Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

Mid Floor Flat 216 Coldharbour Lane

Domestic	1 Units
Floorspace (m2)	35
EPC Rating	DE

Space heating consumption (kWh)	2,601
Cooling consumption (kWh)	0
Water heating consumption (kWh)	613
Other electricity use (kWh)	1,120
Annual total fuel bill	£0

Thermal Energy Demand Intensity (kWh per m2 pa)	74
Energy Use Intensity (kWh per m2 pa)	124

Age of construction	1991 - 1995
Windows	Double glazed windows pre 2002
Wall	Cavity as built
Roof	Another dwelling above
Floor	Another dwelling below
Primary heating	Existing - electric room heaters
Air tightness (ACH @ ambient pressure)	Building regs airtightness (5 n50)
Radiators / emitters	Existing electric

Description of Options for Appraisal

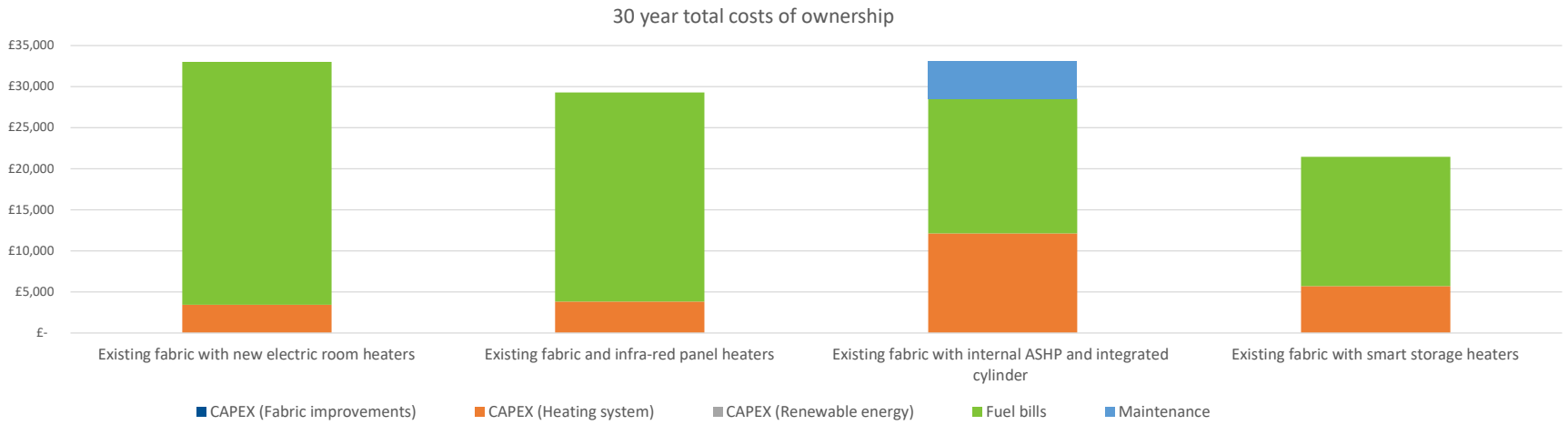
Thermal fabric
This small 1990s flat mid-floor has a relatively low level of thermal demand due to the favourable form factor, with insulated cavity walls and double glazing. Therefore, no additional fabric measures were modelled for this dwelling.

Energy systems
The flat already has electric room heaters. Three alternative electric heating systems were modelled in scenarios 2 - 4 as described in the table below.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new electric room heaters	Existing fabric and infra-red panel heaters	Existing fabric with internal ASHP and integrated cylinder	Existing fabric with smart storage heaters
HVAC system	2kW New electric room heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework , 0	2kW New infra-red panel heaters , 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	2kW 2.8kW max internal ducted ASHP (integrated cylinder) , 0, 0, hot water from main system (electric), 0	2kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
	£2,338	**£2,530**	**£5,550**	**£3,490**
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**	**£1,025**	**£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	**£2,338**	**£2,530**	**£5,550**	**£3,490**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£2,338**	**£2,530**	**£5,550**	**£3,490**
Electricity tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Domestic low overnight Tariff 01:30 - 06:30
Annual fuel bills	**£914**	**£787**	**£507**	**£485**
Annual OPEX (maintenance)	£0	£0	£148	£0
30 year total cost of ownership (excluding grant)	**£33,043**	**£29,325**	**£33,153**	**£21,457**
Annual tCO_2 emissions (2021)	**1.2**	**1.1**	**0.7**	**1.3**
Predicted annual tCO_2 emissions (2030)	**0.6**	**0.5**	**0.3**	**0.6**
Predicted annual tCO_2 emissions (2050)	**0.0**	**0.0**	**0.0**	**0.0**

30 year total costs of ownership

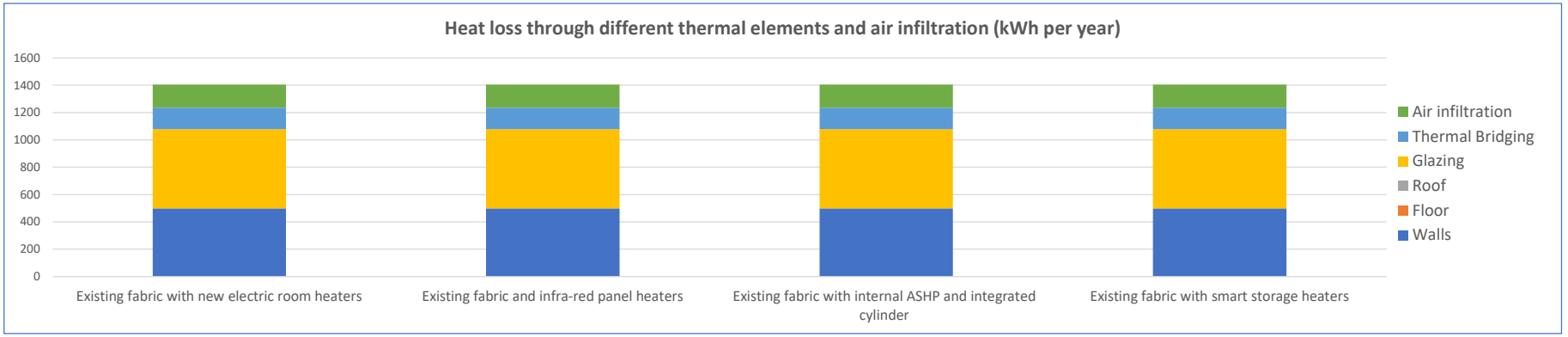


CAPEX
CAPEX for the 4 options is relatively similar, although the internal ASHP in scenario 3 has the highest upfront cost due to the higher cost of the technology and also the need to install new pipework and radiators.

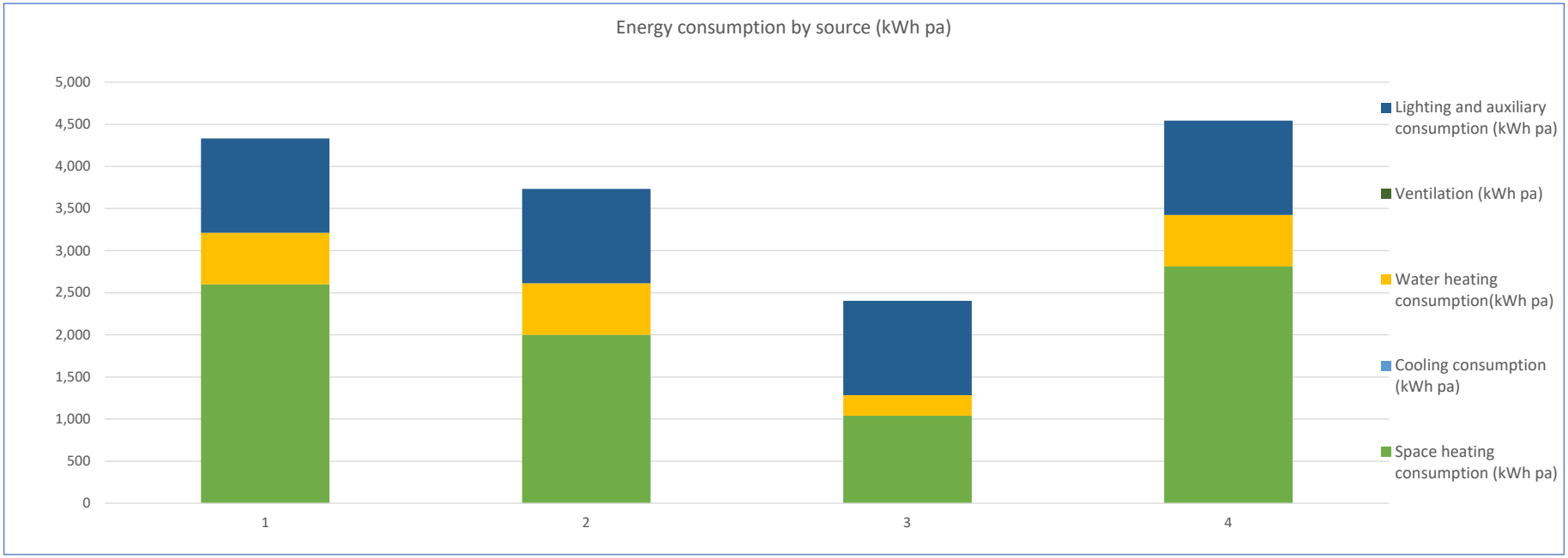
Fuel bills
Fuel bills are highest in the BAU scenario. In scenario 2, the infra-red panel heaters provide heat more efficiently as they are heating objects rather than the volume of air in the room. In scenario 3, the ASHP offers a clear efficiency and cost benefit over direct electric. In scenario 4, the ability to pair HHR storage heaters with very low over-night tariffs provide the lowest overall fuel bills.

30 year lifetime costs
Scenario 4 is modelled as having the lowest lifetime costs with similar fuel bills to scenario 3 but much lower CAPEX.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

	Existing fabric with new electric room heaters	Existing fabric and infra-red panel heaters	Existing fabric with internal ASHP and integrated cylinder	Existing fabric with smart storage heaters
Space heating demand (kWh pa)	2,601	2,601	2,601	2,601
Space heating peak demand (kW)	1.4	1.4	1.4	1.4
Space heating peak demand per flat (kW)	1.4	1.4	1.4	1.4
Peak electricity load @ 6:00pm	1.7	1.4	0.8	0.3
Required flow temperatures °C	60	60	55	60
Space heating consumption (kWh pa)	2,601	2,001	1,040	2,812
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	613	613	245	613
Ventilation (kWh pa)	0	0	0	0
Lighting and auxiliary consumption (kWh pa)	1120	1120	1120	1120
Assumed heating system Seasonal Performance Factor (SPF)	**100%**	**130%**	**250%**	**93%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**74**	**74**	**74**	**74**
Energy Use Intensity - all energy use (kWh per m2 pa)	**124**	**107**	**69**	**130**

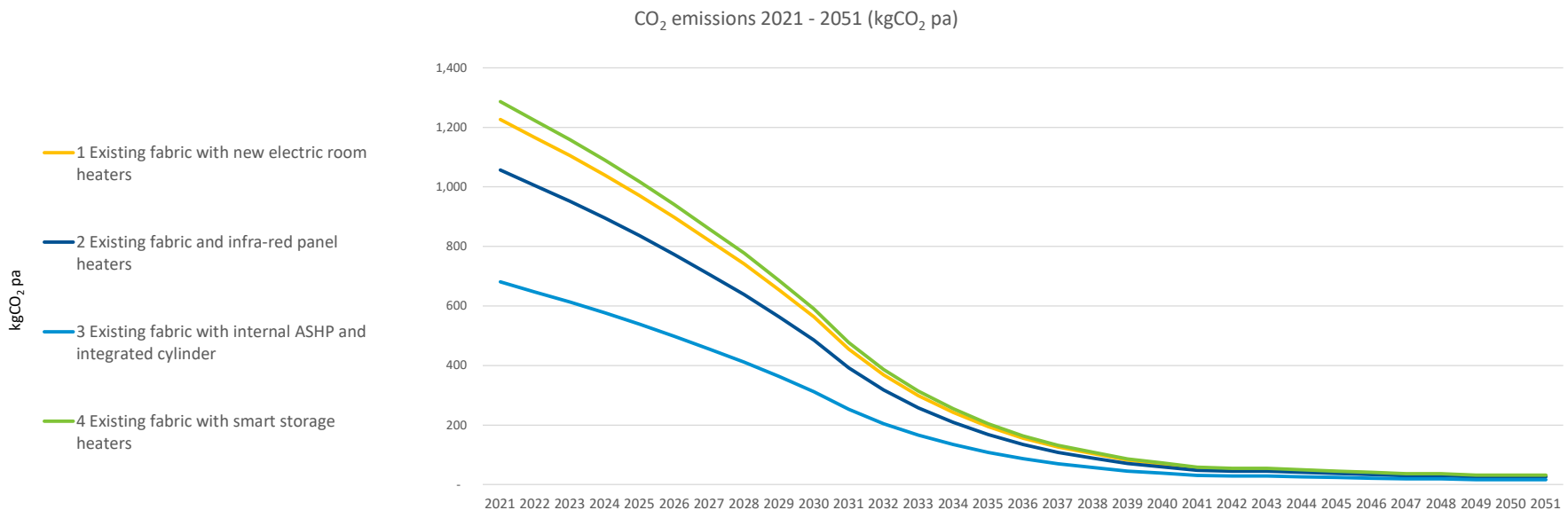
System efficiency is highest in scenario 3. However, there are significant wider energy system benefits to the storage option in scenario 4, with no additional peak load on the electricity network.

Retrofit package CO_2 emissions

tCO_2 in 2021	**1**	**1**	**1**	**1**
Predicted annual tCO_2 emissions (2030)	**0.6**	**0.5**	**0.3**	**0.6**
tCO^2 in 2050	**0.0**	**0.0**	**0.0**	**0.0**
tCO^2 cumulative 2021 - 2050	**12**	**10**	**6**	**12**
tCO_2 saved relative to BAU (30 year cumulative)	**0**	**-2**	**-5**	**1**
CO_2 saving relative to baseline (30 year cumulative)	**0%**	**14%**	**44%**	**-5%**
Additional cost over BAU scenario (30 years)	**£0**	**-£3,718**	**£110**	**-£11,585**
£ per tonne of CO_2 reduction (30 year cumulative)	**NA**	**-£2,294**	**£21**	**£20,348**

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

30 year predicted CO_2 emissions



CO_2 savings
As the existing heating system is electric, the CO_2 savings are relatively smaller than when replacing gas. However, the ASHP option would still reduce CO_2 emissions over 30 years by 44%

Potential impact of Solar PV on all scenarios

	Existing fabric with new electric room heaters	Existing fabric and infra-red panel heaters	Existing fabric with internal ASHP and integrated cylinder	Existing fabric with smart storage heaters
Included in package? (Y/N)	N	N	N	N
System size kW Peak	0.0	0.0	0.0	0.0
System generation kWh pa	0	0	0	0
Utilisation on site kWh pa	0	0	0	0
Utilisation on site kWh pa	0%	0%	0%	0%
Exported to grid kWh pa	0	0	0	0
Assumed system cost £	0	0	0	0
Net impact on fuel bills £ pa	£ -	£ -	£ -	£ -

Solar PV was not modelled for this property.

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