# Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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## Summary of current building

## DRAYMANS COURT 41 STOCKWELL GREEN SW9 9QE

| | |
|---|---|
| **Domestic** | **47 Units** |
| **Floorspace (m2)** | **2250** |
| **EPC Rating** | **B-E** |
| | |
| **Space heating consumption (kWh)** | **128,383** |
| **Cooling consumption (kWh)** | **0** |
| **Water heating consumption (kWh)** | **48,300** |
| **Other electricity use (kWh)** | **88,320** |
| **Annual total fuel bill** | **£0** |
| | |
| **Thermal Energy Demand Intensity (kWh per m2 pa)** | **47** |
| **Energy Use Intensity (kWh per m2 pa)** | **96** |
| | |
| **Age of construction** | 1996 - 2002 |
| **Windows** | Double glazed windows post 2002 |
| **Wall** | Cavity as built |
| **Roof** | Pitched roof with insulation at rafters |
| **Floor** | Insulation unknown or as-built |
| **Primary heating** | Existing - electric room heaters |
| **Air tightness (ACH @ ambient pressure)** | Building regs airtightness (5 n50) |
| **Radiators / emitters** | Existing radiators - double panel, single convector |

## Description of Options for Appraisal

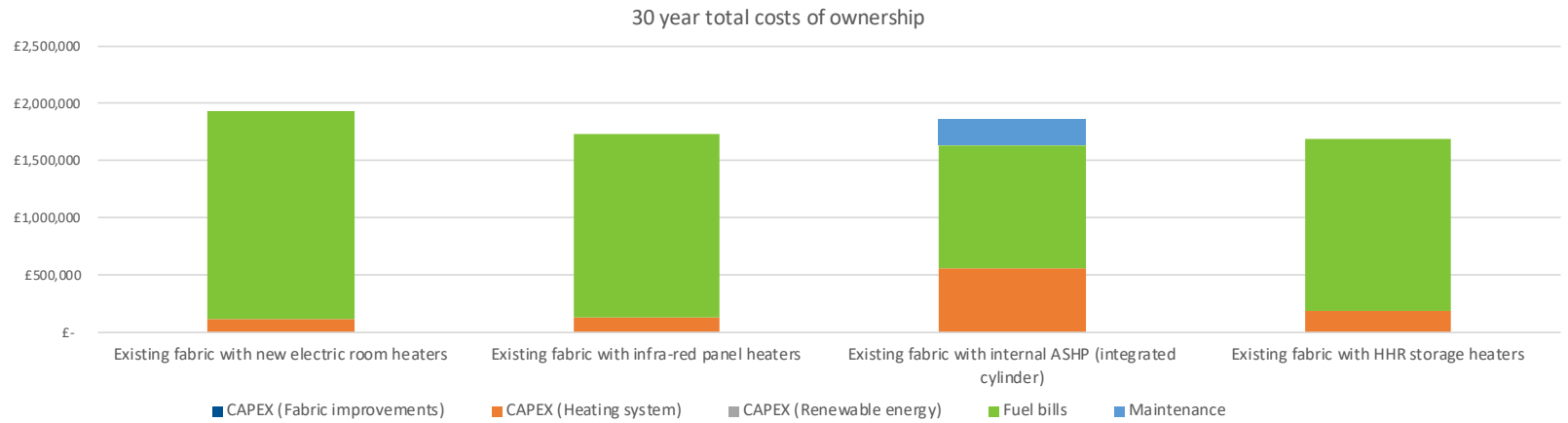
**Thermal fabric measures:**
This block of flats has relatively good thermal fabric performance, with insulated cavity walls, loft insulation and modern double glazing. No further fabric upgrades were considered for this building.

**Heating system:**
The flats are currently heated by direct electric room heaters. In scenarios 2 - 4 we consider three different electric heating options:
Scenario 2: Infra-red panel heaters. Due to the way that radiant panels heat objects rather than the air, infar-red panels can offer greater efficiency than other direct electric heaters.
Scenario 3: We considered the impact of installing internal ASHPs in to each flat, with an integrated hot water cylinder and the installation of new radiators.

## Summary of options appraisal measures, costs & $CO_2$ emissions

| | Existing fabric with new electric room heaters | Existing fabric with infra-red panel heaters | Existing fabric with internal ASHP (integrated cylinder) | Existing fabric with HHR storage heaters |
|---|---|---|---|---|
| **HVAC system** | 57kW New electric room heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework , 0 | 57kW New infra-red panel heaters , 0, 0, New electric immersion heater, Hot water cylinder and associated pipework | 57kW 2.8kW max internal ducted ASHP (integrated cylinder) , 0, 0, hot water from main system (electric), 0 | 57kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework |
| | **£89,758** | **£95,230** | **£260,850** | **£122,590** |
| **Heat emitter and distribution** | 0, 0 | 0, 0 | New in flat wet heating distribution pipework, New - Double panel double convector radiators | 0, 0 |
| | **£0** | **£0** | **£46,005** | **£0** |
| **Thermal fabric measures installed** | ,,, | ,,, | ,,, | ,,, |
| | **£0** | **£0** | **£0** | **£0** |
| **Air tightness** | Natural ventilation , Building regs airtightness (5 n50) | Natural ventilation , Building regs airtightness (5 n50) | Natural ventilation , Building regs airtightness (5 n50) | Natural ventilation , Building regs airtightness (5 n50) |
| | **£0** | **£0** | **£0** | **£0** |
| **Total CAPEX** | **£89,758** | **£95,230** | **£306,855** | **£122,590** |
| **Clean Heat Grant** | £0 | £0 | £0 | £0 |
| **Net CAPEX** | **£89,758** | **£95,230** | **£306,855** | **£122,590** |
| **Electricity tariff** | Treasury Green Book Central Domestic Tariff | Treasury Green Book Central Domestic Tariff | Treasury Green Book Central Domestic Tariff | Domestic Economy 7 00:00 - 07:00 |
| **Annual fuel bills** | **£55,894** | **£49,645** | **£33,118** | **£46,422** |
| **Annual fuel bills (per flat)** | **£1,189** | **£1,056** | **£705** | **£988** |
| **Annual OPEX (maintenance)** | £0 | £0 | £6,956 | £0 |
| **30 year total cost of ownership (excluding grant)** | **£1,931,999** | **£1,740,451** | **£1,856,523** | **£1,690,731** |
| **Annual $tCO_2$ emissions (2021)** | **75.0** | **66.6** | **44.4** | **77.9** |
| **Predicted annual $tCO_2$ emissions (2030)** | **34.5** | **30.6** | **20.4** | **35.8** |
| **Predicted annual $tCO_2$ emissions (2050)** | **1.9** | **1.6** | **1.1** | **1.9** |

## 30 year total costs of ownership

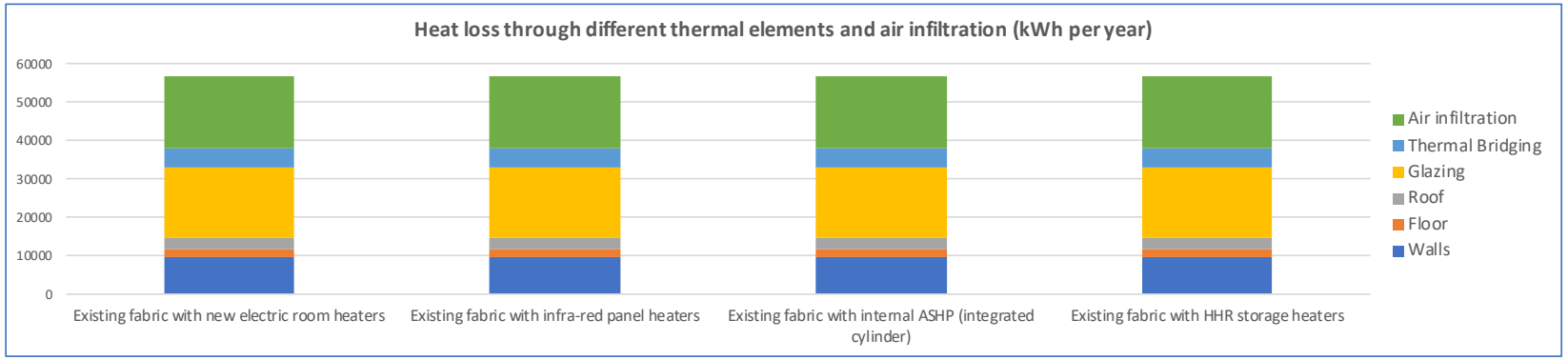



**CAPEX**
Scenario 3 (internal ASHPs with integrated cylinder and new radiators) has by far the highest CAPEX with the other three scenarios having broadly similar CAPEX.

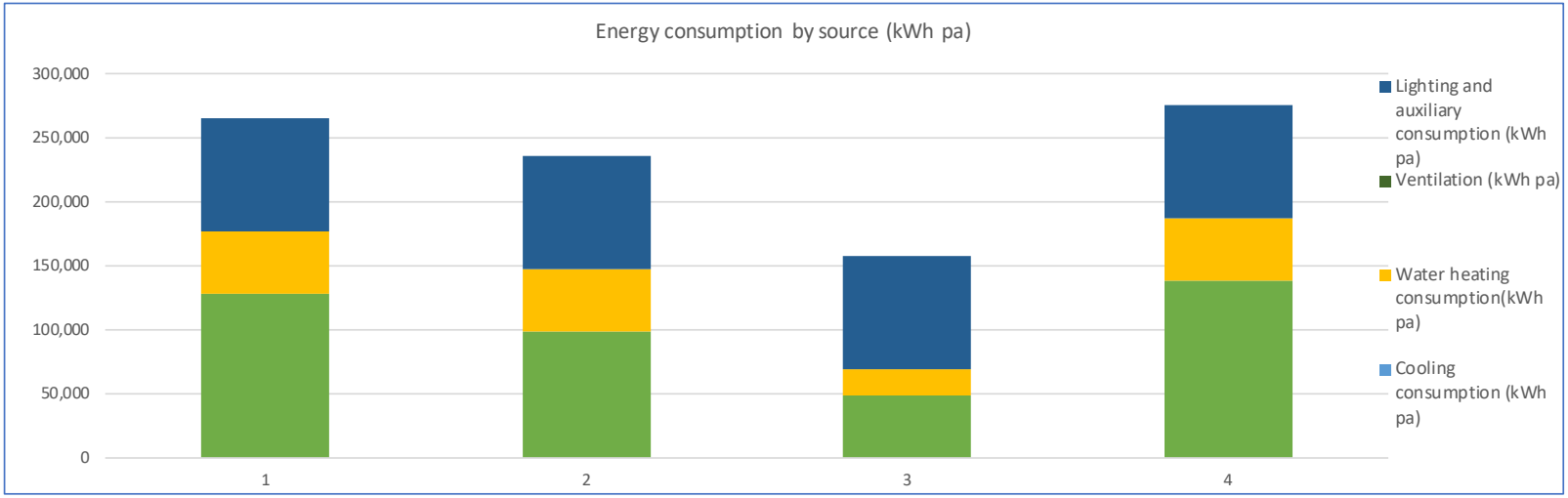
**Fuel bills**
Scenario 3 is modelled as having the lowest fuel bills, due to the high efficiency of the heat pump system relative to the other forms of electric heating. Fuel bills in scenario 4 are also lower than BAU due to the lower overnight rate of the Economy 7 tariff. It is possible that bills in scenario 4 could reduce even further in combination with a 'super off-peak' tariff. However, we considered that there may be network constraints associated with an entire block of flats charing storage heaters and hot water cylinder in a short time period between 01:30 and 05:30.

**30 year cost of ownership**
Scenario 4 has marginally the lowest cost of ownership, with a relatively small increase in CAPEX over BAU off-set by a large reduction in fuel bills.

## Heat loss through thermal elements



## Energy Consumption kWh pa




## Heat demand and heating system efficiency

Whilst off-peak electric systems (e.g. scenario 4) are less efficient than heat pump options, they offer significant advantages in adding no additional electricity load at peak times of day. infra-red systems (e.g. scenario 2) offer an efficiency advantage over other on-peak direct heaters because it takes less energy to heat objects in a room than to heat the body of air. However, in practice their application would depend on suitable wall space being available. Also, the extra efficiency does not fully counterbalance the high cost of on-peak electricity tariffs.

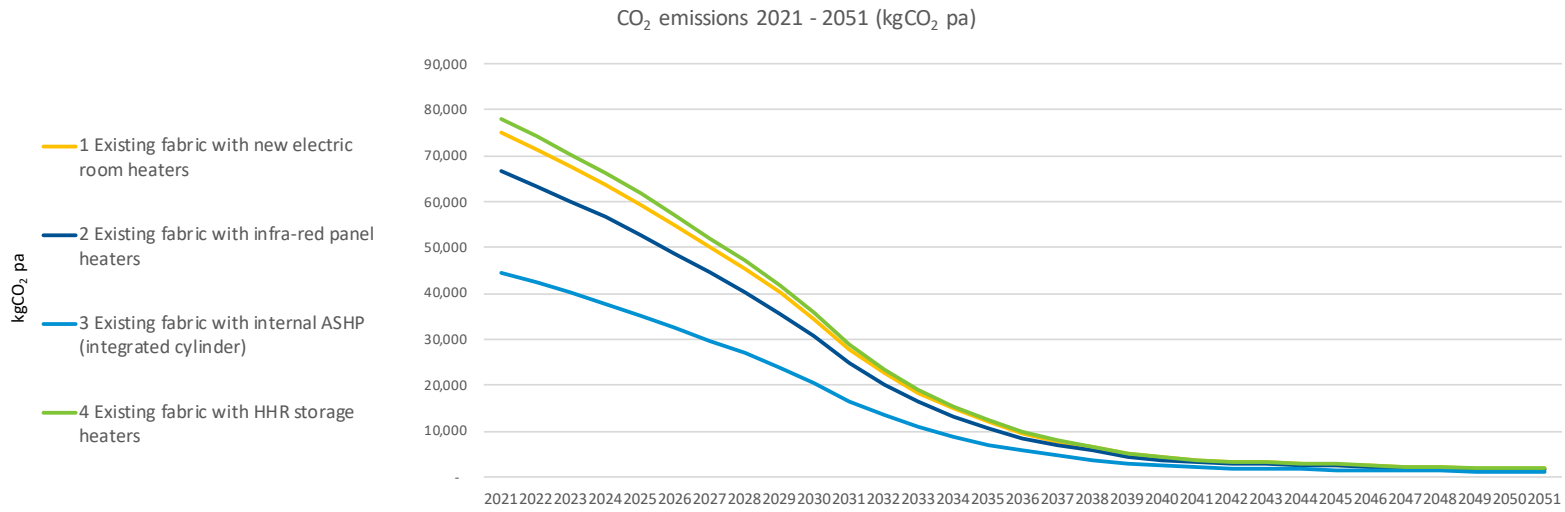
| | Existing fabric with new electric room heaters | Existing fabric with infra-red panel heaters | Existing fabric with internal ASHP (integrated cylinder) | Existing fabric with HHR storage heaters |
|---|---|---|---|---|
| Space heating demand (kWh pa) | 128,383 | 128,383 | 128,383 | 128,383 |
| Space heating peak demand (kW) | 56.6 | 56.6 | 56.6 | 56.6 |
| Space heating peak demand per flat (kW) | 1.2 | 1.2 | 1.2 | 1.2 |
| Peak electricity load @ 6:00pm | 90.7 | 74.7 | 48.0 | 21.3 |
| Required flow temperatures °C | 55 | 55 | 50 | 55 |
| | | | | |
| Space heating consumption (kWh pa) | 128,383 | 98,756 | 49,378 | 138,792 |
| Cooling consumption (kWh pa) | 0 | 0 | 0 | 0 |
| Water heating consumption(kWh pa) | 48300 | 48300 | 19320 | 48300 |
| Ventilation (kWh pa) | 0 | 0 | 0 | 0 |
| Lighting and auxiliary consumption (kWh pa) | 88320 | 88320 | 88320 | 88320 |
| Assumed heating system Seasonal Performance Factor (SPF) | **100%** | **130%** | **260%** | **93%** |
| Assumed distribution losses | **0%** | **0%** | **0%** | **0%** |
| Space heating Thermal Energy Demand Intensity (kwh per m2 pa) | **57** | **57** | **57** | **57** |
| Energy Use Intensity - all energy use (kWh per m2 pa) | **96** | **85** | **57** | **100** |

## Retrofit package $CO_2$ emissions

* negative figures indicate a negative cost of carbon reduction. i.e. the packages of measures reduce 30 year costs and reduce CO2.

| | | | | |
|---|---|---|---|---|
| $tCO_2$ in 2021 | 75 | 67 | 44 | 78 |
| Predicted annual $tCO_2$ emissions (2030) | 34.5 | 30.6 | 20.4 | 35.8 |
| $tCO^2$ in 2050 | 1.9 | 1.6 | 1.1 | 1.9 |
| $tCO^2$ cumulative 2021 - 2050 | 716 | 636 | 424 | 744 |
| $tCO_2$ saved relative to BAU (30 year cumulative) | 0 | -80 | -292 | 28 |
| $CO_2$ saving relative to baseline (30 year cumulative) | 0% | 11% | 41% | -4% |
| Additional cost over BAU scenario (30 years) | £0 | -£191,548 | -£75,476 | -£241,267 |
| £ per tonne of $CO_2$ reduction (30 year cumulative) | NA | -£2,395 | -£259 | £8,584 |

## 30 year predicted $CO_2$ emissions




**$CO_2$ emissions**

All scenarios show significant $CO_2$ reductions over time due to the forecast decarbonisation of the electricity grid. The heat pump option (scenario 3) show as the largest reductions in $CO_2$ emissions in the immediate term.

Scenario 4 (HHR storage heaters) actually shows an increase in $CO_2$ emissions relative to the BAU. This is because the modelled efficiency of the HHR storage heaters is lower than the direct electric systems. However, in practice, storage heaters would provide a valuable flexibility service in the context of an overall low carbon energy system. Also, whilst this modelling did not consider different carbon intensities for different times of

## Potential impact of Solar PV on all scenarios

| | Existing fabric with new electric room heaters | Existing fabric with infra-red panel heaters | Existing fabric with internal ASHP (integrated cylinder) | Existing fabric with HHR storage heaters |
|---|---|---|---|---|
| Included in package? (Y/N) | N | N | N | N |
| System size kW Peak | 20.0 | 20.0 | 20.0 | 20.0 |
| System generation kWh pa | 19,272 | 19,272 | 19,272 | 19,272 |
| Utilisation on site kWh pa | 19260 | 19260 | 19260 | 19258 |
| Utilisation on site kWh pa | 100% | 100% | 100% | 100% |
| Exported to grid kWh pa | 12 | 12 | 12 | 14 |
| Assumed system cost £ | 30000 | 30000 | 30000 | 30000 |
| Net impact on fuel bills £ pa | -£ 4,063 | -£ 4,063 | -£ 4,063 | -£ 4,532 |

**Renewable energy:**
For all scenarios, the impact of a PV system was modelled separately. The table above shows the indicative savings on energy consumption and fuel bills that would occur. The relatively high year round use of electricity

## Impact of Solar PV on Scenario 3 - typical summer and winter days