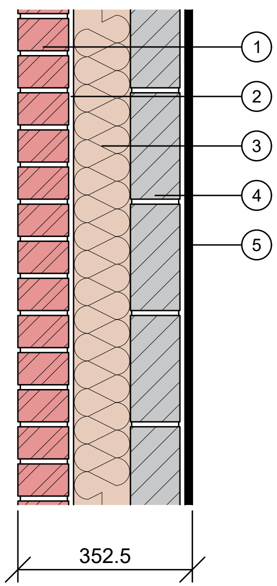
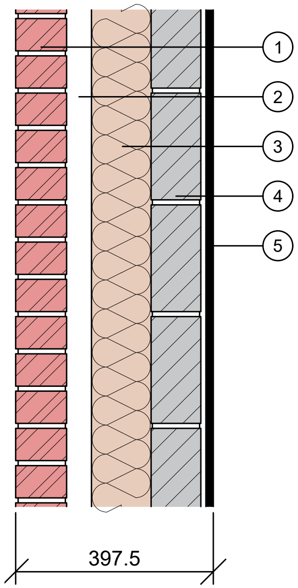
WALLS

Option 1
PIR full fill



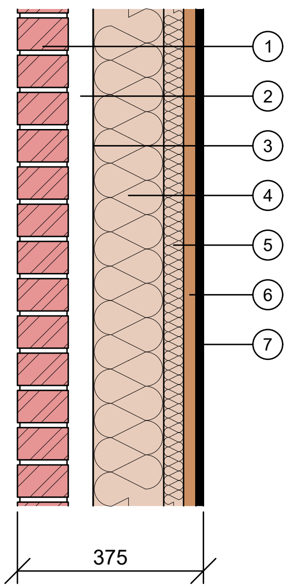
1. 102.5mm brick
2. 10mm clear residual cavity
3. 115mm full fill PIR cavity insulation board
4. 100mm blockwork
5. 25mm skim coated plasterboard on dabs

Option 2
PIR partial fill



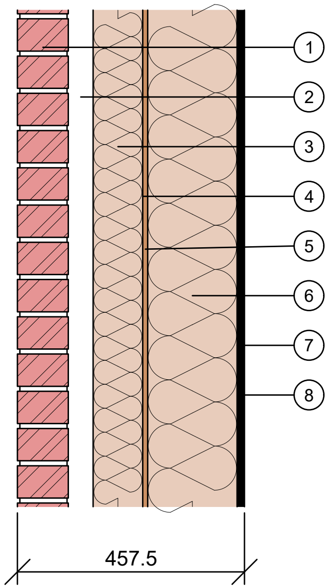
1. 102.5mm brick
2. 50mm clear residual cavity
3. 120mm partial fill PIR cavity insulation board
4. 100mm blockwork
5. 25mm skim coated plasterboard on dabs

Option 3
SIP with PIR infill



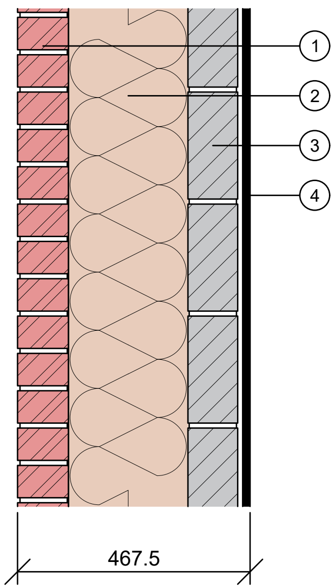
1. 102.5mm brick
2. 50mm clear residual cavity
3. Breathable membrane
4. 142mm SIP system
5. 40mm PIR insulation board
6. 30mm x 25mm timber battens
7. 15mm skim coated plasterboard

Option 4
Mineral wool timber frame



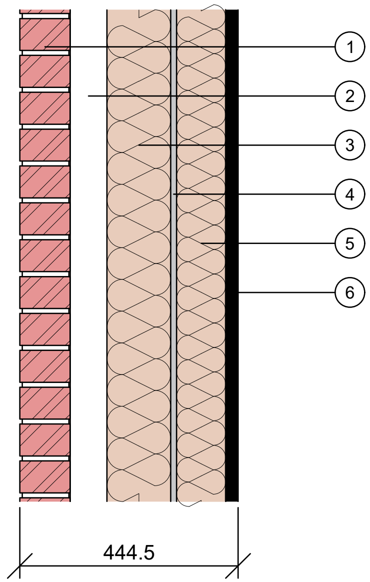
1. 102.5mm brick
2. 50mm clear residual cavity
3. 100mm mineral wool insulation
4. Breathable membrane
5. 9.5mm plywood
6. 180mm mineral wool insulation (inside frame)
7. Polyethylene/polythene
8. 15mm skim coated plasterboard

Option 5
Mineral wool masonry



1. 102.5mm brick
2. 240mm partial fill PIR cavity insulation board
3. 100mm lightweight blockwork
4. 25mm skim coated plasterboard on dabs

Option 6
SFS Mineral Wool and Masonry



1. 102.5mm brick
2. 75mm clear residual cavity
3. 130mm mineral wool insulation
4. 12mm cement particle board
5. 100mm mineral wool insulation
5. 25mm skim coated plasterboard on dabs

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