Chelmsford Zero-Carbon Ready Demonstrator Site

Beaulieu Zone T

Prepared by: Stroma Built Environment Ltd

On behalf of: Chelmsford City Council, Homes England & Countryside Zest

November 2022

Foreword / Disclaimer

This technical analysis has been prepared for the Chelmsford City Council, Homes England & Countryside Zest by Stroma Built Environment, a construction consultancy specialising in sustainability, energy conservation and the application of renewable energy technologies.

This report is intended to evaluate how a proposed housing development designed to 2013 standards could be adapted to meet the energy and carbon saving improvement defined within the Future Homes Standard (as defined within the FHS consultation response Jan 2021).

Product Disclaimer

Throughout this report, numerous branded products have been referenced, as they have been used within the energy calculations to determine the energy and carbon improvements.

Please note that product names have been used within this document to aid the process of viability and costing, and to ensure that the specifications reflect products that exist in the market, rather than theoretical performance. There are alternative products & brands that deliver the same or very similar performance that can be substituted. Brands were selected at random, and Stroma Built Environment do not have any affiliation with the manufacturers of the products referenced within this report.

Report Prepared By:

Date:	Mar 2022	Andrew Mitchell	BEng	Director

Document History:

Issue	Date	Comment	Author
D.01	03.03.2022	Initial Draft Issue	A.M.
V.01	11.07.2022	Final Report Post Comment	A.M.
V.02	18.10.2022	Revision 02	C.C.
V.03	04.11.2022	Revision 03	C.C.

Contents

Executive Summary

This report has been commissioned by developer Countyside Zest and Chelmsford City Council in partnership with Homes England to investigate the design and specification to achieve the Future Homes Standard (FHS) proposed to be implemented in 2025. It then assesses the implications of incorporating these changes to current house types and masterplan layouts used by a volume housebuilder.

The government has sign posted technical improvements within the Future Homes Standard so that all new dwellings will be Net Zero Carbon Ready by 2025.The legislative process is managed by approved document Part L1A of the Building Regulations. The Government has indicated that by 2025 all new dwellings will save 75% more carbon dioxide, when referenced against current regulations.

Sustainability and carbon reduction, whilst important, is not the only aspect of good development, and other important factors, such as placemaking and a legible and well-designed layout in terms of general usability are just as important.

Often these other equally important aspects of site layout design can be overlooked if striving to achieve particular carbon emissions standards. For this reason, this report's focus is on how the pre-existing design could be adapted for compliance with the FHS, within the constraints of the original approved design intent. For this reason, the general architectural design of the standard house types, and general layout of the site, have been taken as fixed.

Zone T of the Beaulieu neighbourhood located within Chelmsford Garden Community and currently at the reserved matters design stage has been selected to complete this review. The site will eventually consist of no.66 1 & 2 bed apartments plus 2,3 ,4 and 5 bed homes. Coincidently the site will also be located next to a planned zero carbon primary school

This report assesses how the design, specification and cost of constructing the proposals at Zone T differs from the baseline position of the 2013 Building Regulations which were in force when the original outline application for Beaulieu was granted in 2014. Many other phased strategic schemes across the country will be in a similar position. The report sets out the 'designed in' carbon reducing technologies and processes to increase the carbon efficiency of the homes to accord with the proposed Part L1A 2025 to achieve the FHS.

No view has been given to the sales potential of homes benefitting from being net zero ready. Further monitoring research will be required when, subject to available funding, the development is built to the net zero ready standard.

There will be alternative options to best design a net-zero ready site, and the very definition of net-zero ready is still evolving, with additional standards in development by the UK Green Building Council (UKGBC). However, this study is intended to evaluate how a volume housebuilder is likely to approach the requirements of the FHS as they are currently understood. Therefore, no evaluation as to exceeding the levels of the FHS has been undertaken, and the most cost-effective route available has been evaluated for the detailed carbon emissions calculations.

Thermal performance of the fabric is to be improved, most notability walls and windows. The report finds that the required thermal resistance for the walls can be achieved within the current 125mm cavity width currently used by Countryside Zest, via the selection of a high performance phenolic rigid board insulation. As a result, the dwelling footprint or internal space does not need to alter. All dwellings will need to be equipped with triple glazed window units to reach the prescribed thermal performance

In line with the core element structure of the proposed 2025 Building Regulations, to reduce energy consumption Air Source Heat Pumps (ASHPs) have been specified for most dwellings. This technology, which, fits the energy saving requirement of the emerging advancing regulations. For the apartments, the suitability of ASHPs is more problematic due to the issues around external apparatus location, hence the proposal is to install direct electric heating, supported by hot water heat pumps (HWHPs) and photovoltaic arrays. Other

options such as direct electric heating and hot water, and Exhaust Air Heat Pumps (EACHs) have also been evaluated.

All upgrade measures, fabric and plant have been costed as an over cost to the standard Countryside Zest home product. Over cost current increases (from the 2013 Building Regulations to achieve FHS) are approximately:

- Houses £12,810 per unit which is 11% of total build cost *
- Apartments £ 5,991 per unit which is 9% of total build cost*

*Costs based on average size unit and exclude allowance for preliminaries, overheads and contingency costs.

In addition to the above cost differentials, the report sets out the following key learning outcomes:

- The required fabric performance uplift can be achieved within a current house type wall cavity and overall width specification used by Countryside Zest with the use of higher performance insulation
- Triple glazing is required for all windows
- Air Source Heat Pumps (ASHP) are required for water and space heating wherever viable
- Exhaust Air Heat Pumps (EAHPs) or Hot Water Heat Pumps (HWHPs), with supplementary Photo Voltaic (PV) arrays wherever ASHPs are not viable
- Orientation and position of buildings is only critical where fabric performance and water/space heating solution does not provide sufficient savings
- Changes to window designs may be required to mitigate overheating risk
- Potential skills shortages will need to be investigated in further detail to ensure deliverability

1. Introduction

1.1 The Government has committed to reducing greenhouse gas emissions to almost zero by 2050. As part of this process the Government has set a road map for the construction industry to achieve net-zero ready homes by 2025. This process has been defined within the Future Homes Standard (FHS), which is to be incrementally incorporated into the building regulations.

1.2 This FHS document defines dwelling performance improvements, over two stage-controlled updates to Approved Document Part L1: Conservation of Fuel and Power, that govern the energy efficiency of new dwellings under the building regulations. These are to be implemented as part of the Building Regulations 2021 (implemented 15th June 2022) and the Building Regulations 2025 (introduction TBC).

1.3 Stroma Built Environment have been commissioned by Countryside Zest and Chelmsford City Council, in partnership with Homes England to investigate the design and specification changes required within a developer's 'standard' house types, to achieve the FHS proposals to be implemented in 2025.

1.4 In order to evaluate the 'real life' practical and financial implications for a volume housebuilder, a development zone in the Beaulieu development within Chelmsford Garden Community in Essex has been chosen to test the emerging national standards. As shown in Figure 1, Chelmsford Garden Community is located to the north east of the city of Chelmsford.

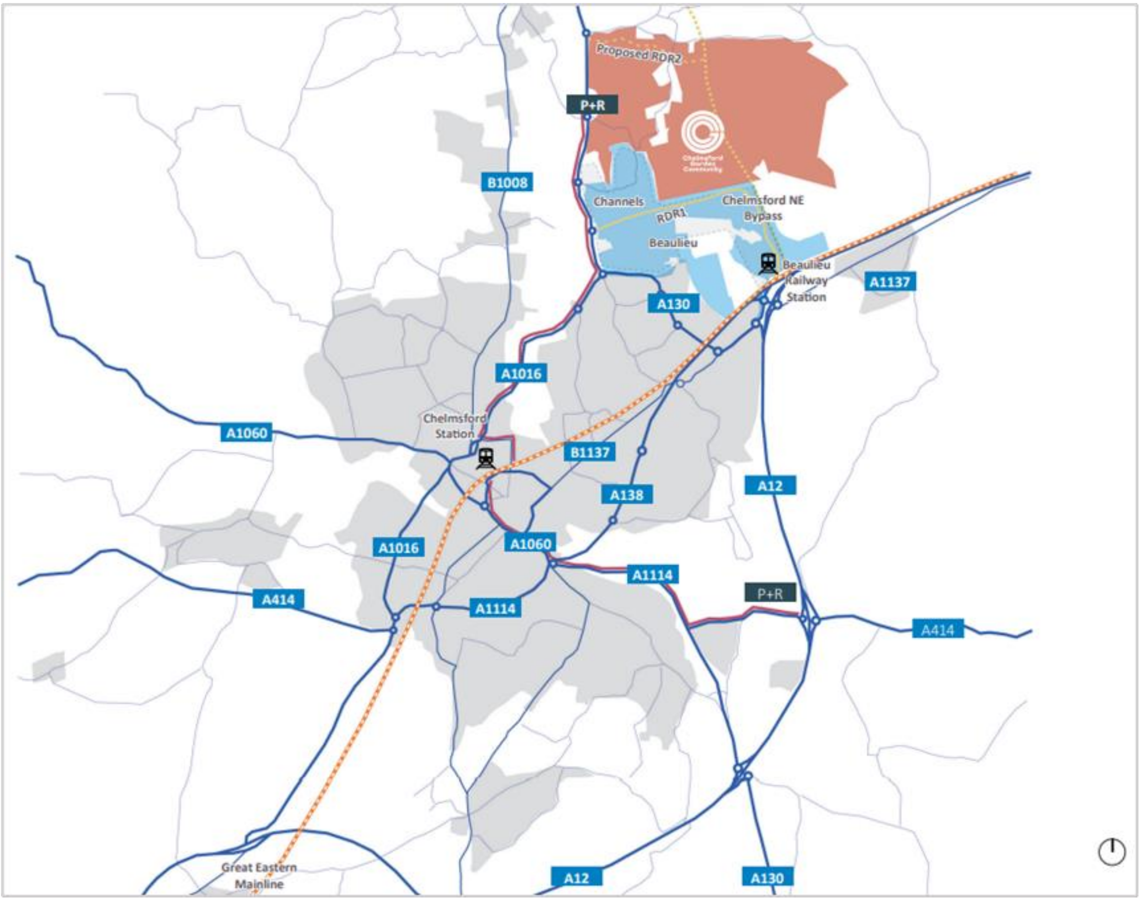

FIGURE 1: LOCATION OF CHELMSFORD GARDEN COMMUNITY

1.5 Zone T of the Beaulieu development has been chosen to test the implementation of the emerging Future Homes Standards (Figure 2)

FIGURE 2: SITE PLAN - ZONE T

1.6 Beaulieu, alongside the Channels development, are the first phases of the Chelmsford Garden Community. Outline planning permission was granted at Beaulieu for up to 3,600 new homes, a neighbourhood centre, Essex's first 'all through' school and further separate primary school, community facilities, new business park and associated infrastructure in March 2014. Planning permission has also been granted for a new rail station and a new Chelmsford North East Bypass which are being delivered through the Housing Infrastructure Fund (HIF).

1.7 The Chelmsford Garden Community was selected for the net zero carbon ready demonstrator site because:

- It is one of the recognised Government's Garden Communities proposals
- The wider Garden Community will be a zero-carbon development when complete
- The first phases are permitted and currently under construction.
- The reserved matters for Zone T of the Beaulieu neighbourhood would fit into the timeline and will be delivered alongside a new zero-carbon primary school
- Countryside Zest (Countryside Partnerships and London & Quadrant) are willing and pro-active partners
- Zone T is located in the heart of the site adjacent to a site for a new primary school which is also set to be Zero Carbon ready.

Context For the Project

1.8 The purpose of stage 1 of this project is to:

- Enable an assessment of the practical and financial implications of delivering new homes in line with the 2025 FHS specification as part of the construction of a strategic development site delivered by a volume house builder.
- Assessment of materials and thermal efficiency of the building envelope to meet the FHS specification, alongside low-carbon heating systems and zero-emission power generation.
- Assessment of the implications of delivery at scale
- Share data and outcomes related to CO_2 emissions of different dwelling types

1.9 The key deliverables are:

- Define the technical specification of Future Homes Standard compliant homes in terms of energy efficiency and primary energy consumption, and a comparative analysis of CO_2 emissions by dwelling type.
- Evaluate how a developers 'standard' house type could be adapted to meet the FHS, in order to minimise cost and design implications.
- Provide cost estimates which detail and categorise the additional costs above and beyond a current BAU scheme by dwelling types.
- A concise written report that sets out the key outcomes of the above deliverables with the relevant datasets and technical specification appended.

1.10 Aspects such as site orientation and architectural design have not been included within the scope, unless required to meet the FHS.

1.11 It is important to note that as the Beaulieu development was granted outline planning permission in March 2014, the baseline for the relevant Building Regulations is Part L of the Building Regulations that were in force in 2013.

2. Review of Part L1A & the Future Homes Standard

The Future Homes Standard

2.1 The UK was the first major world economy to pass a net zero emissions target into law. The target of brining all greenhouse gas emissions to net zero by 2050 is one of the most ambitious in the world.

2.2 In 2018, heating and powering homes accounted for 22% of all greenhouse gas emissions. Central Government as part of its 10-point plan for a green industrial revolution has set out how they seek to achieve net zero by 2050. It includes:

- Decarbonisation pathways to net zero by 2050.
- Policies and proposals to reduce emissions for each sector
- Cross-cutting action to support the transition.

2.3 The FHS for new build homes has been introduced to achieve a considerable improvement in energy efficiency standards for new homes. The energy efficiency and carbon emissions for new dwellings constructed within England is controlled by approved document Part L1A of the Building Regulations. The FHS proposes to improvements to new dwellings to be net zero carbon ready by 2025. The tool to enforce this improvement road map is approved document Part L1A.

2.4 The FHS consultation defines the following improvement in dwelling performance, both referenced against current building regulations (Part L1A2013) –

- 1st Stage – Part L1A 2021 to deliver a 31% carbon saving improvement
- 2nd Stage - Part L1A 2025 to deliver a 75% carbon saving improvement

2.5 Within both the above carbon improvement strategies there are associated energy and fabric target improvements. The implementation date for Part L1A 2021 is June 15th, 2022. Confirmation for the implementation of Part L1A 2025 is yet to be confirmed. The exact structure for 2025 is still subject to further Government consultation, and therefore the basis of this report has been the initial FHS consultation as referenced above.

2.6 The compliance tool used within Part L1A is the Standard Assessment Procedure (SAP). This is the calculation methodology that illustrates that a new dwelling is compliant with Part L1A. With each update to Part L1A a new version of SAP is issued. From June 15th, 2022, we are working to SAP10 and the future 2025 update will move to SAP11. The SAP methodology computes the dwelling performance, in term of fabric performance, energy use & carbon emissions, in line with the requirements for Part L1A. All targets within a SAP calculation are generated by the notional compliance specification. The details of a given proposed dwelling are loaded into the tool and then the target for the given home is generated using the notional U values and plant. The notional specification is not a prescriptive set of values but used to calculate the targets for each of the three compliance matrixes.

2.7 Within SAP10 there are three targets that must be met, Fabric, Energy & Carbon. The Future Homes Standard strategy is to set a road map for all new dwelling to the net zero carbon ready. The key drivers are to reduce total energy consumption within the home and encourage space and water heating to be fuelled by electricity. This is to take advantage of the year-on-year de-carbonisation of the national grid, resulting in a dwelling reducing carbon emissions each year.

The SAP Notional Specification

2.8 As stated, the task is to define a fabric & plant equipment improvement to deliver the proposed FHS (Part L1A 2025) within the fundamental existing house type and site layout already proposed for Zone T.

2.9 All calculations have been completed using the FSAP10 (1.0.52) software, which has been approved for use in compliance calculations for Part L1 2021 by the Department for Levelling Up, Housing & Communities (DLUHC).

2.10 As stated, the notional specifications are not a prescriptive set of targets but give a strong indication of the fabric and plant requirements. The target generated within the calculation is area weighted, so for the elements with the large area the insulation performance needs to be near the notional value. Whilst trade-offs are available to deliver overall compliance, good practice is to meet or exceed the Notional target values.

	2021 Part L Standard
Floor U-value (W/m².K)	0.13
External wall U-value (W/m².K)	0.18
Roof U-value (W/m².K)	0.11
Window U-value (W/m².K)	1.2
Door U-value (W/m².K)	1.0
Air permeability at 50 Pa	5.0 $m^3/(h.m^2)$
Heating appliance	Gas boiler
Heat Emitter type	Low temperature heating
Ventilation System type	Natural (with extract fans)
PV	40% ground floor area
Wastewater heat recovery	Yes
y value (W/m².K)	0.05

FIGURE 3: NOTIONAL SAP10 SPECIFICATION (2021 PART L)

2.11 The above specification has been incorporated within the SAP10 full specification document. Thermal elements have been improved, significantly for external walls and glazing. A notable element within this specification is that Gas Heating is included, supported with an extensive area of photovoltaic array to deliver the energy and carbon savings required. This was unexpected, owing to the Governments pledge to phase out gas in new dwellings.

2.12 For this exercise we need to assess against the future SAP11 specification. Currently the full proposed SAP11 calculation methodology has not be defined. The target carbon improvement has been set at 75% beyond current building regulations. The only current prediction for the target structure for SAP11 & therefore Part L1A 2025 is the notional specification published within the Future Homes Standard consultation response.

	2021 Part L Standard	Indicative FHS specification
Floor U-value ($W/m^2.K$)	0.13	0.11
External wall U-value ($W/m^2.K$)	0.18	0.15
Roof U-value ($W/m^2.K$)	0.11	0.11
Window U-value ($W/m^2.K$)	1.2	0.8
Door U-value ($W/m^2.K$)	1.0	1.0
Air permeability at 50 Pa	5.0 $m^3/(h.m^2)$	5.0 $m^3/(h.m^2)$
Heating appliance	Gas boiler	Low-carbon heating (e.g. Heat pump)
Heat Emitter type	Low temperature heating	Low temperature heating
Ventilation System type	Natural (with extract fans)	Natural (with extract fans)
PV	40% ground floor area	None
Wastewater heat recovery	Yes	No
y value ($W/m^2.K$)	0.05	0.05

FIGURE 4: INDICATIVE FHS NOTIONAL SPECIFICATION

2.13 This document illustrates substantial changes to the notional specification. Firstly, the space and water heating system has changed from Gas Boiler to Heat Pump. Fabric is also improved, walls improving to 0.15 and windows improving to a U value of 0.8. In practical terms, the glazing performance switches the units from high performance double glazed to triple glazed window sets.

2.14 In the absence of a beta version of the SAP11 software, an assessment has been undertaken using FSAP10 software, with the dwelling performance set as the SAP11 notional specification to generate targets. Please note the stated 75% carbon saving uplift is not a prescriptive target, but a goal that the notional is set around. As a result, different dwelling types will deliver a variation in the percentage improvement.

3. Proposed Site – Beaulieu Zone T

3.1 The scheme comprises 66 dwellings, combining houses, and apartments, all in keeping in terms of style with the wider Beaulieu scheme. The selected project zone offers a good representative of the dwelling types for a medium density (16 units per acre or 40 per hectare) traditional low rise housing scheme, with a mix of houses and apartments. Accommodation Schedule is set out in Appendix B

3.2 Pre-application discussions with the local planning authority were taking place before the decision to test Zone T for a zero-carbon ready demonstrator site. This has been used as a baseline to subsequently test the requirements of the proposed Part L (2025) changes.

3.3 Sustainability and carbon reduction, whilst important, is not the only aspect of development, and other important factors, such as general usability, placemaking, and a legible and well-designed layout are also essential. Often these other equally important aspects of site layout design can be overlooked if striving to achieve particular carbon emissions standards. For this reason, this report's focus is on how the pre-existing design could be adapted for compliance with the FHS, within the constraints of the original approved design intent. For this reason, the general architectural design of the standard house types, and layout of the site, have been taken as fixed.

FIGURE 5: SITE PLAN - ZONE T

4. Specification Review

Fabric

4.1 From the notional specification and the proposed compliance structure of SAP, the inclusion of the Fabric compliance target, the dwelling design strategy has to be fabric-first. It will not be possible to meet FHS compliance with efficient plant and renewables alone.

4.2 In defining a fabric strategy, the following must be considered:

- Buildability
- Area-weighting within the dwelling
- Cost

4.3 Heat transfer for a construction element is via three mechanisms, conduction, convection and radiation. Heat transfer will always occur where there is a temperature difference between two bodies, in this case the conditioned air within the building and the external atmosphere. The two temperature zones are always trying to get into equilibrium. Insulation cannot stop this process, but it slows the rate of heat transfer.

4.4 Insulation products are designed to inhibit the heat transfer mechanisms, conduction, convection and radiation. The insulating capability of a material is measured via its thermal conductivity (k, units Watts per metre). The lower the k Value, the greater the thermal performance. Insulation products can be defined within two performance categories, mineral/glass fibre or phenolic foam materials. The latter having the higher thermal resistance performance (k value ranging of 0.017 to 0.019). Mineral wool products having a K value range of 0.032 to 0.040.

4.5 The thermal performance for a given thermal element is a function of the selected insulation material and the thickness of the material installed. Increasing a given thickness of insulation does not deliver a linear improvement in the resulting U value. As the insulation thickness increases, it deliveries a diminishing return on the total thermal performance.

Fabric Design Considerations

Floors	Selected thickness will need to correspond with brick coursing. Note the final U value will be a function of the insulation thickness and the area / perimeter ratio for each dwelling floor plate. There are a number of insulated floor systems that maybe appropriate for this assessment. Delivering both on site construction advantages and cost savings
Walls	A key design criteria is the final wall thickness, which will be a function of the selected insulation product. This will have implication as to the footprint area or the internal floor area of the dwelling. Installation needs to also consider Warranty specification requirement and interstitial condensation risk
Roofs	Relatively straightforward to maximise performance for insulated ceilings, via low cost mineral wool product. Greater consideration is needed to maximise

	performance for ceilings, ensuring ceiling clearance to maximise under rafter installation to reduce thermal bridging through the rafters
Party Walls	All party wall to be fully filled and sealed around all edges. Under Part L definitions ensures the wall can be defined as having a U value of zero. The party wall with also need to satisfy part E sound insulation performance.
Glazing	All glazing will need to be triple-glazed to meet the fabric targets. As stated, the element performance needs to be near the notional thermal performance for all elements of high area. Hence the notional specification of 0.8 calls for the installation of Triple Glazed Window sets.
Doors	Doors represent a low area weighting, and the notional specification is in line current insulated door performance.

Renewable Technology

4.6 Renewable energy is defined as energy derived from energy flows that occur naturally and repeatedly in the environment. It may be contrasted with energy sources that can be depleted such as fossil fuels or uranium-238-based nuclear power. It therefore follows that the commonly used phrase "equipment to generate renewable energy" is an oxymoron since renewable energy cannot be "generated" – the true function of the technology is to harness a natural energy flow.

4.7 Renewable energy technologies, with a couple of exceptions, all utilise energy from the sun – either directly or indirectly, the exceptions being true geothermal, which uses heat from the earth's core, and tidal / marine current electricity generation which uses the gravitational forces between the earth and the moon, (although some marine currents are also greatly affected by solar energy). Insofar as this report is only concerned with practical options for on-site renewable energy, these options are not considered further. The remaining range of "solar" technologies are however vast, and some would not even appear to be solar on superficial inspection. They can be summarised as follows:

- Solar thermal – direct heating of water for space heating or domestic hot water.
- Photovoltaic – direct generation of electricity from sunlight.
- Hydroelectricity – use of solar (water cycle) driven water flows to generate electricity.
- Wind turbines – use of solar driven air movement to generate electricity.
- Heat pumps – extraction of solar heat from the earth, atmosphere or water bodies.
- Bio-fuels – combustion of solid or liquid bio-fuels to produce heat or electricity.

4.8 For more detailed analyses of all listed technologies, and the reasons for their exclusion on this proposed development, please see appendix A.

4.9 From the predicted SAP11 notional specification it is evident that dwellings will ideally be equipped with Heat Pumps to match the calculation targets.

5. Detailed Technical Review

Please note that existing products have been used within this document to aid the process. There are alternative products & brands that deliver the same or very similar thermal performance that can be substituted. Stroma have no affiliation with the brands that have been selected at random, and they are not deemed preferred over any other available product of similar performance and BBA certification

External Wall Analysis

5.1 The following illustrates a number of options to achieve the target U value of 0.15 W/m2/k. Listed is the required cavity thickness and the overall resulting wall thickness.

Option	Build-Up	U-Value	Insulation	Cavity Width	Wall Thickness
1	Plasterboard on dabs/3.6N Aerated Block/mineral wool/brick	0.15	Dritherm Mineral wool (k 0.32)	185mm	418mm
2	Insulated Plasterboard on dabs/3.6N Aerated Block/mineral wool/brick	0.15	Dritherm & insulated plasterboard	150mm	403mm
3	Plasterboard on dabs/3.6N Aerated Block/platinium Ecobead/brick	0.15	EPS bead	190mm	423mm
4	Insulated Plasterboard on dabs/3.6N Aerated Block/platinium Ecobead/brick	0.15	EPS bead & Insulated plasterboard	150mm	403mm
5	Plasterboard on dabs/3.6N Aerated Block/Kingspan K106/brick	0.14	Phenolic Foam	125mm	358mm

5.2 Results illustrate a variation in wall thickness of 60mm from the widest, mineral wool to the narrowest Phenolic foam.

5.3 Two build ups (options 2 & 3) include an insulated plasterboard. This is discounted due to the following:

- Buildability concerns and thermal bridging issue at internal stud wall to external junctions.
- Interstitial condensation considerations

5.4 Dritherm 32 is a market leading mineral wool product in term of thermal resistance. To achieve the target U value 185mm of the product fully filling the cavity. This will require two thickness of the product, 100mm & 85mm, to the used, as Knauf do not manufacture a 185mm thick batt. This therefore moves the proposed installation outside the specification defined within the product British Board of Agrément (BBA) certificate

5.5 Approval from both building control and warranty provider will need to be sort to install the Dritherm insulation outside that defined in the BBA certificate.

5.6 Option 3, Platinum Ecobead (polystyrene bead) has no limit to the width of the cavity within the BBA certificate.

5.7 Kingspan K106 (phenolic Foam) is a fully fill insulation product that takes the advantage of a material type with the lowest K value. The insulation install thickness is 115mm with a 10mm clear zone is in line with the BBA certificate.

External Wall Proposal

5.8 From the listed five install options only two currently have BBA certificates for the proposed installations, Ecobead and Kingspan K106. Both will be costed. One notability consideration is the buildability of the selected system.

5.9 Ecobead build process is common across all cavity thicknesses. The main consideration will be the availability of wall ties and structure considerations.

5.10 The Kingspan K106 product is a solid material that will fill 92% of the cavity width. Historically with Phenolic board insulation you'd leave a minimum 50mm clear cavity, to prevent moisture transfer from the external façade, inward (this also aids the build process giving the bricklayer room behind the outer course). This product has eliminated this issue by the inclusion of plastic membrane that stops water transfer across the cavity. All insulation boards need to be taped at joints. K106 is therefore costly to build, minimal clearance behind the bricks and the taping slows the build time. This will be incorporated within the costing analysis.

5.11 The current Part L1A wall specification is a 125mm full fill cavity with Superwall 36 glass insulation (u value 0.22w/m2K). The above specification of 0.15 represents a 30% improvement in thermal performance.

Floor Insulation Proposal

5.12 A performance U value of 0.13w/m2K is the target in line with the FHS notional specification. The proposal is to use the current standard Countryside system, with additional overlaid insulation to meet the target. The current Part L1A floor Specification is 75mm insulation overlay over the above insulation between the concrete beams.

5.13 A 150mm insulation overlay will be required to meet the FHS target, which may require an additional brick course.

Roof Insulation Proposal

5.14 The current Countryside roof insulation specification is 400mm of loft roll. This matches the notional FHS roof insulation specification of 0.11 w/m2K. As a result no specification upgrade is required.

Window Proposals

5.15 In line with the notional FHS specification all dwellings will need to be equipped with triple glazing to achieve a thermal performance of around 0.8 w/m2K. Thermal resistance of this magnitude is not possible with double glazed units.

5.16 This is a significant upgrade compared to the current specification of high-performance double-glazing

Plant Selection – Houses

5.17 As already stated, the SAP11 notional specification looks for the selection of heat pumps to deliver space and water heating.

5.18 Heat pumps collect low temperature heat from renewable sources and "concentrate" it to a usable temperature. Fossil fuel based (grid) electricity is generally required to operate the pumps and the renewable component of the output is therefore by convention taken as the difference between the output energy and the input energy. A typical heat pump will deliver 4-5 kWh of useful energy for every 1 kWh of input energy. A heat pump operating in this way can therefore be deemed to have delivered 3-4 kWh of renewable energy.

5.19 There are two common types of heat pump – ground source and air source. In urban locations ground source heat pumps are rarely viable, due to the complexity of drilling boreholes to collect heat. Air source heat pumps fit the underlying structure for the Future Homes Standard. Reducing energy consumption and take advantage of the year on year improving low carbon national grid electricity.

5.20 For this exercise all Heat Pump operational performance efficiencies has been taken for the SAP Product Characteristic Database (PCDB).

5.21 Note the Heat Pump market within the UK is immature, with a broad range of operating efficiencies and limited availability of qualified installation professionals.

5.22 A review of the commercially available units has indicated that the Panasonic ASHP Monoblock range offers a suitable solution for the houses, due to the best in class level performance and forecasted purchase availability. With this solution, outside equipment will need to be housed near to the property. This solution has not been deemed suitable for the apartment block, due to the technical and visual issue around housing the external units

5.23 A Monoblock Heat Pump aids the installation of the apparatus by containing all the refrigerant within the external unit, with the only penetrations into the house being a supply and return. This de-skills the installation. A heat pump installation requires a hot water cylinder as instantaneous hot water is not possible. The space heating delivery temperature will be lower than a traditional gas system, therefore there are two emitter options under floor heating or oversized radiators. This approach, a low temperature heat source has been stated as a requirement within the Future Homes Standard documents.

FIGURE 6: HEAT PUMP INSTALLATION

Plant Selection – Apartments

5.24 Within the proposed scheme there are two types of apartments. In the north east is a block of nine apartments. And across the site there are flats over garages (FOGs) and maisonettes.

5.25 For the apartment block it is deemed unsuitable to install Heat Pumps due to the external apparatus. These either need to be hung on the façade or within a centralised location near the building. The roof, being of traditional pitched design does not offer a location to house equipment. The maisonettes and FOGs are deemed suitable for heat pump installation.

5.26 As a result, there are three options considered to deliver SAP11 performance. All systems considered are electrically powered, and therefore have the capacity to be powered with renewable electricity, subject to grid decarbonisation and local generation

- Install Exhaust Air Heat Pumps (EAHPs) within each apartment
- Install direct electric systems with substantial PV to offset emissions
- Install ducted heat pumps for hot water generation & PV to offset direct electric heating

5.27 An EAHP mimics the heat delivery of traditional heat pump, but the energy source is not the external air, but the 'wet' internal air from the bathrooms and kitchen. The unit incorporates ventilation system, drawing air from the wet rooms. It extracts the latent heat (energy from the air moisture) and compresses the energy to a useful temperature, to deliver space & water heating. The unit requires no external apparatus, only venting as with a ventilation system with heat recovery. The heat pump sits above a hot water cylinder, all packaged into one unit. This type of system would not require the addition of a solar array to meet the FHS.

5.28 An alternative approach will be to deliver all space and water heating via direct electric heating and supplement this with an extensive photovoltaic array to offset both the energy demand and carbon emissions. The roof pitch face east /west, and could potentially accommodate up to 25-30kWp of PV. Unfortunately, to meet SAP11 compliance with this approach would require approximately 47kWp of PV, which could not be accommodated on the roof of the building. It is possible that a re-orientation of the block to provide a substantial area of south facing roof pitch could result in compliance. However, even with a south facing array, in excess of 30kWp would be required, which would unlikely be able to be accommodated on a single pitch of the roof.

5.29 The reason for non-compliance with the above is due to the primary energy demand target. The emissions criteria are exceeded by over 50% with the above approach, however, the primary energy demand, a new metric for SAP10 onwards will require the above sizing.

5.30 The third solution for the apartment block is a hybrid of the above. A hot water heat pump (HWHP) to deliver the water heating and space heat from direct electric heating. A Dimplex Edel is a single unit containing a heat pump (requires ventilation to external) with an integrated hot water cylinder. This will deliver 100% of the annual hot water requirements. A Photovoltaic array will be required to compensate for the direct electric heating. This is currently calculated at 15 kWpeak (East / West).

5.31 One additional aspect that must be considered is the impact of the EPC rating of the dwelling, which is not directly linked to energy efficiency, but predicted running costs. The most favourable of the options above for this element would be the EAHP system. Whereas, direct electric heating and hot water, with a PV offset, is likely to result in EPC ratings of D or below owing to the high cost of electricity as a fuel. The only way to improve this would be to individually connect each apartment to its own PV system, which would allow the generation to be realised within the dwelling's EPC rating.

6. Cost Implications

Fabric Costs

6.1 As detailed the three-fabric improvements required to deliver a FHS compliance are:

- Floor insulation - Increase in overlay to Cube 6 flooring system
- External wall – Installation Kingspan K106 rigid insulation board
- Glazing – upgrading all windows to triple glazed units.

6.2 All the costing data has been provided by Countryside Zest and collated during March 2022, and therefore subject to inflation changes post this date.

6.3 All figure quoted are uplift costs from the current Countryside SAP2012 specification. All cost excludes FOGs within the analysis

6.4 Houses average uplift costs per fabric element:

- Floor insulation £746 per unit (0.6% uplift)
- External wall £5,127 per unit (4.3% uplift)
- Glazing £1,437 per unit (1.2% uplift)

6.5 Flats average uplift costs per fabric element:

- Floor insulation £307 per unit (0.5% uplift)
- External wall £2,374 per unit (3.7% uplift)
- Glazing £910 per unit (1.4% uplift)

6.6 The predicted over cost for the improved external wall U value, includes replacing mineral wool with the Kingspan K106 installation and allowance for the additional labour costs, due to the slow build rate.

Plant and Renewables Costs

6.7 The key plant variation within the house to deliver FHS energy performance is the replacement of the Gas boiler system with an Air Source Heat Pump.

6.8 The strategy for the apartment differs, with all units to have direct electric space and a Dimplex Edel ASHP hot water cylinder, supported by a photovoltaic array.

- Houses ASHP uplift cost £5,500 per unit (4.6% uplift)
- Apartment Block electric heating, HWHP & PV £2,400 per unit (3.7% uplift)

Total over cost to achieve FHS

6.9 The estimated extra over cost to deliver from 2013 Part L to FHS within the current standard Countryside dwelling types proposed for Beaulieu Zone T is:

- Houses £12,810 per unit which is 11% of total build cost *
- Apartments £5,991 per unit which is 9% of total build cost*

Total estimated cost is £784,000 which is a 10% uplift of the total scheme build cost.

*The above costs exclude allowance for preliminaries & overheads and contingency costs.

7. Dwelling Overheating

Part O of the Building Regulations

7.1 At the same time as the introduction of the 2022 uplift to the Part L1A, a new element within the Building Regulations is to be implemented, reviewing whether new dwellings are at risk of overheating during the summer months.

7.2 The government has introduced this new element into the building regulation to ensure that all new homes are habitable into the future, with reference to predicted global warming temperature rises. The goal is to ensure that dwellings are habitable without the need to install Air Conditioning systems.

7.3 The World Health Organisation (WHO) attributed 70,000 deaths within Europe during the summer of 2003, due to that summer's heat wave. There is a health risk from dwellings that overheat and therefore the government has implemented Part O to ensure design considerations are enforced to limit the risks. Since this heatwave, the UK has recorded ever increasing temperatures, with 3 out of the past 5 years recording record highs within England during the summer, and the summer of 2022 topping 40°C in some areas.

7.4 The document details two route to compliance, via the Simplified method or Dynamic thermal modelling.

7.5 The simplified method is a prescriptive set percentage of glazing area vs floor area, and minimum window free opening area again as a function of floor area. The percentage criteria changes, depending on the orientation of the glazing. West deemed to be the worst-case orientation, as the sun is at its lowest and therefore the sunlight can penetrate directly into the rooms. Two locations, central Manchester and Great London are regarded to be areas of high risk (due to higher summer temperatures as a result of the urban heat island effect) and therefore higher targets are set.

7.6 The 2nd compliance route, via Dynamic thermal modelling can be used if the dwelling designer wishes to over glaze or when a unit does not pass via the simplified route. This option allows more beneficial elements to be assessed, such as mechanical ventilation units, shading profiles and glazing treatments.

7.7 For the exercise at Beaulieu Zone T it is deemed prudent to assess the proposed dwellings against Part O, to ensure design convergence with all new elements of the Building Regulations. For the initial design review all dwelling types have been assessed against the simplified methodology.

Part O Calculation Results

7.8 The core design strategy assessed within the simplified part O method is to:

- Limit Solar Gains
- Maximise purge ventilation for natural cooling

7.9 Part O is looking to limit internal solar temperature gain by restricting glazing areas, and where glazing is installed to ensure it is openable. The resident can then purge vent the conditioned spaces by opening the windows.

7.10 For this initial review we have assumed a 'traditional' opening window profiles, as the design is at an early stage. For example, a 1.2m x 1.2m window unit, only one half can be opened (note at this stage of the design process the window units have not been fully designed). All windows can be opened to 90 degrees.

7.11 Summary results are illustrated below:

Part O compliance					
House type	Glazing Area %	Glazing % most Glazed room	Min Free Area (openings)	Min Free Area bedrooms (openings)	Compliance
M201 GF	✓	✓	✓	✓	Yes
M201 1st F	✓	×	✓	✓	No
HT301	✓	✓	✓	✓	Yes
HT305	✓	✓	✓	✓	Yes
HT202	✓	×	✓	✓	No
HT412	✓	✓	×	✓	No
HT404	✓	✓	✓	✓	Yes
HT425	✓	✓	✓	✓	Yes
HT401	✓	✓	✓	✓	Yes
HT303	✓	×	✓	✓	No
HT307	✓	×	✓	✓	No
HT203 FOG	✓	×	×	✓	No
HT 1B1P	✓	✓	✓	✓	Yes
HT 4B	✓	✓	✓	✓	Yes
FT T1	✓	✓	✓	✓	Yes
FT T2	✓	✓	×	✓	No
FT T3	✓	✓	×	✓	No

7.12 Results illustrate non-compliance for several dwelling types, against both key criteria, over glazing and insufficient opening areas. This shall need to be actioned during the detailed design in order to ensure compliance.

7.13 The strategy to achieve compliance will be to:

- Reducing glazing areas where required.
- Increase window opening (replace fixed panels with opening lights)

8. Summary of Design Variations

8.1 The following details a number of minor design variations as a consequence of targeting the FHS specification requirements, both fabric and plant.

Fabric

8.2 The key fabric improvement is the increase external wall thermal performance, achieving a thermal U value performance of 0.14 w/m2K. This has been achieved with the Countryside standard wall build-up, incorporating a 125mm cavity. As a result, the dwelling plot floor print or living space within does not change. No amendments to the Zone T site plan layout are therefore required.

8.3 The installation of triple glazed window units needs to be reviewed in terms of structural loading and site installation. Such units have become lighter, but selected window units will need to be assessed.

8.4 As detailed above all glazing areas and opening profiles need to be assessed with reference to the part O, overheating assessment. For specific dwelling types glazing areas reduced and/or window opening increased.

Plant

8.5 Installation of ASHP has the following key implementation to the dwelling design:

- Plant location – external units need to be near the dwelling to limit losses, but siting needs also to minimise noise and visual impact
- All houses will need to be equipped with a hot water cylinder, consuming internal space.
- If heat delivery is via radiators, this will need to be oversized and therefore room layouts could be compromised.
- The site will need to have available electrical capacity, ASHP installs more than double the electrical capacity compared to a ‘gas’ site.

8.6 All apartments in the block will be equipped with directed electric heating and PV panels, the array will be connected to the landlord supply.

8.7 The energy (& carbon) saving benefit will be attributed to each dwelling within the block as a proportion of apartment floor area. This will be included within the Building Regulation documents, however, shall not impact the EPC rating, owing to the way EPCs are produced

8.8 The benefit of the connection configuration means that only one electrical inverter is required, converting the generated DC to AC current. This reduces the install cost and increases the system operating efficiency. The electrical demand for the communal areas is offset be the renewable generation and the landlord delivers that back to the residents via a reduction in scheme charges. Passing on savings are therefore at the will of the landlord. Part L1A of the Building Regulations defines this calculation methodology, but there is no contractual requirement for the landlord to pass on the saving to the individual residents.

8.9 An alternative approach will be to divide a proportion of the PV array to each flat and deliver the renewable energy direct to each. This will increase the capital cost, inverters and additional electrical infrastructure throughout the building. There is also the added complication of each resident owning directly a number of PV panel housed on a communal roof structure. This will, however, directly affect the EPC ratings of each dwelling

Site Layout & FHS Suitability

8.10 This exercise has been to review the design consequences of upgrading the proposed Beaulieu Zone T scheme to meet the Future Homes Standard.

8.11 The project has indicted that the site layout is suitable to deliver the Future Homes Standard. The predicted carbon saving via the selected Countryside House types is possible with minimum variation the current build specification.

8.12 It would obviously be possible to improve the layout of the site to further reduce energy demand and increase renewable generation. However, as previously noted, sustainability, however important, is only one aspect of design, and this report has aimed to determine whether other important factors can avoid the need to be sacrificed in the pursuit of the FHS requirements.

8.13 Countryside currently employs a 125mm cavity wall construction. With an upgrade in insulation material, to Kingspan K106 rigid insulation board, the target U value can be exceeded. As a result, the dwelling footprint area does not change and therefore the site layout does not need to be re-viewed for Part L1A 2025.

8.14 Houses incorporating ASHP will need to house external plant. This can be incorporated within the dwelling types and site layout. Future alternations to dwelling types design may wish to review install locations in detail to find the 'best location' to limit visual & noise impact and maximise amenity space (house plant to the side of dwellings).

8.15 Several dwelling types fail the simplified overheating assessment (for Part O). A review of results indicate that a set of minor amendment will result in full compliance. Either glazing areas within the 'most glazed' room needs to be reduced and/or glazing openable areas to be increased. Glazing openings can be increase by the installation of double opening window sets. At this stage of the design process full glazing specification has not been clarified and the completed assessment has been completed conservatively. It is recommended that the simplified compliance method of Part O be used to influence the design as it is progressed. Alternatively, a CIBSE TM59 assessment could be completed to demonstrate compliance, however, this would come at significant additional analysis cost.

8.16 The block of flats is to utilise a PV array alongside a hot water heat pump to deliver the energy savings. Current design is to install a traditional pitched tiled roof, in keeping with the neighbouring houses. The E/W orientation of the roof is not the best orientation, however, by utilising the DHW ASHP system, the required array size is relatively small, even with the less than idea orientation.

8.17 The roof design also influenced the heating and renewable strategy. The flats could have been equipped with standard ASHP, but the external apparatus would require housing within the architectural intent. Currently the only feasible location would be at ground level within a 'plant room', which is not optimal for ASHP installations.

8.18 Changing the roof design, from a pitched to a flat roof opens the options for plant selection. If PV is still selected orientation is now not an issue, it can be housed directly south. If ASHP is the preferred solution the plant can be housed on the roof. Parapet walls can then be designed to shield the visual impact of the renewable technology from the ground. It is important to understand however that flat roofs are less desirable from a lifetime sustainability perspective, as they require more frequent upkeep and replacement than pitched roofs.

8.19 For the maisonettes, it is expected that the same approach to the houses can be used, with two external units in place of one.

9. CO_2 Emissions Reduction

9.1 As stated, the goal of the Future Homes Standard is to reduce new build dwelling emissions for future building stock to be Zero Carbon by 2050. Calculated result for Beaulieu Zone T. As part of this, the FHS targets a reduction of 75% over the 2013 Part L baseline

9.2 Predicted Site Wide Emissions

- Part L1A 2013 Baseline Emissions

- Houses/maisonettes -	17.49 (kg/m^2)/year	107,076 kg/year
- Apartment block -	19.68 (kg/m^2)/year	10,852 kg/year
- Total Site -	17.67 (kg/m^2)/year	117,928 kg/year

- Part L1A 2025 (FHS) Emissions)

- Houses -	4.34 (kg/m^2)/year	26,570 kg/year
- Apartment block -	4.39 (kg/m^2)/year	2,425 kg/year
- Total Site -	4.35 (kg/m^2)/year	28,995 kg/year
-		

- Site-wide percentage CO_2 reduction – 75.06%

9.3 The results illustrate that the proposed specification uplift, fabric and plant, across the proposed scheme result is a 75% carbon saving. Meeting the desired percentage uplift documented within the Future Homes Standard consultation response Jan 2021.

10. CO_2 Emissions Beyond the FHS

10.1 All the emissions stated are for regulated energy consumption, as defined within Part L1a of the building regulations. This does not account for un-regulated emissions associated with plug-in appliances, car charging or cooking.

10.2 To achieve Zero Carbon the total emissions are dependent on the resident's activity. To advance the defined FHS strategy PV arrays can be installed to deliver a Zero Carbon dwelling.

10.3 The energy & carbon savings from PV (within SAP10) is:

- 1kWp, South-East orientated @ 30° pitch
- 1,230 kWh/year generated & 111 kg/CO_2/year offset

10.4 Current site wide residual CO2 emissions once FHS has been achieve is 29 tonnes of CO_2. To offset 100% of the regulated emissions the site wide PV requirement is 261 kWp

Unregulated

10.5 BREDEM 12 is a calculation methodology that estimates the unregulated energy usage of dwelling, developed by the BRE and it is an available tool to estimate elements of energy consumption. Using this tool, the following estimate has been calculated to assess total site wide energy consumption and associated carbon dioxide emissions for the unregulated consumption for plugin appliances and cooking.

10.6 Site wide energy consumption - 27.2 tonnes of CO_2

10.7 To achieve zero un-regulated emissions the site wide PV requirement is – 245 kWp

10.8 EV charging is also an expected end-use within the development, which should not be ignored

10.9 Taking an assumed mileage and vehicle average operating efficiency of the following:

- Annual mileage 10,000 miles
- Operating efficiency 0.25 kWh/mile
- The annual car charging demand 2000kWh/year per dwelling
- Site wide (assuming 1off EV per dwelling) 140,000kWh/year - 19.04 tonnes CO_2 per year

- PV to offset emissions - 172 kWp

Total Offset to achieve Net-Zero Carbon

10.10 Total site wide PV array size to deliver a Zero Carbon site including taking regulated emissions to zero, and offsetting the demand from unregulated emission & electric vehicle demand is:

- Total PV array size - 693 kWp

10.11 This translates to approximately 10.5 kWp per dwelling, which would not be able to be accommodated on the dwelling roofs. A solar development of this scale would instead require both rooftop mounted systems, and a supplementary ground mounted array near to the site.

10.12 Alternatively, as much PV as viable could be accommodated into the site design, and the remainder offset via the purchase of renewable electricity. As the site does not utilise any fossil fuels, this, or other offsetting mechanisms would be one method of achieving zero emissions at the site

11. Conclusions/Next Steps

11.1 This study has concluded that the implementation of Part L (2025) could be achieved with existing technology, in a form that would not impact on the layout of the house types or masterplan.

11.2 Thermal performance of the fabric was improved, most notability walls and windows. The required thermal resistance for the walls can be achieved within the current Countryside 125mm cavity width, via the selection of a high performance phenolic rigid board insulation. As a result, the dwelling footprint or internal space does not need to alter. All dwellings will need to be equipped with triple glazed window units to reach the prescribed thermal performance.

11.3 In line with the core structure of the Building Regulations, to reduce energy consumption Air Source Heat pumps have been specified for all viable property types. This technology, taking one unit of electricity to deliver 3 units of heat, fits the energy saving requirement of the advancing regulations.

11.4 For the apartments the suitability is more problematic due to the issues around external apparatus location, hence the proposal is to install direct electric heating, supported by internal hot water heat pumps and photovoltaic arrays.

11.5 All upgrade measures, fabric and plant have been costed by Countryside Zest as an over cost to the standard Countryside product. Over cost current increases are:

- Houses £12,810 per unit which is 11% of total build cost *
- Apartments £5,991 per unit which is 9% of total build cost*

*The above costs are based on average size unit and exclude allowance for preliminaries & overheads and contingency costs.

11.6 As mentioned, the core conclusion is that the proposed performance uplift can be housed within current Countryside Zest dwelling footprints, resulting in no fundamental changes to the proposed layout. Additionally, the masterplan layout does not need to change in respect of orientation or indeed to “fit-in” extra technology. This is a benefit in that compliance with the FHS will not result in any significant changes to current operations and will aid implementation. Obviously the extent that this data can be applied to alternative housebuilders shall depend on their own existing specifications.

11.7 In terms of further areas of study, we would recommend the following:

- Evaluation/viability of achieving PassivHaus/UKGBC emerging targets. These have not yet been finalised, however, are expected to involve the reduction of heating demand to <15 (kWh/m²)/year. By contrast, the current Part L1A 2013 baseline is circa 40 kWh/m²/year (dependent on dwelling type), and the above proposed FHS specification is approximately 25kWh/m². If this target of 15kWh/m² could be achieved, it would further reduce demand, and significantly reduce the amount of renewable generation required to achieve net zero.

- Costing data is currently estimated based on the specific Countryside Zest house type and construction proposals. A wider view of more generalised construction types would provide a wider dataset, however, would not be able to be applied in a live site situation, as in this case, and the scope of this report

- Availability of new technologies on a “mass” scale. i.e. the Air Source Heat pumps. It is yet untested as to whether the supply chain would cope with the increased demand

- Sales Value Impact, will the FHS result in an increase in sales values?.

- Availability of qualified labour to install new technologies. It is yet untested whether the labour supply could cope with the increased demands of changing their traditional techniques and/or how this would impact on the sully and demand of skilled labour. This is mitigated somewhat by the selection of monobloc heat pumps to de-skill the installation. However, a skills shortage is still expected that should be evaluated further to as far as practical de-risk impacts to the build programme.

Appendix A: Renewable Energy Options

Background information on renewable energy systems

The following sections contain a summary of each alternative possibly-applicable technology, a comparison of the advantages and disadvantages of technologies relevant to this development, and the reasons it was not proposed.

A1.1 Solar thermal panels

Solar thermal panels can provide 400 kWh of *useable* hot water per year for every square metre of panel. Under normal circumstances this energy will replace gas, and because the emissions factor for gas is only 0.216 $kgCO_2/kWh$ the reduction in carbon dioxide emissions, allowing for the boiler efficiency, is modest at approximately 86 $kgCO_2/m^2$. For most of the dwellings assessed the proposal is to provide water heating via an ASHP. The two Solar thermal & ASHP are compatible.

The limitation with solar thermal is that energy demand, demand for daily consumption of hot water is capped. Adding extra panel to the roof above this cap will not improve the dwelling carbon saving.

Installation & maintenance is more costly than PV. Unit are pumped into the hot water system, though the roof structure and require annual maintenance.

Roof area is limited, and the installation of a PV array is more cost effective and beneficial to the resident.

A1.2 Wind turbines

Micro wind turbines produce electricity and can be grid-connected in the same way as photovoltaic panels. There are two main concerns with wind turbines – aesthetic considerations, and the limited output in an urban environment. It was considered that while in this location the visual impact of a modest-sized unit could be unacceptable, the presence of the tall buildings, including the apartment block to the north-east of the site, on a dense site would create wholly unsatisfactory wind conditions, so this technology was not considered further.

A1.3 Bio-fuels

In the UK at present the commercial bio-fuels that can be used in the context of emissions reduction in the built environment are confined to either wood pellets or wood chips (biomass) or in special cases glycerine for CHP. Bio-diesel is not an acceptable fuel as it is easily replaced by petro-diesel so does not qualify under the applicable regulations. A small, automated pellet boiler could installed, but to be viable the site would need to include a heat network & energy centre. The layout of the site, mostly houses will make a heat network inefficient due to losses.

Selection of a low carbon fuel source will not address the new 'Future Homes' directive to lower energy demand, so the scheme will need an extensive 2nd renewable strategy to deliver the required savings.

Selection of a Bio-fuel will also increase the emissions of NO_x and have resulted in significant emissions of particulates which were judged to be unacceptable in this location

A1.4 Combined Heat & Power (CHP)

As with bio-fuel installing a CHP unit will require a heat network to all dwelling. The layout of the site, mostly houses will make a heat network inefficient due to losses.

CHP engines historically have relied on the locally generated of electricity offsetting the carbon emissions for the national grid. As the nation grid has been de-carbonised over the last few year the offset has been reduced and hence a scheme with a CHP plant will now not pass building regulations. Due to these facts CHP has been omitted.

A1.5 Heat pumps

Heat pumps collect low temperature heat from renewable sources and “concentrate” it to a usable temperature. Fossil fuel based (grid) electricity is generally required to operate the pumps and the renewable component of the output is therefore by convention taken as the difference between the output energy and the input energy. A typical heat pump will deliver 3 kWh of useful energy for every 1 kWh of input energy. A heat pump operating in this way would therefore be deemed to have delivered 2 kWh of renewable energy.

As stated within the body of the report Heat Pumps matches the core strategy of the future homes standard. Reducing the energy demand for new homes and now with the de-carbonisation of the nation grid also delivering carbon savings. Hence this technology has been selected for the majority of the Beaulieu scheme.

A1.6 Hydrogen Fuel

Hydrogen fuel is a part or full replacement for natural gas to be consumed within a combustion boiler. Currently there is not nation available of 100% hydrogen for combustion. If a boiler runs on 100% Hydrogen fuel, result space & water heating will be Carbon free.

Most modern Gas Condensing boilers can run on a 20% Hydrogen / 80% natural gas mix with out any modifications. Such a configuration will result in a 6% carbon saving.

The requirement to reduce Energy demand as defined with the FHS will not be addressed by a switch to 100% Hydrogen fuel. Renewables will need to be included added to the dwellings to deliver the required energy savings

Lack of 100% hydrogen for combustion available and the fuel not able to directly deliver an energy saving makes this option unfeasible for the near future.

Appendix B: Accommodation Schedule

	Private											
				Houses								
	M-201.2		HT-203-FOG	HT-202	HT-309	HT-305	HT-307	HT-401 (NM)	HT-404	HT-412	HT-405.2	HT-500.1
occupancy	2b3p	2b3p	2b3p	2b3p	3b5p	3b5p	3b5p	4b8p	4b6p	4b6p	4b5p	5b8p
sqm	61.9	72.1	72.6	72.0	95.4	101.8	117.9	131.9	117.6	148.6	130.8	181.7
sqft	666	776	781.5	775.0	1026.9	1095.8	1269.1	1419.8	1265.8	1599.5	1407.9	1955.8
quantity	4	4	1	5	5	4	1	2	6	10	3	3
total sqft	2665	3104	781	3875	5134	4383	1269	2840	7595	15995	4224	5867
mix	9			5	10			21				3
	19%			10%	21%			44%				6%
flats/houses	9			39								
	19%			81%								
total	48											
	73%											

	Shared ownership				Affordable Rent						
					Flats	Maisonette		Houses			
	F-1B2P-T1	F-1B2P-T2	F-2B4P-attic	F-2B4P	F-1B2P-wc	M-201.2		H-2B4P-AFF	H-3B5P-AFF	H-4B6P-AFF	
occupancy	1b2p	1b2p	2b4p	2b4p	1b2p	2b4p	2b4p	2b4p	3b5p	4b6p	
sqm	50.4	55.8	72.4	79.1	79	72.2	79.3	80.8	93.0	115.2	
sqft	543	601	779	851	850	777	854	870	1001	1240	TOTAL
quantity	3	3	1	1	1	2	2	1	2	2	66
total sqft	1628	1802	779	851	850	1554	1707	870	2002	2480	72257
mix	6		1	1	1	2	2	1	2	2	
	75%		13%	13%	10%	20%	20%	10%	20%	20%	
flats/houses	8				1	4		5			
	100%				10%	40%		50%			
total	8				10						
	12%				15%						