BRISTOL COUNCIL CLIMATE EMERGENCY DEVELOPMENT PLAN DOCUMENT

TECHNICAL EVIDENCE BASE FOR NEW HOUSING POLICY – HIGH RISE

Jan 2023 | Rev D

Currie & Brown

Etude

Executive Summary

An evidence base for net zero operational carbon buildings

The purpose of this report is to provide a technical evidence base to support the energy performance requirements of a high-rise block for Bristol City Council. The report should be read in conjunction with the technical evidence base for new housing, prepared for Cornwall Council in June 2021. It assumes that similarly to the CC report, the current policy requires new homes to achieve a space heating demand of less than 30kWh/m^2/year, a total energy use of less than 40kWh/m^2/year, and a net zero energy balance on site through use of solar photovoltaics.

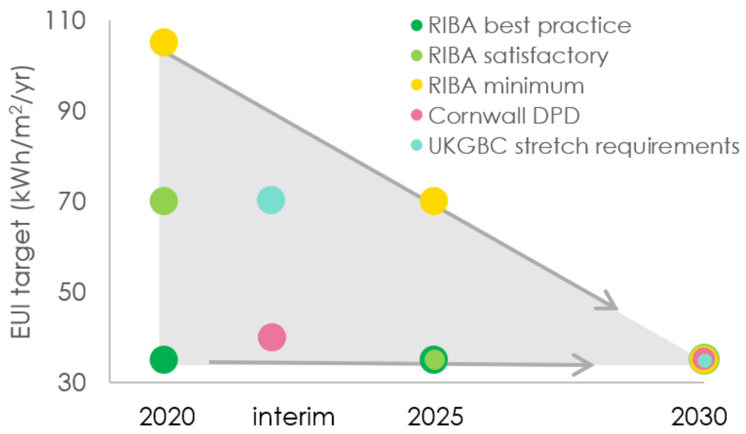
Evaluation of policy options

Seven policy scenarios were assessed for a high-rise building type (16 storeys) through detailed energy and cost modelling. Policy options included the building being compliant with Part L 2013, Part L 2021 and Part L 2025, UKGBC's net zero definition, a current policy (Policy Option A - similar to Cornwall Council's report mentioned previously) and a future policy option that is in line with RIBA and UKGBC targets for 2030 (Policy Option B).

Key findings from energy modelling

Energy and cost modelling indicates that:

- it is possible to achieve net zero carbon homes using best practice on-site solar PV design and specification. Generally, some high-rise buildings may require additional off-site renewable energy generation to achieve a net zero energy balance due to site or design constraints.
- It is important to note that a solar tenant model approach, distributing the solar energy generated to all flats, instead of only the landlord supply is required to maximise savings.
- Actual space heat demand is likely to be 200-570% higher than indicated by SAP calculations, but still relatively low, when compared to low and mid-rise blocks.
- Policy Option A would lead to running costs approximately 10-50% lower than a building built to comply with Part L 2021.
- Policy Option A would deliver net zero carbon homes for a construction cost between 2.4-3.0% more than a home that is compliant with Part L 2021. Cost differences are expected to decrease over time as experience and markets for low carbon buildings grow.
- Electricity use calculated by energy modelling relates well to metered electricity use data, supporting the use of total energy use targets.



Total energy use targets from RIBA, UKGBC and Cornwall Council's DPD are converging at different rates. Evidence supports early adoption of targets to avoid costly retrofit and remain within carbon budgets.

Sustainable Energy and Construction – Current Policy requirement

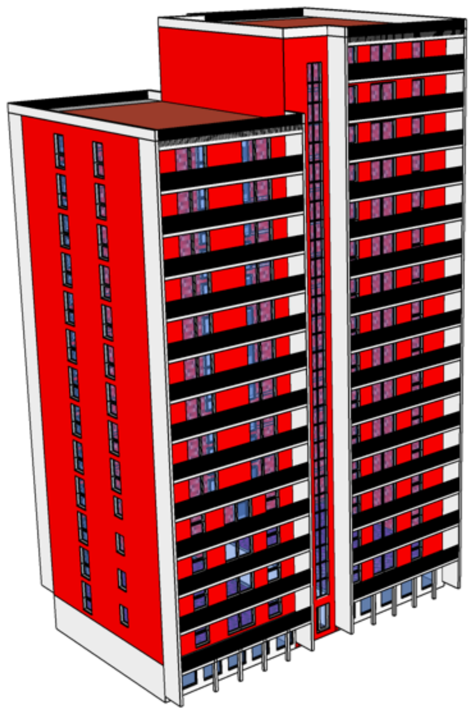
This evidence base focuses on Sustainable Energy and Construction and in particular on the requirements for new residential developments. Specifically, it assumes that the residential development proposals will be required to achieve Net Zero Carbon by accomplishing:

- *A space heating demand of less than 30kWh/m²/annum;*
- *A total energy use of less than 40kWh/m²/annum; and*
- *On-site renewable generation to match the total energy use, with building mounted solar PV.*

The **technical assessment (Section 2.0)** demonstrates that it is technically feasible for a high-rise building type to:

- Achieve a space heating demand between than **15-20kWh/m²/annum**
- Achieve a total energy use of less than **35kWh/m²/annum**
- Install on-site renewable generation (in the form of roof & façade mounted solar PV) to match the total energy use.

The **cost assessment** (**Section 3.0**) provides an assessment of the additional construction costs which would be involved in meeting the above requirements. It also outlines the benefits in terms of running energy costs which would be delivered by complying with the above policy.



The technical feasibility and cost impact of Policy SEC 1 of Cornwall's Climate Emergency Development Plan Document (DPD) has been tested on a typical Bristol high-rise block

Background | Recent guidance on new buildings

Important research and guidance on new buildings has been published in the last 18 months.

The Committee on Climate Change report 'UK housing – fit for the future?' highlights that we need to build new buildings with 'ultra-low' levels of energy use. It also makes a specific reference to space heating demand and recommends a maximum of 15-20 kWh/m^2/yr for new dwellings.

A supporting technical study undertaken by Currie & Brown and AECOM confirms that a switch to low carbon heating is essential in achieving long term carbon savings, but that this must be supported by significant improvements in energy efficiency in order to manage running costs and avoid external costs to the wider energy system (e.g. electricity infrastructure). The study indicates that significant reductions in space heating demand can be achieved at lower cost than smaller improvements, as it enables savings in the size and extent of the heating system.

There is also a growing consensus on the need for total energy use as a key metric, expressed as an Energy Use Intensity (EUI). One of the key advantages is that it can be checked once the building is occupied without further modelling or analysis.

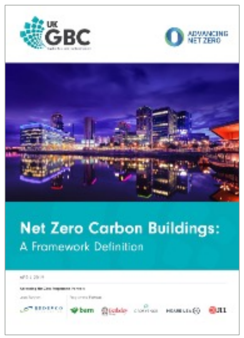
Generally, these research or guidance documents also highlight that the potential for offsetting from new buildings is extremely limited and should be reserved for exceptional circumstances, rather than standard practice.

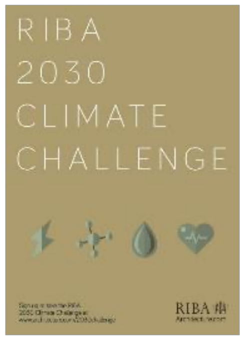
[1] *For comparison, Passivhaus requires 15 kWh/m^2/yr and Etude's experience from energy modelling of new domestic buildings suggests a heating demand ranging between 60-100 kWh/m^2/yr is typical.*

15-20
kWh/m^2/yr

The UK housing: Fit for the future? report *published by the Committee on Climate Change in February 2019 recommends ultra-low levels of energy use and a space heating demand of less than 15-20 kWh/m^2/yr*

The costs and benefits of tighter standards for new buildings *report, produced by Currie & Brown and AECOM for the Committee on Climate Change's UK housing: Fit for the future? report*





Guidance on the need for net zero carbon buildings and total energy use targets has been published by the UKGBC, the RIBA and LETI

1.0

Approach to energy modelling

This section explains our approach to the brief:

- Approach to energy modelling
- The seven policy scenarios
- The building type

Energy modelling | Approach

Software

We have modelled the performance of a typical high rise-building in **Stroma FSAP 2012** (for standard Part L 2013 SAP calculations only), **Stroma FSAP 10.2** (for the rest of Part L SAP calculations) and **PHPP 9.6a** using **DesignPH 2.0.06** (for PHPP calculations)

PHPP is the tool used for Passivhaus and AECB certification. Post occupancy studies* have consistently shown that it provides a more reliable prediction of a building's space heating demand and energy use relative to Part L calculations.

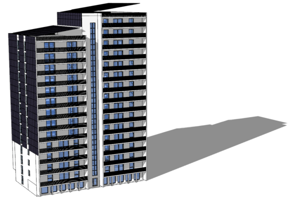
DesignPH is used in combination with PHPP to provide more accurate shading analysis, based on a 3D model of the building and its surroundings.

We have also used the **European Commission's PVGIS** tool to calibrate solar generation calculated by PHPP.

Approach

In developing our assumptions, we have tried to adopt the mindset of a developer, i.e. finding the simplest and most economic ways of complying with each requirement.

PHI Low Energy Building Verification



Building:	High Rise Block		
Street:			
Postcode/City:			
Province/Country:	Bristol	GB-United Kingdom/ Britain	
Building type:			
Climate data set:	GB0005a-Exeter		
Climate zone:	4: Warm-temperate	Altitude of location:	12 m
Home owner / Client:			
Street:			
Postcode/City:			
Province/Country:			

Architecture:		**Mechanical engineer:**	
Street:		Street:	
Postcode/City:		Postcode/City:	
Province/Country:		Province/Country:	
Energy consultancy:	Etude	**Certification:**	
Street:		Street:	
Postcode/City:		Postcode/City:	
Province/Country:		Province/Country:	

Year of construction:		Interior temperature winter [°C]:	20.0	Interior temp. summer [°C]:	25.0
No. of dwelling units:	97	Internal heat gains (IHG) heating case [W/m²]:	3.2	IHG cooling case [W/m²]:	3.2
No. of occupants:	133.3	Specific capacity [Wh/K per m² TFA]:	132	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

						Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	4386.1					
Space heating	Heating demand	kWh/(m²a)	7	≤		30	-	yes
	Heating load	W/m²	8	≤		-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤		-	-	-
	Cooling load	W/m²	-	≤		-	-	
	Frequency of overheating (> 25 °C)	%	3	≤		10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤		20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.4	≤		1.0		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	33	≤		-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	40	≤		75	75	yes
	Generation of renewable energy (in relation to pro-jected building footprint area)	kWh/(m²a)	342	≥		-	-	

[2] Empty field: Data missing; '-': No requirement

PHPP 9.6a was used to model expected real-world energy performance of the notional high-rise building type.

*Examples include the CEPHEUS project and Mitchell, R and Natarajan, S (2020) *UK Passivhaus and the energy performance gap*. Energy and Buildings. Vol 224

Our focus was on modelling seven different scenarios, representing the current national trajectory for building regulations, and several improved specifications that can deliver net zero carbon on site. These scenarios are outlined below.

Part L 2013

This scenario is based on a specification that achieves typical levels of performance required for the Part L 2013 notional building. It has been sense-checked against fabric assumptions from the planning application submitted for the 4 Stafford Street development where the modelled high-rise building typology was extracted from. A communal gas boiler is assumed to provide all heating.

Part L 2021

This scenario is based on the notional building specification provided by the government in their recent response to the Future Homes Consultation. Changes include modest improvements to insulation, shower drain wastewater heat recovery and roof mounted solar PV. While heating is still based on a gas boiler, it is possible that developers could use heat pumps instead of wastewater heat recovery and solar PV to achieve the required performance. Airtightness is relatively poor at $5m^3/m^2hr$ and ventilation is achieved mechanically without heat recovery.

Part L 2025

This scenario is also based on an additional notional building specification provided by the government in their response to the Future Homes Standard Consultation. Insulation levels and glazing performance are increased close to that required for Passivhaus, however airtightness remains poor at $5m^3/m^2hr$ and no heat recovery ventilation is required. Shower drain wastewater heat recovery and solar PV are dropped from the notional building, but a heat pump is added.

Part L 2025 + PV

This is identical to the previous scenario, with the addition of the maximum capacity of solar PVs (both on roof and façade) to examine the maximum coverage of energy consumption that can be achieved on site.

UKGBC 2025 Stretch

This scenario is based on the UKGBC's 2025 stretch target, including a fabric efficiency of 15-20kWh/m^2/yr, in line with the Climate Change Committee's recommendations. This requires a similar level of fabric performance to Part L 2013, with the majority of gains delivered by improving the airtightness to $3m^3/m^2hr$ and use of heat recovery ventilation.

The EUI target for this scenario is set at 70kWh/m^2/yr on the basis that a large allowance, of around 45kWh/m^2/yr has been provided for appliances, small power, lighting, pumps and fans. The solar PV on site has been maximized, similarly to Part L 2025 + PV scenario.

Policy Option A (current)

A scenario with a very similar fabric & mechanical specification to that of UKGBC, with a more realistic allowance for unregulated energy. This is sufficient to achieve a space heat demand of <30kWh/m^2/yr, in line with the draft Cornwall DPD requirement, representing a reduction in space heat demand of around 50% relative to Part L 2013 & 2021. Space and water heating is provided by a heat pump, which is required to achieve the EUI target of <40kWh/m^2/yr. The solar PV installation has been maximized, to achieve net-zero balance on site.

Policy Option B (future)

This scenario, has been considered as a probable future requirement to introduce the maximum fabric and energy improvement on a high-rise block (better than CCC, LETI and RIBA recommendations) in order to make it easier to achieve a net-zero balance on site with a smaller number of installed panels being required.

Energy modelling | Building type selection

The building type

The building that was selected to test the technical and financial viability of each policy scenario was based on a recently designed high-rise block that was part of a larger development (4 Stafford Street) and was slightly modified to work as a standalone block. Testing a building that reflects the current design principles at Bristol was important to ensure that the policy is viable across developments around the city, as discussed below.

Heat Loss Form Factor

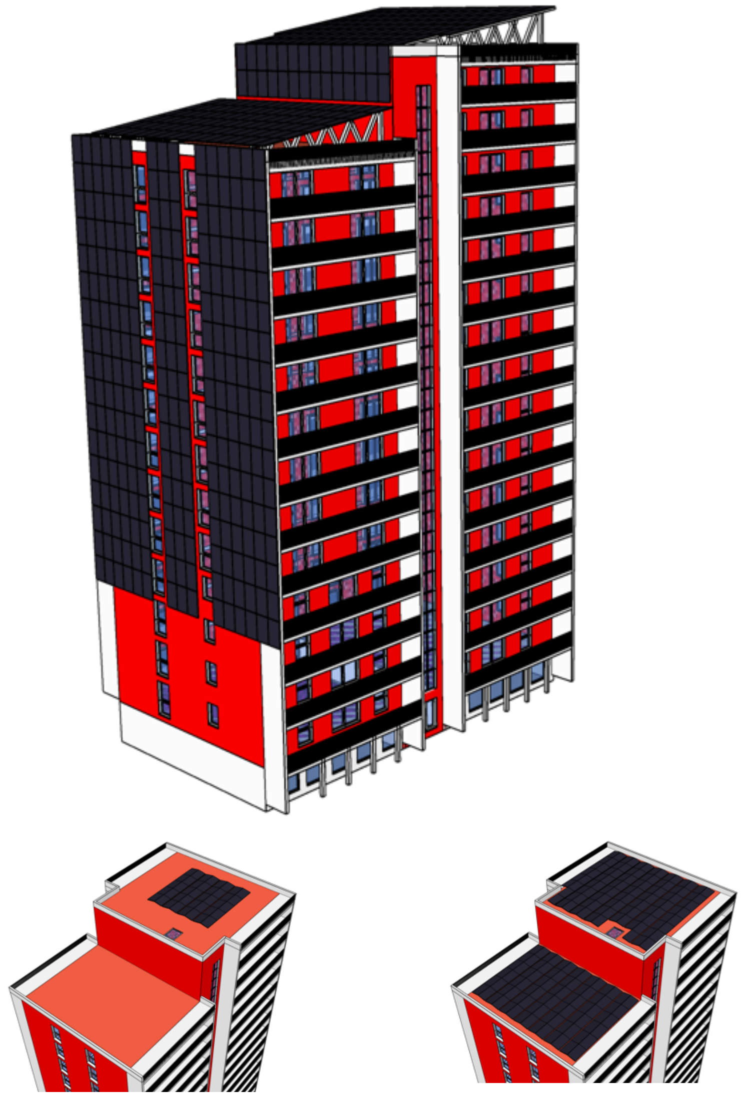
The heat loss form factor, often abbreviated to 'form factor', is the ratio of a building's heat loss area to its internal floor area.

Contrary to small buildings which have a lot of heat loss area against a small internal floor area, large blocks of fats or high-rise blocks present a relatively low heat loss area when compared to their internal floor area, and have low form factors, typically below 2.5. As a result, they naturally have lower levels of heat loss and therefore require less insulation to comply with the policy scenarios.

Potential for Solar PV

On the other hand, the ratio of suitable roof area for solar PV panels is quite small. High-rise blocks of flats have internal floor areas that are more than ten times higher than their roof area. This means there is less roof space available to install solar PV for each individual dwelling, relative to i.e., a bungalow.

In practice, in the UK, it is usually possible to achieve a net zero energy balance on site with a roof top PV panel installation only, in buildings up to six stories in height, though this requires best practice fabric efficiency and solar PV design. For taller blocks, it is also possible through the use of façade mounted PV panels.



The high-rise building form tested with integrated façade and monopitch PV panel design. SAP baseline and concertina maximum roof mounted outputs were also calculated, considering perimeter access corridors for both layouts.

2.0

Technical assessment

This section presents:

- Specifications for each policy scenario
- Performance against the three DPD policy requirements:
    1. Space heat demand
    2. Total energy use
    3. On-site solar generation
- Carbon emissions

High-rise Block

Specifications, assumptions and modelling results for the selected 16 – storey high rise block, incl. 97 flats

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Energy modelling | High-rise Block

This study focuses on a high-rise housing type to test the impact of different policy approaches. A 97-unit building was selected, which was designed as part of new build development and has been slightly modified to work as a stand-alone high-rise block.

Building fabric

The property has a gross internal floor area of 5,230m². The main entrance faces the street to the Southeast. The property has typical glazing proportions and layout for this type of home with curtain walling along the main stair core facade. The form heat loss factor of **1.05** is very low, as expected for a large block of flats with a straightforward design.

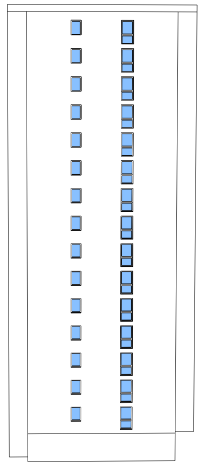
Low carbon heating

The most suitable low carbon heating system is likely to be an air or ground source heat pump. To minimize distribution losses and overheating risk, the system would likely be based around a small individual heat pump in each flat, which would be supplied with water at ambient temperatures via a communal loop. Heat would be fed into the communal loop from a rooftop air source heat pump or ground borehole array. Suitable heat emitters include radiators, or underfloor heating for scenarios with poorer fabric efficiency. Direct electric heating would not typically achieve the EUI requirement without cost-prohibitive levels of fabric efficiency.

Solar PV

The property has sufficient space for around 110 rooftop solar panels if they are mounted in an East/West type concertina array, whereas 220 panels could be fitted in a monopitch arrangement. Over 500 panels could be accommodated by optimizing the roof to create a pair of large monopitch solar arrays, while also using the southwest façade. For Option A, 503 panels with this arrangement are required to achieve net zero on site.

Southeast Elevation (front)



Northeast Elevation (side)

A typical high-rise block of flats was selected from a recent development and was slightly modified to act as a standalone block

A 3D model of the flats and surrounding features was created in DesignPH 2.0.06 and used to calculate solar gains and shading for PHPP.

Energy modelling | High-Rise Block Specifications

	Part L 2013	Part L 2021	Part L 2025 (FHS)	Part L 2025 (FHS) + PV	UKGBC 2025	Policy Option A (current)	Policy Option B (future)
Description	Typical developer specification to achieve compliance with Part L 2013 (based on submitted planning application)	Notional building specification for Part L 2021, provided by government	Indicative notional building specification for Part L 2025, provided by government	Indicative notional building specification for Part L 2025, provided by government	15-20 kWh/m²/yr Fabric, <70KWh/m2yr energy demand	Cost optimised fabric to achieve <30KWh/m2yr heating demand and <40KWh/m2yr energy demand	Passivhaus with heat pump and solar PV
Net zero compliant?	✗	✗	✗	✗	✗	✓	✓
Floor (W/m^2K, SAP adjusted)	0.15	0.15	0.11	0.11	0.15	0.15	0.15
Walls (W/m^2K)	0.21	0.20	0.18	0.18	0.21	0.21	0.18
Roof (W/m^2K)	0.16	0.16	0.11	0.11	0.16	0.16	0.11
Windows (W/m^2K)	1.4 (double-glazed)	1.36 (double-glazed)	0.8 (triple-glazed)	0.8 (triple-glazed)	1.3 (double-glazed)	1.3 (double-glazed)	0.8 (triple-glazed)
Doors (W/m^2K)	1.0 – 1.3	1.0 – 1.3	1.0 – 1.3	1.0 – 1.3	1.0 – 1.3	1.0-1.3	0.9-1.0
Thermal bridging ($kWh/m^2/yr$)	7	5	4	4	4	4	4
Air Permeability ($m^3/m^2/hr$)	5	5	5	5	3	3	1
Ventilation	Positive input mechanical ventilation	Positive input mechanical ventilation	Positive input mechanical ventilation	Positive input mechanical ventilation	MVHR, 88% heat recovery	MVHR, 88% heat recovery	MVHR, 88% heat recovery
Heating System	Gas Boiler	Gas Boiler. Shower drain waste water heat recovery	Individual heat pumps fed by ambient temp communal loop supplying radiators at 55˚C. 150 litre DHW tank	Individual heat pumps fed by ambient temp communal loop supplying radiators at 55˚C. 150 litre DHW tank	Individual heat pumps fed by ambient temp communal loop supplying radiators at 45˚C. 150 litre DHW tank	Individual heat pumps fed by ambient temp communal loop supplying radiators at 45˚C. 150 litre DHW tank	Individual heat pumps fed by ambient temp communal loop supplying radiators at <45˚C. 150 litre DHW tank
Solar PV	-	17kW	-	206kW	206kW	206kW	183W

Etude

Energy Modelling | High-rise Block – DPD requirement for space heating demand

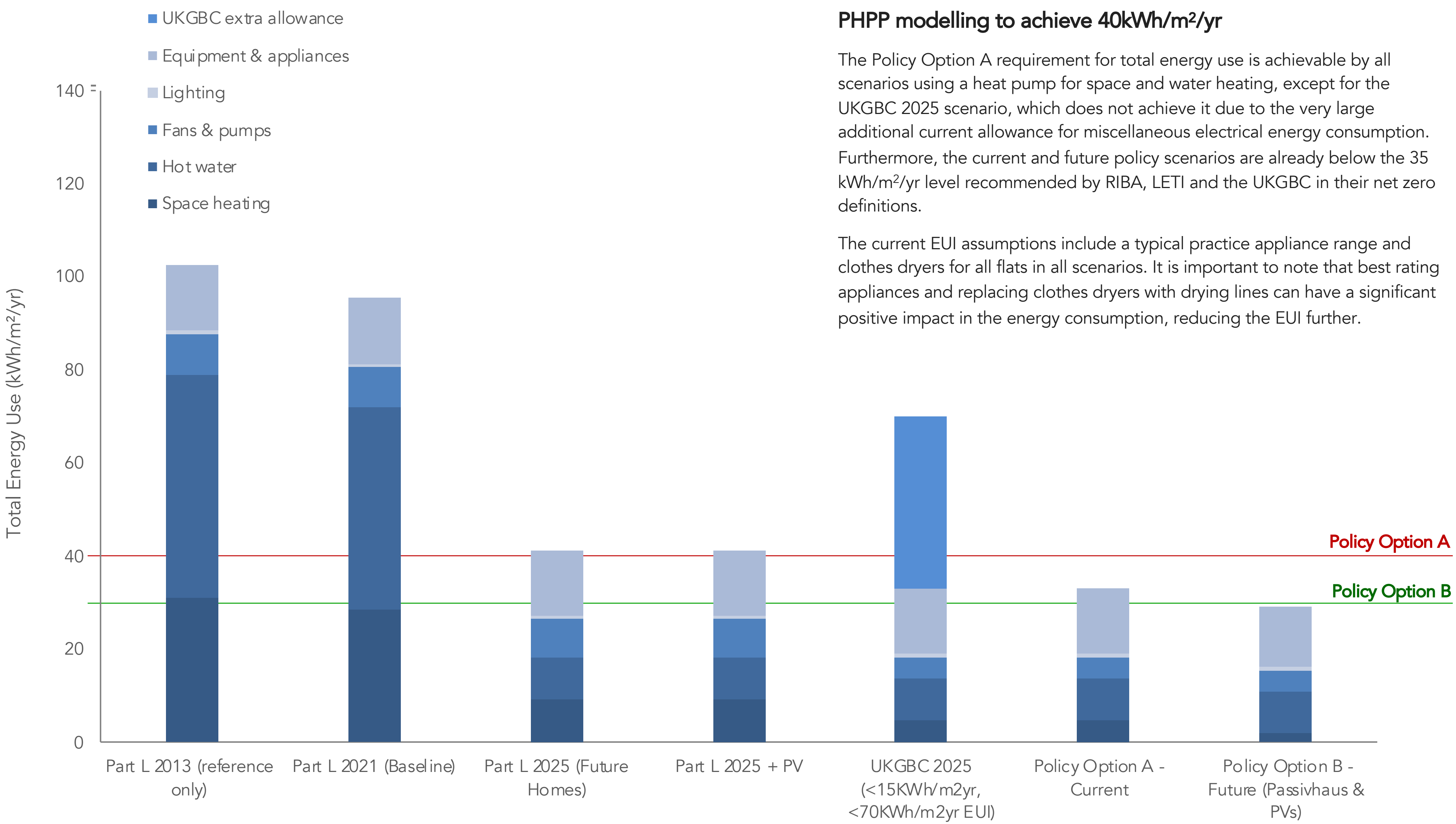
PHPP modelling to achieve 30kWh/m²/yr

PHPP modelling indicates that even with the Part L 2013 fabric requirement, due to the building's low form factor, it is relatively easy to achieve a heating demand close to 30 KWh/m²/yr. The proposed Policy Option A requirement (introduction of MVHR and improved air tightness) can reduce space heat demand even further, by around half when compared to to Part L 2013 & 2021 with a very similar fabric.

By 2025, the low form factor and compliance with Part L fabric can lead a high-rise building to perform almost two times better than the current Climate Change Committee, LETI and RIBA recommendations just by introducing an MVHR unit and a better air tightness.

Space heat demand calculated by PHPP 9.6a for each scenario, compared to different policy requirements under consideration.

Energy Modelling | High-rise Block – DPD requirement for total energy use

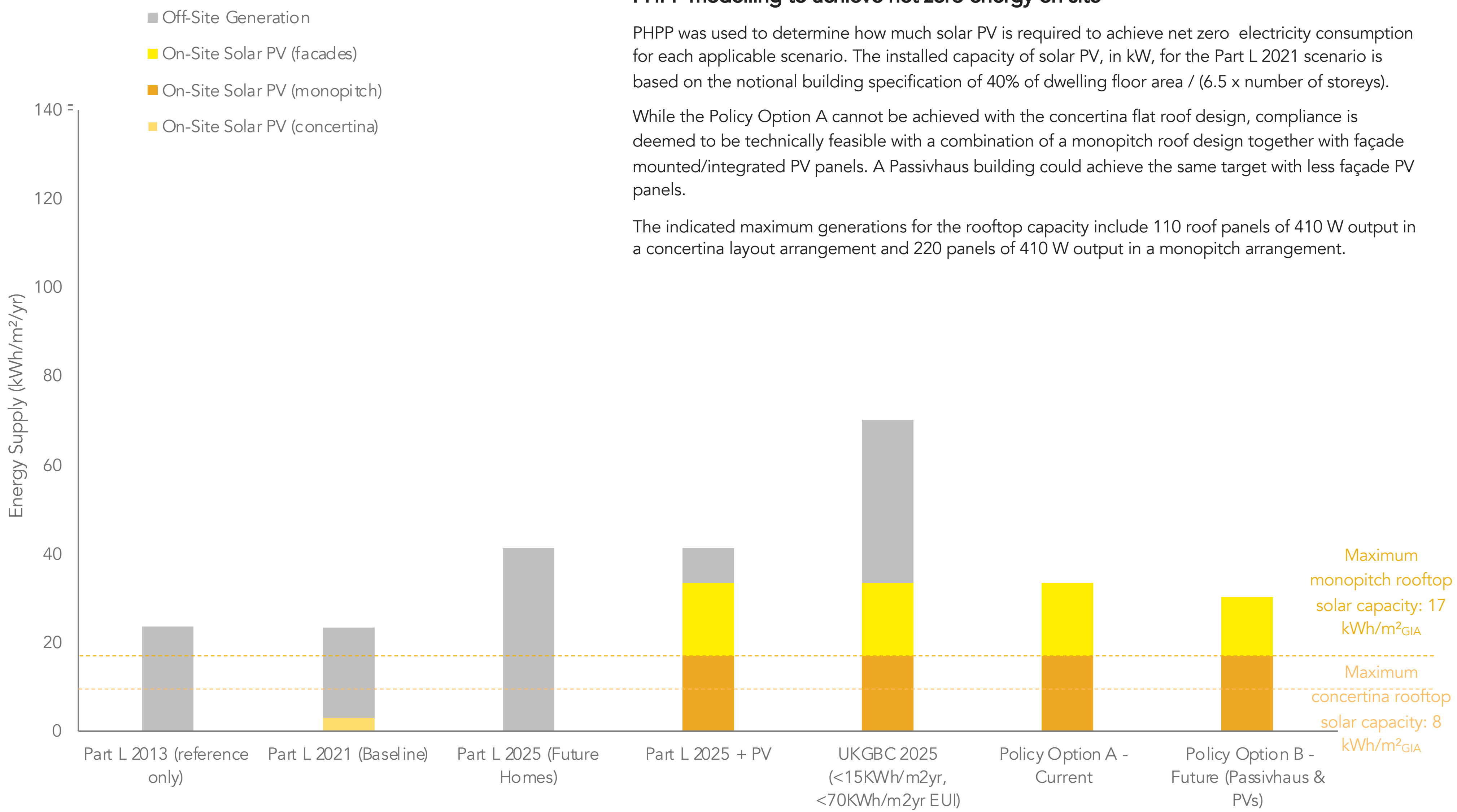


Total energy use calculated by PHPP 9.6a for each scenario.

PHPP modelling to achieve 40kWh/m²/yr

The Policy Option A requirement for total energy use is achievable by all scenarios using a heat pump for space and water heating, except for the UKGBC 2025 scenario, which does not achieve it due to the very large additional current allowance for miscellaneous electrical energy consumption. Furthermore, the current and future policy scenarios are already below the 35 kWh/m²/yr level recommended by RIBA, LETI and the UKGBC in their net zero definitions.

The current EUI assumptions include a typical practice appliance range and clothes dryers for all flats in all scenarios. It is important to note that best rating appliances and replacing clothes dryers with drying lines can have a significant positive impact in the energy consumption, reducing the EUI further.



PHPP modelling to achieve net zero energy on site

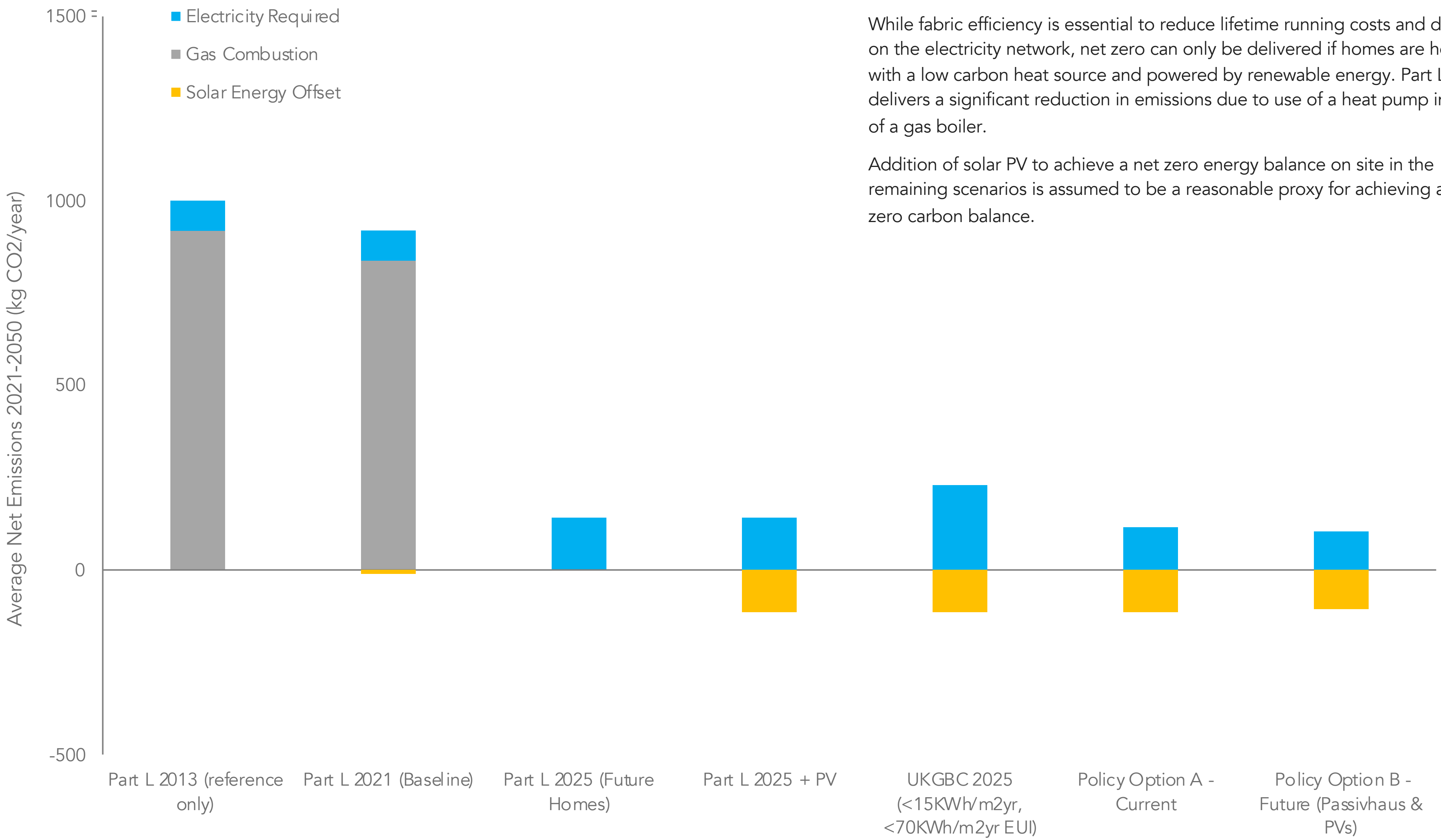
PHPP was used to determine how much solar PV is required to achieve net zero electricity consumption for each applicable scenario. The installed capacity of solar PV, in kW, for the Part L 2021 scenario is based on the notional building specification of 40% of dwelling floor area / (6.5 x number of storeys).

While the Policy Option A cannot be achieved with the concertina flat roof design, compliance is deemed to be technically feasible with a combination of a monopitch roof design together with façade mounted/integrated PV panels. A Passivhaus building could achieve the same target with less façade PV panels.

The indicated maximum generations for the rooftop capacity include 110 roof panels of 410 W output in a concertina layout arrangement and 220 panels of 410 W output in a monopitch arrangement.

On-site solar energy generation calculated by PHPP 9.6a for each scenario. Part L 2013 and 2021 scenarios use a gas boiler, so electricity demand is lower than for other scenarios. Grey bars show off-site electricity generation that must be imported from the electricity grid.

Energy Modelling | High-Rise Block – Operational CO_2 Emissions



Heat pumps and solar PV are essential to achieve net zero

While fabric efficiency is essential to reduce lifetime running costs and demand on the electricity network, net zero can only be delivered if homes are heated with a low carbon heat source and powered by renewable energy. Part L 2025 delivers a significant reduction in emissions due to use of a heat pump instead of a gas boiler.

Addition of solar PV to achieve a net zero energy balance on site in the remaining scenarios is assumed to be a reasonable proxy for achieving a net zero carbon balance.

Average annual net CO_2 emissions for 2021-2050. Assumes 216gCO_2 produced per kWh of gas consumed and electricity carbon intensity figures based on HM Treasury Green Book values.

3.0

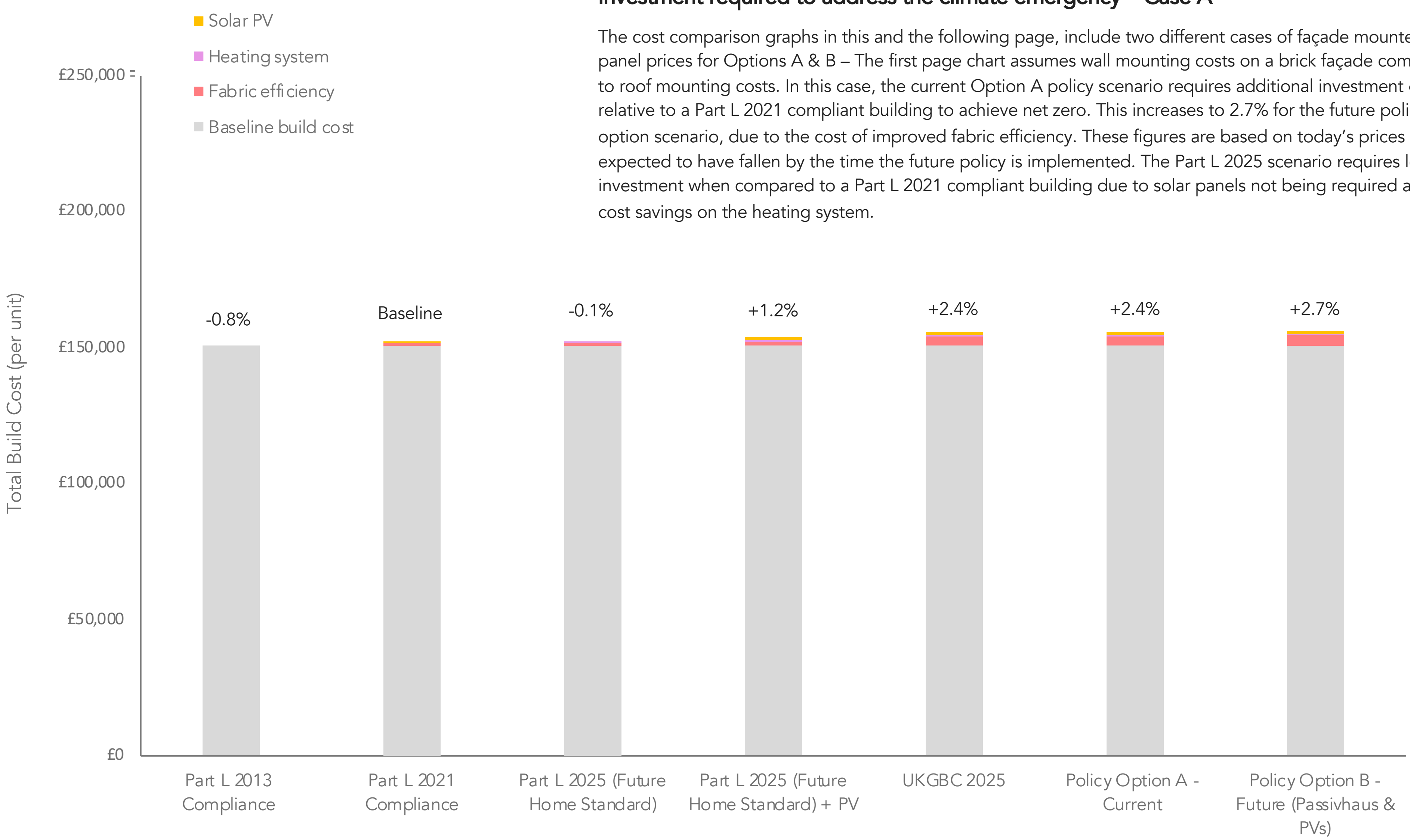
Cost assessment

For each building type and policy scenario, this section presents:

- Capital costs (assuming a typical level of fit out and specification)
- Operational energy costs

Investment required to address the climate emergency – Case A

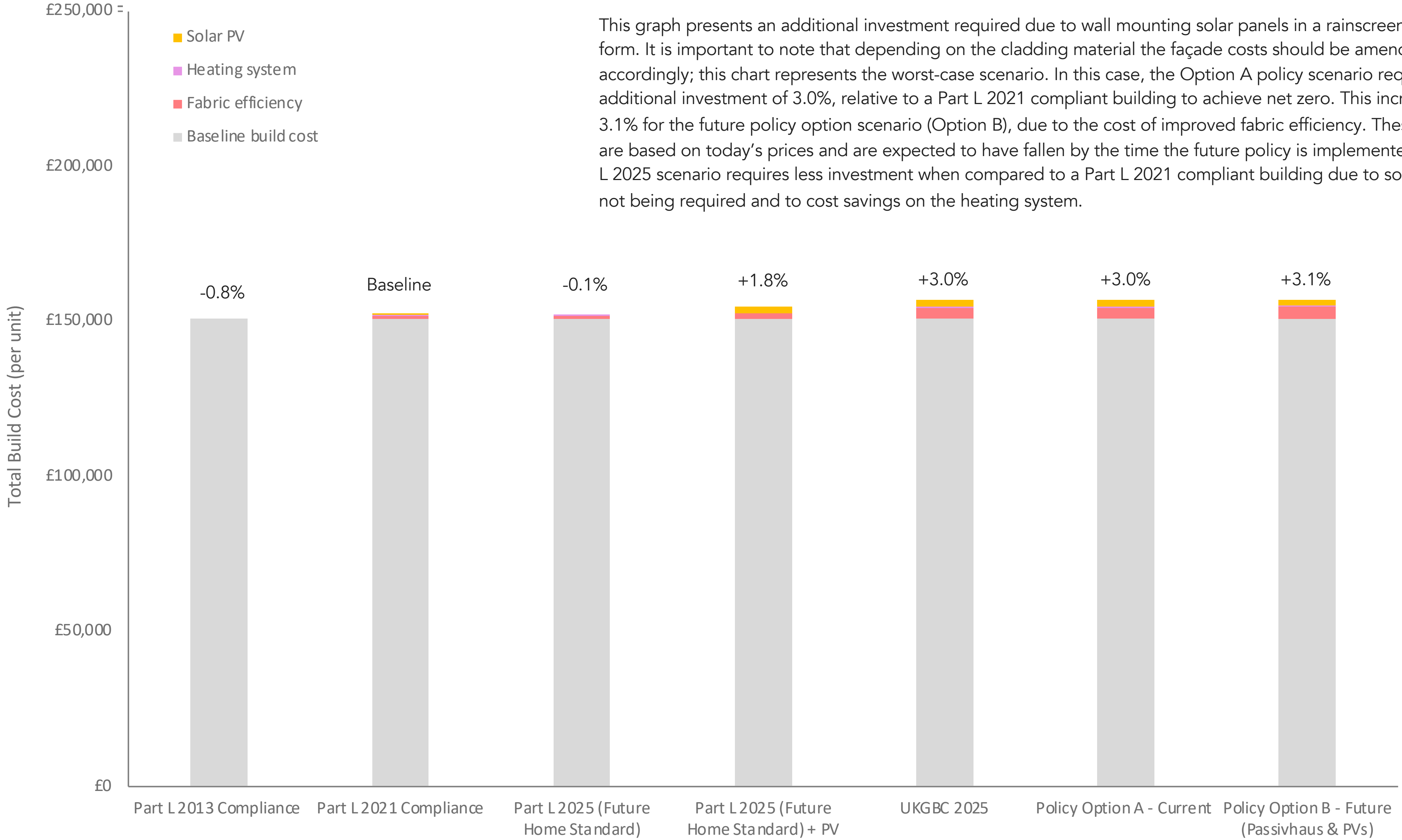
The cost comparison graphs in this and the following page, include two different cases of façade mounted solar panel prices for Options A & B – The first page chart assumes wall mounting costs on a brick façade comparable to roof mounting costs. In this case, the current Option A policy scenario requires additional investment of 2.4%, relative to a Part L 2021 compliant building to achieve net zero. This increases to 2.7% for the future policy option scenario, due to the cost of improved fabric efficiency. These figures are based on today's prices and are expected to have fallen by the time the future policy is implemented. The Part L 2025 scenario requires less investment when compared to a Part L 2021 compliant building due to solar panels not being required and to cost savings on the heating system.



Total build costs for the high rise modelled block based on analysis by Currie and Brown (incl. assumption of wall mounted PVs on a brick façade). Percentage cost uplift relative to a Part L 2021 compliant building is also shown.

Investment required to address the climate emergency – Case B

This graph presents an additional investment required due to wall mounting solar panels in a rainscreen cladding form. It is important to note that depending on the cladding material the façade costs should be amended accordingly; this chart represents the worst-case scenario. In this case, the Option A policy scenario requires an additional investment of 3.0%, relative to a Part L 2021 compliant building to achieve net zero. This increases to 3.1% for the future policy option scenario (Option B), due to the cost of improved fabric efficiency. These figures are based on today's prices and are expected to have fallen by the time the future policy is implemented. The Part L 2025 scenario requires less investment when compared to a Part L 2021 compliant building due to solar panels not being required and to cost savings on the heating system.



Total build costs for the high rise modelled block based on analysis by Currie and Brown (incl. assumption of façade mounted PVs on a rainscreen cladding system). Percentage cost uplift relative to a Part L 2021 compliant building is also shown.

Cost Modelling | Electricity Tariffs assumed for energy cost comparisons

The importance of electricity tariffs

Energy costs in all electric net zero buildings are determined by the cost of grid electricity and the amount of solar energy that can be used on site. Several types of electricity tariff are available. The ability to take advantage of cheaper tariffs and free solar energy is 'unlocked' by policy scenarios with excellent levels of fabric efficiency, such as the current DPD scenario.

Homes with excellent levels of fabric efficiency lose heat very slowly, which means that heat pumps can be turned off for many hours at a time without the indoor temperature significantly changing. All scenarios that use a heat pump are also assumed to have a hot water tank, which can store water for many hours without significant reductions in temperature. This means that homes in several of the policy scenarios would be able to operate their heat pumps when electricity is cheap, or free in the case of solar energy. In practice, smart controls would perform this function automatically in the background.

Fixed Tariffs

The Part L 2013 and Part L 2021 scenarios are assumed to be on a traditional fixed electricity tariff of 28.0* pence per kWh, as they both use gas boilers, therefore have limited potential to use cheap off-peak electricity.

Economy 7 or 10 Tariffs

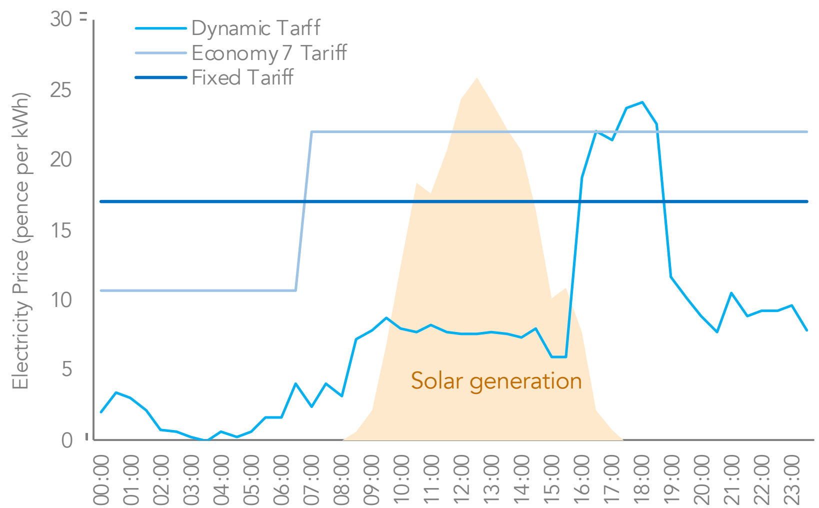
Any of the remaining scenarios could use Economy 7 or Economy 10 tariffs, however we have assumed the ability of homes in the Part L 2025 scenario to take advantage of these tariffs is somewhat limited by their poor airtightness. These homes could still lose heat quickly in windy weather, so heating may still be required during times of peak electricity pricing. For these scenarios we have assumed an average electricity cost of 22.5 pence per kWh.

Dynamic Tariffs

The three scenarios with the best levels of fabric efficiency are assumed to be able to take good advantage of dynamic electricity tariffs. Comparison of energy monitoring and dynamic tariff pricing data for an existing net zero home with a heat pump in 2021 and 2022 indicates that an average electricity cost of around 18 pence per kWh is possible. This rate has been assumed for operational energy cost calculations.

The assumption is based on the current price cap period rates (1/04/22-30/09/22) (Source: OFGEM)

Smart thermostats, solar hot water diverters, and solar electric vehicle chargers are already on the market and provide effective ways to maximise solar self consumption.

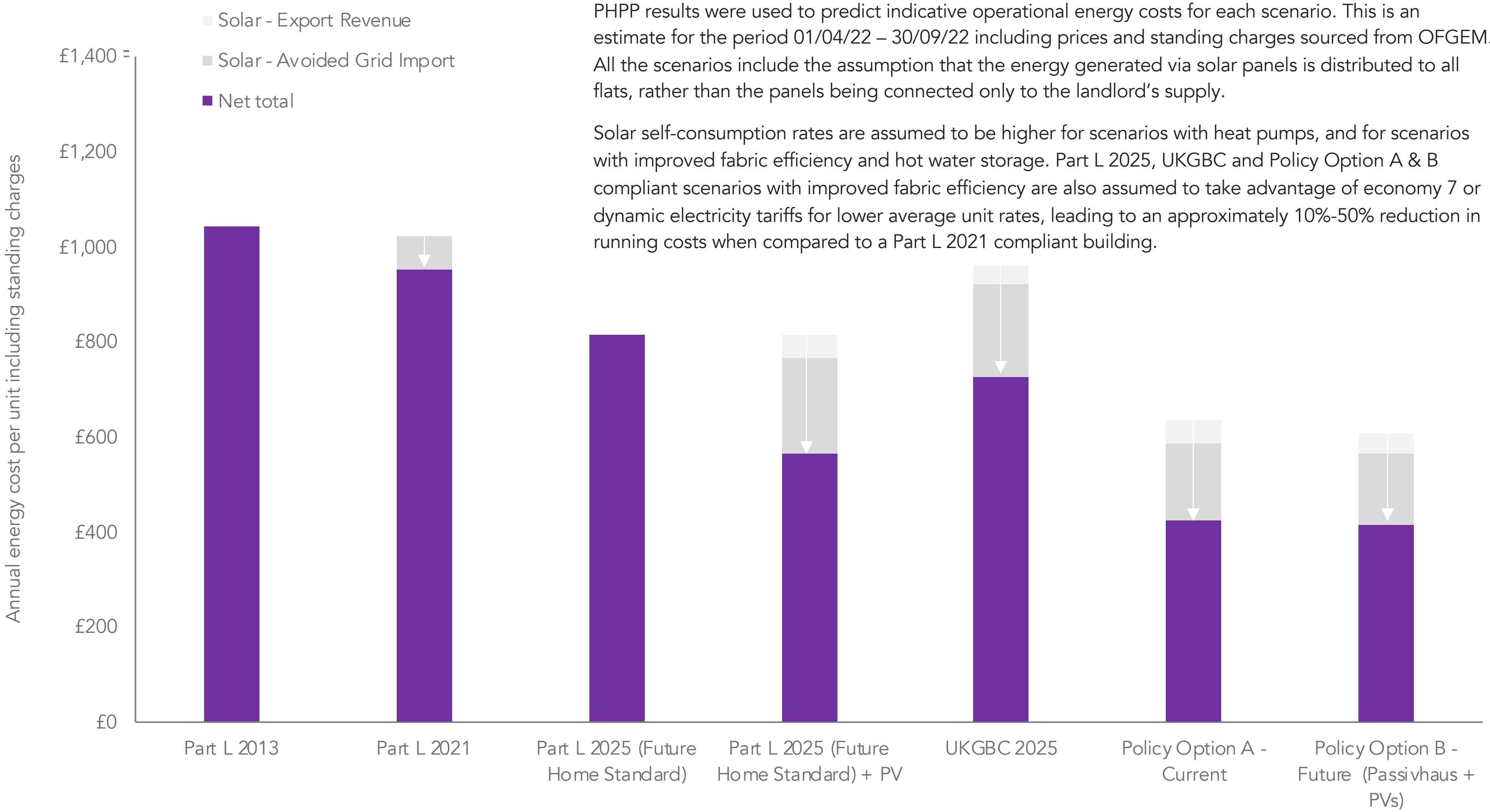


Electricity prices and typical solar generation profile for a winter's day. Most net zero buildings are expected to have heat pumps, which can use cheap off-peak electricity, or free solar electricity, so the average cost is cheaper than a fixed tariff. Heat demand in net zero buildings is typically so low that solar can still provide useful amounts of energy for most of the winter.

PHPP modelling to predict energy costs

PHPP results were used to predict indicative operational energy costs for each scenario. This is an estimate for the period 01/04/22 – 30/09/22 including prices and standing charges sourced from OFGEM. All the scenarios include the assumption that the energy generated via solar panels is distributed to all flats, rather than the panels being connected only to the landlord's supply.

Solar self-consumption rates are assumed to be higher for scenarios with heat pumps, and for scenarios with improved fabric efficiency and hot water storage. Part L 2025, UKGBC and Policy Option A & B compliant scenarios with improved fabric efficiency are also assumed to take advantage of economy 7 or dynamic electricity tariffs for lower average unit rates, leading to an approximately 10%-50% reduction in running costs when compared to a Part L 2021 compliant building.



	Part L 2013	Part L 2021	Part L 2025 (Future Home Standard)	Part L 2025 (Future Home Standard) + PV	UKGBC 2025	Policy Option A - Current	Policy Option B - Future (Passivhaus + PVs)
Gas Price (p/kWh)	7.2	7.2	-	-	-	-	-
Average Electricity Price (p/kWh)	28.0	28.0	22.5	22.5	18.0	18.0	18.0
Solar Consumption	-	20%	-	40%	30%	50%	50%

Annual energy costs including standing charges, based on PHPP predicted energy use. Solar PV savings from avoided grid import, and value of exported solar energy also shown.

Appendix 1

Cost modelling results

This appendix contains the results of cost modelling for the different policy scenarios

Cost modelling results | Summary Table

		Part L 2013	Part L 2021	Part L 2025	Part L 2025 PV	UKGBC 2025	Policy Option A - Current	Policy Option B - Future
	Solar PV	-£114	Baseline costs	-£114	£1,174	£1,174	£1,174	£1,027
High-rise flats	Heating System	-£473	Baseline costs	-£165	-£165	-£131	-£131	-£197
	Fabric Efficiency	-£650	Baseline costs	£181	£800	£2,684	£2,684	£3,206

Table of cost modelling results for all policy scenarios including an assumption for brick wall mounted solar panels

		Part L 2013	Part L 2021	Part L 2025	Part L 2025 PV	UKGBC 2025	Policy Option A - Current	Policy Option B - Future
	Solar PV	-£114	Baseline costs	-£114	£2,066	£2,066	£2,066	£1,764
High-rise flats	Heating System	-£473	Baseline costs	-£165	-£165	-£131	-£131	-£197
	Fabric Efficiency	-£650	Baseline costs	£181	£800	£2,684	£2,684	£3,206

Table of cost modelling results for all policy scenarios with rainscreen cladding mounted solar panels.

Costs are based on typical UK construction costs from Currie and Brown. Local costs of construction and measures required to comply with policy may vary and should not be independently altered. Costs do not factor in anticipated future reductions due to learning rates once policy is adopted.