Gresham Estate

Decarbonisation Plan

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Gresham Estate
Decarbonisation plan

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APPENDICES

1.0 EXECUTIVE SUMMARY

1.1 Thirteen Group commissioned Savills to undertake an Energy Study as part of a wider project. This also included North Star Housing Group as a stakeholder in the estate. This executive summary provides a brief overview of the outcomes. The study outlines high level options for improving the energy performance of the housing stock on the estate.

1.2 The first stage of the exercise included a survey of the stock. This covered a total of 410 units and included:

- A stock condition survey to evaluate that remaining life of existing components.
- An RdSAP survey to identify current energy performance.
- A more detailed energy survey to support the identification of challenges in retrofit.

1.3 The second stage was an energy study. This used the data collected during the survey activity. The methodology adopted has been to model a series of building improvements (designed to reduce carbon emissions) against a selected set of property archetypes, in order to determine the costs and the resultant reductions in both energy consumption and carbon emissions. These factors have then been scaled up to the whole stock (672 units). More detailed studies at a property level will be required as there are likely to be considerable variations from the general assumptions.

1.4 The extent of potential solutions and measures is wide ranging, but follows the principle that all heating currently utilising fossil fuels will eventually need to be replaced with electricity. Net zero carbon could technically be achieved merely by swapping fossil fuel heating with electric or other non-carbon forms of heating and allowing the decarbonisation of the national grid to be completed over time – therefore ensuring zero emissions. However, such an approach would require huge infrastructure investment in the grid to meet the increased demand and is also likely to push up tenant fuel bills. It appears unlikely that a social landlord would want to follow such an approach.

1.5 Instead, most social landlords seek to balance the effect from moving away from gas heating (the majority of the stock is heated by individual gas boilers) on fuel bills, which would require reducing the energy demand prior to a heating switch. The 'sweet spot' would be one that increases dwelling performance sufficiently to meet environmental objectives and manages energy costs; this 'sweet spot' will change with the rebalancing of tariffs between gas and electricity.

1.6 We have targeted a scenario with the following outcomes: EER of C, a space heat demand (SAP box 99) of 90 kwh/m2 or less, residual emissions of c.0.5tCO2pa (c.80% from the base position) and a reduction in running cost. It is important to note that these targets have been selected for the purposes of creating an overall scenario, but that they are not necessarily what will be adopted by either of the landlords.

1.7 The improvement options evaluation is applied in three stages:

- The first stage in the main scenario emerging from the study is to reduce energy demand in dwellings, which involves upgrading insulation – including external walls, roofs, and floors (where practicable). Introducing high levels of insulation creates a potential risk of damp and mould and therefore it is imperative that ventilation is also introduced in parallel.

- The second stage is to install alternative heating systems. We have adopted heat pumps as the most likely technology, with a majority of air-source systems owing to their cost and relative ease of install compared to ground-source. Other solutions may well emerge; pilot schemes are looking at other fuels such as low carbon heat networks and hydrogen – but at this stage electric heat pumps are thought to be the most likely solution. The main scenario assumes that existing gas boilers will be retained until they are due for life cycle replacement in the later part of the plan.

- The third stage is renewable energy technologies. For the purposes of this exercise we have assumed solar PV where needed to achieve the target objectives. This is primarily where properties would not achieve a C rating without it. Clearly the organisations may decide that a wider adoption of such technologies is appropriate.

1.8 Our calculations show that these selected measures will reduce the total CO2 emissions from the stock by c.81% from a current base position of approximately 17,133 tonnes to 3,313 tonnes of CO2 per year, with average carbon emissions per dwelling reducing to less than 0.5 tonnes per year. This residual CO2 emission is due to the fact that the national grid has not yet been de-carbonised. Similarly, energy consumed by a typical household reduces by 74%. As this energy is now all electricity, which has a higher tariff than gas, energy bills per tenant reduce on average by a significantly smaller proportion (34%).

1.9 The estimated budget to achieve this scenario is in the range of £24.3m excluding VAT depending on the technologies adopted. This equates to an average cost of approximately c.£36k per property.

1.10 The scenario assumes flexibility on when the work would be done, to enable alignment with existing component lifecycles. Taking into consideration the £4.47m of related works already contained in the current 30 year stock condition cost forecast, the budget requirement reduces to approximately £19.86m – equating to c.£30k per dwelling excluding VAT. If the organisations were to set a target for the delivery of this work that did not align with existing lifecycles it would reduce this offset and therefore increase the net cost per property.

1.11 This figure does not allow for any grant funding, but the scenario does target outcomes that are compatible with current Social Housing Deacrbonisation Fund (SHDF) requirements.

1.12 It should be noted that the costs of measures used are what we assume would become achievable in a mature market with sizeable, well-prepared programmes. Current prices are volatile owing to: current price inflation, limited capacity and experience, and projects

(particularly those utilising grant funding) having challenging timeframes. Any grant, in the short term, may simply offset these higher prices.

1.13 The organisations will also need to consider the impact of any target – thought most likely to be EPC C – to upgrade the poorest performing stock in the short to medium term. This may impact the timing of expenditure.

1.14 Unsurprisingly, the choices of work measures have a significant impact on outcomes and costs. We have produced an overall scenario, but this may not reflect the approach that the organisations choose to/are able to implement at property level. These require further detailed review by the landlords in the context of its own objectives, in order to develop the most appropriate strategy and associated programme of work.

1.15 Prior to programming investment, each landlord should evaluate the wider asset management considerations, especially in respect of the financial performance of the housing stock. This is not to say disposals or redevelopment are inevitable, as factors other than the financial performance of an asset must be considered in decision making on the future of stock and the costs of retention should be understood before work is planned as well.

2.0 INTRODUCTION AND APPROACH

2.1 In accordance with our proposal we have undertaken a desktop Zero Carbon study of the 672 tenanted units on the Gresham Estate. This included:

- An overview of current Government policy
- An assessment of the current energy efficiency of a set of building archetypes
- An assessment of the improved energy efficiency of the selected archetypes on the basis of a series of energy efficiency measures
- Costing the improvement works and scaling up the total costs against the whole stock
- Development of a potential zero carbon energy strategy setting out high level principles of implementing the energy efficiency measures

2.2 The data used in the preparation of this study is the 411 RdSAP surveys undertaken by Savills as part of the exercise. This level of energy data represents a reasonable proportion of the whole stock, and our modelling to the whole portfolio has been built up from this dataset.

2.3 From the data provided, Savills has analysed the housing stock and identified an agreed series of archetypes based on the types of housing that are considered most representative of the stock in terms of:

- Age
- Built form
    - House – Terrace, Semi-detached
    - Flat – Low/High Rise; Ground/Mid/Top Floor
- Fuel Source
    - Gas
    - Electric

2.4 A sample property from each of these archetypes has been modelled to assess its existing position in respect of energy efficiency, fuel consumption, and carbon emissions – thus setting the baseline position. We have then applied a range of measures to each dwelling, designed to reduce carbon emissions and fuel consumption. The impact of these measures is tabulated and compared against the base position. This results in a revised energy efficiency standard together with carbon emissions per year for each archetype, which is then scaled up to the full stock.

2.5 The assessment of each archetype has involved the following:

- **Existing Dwelling** – Current RdSAP data has enabled each property type to be assessed and the current energy performance identified. Savills has taken the RdSAP survey data and transferred it into full SAP (version 10) in order to ascertain a more accurate calculation. Full SAP uses updated emissions factors for electricity and due to various other aspects, will often show a difference of up to +/- 5 SAP points compared to RdSAP.
- **Recommended Improvements** – We have applied a series of improvements, as discussed in more detail below, and developed a variety of options for your consideration.

2.6 These permutations have been applied across the various archetypes which, in respect of flats, involves modelling ground floor, mid floor, and top floor dwellings.

2.7 This has culminated in the assessment of 14 different dwelling types involving over 190 different improvement package options across these archetypes.

2.8 A summary of the outcomes from the modelling is shown at appendix three.

2.9 The improvement measures considered during each assessment include various packages of work including the following components:

2.9.1 **Flooring** – installation of thermal insulation to all ground floors, whether they are suspended timber construction or concrete, to a U Value of 0.25W/m2k. Options involve

insulation potentially being sprayed to the underside of a suspended timber floor via the floor void or alternatively the floorboards lifted and insulation applied between the joists and floorboards. For suspended concrete floors, sprayed insulation is a possibility but for solid floors installation of insulation effectively involves hacking up the floor and relaying with a new insulated floor. In this regard we have discounted the possibility of installing the insulation on top of existing concrete floors due to the adjustment required to all door openings and staircases as well as replacement of kitchens, for example. Whilst thin insulation products are becoming available, they are currently expensive. Floor insulation is particularly challenging to install. We have therefore modelled options with and without floor insulation.

2.9.2 **External Wall Insulation or Internal Wall Insulation** – The use of EWI or IWI on either solid walls or existing cavity walls that are of sub-standard construction with the aim of achieving a U value of 0.3 where practicable (IWI achieves poorer U values owing to our assumption that a vapour permeable product would be required). In determining whether external wall insulation is required, we have adopted standards based upon building regulations prevailing at the time of construction. Properties with successfully filled cavities will most likely be of a suitable insulation standard that external wall insulation would not typically be required, but we have modelled both with and without additional insulation measures in some cases. We have also considered the introduction of insulation to internal walls that border unheated areas such as circulation corridors in flats and for the provision of cavity wall insulation to party walls where applicable.

2.9.3 **Windows** – We have assumed the replacement of windows with new PVCu high efficiency units (double or triple glazed) with a U value of 1.2 (a good specification double glazed unit, triple could achieve 1.0). We recognise that PVCu may not be applicable in all locations or with specific dwelling types but we have used this as a standard for cost purposes.

2.9.4 **New Insulated Doors** – We have assumed the introduction of a new insulated door both for houses and flats (assuming flats open into unheated corridors).

2.9.5 **Ventilation Systems** – We have allowed for the installation of ventilation systems which will be essential to prevent build-up of condensation or mould in a well-insulated but sealed building. We have made assumptions about the type of ventilation system, but a full assessment will be required. Too many previous EWI projects have had unintended consequences of condensation and mould and this must be avoided.

2.9.6 **Heat Pumps** – We have allowed for the substitution of gas heating with air source heat pumps or ground source heat pumps together with the provision of new programmers and thermostats as well as a new radiator system adopting larger, low temperature units. We have not carried out any technical assessment in respect of the merits of either of these systems nor their suitability for use in the blocks and dwellings themselves. Performance is based on SAP defaults, so actual design may improve this subject to specification.

Similarly, we have allowed for the introduction of new electric immersion hot water heating systems to complement the air source heat pumps. Additional solar thermal systems could be considered, these are modelled but are not selected here at this stage.

One of the challenges of switching from gas to electric heating is the current price tariff differential between both fuel types, with electric being over 3 times the cost per kWh. Although a heat pump is more efficient than a gas boiler and hence will result in a reduction of energy consumed in a dwelling, the energy reduction is unlikely to be sufficient to offset the extra tariff without additional insulation measures being installed. Switching directly from gas to a heat pump will therefore result in an initial increase in a tenant's annual fuel cost. This analysis is based on SAP assumptions which use out of date fuel pricing. We can therefore expect this variance to have increased significantly, based on recent price rises. As the efficiency and performance of heat pumps improves with technology, this disparity will also reduce. It is also worthy of note that the Heat and Buildings Strategy targets a reduction in the price tariff differential.

2.9.7 **Renewables –** PV could be adopted to assist in reducing tenants fuel bills where electric heat pumps are installed and we have modelled this. Whilst it is not necessarily an essential measure in the overall reduction of carbon emissions to the stock, it is needed in some cases to meet the wider target objectives (for example, EPC C) adopted for the scenario. It may be a suitable solution in the event that some fabric measures are difficult to implement for aesthetic, architectural or other technical reasons and therefore the energy demand in the dwelling cannot be sufficiently reduced to offset the higher electric tariff.

There may be other reasons to consider renewables, storage and smart management technologies. Again, these are not considered at this stage, but we do comment on this as part of strategy development.

3.0 CURRENT POLICY – GOVERNMENT AND LOCAL

3.1 The UK is committed by a 2019 amendment to the Climate Change Act to achieving a 'Net Zero Carbon' by 2050. One of the implications of this is that by 2050, energy use in homes must not contribute to Greenhouse Gas Emissions; the use of fossil fuel for space and water heating, and for cooking will not be possible. In parallel, the Fuel Poverty Regulations establish a target to achieve EPC C for as many households in fuel poverty by 2030 as is reasonably practicable. Many RPs have subsequently adopted 2030 targets to achieve EPC C.

3.2 Government policy has been evolving, but the Heat and Building Strategy was published on 18th October 2021 which set out the general direction of travel. This strategy sets out the government's plan to significantly cut carbon emissions from the UK's 30 million homes. Whilst the Strategy is too extensive to summarise in detail here, we can highlight some useful principles quoted directly from it below:

3.3.1 **The journey to Net Zero buildings starts with better energy performance**. Improving energy efficiency by adopting a fabric-first approach is key in ensuring the transition to low-carbon heating is cost-effective and resilient. 'Fabric-first' means focusing on installing measures that upgrade the building fabric (e.g. walls/lofts) itself before making changes to the heating system.

3.3.2 **Ultimately, Net Zero will mean gradually, but completely, moving away from burning fossil fuels for heating**. Which is why we are setting the ambition of phasing out the installation of new natural gas boilers from 2035. The future is likely to see a mix of low-carbon technologies used for heating: electrification of heat for buildings using hydronic (air-to-water or ground-to-water) heat pumps, heat networks and potentially switching the natural gas in the grid to low-carbon hydrogen.

3.3.3 **We need to act now to develop the market and bring down costs for energy efficient low-carbon heat**. Heat pumps and Heat Networks are proven scalable options

for decarbonising heat and will play substantial roles in any Net Zero scenario, so we need to build the market for them now.

3.3.4 **We will take major strategic decisions on the role of Hydrogen for heat by 2026**. In particular, we will explore the potential to use hydrogen for heating buildings in the next few years to inform a strategic decision on the role of hydrogen in decarbonising heat.

3.3 Building on this, the Government have also proposed a £3.8 billion Social Housing Decarbonisation Fund (SHDF) in order to aid in the improvement in the energy performance of socially rented homes over a 10 year period in a series of waves. A small demonstrator project has preceded Wave 1 of the SHDF which saw £179 million being offered to projects with a target completion date of March 2023.

3.4 Wave 2 of the SHDF has been open for bids with £800 million of funding available over a longer period of two years, up to 2025. The policy objective means that funding should not only support the installation of energy performance measures in social homes, but also help to develop capacity and capability in the retrofit sector. The funding is focused primarily on properties below EPC C and on fabric measures and low carbon heating. Non-cavity wall properties attract the most funding and low carbon heating is funded for off gas grid properties only. Funding is a maximum of 50/50 with caps applied depending on current EPC rating.

4.0 RESULTS OF MODELLING

4.1 Individual archetype assessments and improvement options evaluations have been undertaken for each selected archetype. This resulted in a series of individual improvement packages that could be adopted. Packages were then selected for each archetype to produce a main scenario. It is this scenario that is discussed in this report.

4.2 The chosen packages produce a scenario aligned to achieving the target objectives:

a. EPC C (once heat is decarbonised)
b. Space Heat Demand of 90kwh/m2 or less (SAP Box 99)
c. Fuel bill reduction
d. Carbon emissions less than c.500kg per property per annum

4.3 The modelling has currently been done at a high level – based on archetypes as detailed in section 2 – and it is important to note that the selected packages do not consider deliverability at property level. The reality is that the packages will not be suitable for all properties and alternatives will need to be considered in due course.

4.4 The gross cost of the packages applied to each dwelling vary from £18,359 to up to £55,466 per dwelling. The total cost – when the selected packages are applied to all modelled dwellings with RdSAP data and then extrapolated to dwellings without RdSAP – is estimated to be in the region of £19.5m. These costs exclude VAT, management costs and fees/on costs.

4.5 We have added an indicative allowance for management costs and contingency. This increases the gross cost to c.£24.33m. No grant has been assumed at this stage. The average cost is approximately £36,202 per dwelling.

4.6 It should be noted that the costs of the measures used are what we assume would become achievable in a mature market with sizeable, well-prepared programmes. Current prices are

volatile owing to: current price inflation, limited capacity and experience, and projects (particularly those utilising grant funding) having challenging timeframes. Any grant, in the short term, may simply offset these higher prices.

4.7 Some of the work included in the selected packages are likely to be already included in existing investment forecasts. For example, each landlord's investment plans are likely to already include for window and door replacement. The total for this – calculated from the stock condition data collected at the same time as the energy survey – is £4.47m.

4.8 The below table details the variance that has been calculated in energy consumption, fuel bills (noting our previous comments regarding the out of date nature of the tariffs used in SAP) and carbon emissions across the whole stock in the scenario described above.

Total Stock - Consumption and Emissions

		Current	Post Prog	Variance	Var %
Energy Consumption	kWh/yr	**8,566,525**	**2,206,820**	**-6,359,705**	**-74%**
Energy Cost	£/yr	**£537,465**	**£354,416**	**-£183,049**	**-34%**
CO2 Emissions	kg CO2/yr	**1,713,337**	**331,390**	**-1,381,947**	**-81%**

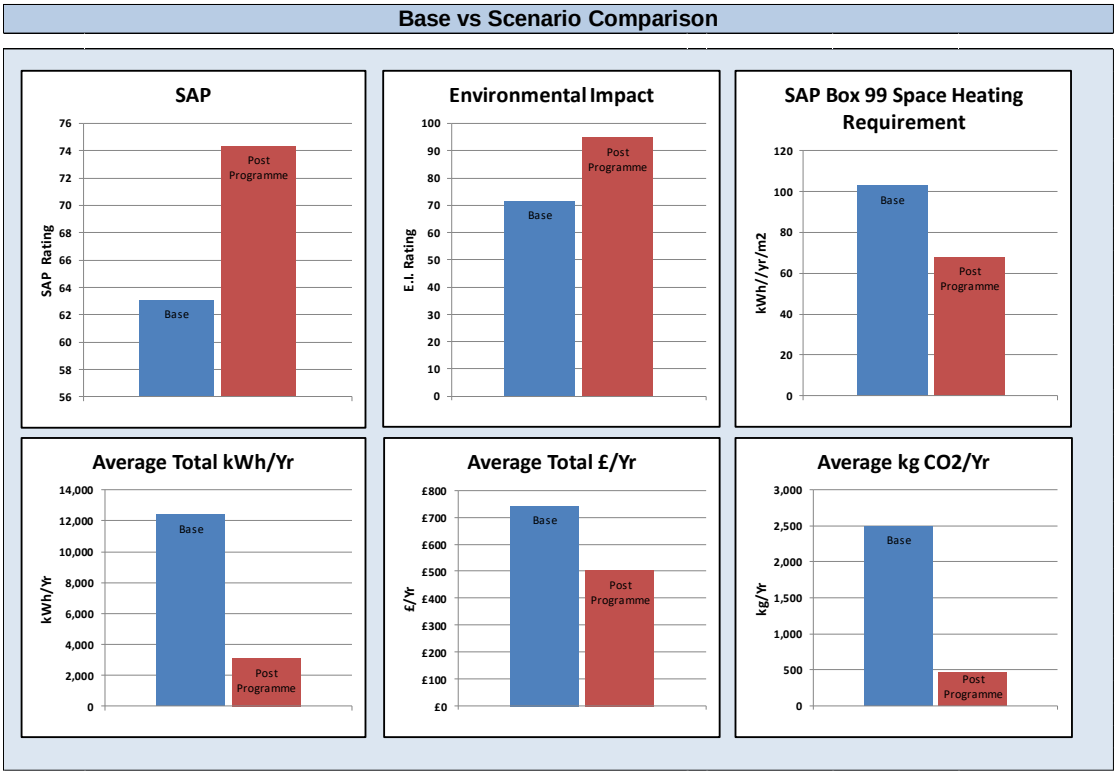
4.9 The results represent a 34% decrease in the average cost of energy per year for tenants across the stock, however the reduction in carbon emissions is much greater than this. This is due to electricity currently being much more expensive than gas to use. It must be noted that the energy costs within SAP do not reflect the current levels of energy pricing, but these figures will give an indication of the relative differences associated with the different improvement packages.

4.10 The net costs (once all the existing SCS allowances have been removed as above) of all of the detailed packages has also been calculated. This produces a net cost per property at £29,547 excluding VAT. This is summarised below:

Total Stock - Costs		
Package Costs	£	£19,462,454
Gross Cost inc A&A & Contingency	£	£24,328,067
Total Grant	£	£0
Net Total Package Costs	£	£24,328,067
Total Existing Investment	£	£4,472,267
Net Total Less Existing Investment	£	£19,855,801

4.11 It also has to be noted that if any targets or works are shifted to an earlier date, then the SCS costs detailed above will be significantly lower as the proposed energy works will need to be carried out before the works are programmed in to the current plan – making the net costs considerably higher.

4.12 The results are further detailed in the following graphs:



4.13 Average SAP ratings resulting from the packages in the main scenario are 74, with all properties achieving EPC C. The environmental impact across the stock also improves significantly following these proposed measures.

4.14 Over the next 30 years it is expected that the performance of low/zero carbon technology will improve and costs will reduce as they become more prevalent and mainstream. We have made no assumptions around this.

4.15 More detailed outcomes relating to each archetype are included at appendix two. It is important to note that we have not covered every archetype but rather considered the most common and extrapolated results. Further archetypes will need to be considered in due course. A summary each archetype is below:

- Archetype A. Pre 1950 end of terrace house with solid walls. Mains gas heating. Note that this property has existing external wall insulation, but we have modelled a variant without the EWI.
- Archetype B (EWI). Pre 1950 mid terrace house with solid walls. Mains gas heating. Note that this property has existing external wall insulation.
- Archetype B. Pre 1950 mid terrace house with solid walls. Mains gas heating. Note that this property is a variant of B(EWI) but without external wall insulation.
- Archetype C. 1950-1976 mid terrace, system built house with existing EWI. Mains gas heating.
- Archetype D. 1976-1995 mid terrace house with cavity walls. Mains gas heating.
- Archetype E. 1991-1995 end of terrace house with timber frame. Existing ASHP.
- Archetype F. 2007-2011 semi detached house with timber frame. Existing ASHP.
- Archetype G. 1991-1995 end of terrace bungalow with timber frame. Existing ASHP.
- Archetype Hg. 1950-1976 ground floor flat, system built with existing EWI. Mains gas heating.
- Archetype Ht. 1950-1976 top floor flat, system built with existing EWI. Mains gas heating.
- Archetype It. 1976-1982 top floor flat, existing cavity wall. Mains gas heating.

- Archetype Jg. 2007-2011 ground floor flat with NIBE heat pump.
- Archetype Jm. 2007-2011 mid floor flat with NIBE heat pump.
- Archetype Jt. 2007-2011 top floor flat with NIBE heat pump.

5.0 KEY PRINCIPLES TO CONSIDER IN FORMING A NET ZERO CARBON STRATEGY

5.1 In order to achieve the ambitions detailed in this report, a robust strategy will need to be adopted. Whilst we have not assessed capacity in the landlords business plans, it is unlikely that the level of expenditure indicated in this study is affordable.

5.2 At this stage, the strategy is likely to comprise of broad principles around working towards NZC. We anticipate that this strategy will be revised from learning from early retrofit activities. We would therefore expect the strategy to develop considerably in the coming years.

5.3 Some of the stock has already benefited from some retrofit activities/low carbon heating. The extent and nature of these works will influence future strategy, but in most cases the existing measures will require replacement before 2050 anyway. A summary is below:

Existing solid wall properties. Over half of the surveyed properties of this archetype already have external wall insulation (EWI). We have assumed that the properties already benefiting from EWI will not require further insulation, but this may need to be reconsidered on the basis of existing condition and the plans for the remaining properties. In many places the EWI and render finishes are damaged or deteriorating and are stained by water run-off and green mould growth. The details of the EWI appear poor and at risk of leaking where the roofs of bay windows abut insulated walls and where downpipes and stone lintols over first floor windows interrupt the EWI and the capping. There is consistently little or no eaves overhang to protect the top of the EWI from weather, only metal top cappings, with gaps between the cappings and the eaves. At the base of the walls, the EWI finish stops at DPC level, with a black finish beneath, to pavement level.

The detailing of the EWI may increase the risk of condensation, damp and mould (CDM) in certain areas. At low level on the ground floors, there are likely thermal bridges because the EWI does not extend below the DPC. At high level in upstairs rooms, there are likely thermal

bridges from the EWI not connecting or overlapping with roof insulation. This highlights the need for appropriate detailing at corners, junctions, edges and protrusions in any future EWI schemes (including replacement of the existing). It also highlights the need for effective ventilation.

Whilst we have assumed that the units without EWI will have this installed as part of the future strategy, the landlords will need to consider the optimum strategy here. In our view, the units with existing EWI often look visually inferior to those without EWI. EWI is a higher risk measure for the reasons outlined above and the detailing of any EWI scheme would likely vary considerably from the existing properties. In addition, some of the terraces are broken up by owner occupiers.

Older system-built stock. The 1960/70s low-rise system built properties also have EWI installed (e.g. Petch Close). The EWI to these units appears to be of much better quality than the solid wall stock. These properties exhibited black water staining above most windows and above the bottom trays (at DPC level). Our inspections were limited by being visual only, but suggest this was on the surface rather than water being trapped behind the EWI or behind the render. More intrusive inspections would confirm. Whilst the existing EWI produces sufficient performance to meet the requirements when combined with other measures, these system built units are likely to have wider asset management considerations.

Stock with existing heat pumps. Many of the newer properties are already heated by heat pumps of varying ages. 41 are the NIBE systems at Southwell/Salisbury Court. It is worthy of note that we didn't have detailed information on the current models and system design, so have often used defaults. This may mean that the base position underestimates current performance. It is assumed that all of the existing heat pumps and associated heating and hot water distribution and controls are replaced.

Renewables. 11 units benefit from existing solar PV installations. As this is relatively small proportion of the stock overall we have not considered this further in our analysis.

5.4 Based on the results of this study, we believe that the key principles of the emerging strategy are as follows:

- Set targets that focus on carbon reduction, but that balance tenant running cost and affordable warmth.

- Target worst first (initially properties below EPC C) where practicable and maximise use of available grant funding, but avoiding the premature replacement of existing components.

- Align to existing investment plans to achieve value for money and minimise tenant disruption (i.e. deal with improvements when replacing existing components where practicable).

- Compare the cost of proposed energy efficiency investment against the impact in terms of carbon reduction and affordable warmth.

- Develop a strategy for the involvement of leaseholders. This is particularly important for EWI and block schemes.

- Evaluate financial and social asset performance and consider alternative strategies for stock with limited life. This may be particularly important on the older and system built stock where an evaluation of future life based on the contribution to organisational aims and objectives is recommended.

- Fabric first – focus on fabric measures initially where practicable, and consider alternatives (such as solar PV) to offset where they are not.

- Low carbon heating – acknowledge the technological, satisfaction, and running cost challenges with the removal of gas boilers mean that they are likely to remain in the short to medium term, but ensure there is development in the of understanding of the

options to advance and develop the market for alternatives. Replace existing systems when they become due.

- Renewables – develop the strategy on renewables considering the potential for the technology to support affordability and potential to assist in balancing supply and demand in the longer term.

- Pilot different options in the early part of the plan in order to understand actual performance, satisfaction, deliverability, and cost.

- Make sure that any new homes meet the standard now.

5.5 More detail on the approach to reduction of energy demand through fabric measures and the subsequent decarbonisation of heat is set out below:

5.4.1 Stage 1: Reduction of Energy Demand – Fabric Improvements – Immediate start

A focus on initially improving the building fabric (walls, windows, doors, floors (timber) roofs etc.) to reduce heat loss and demand for heat, where feasible, will help to tackle the issue of affordable warmth going forwards. Whilst many fabric improvements are relatively straightforward, insulation of walls and solid floors is challenging. External wall insulation will be the starting point for the solid walls, but consideration of other wall insulation options will be required where EWI is not practicable.

Internal wall insulation and insulation of solid floors are likely to be challenging in tenanted properties, so early schemes should test the viability of this or consider alternative options such delivery at void stage. Where improvements to elements of fabric are not practicable, they do not offer value for money, or they do not achieve the target level alone, “renewable” technologies (e.g. PV) can act as an offset, but care needs to be taken to ensure that the fabric performance leaves the building ‘heat pump ready’.

Whenever a property is insulated, it is imperative that appropriate ventilation is also installed so as to avoid any moisture or condensation build-up.

The most efficient delivery method is likely to be align to existing component replacement. Some works will need to be accelerate to address dwellings currently below EPC C by 2030 in order to meet Fuel Poverty Regulations targets where practicable.

5.4.2 Stage 2: Technological Solutions to Building Services/Decarbonisation of Heat 2035-2050

The next stage would be to move to low/no carbon heating technologies by removing gas boilers and transition to electric powered sources i.e. ASHPs and GSHPs. The Heat and Building strategy targets a decision on the potential of hydrogen by 2026. The aim should be to prioritise this investment according to energy performance and subject to cost benefit analysis whilst also selecting technologies that are still considering affordable warmth, carbon reduction, suitability, and affordability. Many RPs are aiming to move away from gas boilers before 2035 where there is fabric performance that supports this and it is deliverable without affecting affordable warmth. Working closely with residents on how they can achieve the maximum benefit from these new heating technologies is essential.

It cannot be ignored that changing the building services to all electric today will potentially overload the local electricity distribution networks and hence lead to wider problems. This element of the strategy can therefore only be introduced over a period of time when the supply capacity is known; this itself depends on an understanding of future energy strategy across sectors beyond residential and the infrastructure has been upgraded. The challenges of this technological change will need to be understood in order to advance these technologies and to help develop the market for alternatives. It may be that renewables, storage, and smart management platforms are needed to help with grid balancing and affordability.

Within this commission we have not assessed the actual feasibility of installing ASHPs or GSHP's in existing dwellings and this requires ascertaining on an individual block or dwelling basis. There will inevitably be some installation challenges in some dwellings and blocks, especially those with many leaseholders. Early feasibility work will be important in understanding medium term options.

We have assumed that any solar PV installations need to meet the target outcomes are delivered at this stage.

It will also be necessary for landlords to remove gas cookers and consider their replacement with low energy induction hobs. As cookers are usually a tenant cost we have not included this component in our costings, but this will depend on your own policies in this regard.

5.6 A final stage may involve the introduction of further low and zero carbon renewable technologies to dwellings in order to off-set residual carbon following the implementation of stages 1 and 2. This could also include adding storage capacity in order to aid grid balancing and affordability. This is not considered here.

5.7 At all stages of our proposed strategy it important to use remaining resources to align to existing investment plans where possible, as well as targeting the worst first (where practicable and affordable), in order to achieve value for money and to minimise disruption. Another way that the landlords can ensure they remain on track towards Net Zero is by making sure any new homes that are to be developed on the estate already meet the standards now, in order to avoid extra retrofit of these in the future.

Appendix 1

Methodology

Methodology

The analytical methodology adopted for this housing stock energy assessment project is in eleven stages:

1. Collate housing stock energy data from the housing stock condition or asset management database. In this case these were collected from RdSAP surveys. A process of data 'cleaning' is used to identify and fill gaps, and to identify and correct inconsistencies.

2. Process the housing stock energy data using low-precision Standard Assessment Procedure (SAP) software to calculate an approximate SAP energy rating for every dwelling (if this is not already known). From these results, prepare housing stock energy profiles and KPIs. Attributes profiled are dwelling age and built form (to provide a check of the characteristics of the stock), SAP energy rating, EPC bands (A-G), annual fuel costs and carbon dioxide emissions. The profiles are presented as histograms (bar charts) showing the numbers of dwellings with each attribute variable. The calculated KPIs are the average and minimum SAP energy ratings, the average and maximum annual fuel cost, and the average and maximum annual carbon dioxide emissions associated with energy use. Together, these KPIs characterise the performance of the housing stock as existing.

3. Sort the housing stock energy database successively on three Reduced Data SAP (RDSAP) fields, to identify thermally distinct dwelling types. The three fields are Age Band, Built Form and Heating Type. Aggregation is usually carried out by combining types from Age Bands that result is similar assumed thermal transmittances (U values) for external walls and exposed floors. Reviewed the resulting set of types with the housing organisation's team to ensure that it provides an acceptable representation of the housing stock; additional types may be added to reflect local variation, or more aggregation may be appropriate, at this stage.

4. Once the set of dwelling types has been agreed, identify one or more dwellings (the 'archetypes') to represent each type. The archetypes must be dwellings for which there are

RDSAP data collected by DEAs for EPCs. Once the archetypes have been identified, data for flats are copied and edited to provide examples of ground-, mid- and top-floor variants. Note that in a stock with many flats this process can significantly increase the number of archetypes.

5. Extract the RDSAP data for each archetype and variant from the database and upgrade it to Full SAP format for analysis. Where precise Full SAP data cannot be obtained or are not evident, the RDSAP 'least unlikely' default values are adopted. Where window areas or heating system details (e.g. controls) are known, these are added to the data set.

6. Assess the energy performance of each archetype using Full SAP software. The results of these analyses are the SAP energy rating, Environmental Impact (EI) rating, and the estimated annual fuel use, fuel costs and carbon dioxide emissions (broken down by end uses), for each archetype, under SAP standard occupancy.

7. Establish and agree a comprehensive schedule of improvement cost rates covering all improvement measures and ancillary costs such as scaffolding. This schedule is specific to the housing organisation and should be as up to date as possible. Where reliable costs for new measures are not available, Savills can provide figures from other projects.

8. Identify and evaluate improvement options for each archetype, using Full SAP, with a view to establishing the improvement package options that will improve energy performance. The target energy performance levels are outlined in the report. These analyses are conducted using a 'fabric first' approach, in which measures to improve the whole building fabric (and thus reduce energy demand) are given priority, followed by measures to improve the efficiency and responsiveness of building services (heating and hot water) in order to satisfy demand efficiently and remove fossil fuels, all in accordance with any Housing Net Zero Carbon Strategy (if available). Renewable energy generation systems such as solar PV are modelled but are generally reserved for situations where the property cannot meet the agreed performance levels in a cost effective way through fabric and low carbon heat.

9. Apply costs from the schedule of improvement cost rates to the identified improvement option package for each archetype, at each stage of the process. Tabulate the results of the analyses for each archetype and improvement package option, including the SAP energy rating, the EI rating, estimated annual fuel use, fuel costs, carbon dioxide emissions after improvement (broken down by end uses), the percentage reduction in carbon dioxide emissions and the carbon cost effectiveness[1] of the packages. Review the results of the improvement option evaluation with the housing organisation and agree a preferred package of improvements for each archetype.

10. Scale-up the results of the improvement option evaluation for each archetype to stock level, by multiplying the assessed improvement costs and estimated annual fuel use, fuel cost and carbon dioxide emissions by the population of each dwelling type. Tabulate the overall fuel use, fuel cost and carbon dioxide emissions for the whole stock, by dwelling type. Tabulate fuel use, fuel cost and carbon dioxide emissions savings for the whole stock, by dwelling type. Recalculate the housing stock profiles and stock-level KPIs for the improved housing stock, for comparison with those obtained at stage 2 above. The updated stock profiles and KPIs characterise the performance of the housing stock after improvement.

11. Subtract from the estimated overall improvement costs the costs of measures that are already in the housing organisation's investment plan, in order to establish how much additional funding may be required to bring the stock to net-zero carbon ready' status.

Appendix 2

Example of Assessment Results

Example of Assessment Results

- End of Terrace House
- 74m2
- Mains Gas
- Modelled without EWI

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 2 / Existing Heating	£13,945	192.5	164.3	-28	46	51	5	£1,118	£1,001	-£117	4,473	3,945	-528
Fabric and Ventilation 3 / Existing Heating	£37,487	192.5	73.2	-119	46	70	24	£1,118	£623	-£495	4,473	2,246	-2,227
Fabric and Ventilation 3 / ASHP	£50,726	192.5	68.1	-124	46	68	22	£1,118	£652	-£466	4,473	620	-3,853
Fabric and Ventilation 3 / ASHP / Solar PV	**£55,466**	**192.5**	**68.1**	**-124**	**46**	**76**	**30**	**£1,118**	**£481**	**-£637**	**4,473**	**439**	**-4,034**
Fabric and Ventilation 3 / GSHP	£56,726	192.5	68.1	-124	46	74	28	£1,118	£494	-£624	4,473	517	-3,956

Example of Assessment Results

- Mid Terrace House
- 89m2
- Mains Gas
- Existing EWI

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 1 / Existing Heating	£7,003	93.5	72.3	-21	66	71	5	£793	£688	-£105	3,028	2,551	-477
Fabric and Ventilation 2 / ASHP	**£28,183**	**93.5**	**52.6**	**-41**	**66**	**72**	**6**	**£793**	**£631**	**-£162**	**3,028**	**606**	**-2,423**
No Fabric and Ventilation / ASHP	£13,239	93.5	87.2	-6	66	61	-5	£793	£875	£82	3,028	824	-2,204
No Fabric and Ventilation / ASHP / Solar PV	£18,969	93.5	87.2	-6	66	69	3	£793	£700	-£93	3,028	643	-2,385

Example of Assessment Results

- Mid Terrace House
- 89m2
- Mains Gas
- Variation with no EWI

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 3 / Existing Heating	£29,872	135.5	53.2	-82	57	74	17	£1,010	£604	-£406	3,978	2,134	-1,845
Fabric and Ventilation 6 / Existing Heating	£29,062	135.5	64.5	-71	57	72	15	£1,010	£662	-£348	3,978	2,388	-1,591
Fabric and Ventilation 3 / ASHP	**£43,111**	**135.5**	**49.6**	**-86**	**57**	**73**	**16**	**£1,010**	**£626**	**-£384**	**3,978**	**598**	**-3,380**
Fabric and Ventilation 3 / ASHP / Solar PV	£47,851	135.5	49.6	-86	57	80	23	£1,010	£453	-£557	3,978	417	-3,562

Example of Assessment Results

- Mid Terrace House
- 87m2
- Mains Gas
- System built existing EWI

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 1 / Existing Heating	£2,963	90.6	84.9	-6	71	72	1	£670	£649	-£21	2,991	2,863	-128
Fabric and Ventilation 1 / ASHP	£15,852	90.6	79.2	-11	71	64	-7	£670	£803	£133	2,991	759	-2,232
Fabric and Ventilation 2 / ASHP	£25,428	90.6	65.6	-25	71	68	-3	£670	£721	£52	2,991	684	-2,307
Fabric and Ventilation 2 / ASHP / Solar PV	**£31,428**	**90.6**	**65.6**	**-25**	**71**	**81**	**10**	**£670**	**£432**	**-£238**	**2,991**	**347**	**-2,645**

Example of Assessment Results

- Mid Terrace House
- 80m2
- Mains Gas

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 1 / ASHP	£16,559	94.5	83.8	-11	66	63	-3	£734	£775	£41	2,797	733	-2,063
Fabric and Ventilation 2 / ASHP	£24,724	94.5	74.1	-20	66	66	0	£734	£717	-£17	2,797	681	-2,116
Fabric and Ventilation 2 / ASHP / Solar PV	**£29,914**	**94.5**	**74.1**	**-20**	**66**	**76**	**10**	**£734**	**£502**	**-£232**	**2,797**	**444**	**-2,352**
Fabric and Ventilation 3 / ASHP	£36,245	94.5	52.4	-42	66	73	7	£734	£589	-£145	2,797	565	-2,231

Example of Assessment Results

- End of Terrace House
- 72m2
- Existing Heat Pump

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 2	£17,318	134.9	94.9	-40	49	57	8	£981	£831	-£150	897	750	-147
Fabric and Ventilation 2 / ASHP	£30,207	134.9	73.4	-62	49	68	19	£981	£639	-£342	897	608	-290
Fabric and Ventilation 2 / ASHP /Solar PV	**£34,947**	**134.9**	**73.4**	**-62**	**49**	**76**	**27**	**£981**	**£470**	**-£511**	**897**	**427**	**-470**
Fabric and Ventilation 2 / GSHP	£36,207	134.9	73.4	-62	49	75	26	£981	£478	-£503	897	505	-393

Example of Assessment Results

- Semi Detached House
- 77m2
- Existing Heat Pump

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 1 / Existing Heating	£926	103.1	87.8	-15	51	55	4	£1,040	£963	-£77	933	861	-72
Fabric and Ventilation 2 / Existing Heating	£8,704	103.1	80.0	-23	51	56	5	£1,040	£926	-£113	933	827	-106
Fabric and Ventilation 2 / ASHP	**£21,593**	**103.1**	**63.5**	**-40**	**51**	**70**	**19**	**£1,040**	**£619**	**-£421**	**933**	**590**	**-343**
Fabric and Ventilation 2 / ASHP / Solar PV	£26,783	103.1	63.5	-40	51	80	29	£1,040	£407	-£633	933	353	-579

Example of Assessment Results

- End of Terrace House
- 49m2
- Electric

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 3 (RIR Only) / ASHP	£27,707	145.8	73.9	-72	50	69	19	£811	£493	-£319	727	472	-254
Fabric and Ventilation 3 (RIR Only) / ASHP / Solar PV	£31,457	145.8	73.9	-72	50	73	23	£811	£432	-£379	727	415	-312
Fabric and Ventilation 2 / ASHP	£22,320	145.8	90.6	-55	50	65	15	£811	£552	-£259	727	526	-200
Fabric and Ventilation 2 / GSHP	**£28,320**	**145.8**	**90.6**	**-55**	**50**	**73**	**23**	**£811**	**£413**	**-£398**	**727**	**436**	**-290**

Example of Assessment Results

- Semi Detached Flat
- 50m2
- Mains Gas

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Ground- Fabric and Ventilation 2 / Existing Heating	£6,491	99.5	87.6	-12	67	69	2	£542	£510	-£32	1,941	1,795	-146
Ground- Fabric and Ventilation 2 / ASHP	£18,710	99.5	82.0	-18	67	68	1	£542	£512	-£30	1,941	488	-1,453
Ground- Fabric and Ventilation 2 / ASHP / Solar PV	£23,630	99.5	82.0	-18	67	79	12	£542	£335	-£206	1,941	285	-1,656
Ground- Fabric and Ventilation 2 / GSHP	**£24,710**	**99.5**	**82.0**	**-18**	**67**	**75**	**8**	**£542**	**£385**	**-£157**	**1,941**	**405**	**-1,536**
Top- Fabric and Ventilation 2 / ASHP	**£19,416**	**73.5**	**54.6**	**-19**	**72**	**75**	**3**	**£468**	**£403**	**-£65**	**1,617**	**390**	**-1,227**

Example of Assessment Results

- End of Terrace Flat
- 89m2
- Mains Gas
- Top Floor

		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	**Package Cost**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**	**Base**	**Post Package**	**Variance**
Fabric and Ventilation 1 / Existing Heating	£5,625	100.7	86.2	-14	66	69	3	£633	£587	-£46	2,832	2,559	-274
Fabric and Ventilation 2 / Existing Heating	£10,276	100.7	77.5	-23	66	70	4	£633	£561	-£71	2,832	2,397	-435
Fabric and Ventilation 2 / ASHP	£22,485	100.7	77.1	-24	66	67	1	£633	£609	-£24	2,832	580	-2,252
Fabric and Ventilation 2 / ASHP / Solar PV	**£27,135**	**100.7**	**77.1**	**-24**	**66**	**75**	**9**	**£633**	**£451**	**-£182**	**2,832**	**410**	**-2,422**

Example of Assessment Results

- End of Terrace Flat
- 64m2
- Electric

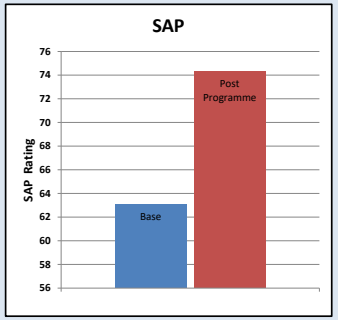
		Space Heating Requirement			SAP			Running Costs			kg CO2/yr.		
Package	Package Cost	Base	Post Package	Variance	Base	Post Package	Variance	Base	Post Package	Variance	Base	Post Package	Variance
Ground- Fabric and Ventilation 2 / ASHP	£18,359	63.5	59.8	-4	67	72	5	£636	£525	-£111	569	506	-63
Mid- Fabric and Ventilation 2 / ASHP	£18,359	47.5	44.2	-3	71	76	5	£559	£445	-£114	498	435	-63
Top- Fabric and Ventilation 2 (including roof) / ASHP	£29,594	70.6	52.9	-18	65	74	9	£671	£490	-£181	601	475	-126

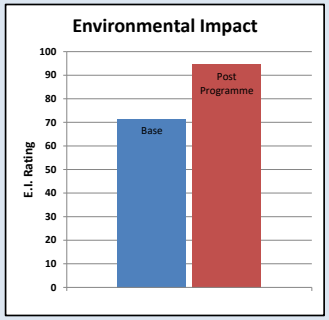
Appendix 3

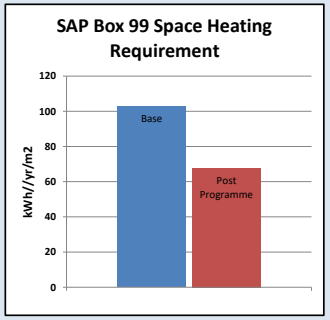
Summary Outputs

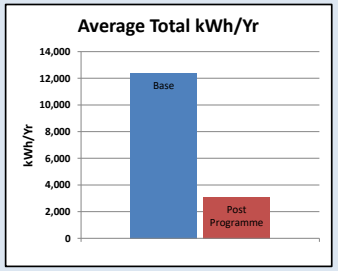
Improvement Option Evaluation - Results Summary

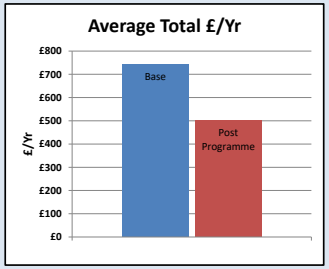
Base vs Programme KPI Comparison

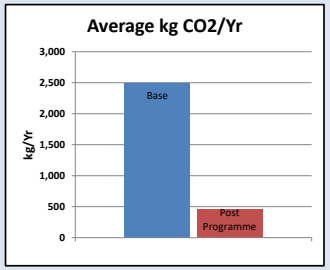












Total Stock - Consumption and Emissions

		Current	Post Prog	Variance	Var %
Energy Consumption	kWh/yr	8,566,525	2,206,820	-6,359,705	-74%
Energy Cost	£/yr	£537,465	£354,416	-£183,049	-34%
CO2 Emissions	kg CO2/yr	1,713,337	331,390	-1,381,947	-81%

Total Stock - Costs

Package Costs	£	£19,462,454
Gross Cost inc A&A & Contingency	£	£24,328,067
Total Grant	£	£0
Net Total Package Costs	£	£24,328,067
Total Existing Investment	£	£4,472,267
Net Total Less Existing Investment	£	£19,855,801

Average per Unit

Cost	£	£29,547
CO2 Emissions	Kg/Yr	469
SAP	Score	74
Running Costs	£/Yr	£502
Environmental Impact	Score	95

Appendix 4

Limitations

TERMS OF BUSINESS
CONSULTANCY

Savills (UK) Limited's standard terms of business are set out below. The accompanying engagement letter (the Letter) may vary these terms. The Letter and the terms of business will together form our Terms of Appointment and, as required by The Estate Agents Act 1979 also constitute the written terms of business which, along with their fees, agents are required to confirm to their clients. When you have read and understood the Letter and these Terms, you should sign and return the copy of the Letter to us to record your acceptance of them. If you fail to return the copy to us or fail to acknowledge your acceptance in writing (including by email), but continue to instruct us in relation to the Services, you will be deemed to have accepted these terms and the conditions set out in the Letter.

In this agreement, any reference to "we", "our" or "us" is to Savills (UK) Limited, reference to "you" is to the client to whom the Letter is addressed and references to the "Appointment" is to our appointment under the Terms of Appointment. In these terms the singular includes the plural and the masculine includes the feminine.

1.0 Our Responsibilities

1.1 Our role and responsibilities as agent and/or consultant, as appropriate, are set out in the Letter.

1.2 We undertake to comply with the terms of the Estate Agents Act 1979, the Consumer Protection from Unfair Trading Regulations 2008 (CPRs), the Business Protection from Misleading Marketing Regulations (BPRs) and other legislation where relevant to our Appointment as agent and/or consultant.

2.0 Fees

2.1 Responsibility for Payment of Fees, Costs & Charges

2.1.1 The person or company identified in the Letter as the client is responsible for payment of our fees, costs and charges. If more than one party is to be responsible, the Letter should be signed by all relevant parties and their liability will be joint and several.

2.1.2 From time to time we may pay commission to third parties who introduce new clients or new business to us. This may include an introduction made to you or in respect of business that we conclude for you. We pay commission out of revenue earned from the relevant introduction.

2.2 Calculation of Fees

2.2.1 Our fees for the Appointment are set out in the Letter.

2.2.2 Unless otherwise agreed in writing, our fees are exclusive of any other specialist consultants' advice that may be required e.g. service engineers. We will advise you of the need for such advice as necessary. When the Appointment of another specialist consultant is required, we will undertake responsibility for the co-ordination and integration of such specialist consultant's work, but the appointment will be made directly between you and the other specialist consultant, and will form a separate contractual relationship. Unless otherwise agreed in writing, we have no responsibility for such other specialist consultant's performance of your instructions. Where you approve the appointment of a specialist consultant, you hereby authorise us to enter into a contract with such consultant on your behalf.

2.3 Expenses

2.3.1 In addition to the fees quoted above, reasonable disbursements will be charged. Travel and subsistence, photography, printing, photocopying, binding, postage and couriers are all charged as disbursements.

2.3.2 Until we receive written authority to proceed in connection with incurring disbursements, we reserve the right not to proceed with the consultancy.

2.4 Timing of Payment

2.4.1 Unless otherwise specified in the Letter, we shall raise invoices for our fees on a monthly basis.

2.4.2 Subject to clauses 2.1 to 2.3 above, our fee and any outstanding expenses are due and payable within 14 days following receipt of invoice.

2.5 VAT

2.5.1 All our fees, costs and charges are exclusive of Value Added Tax, which (where applicable) will be paid by you to us in addition to the sums due.

2.6 Interest and Recovery of Fees

2.6.1 Interest will be payable at 4% above the Barclays Bank base rate from time to time on any invoice that remains unpaid for 14 days after payment is due.

2.6.2 If we find it necessary to use solicitors or other parties to recover agreed fees, costs or charges, you agree to pay any reasonable costs incurred by us in this respect.

3.0 Suspending and Terminating Instructions

3.1 You or we may at any time terminate the Appointment by giving not less than 28 days' written notice (unless otherwise agreed in the Letter). Notice by either side does not detract from our right to charge fees under clause 2.0 above.

3.2 Either party may terminate this Appointment immediately upon giving notice in writing to the other party if (in the reasonable opinion of the terminating party) any one of more of the following events occurs or is likely to occur:

3.2.1 a party making any voluntary arrangement with its creditors, entering administration or going into liquidation; or

3.2.2 a security holder taking possession, or a receiver or administrative receiver being appointed, over all or any part of the property or assets of a party; or

3.2.3 any other similar or analogous event in any jurisdiction;

3.2.4 the other party commits a material breach of these Terms of Appointment.

3.3 We may suspend performance of our obligations under these Terms of Appointment without liability if you fail to pay any sum when due and fail to rectify such breach within seven days of receiving notice of non-payment.

3.4 If this Appointment is terminated or suspended for any reason under clause 3.0 above, you shall pay all fees and expenses due, commensurate with the services performed, including time spent in closing down the instruction. We reserve the right to invoice for all disbursements incurred to date and the greater of the time-charge for the work carried out or:-

3.4.1 Lump-sum fixed fees: pro-rata the fee by reference to the stage that work has reached;

3.4.2 'Success' fees: a reasonable percentage of the anticipated fee, by reference to the stage in negotiations that has been reached;

4.0 Limitation of Liability

4.1 Neither party will be liable for any loss of profit (other than in respect of our fees, costs or charges), loss of business or goodwill, or for any special, indirect or consequential loss or damage suffered by the other (including as a result of an action brought by a third party), save that nothing in these Terms of Appointment will exclude or restrict any liability which either party may have for (i) death or personal injury arising out of negligence, (ii) fraudulent misrepresentation or (iii) any other liability which cannot be restricted or excluded by law.

4.2 We will not be liable for any loss as a result of your receipt of any information, data or communications supplied or sent by us electronically, where through no fault of our own the relevant information, data or communication has been corrupted or otherwise modified as a result of it being supplied or sent electronically. You will be responsible for ensuring that any materials you provide or send us by any electronic medium and/or by computer disk are, and remain, virus free.

4.3 Subject to clauses 4.1 and 4.2 our total aggregate liability in contract, tort (including negligence or breach of statutory duty), misrepresentation, restitution or otherwise, arising in connection with the performance or contemplated performance of the Appointment or otherwise under the Terms of Appointment, unless otherwise agreed in writing, shall be limited to £5.0m. Where we agree in writing to accept liability to more than one party, the limit on our liability in this clause will be shared between such parties (including you), and it is up to you and such parties to decide how our liability is to be apportioned.

5.0 Indemnity

5.1 Subject to clause 4.0 above you will indemnify and keep us indemnified on an after tax basis against all losses, damages, costs and expenses suffered or incurred by us, arising out of or by virtue of your instructions to us or arising out of any act, omission or default by you, any joint agent or any other third party instructed by you, other than any losses, damages, costs and expenses arising by virtue of our default or negligence.

5.2 During the term of the Appointment and for a period of 6 years thereafter, we will maintain in force, with a reputable insurance company, professional indemnity insurance in an amount not less than £5.0m and shall, on your request, produce confirmation from our insurance broker giving details of cover and that the current year's premium has been paid.

6.0 Compliance

6.1 The CPRs and BPRs

6.1.1 Under the CPRs and BPRs it is a criminal offence for an agent to make inaccurate or misleading statements about property whether in sale particulars, adverts, photographs or verbal statement. This includes making statements that might give the wrong impression about a property and includes omitting facts. You will be asked to verify certain information and must assist to the best of your knowledge.

6.1.2 You will ensure that you advise us of all material facts relevant to us acting as agent and that all information provided by you and/or your professional advisers is and remains complete, accurate and not misleading, for example:

6.1.2.1 you will inform us of any unusual or onerous encumbrances, restrictions, easements, outgoings or conditions attaching to the property; and

6.1.2.2 you will inform us if the property does not comply with all relevant statutory requirements or if the property has not been constructed or is occupied in contravention of or is to be sold or let without valid planning permissions and building regulation and all other approvals required by regulation; and

6.1.2.3 you will check all marketing materials and promptly notify us if any part of those materials is or becomes incomplete, inaccurate or misleading.

6.1.3 We will notify you as soon as reasonably practicable if we become aware that any information provided by you is incomplete, inaccurate or misleading. You will be responsible for any additional costs subsequently incurred by us to ensure that the circulation of incomplete, inaccurate or misleading information is rectified, whether by the reissue of amended marketing materials or otherwise.

6.2 Money Laundering

6.2.1 We are obliged to identify our clients in accordance with the requirements of The Money Laundering, Terrorist Financing and Transfer of Funds (Information on the Payer) Regulations 2017. We are likely to request from you, and retain, some information and documentation for these purposes and/or make searches of appropriate databases electronically. For the avoidance of doubt, searches may also be conducted on directors and “beneficial owners” of the client as required by the legislation. If satisfactory evidence of your identity is not provided within a reasonable time, there may be circumstances in which we are not able to proceed with the instruction. Furthermore, under the Regulations, if the property is owned by any form of corporate body (including trusts etc), the corporate body has a legal obligation to provide us with information in order to allow us to identify the beneficial owner.

6.2.2 The provision of our services is a business in the regulated sector under the Proceeds of Crime Act 2002 and, as such, we are required to comply with this legislation which includes provisions that may require us to make a money laundering disclosure in relation to information we obtain as part of our normal work. It is not our practice to inform you when such a disclosure is made or the reasons for it because of the restrictions imposed by the 'tipping off' provisions of the legislation.

6.3 Data Protection

6.3.1 We may use your personal information in our provision of services to you. Please see our Privacy Notice for details of how your personal information will be used. Our Privacy Notice can be found at the following web address: http://www.savills.co.uk/footer/privacy-policy.aspx

6.4 Equality Act 2010

6.4.1 We are committed to promoting equality and diversity in all our dealings with clients, suppliers, third parties and employees and require that you co-operate with this approach. If you would like to see a copy of our equality and diversity policy please contact the Company Secretary at 33 Margaret Street, London W1G 0JD, or compliance@savills.com.

6.5 Anti-Corruption

6.5.1 You shall comply at all times with all applicable laws, statutes and regulations relating to anti-bribery and anti-corruption including but not limited to the Bribery Act 2010.

7.0 Health and Safety

7.1 You are responsible for all health and safety, and environmental obligations in accordance with all relevant laws, enactments, orders, codes of practice and regulations in relation to our Appointment.

7.2 You must ensure that we are notified of and provided with all relevant information relating to risks to health and safety and any documentation and/or measures in place to manage those risks. This includes any relevant information to ensure that any viewings or visits are conducted safely.

8.0 Confidentiality

8.1 Each party undertakes that it shall not disclose to any person any confidential information concerning the business, affairs, customers, clients or suppliers of the other party except as permitted by clauses 8.2 and 8.3 below.

8.2 Each party may disclose the other party's confidential information:

8.2.1 to its employees, officers, representatives, contractors, sub-contractors or advisers who need to know such information for the purposes of carrying out the party's obligations under Terms of Appointment ("Permitted Recipients"). Each party shall ensure that its Permitted Recipients comply with this clause 8; or

8.2.2 with the other party's prior consent; or

8.2.3 as may be required by law, court order or any governmental or regulatory authority.

8.3 Neither party shall use any other party's confidential information for any purpose other than to perform its obligations under these Terms of Appointment.

8.4 The provisions of this clause shall survive any termination of this Appointment.

9.0 Use of Information

9.1 Subject to our confidentiality obligations under clause 8, information provided to us by you, or relating to our instructions may be published or otherwise used by us for marketing purposes either before or after the expiry or termination of our Appointment.

9.2 All advice and services produced for you ("Work") is to be regarded as confidential to the party to whom it is addressed and is intended for the use of that party only. Consequently, in accordance with current practice, no responsibility is accepted to any third party in respect of the whole or any part of the Work. Before the Work, or any part of it is reproduced, our written approval as to the form and context of such publication must be obtained.

10.0 Intellectual Property Rights

10.1 All Intellectual Property Rights and all other rights in all reports, drawings and accounts and other documentation created, prepared or produced by us in relation to our Appointment shall be owned by us. Subject to 10.2 below, we license all such rights to you free of charge and on a non-exclusive, worldwide basis to such extent as is necessary to enable you to make reasonable use of such reports, drawings and accounts and other documentation.

10.2 You acknowledge that, where we do not own any pre-existing materials, your use of rights in pre-existing materials is conditional on us obtaining a written licence (or sub-licence) from the relevant licensor or licensors on such terms as will entitle us to license such rights to you.

11.0 Complaints Procedure

11.1 In accordance with the Royal Institution of Chartered Surveyors' Rules of Conduct, we operate a formal procedure to deal with complaints from clients and others. Details of this procedure are available from the Complaints Handling Officer (complaints@savills.com).

11.2 For unresolved business to business complaints there are provisions for matters to be referred to mediation or arbitration as appropriate. We are also members of the 'Property Redress Scheme' for the resolution of any consumer complaints that are not satisfactorily resolved between the parties.

11.3 Your right to pursue any dispute through the courts is not affected by the option to resolve a dispute through the complaints procedure or arbitration.

12.0 Third Party Rights

12.1 We are a member of the group of companies whose ultimate holding company is Savills plc. These Terms of Appointment, including any written variation, may be enforced by any member of the Savills Group pursuant to the Contracts (Rights of Third Parties) Act 1999, but otherwise the Provisions of the Contracts (Rights of Third Parties) Act will not apply.

12.2 Notwithstanding that these Terms of Appointment may be enforced by Savills Group, the Terms of Appointment may be varied or the Appointment may be suspended or terminated in accordance with the Terms of Appointment or by mutual consent, in each case without the consent of any such third party.

13.0 Assignment

13.1 You shall not be entitled to assign, sub-contract or otherwise dispose of any of your rights or obligations under these Terms of Appointment without our prior written consent.

13.2 We may at any time and without seeking your consent, assign or sub-contract our rights and obligations under these Terms of Appointment to another company within the Savills Group (the "Transferee"). On condition that the Transferee undertakes for your benefit to perform with effect from the date of assignment all of our obligations under these Terms of Appointment in our place, you shall accept such performance and shall release us from any and all obligations and liability under these Terms of Appointment arising on or after the date of assignment.

14.0 Order of Priority

14.1 The Letter and these terms are to be read together as a single document which make up the Terms of Appointment. In the event of any conflict, the terms of the Letter will prevail

15.0 Force Majeure and similar

15.1 We reserve the right to delay performance or to cancel the Appointment (without liability to you) and we will not be liable to you for any delay in performing or failure to perform our obligations under the Terms of Appointment where that delay or failure is caused by any circumstances beyond our reasonable control including, without limitation, acts of God, governmental actions, war or national emergency, acts of terrorism, protests, riot, civil commotion, fire, explosion, flood, epidemic, lock-outs, strikes or other labour disputes (whether or not relating to either party's workforce) or your default provided that, if the event in question continues for a continuous period in excess of 10 days, you shall be entitled to give notice in writing to us to terminate the Appointment.

16.0 Severability

16.1 If any provision of the Terms of Appointment (or part of any provision) is found by any court or other authority of competent jurisdiction to be invalid, illegal or unenforceable, that provision or part-provision shall, to the extent required, be deemed not to form part of the Terms of Appointment, and the validity and enforceability of the other provisions of the Terms of Appointment shall not be affected. If a provision of these Terms of Appointment (or part of any provision) is found illegal, invalid or unenforceable, the provision shall apply with the minimum modification necessary to make it legal, valid and enforceable.

17.0 Entire Agreement

17.1 The Terms of Appointment constitute the entire agreement and understanding of the parties as to the subject matter of the Terms of Appointment. They supersede any prior agreement or understandings between the parties and no variation of the Terms of Appointment will be binding unless agreed in writing.

18.0 Applicable Law and Jurisdiction

18.1 These Terms of Appointment and any dispute or claim, including a dispute or claim of a non-contractual nature, arising under or in connection with these Terms of Appointment shall be governed by and construed in accordance with the law of England and Wales.

18.2 The parties to these Terms of Appointment irrevocably agree that, subject as provided below, the courts of England and Wales shall have exclusive jurisdiction over any dispute or claim arising under or in connection with these Terms of Appointment. Nothing in this clause shall limit our right to take proceedings against you in any other court of competent jurisdiction, nor shall the taking of proceedings in any one or more jurisdictions preclude the taking of proceedings in any other jurisdictions, whether concurrently or not, to the extent permitted by the law of such other jurisdiction.

18.3 Where relevant, the Terms of Appointment will be subject to both the 2008 edition of the RICS *'Surveyors acting as Expert Witnesses'* and *'Surveyors acting as Advocates' Practice Statement and Guidance Notes'* and the Civil Procedure Rules and Pre-Action Protocols that came into force in April 1999. A judicial or quasi-judicial body in the United Kingdom may rely upon our subsequent Expert Evidence. A copy of the *RICS 'Surveyors acting as Expert Witnesses and Advocates Practice Statement and Guidance Notes'* can be supplied to you on request.

19.0 Provision of Service Regulations

19.1 Under the Provision of Service Regulations 2009, we are required to make certain information available to customers to whom we are providing services. This information can be found at the following web address: http://www.savills.co.uk/footer/provision-of-services-regulations.aspx

19.0 Additional terms applicable to Rating Services

19.1 You confirm that we shall have full authority to settle rating negotiations directly with the Valuation Officer on your behalf without receiving your prior recommendation with regard to any agreement or withdrawal.

19.2 In the event that our negotiations with the Valuation Office Agency do not bring about a successful outcome (including for example a change in the Rateable Value) we will make a recommendation to you as to the opportunity for appeal to Valuation Tribunal. We may agree to carry out such appeal services to the upper tribunal/ appeal courts where it considers in its reasonable discretion that the matter has a reasonable prospect of success. The parties confirm and acknowledge that the fees in respect of these services shall be negotiated and agreed by the parties separately (acting reasonably) taking into account the particular circumstances of the case but the general terms of these Terms of Appointment shall apply to any such services.

19.3 We shall not accept rate refunds from Local Councils on your behalf pursuant to these Terms of Appointment and any such arrangements shall be by separate written agreement between the parties.

19.4 We may render invoices in respect of the Fees following a change in the Rating List in respect of the relevant Property or following receipt of an amended rate demand from the Local Council showing a lower Rateable Value (and evidence of such shall be presented to us by you promptly) or on receipt of any other such unequivocal evidence demonstrating a total liability reduction. Invoices shall be in respect of the total savings throughout the Rating List and shall be based on an estimated Uniform Business Rate (UBR) multiplier (calculated in line inflation at a rate as based on the Consumer Prices Index).

19.5 For the avoidance of doubt:

19.5.1 a fee is not payable on receipt of the Valuation Officer's acceptance or acknowledgement of a proposal;

19.5.2 a fee is not payable notwithstanding the withdrawal of a proposal; and

19.5.3 where an assessment is reduced, but there is no immediate or anticipated monetary benefit to you in the form of refunds or reduced Rateable Value liability, you shall be charged on a time spent basis. We shall only act in relation to such matters with express instruction from you.

19.6 You acknowledge that in the event a matter is progressed to appeal, you shall be liable in respect of any appeal fees. You should consult the Enterprise Act 2016 for information regarding such fees.

19.7 You further acknowledge that there are civil penalties applicable if incorrect information is supplied knowingly, recklessly or carelessly by you, or by us to the Valuation Office Agency on your behalf.

19.8 The Services shall be supplied in accordance with the RICS/IRRV/RSA Rating Consultancy Code of Practice (as from time to time in force) which regulates RICS consultancy work. A copy of the current code is available on request from us.

20.0 Regulation by RICS

20.1 Savills (UK) Limited is regulated by RICS for the provision of surveying services. This means we agree to uphold the RICS Rules of Conduct for Firms and all other applicable mandatory professional practice requirements of RICS, which can be found at www.rics.org. As an RICS regulated firm we have committed to cooperating with RICS in ensuring compliance with its standards. The firm's nominated RICS Responsible Principal is Tim Maynard (tmaynard@savills.com), Chief Financial Officer/Operations Director.

LIMITATIONS OF SURVEY

1. Repairs and replacements will be costed on a "like for like" replacement basis, with improvements and contingency works dealt with as a separate exercise where they do not clearly form part of the repair process. In the event of the remedial works requiring vacation of the property, no allowance will be made in the costings for such relocation.

2. Savills will not be undertaking structural surveys of the properties and will not inspect woodwork or other parts of the structure which are covered, unexposed or inaccessible. It will therefore not be possible to report that such parts are free from defects. We have not included for the use of long ladders to gain access to roofs. Roof voids will be accessed where safe to do so, utilising standard surveyor's lean-to ladders for readily accessible parts of the common areas.

3. Inspections will not be made of flues, ducts or voids or any similarly enclosed areas, access to which is not readily available at the time of our inspection and we will therefore be unable to report that such areas remain free from defect.

4. No specific inspection or specialist testing will be undertaken to establish whether high alumina cement concrete, calcium chloride additives, woodwool slab permanent formwork construction, asbestos or other deleterious materials are present within the construction.

5. No samples will be taken nor any analysis made of the sulphate content of the load bearing sub-soil adjacent to the foundations.

6. No testing of electrical, mechanical, water, drainage, air conditioning, lifts or other services will be undertaken by Savills. It should not be construed that the inspection of the services will be a detailed engineering appraisal. Generally, manhole covers will not be lifted or below ground drainage tested. We will identify if there is any surface indication of defects which require further investigation. Such investigations will be chargeable as an additional fee.

7. Our total aggregate liability to you in connection with the performance of the Stock Condition Survey or otherwise (howsoever it arises and whether under this letter or agreement collateral to this) shall in no circumstances exceed £5m. For the avoidance of doubt, we shall not be liable for any indirect loss, including but not limited to loss of: profit, business, contracts, revenues or anticipated savings or any special, indirect or consequential damage of any nature whatsoever.

8. Savills will not be making any formal enquiries in respect of existing user rights, town planning and road widening, legal interests, fire certificates, effluent agreements, party wall agreements, prescriptive rights, easements, wayleaves, statutory consents or contaminated land.