Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

29 BATES CRESCENT SW16 5AP

Domestic	**1 Units**
Floorspace (m2)	**78**
EPC Rating	**D**
Space heating consumption (kWh)	**8,542**
Cooling consumption (kWh)	**0**
Water heating consumption (kWh)	**1,560**
Other electricity use (kWh)	**2,496**
Annual total fuel bill	**£404**
Thermal Energy Demand Intensity (kWh per m2 pa)	**93**
Energy Use Intensity (kWh per m2 pa)	**162**
Age of construction	1991 - 1995
Windows	double glazing, unknown install date
Wall	Cavity as built
Roof	Pitched roof with insulation at joists
Floor	Insulation unkown or as-built
Primary heating	Existing - condensing gas boiler
Air tightness (ACH @ ambient pressure)	Poor performing airtightness (10 n50)
Radiators / emitters	Existing radiators - single panel single convector

Description of Options for Appraisal

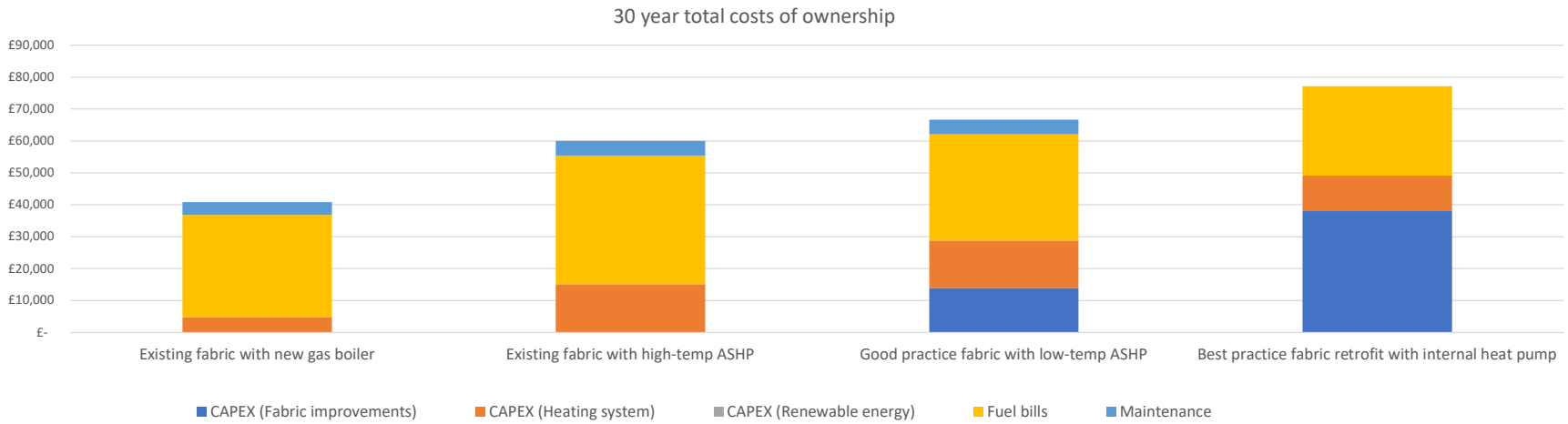
Thermal fabric measures:
Whilst this 1990s property has relatively good levels of insulation, there is still much room for improvement. Therefore, in scenario 3, we model the impact of upgraded loft insulation and high performance triple glazing. In scenario 4 we include external wall insulation and floor insulation.

Heating system:
In scenario 1, we replace like for like with a gas boiler.
In scenario 2, we replace with a standard Air Source Heat Pump with upgraded radiators which, according to our model should enable flow temperatures below 55°C.
In scenario 3, we replace with a standard Air Source Heat pump and upgraded radiators.
In scenario, due to the very low levels of residual heat loss, we consider installing an internal Air Source Heat Pump integrated with a hot water cylinder.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new gas boiler	Existing fabric with high-temp ASHP	Good practice fabric with low-temp ASHP	Best practice fabric retrofit with internal heat pump
HVAC system	4kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	4kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	3kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	2kW 2.8kW max internal ducted ASHP (integrated cylinder) , 0, 0, hot water from main system (electric), 0
	£2,400	**£7,750**	**£7,750**	**£5,550**
Heat emitter and distribution	Existing pipework, Existing radiators - single panel single convector	Existing pipework, New - Double panel double convector radiators	Existing pipework, New - Double panel double convector radiators	0, 0
	£0	**£0**	**£0**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, Loft insulation (Joists) 0 - 270mm, high performance triple glazing ,	External wall (Mid price), Loft insulation (Joists) 0 - 270mm, high performance triple glazing , Insulate Suspended floor (difficult access)
	£0	**£0**	**£13,540**	**£37,142**
Air tightness	Natural ventilation , Poor performing airtightness (10 n50)	Natural ventilation , Poor performing airtightness (10 n50)	MEV, Building regs airtightness (5 n50)	MVHR (de-centralised) , Enerphit airtightness (1 n50)
	£0	**£0**	**£390**	**£936**
Total CAPEX	**£2,400**	**£7,750**	**£21,680**	**£43,628**
Clean Heat Grant	£0	£5,000	£5,000	£0
Net CAPEX	**£2,400**	**£2,750**	**£16,680**	**£43,628**
Electricity tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff
Annual fuel bills	**£930**	**£1,245**	**£1,027**	**£864**
Annual OPEX (maintenance)	£129	£148	£148	£0
30 year total cost of ownership (excluding grant)	**£40,810**	**£60,027**	**£66,695**	**£77,166**
Annual tCO_2 emissions (2021)	**2.6**	**1.7**	**1.4**	**1.2**
Predicted annual tCO_2 emissions (2030)	**2.2**	**0.8**	**0.6**	**0.5**
Predicted annual tCO_2 emissions (2050)	**1.9**	**0.0**	**0.0**	**0.0**

30 year total costs of ownerhsip



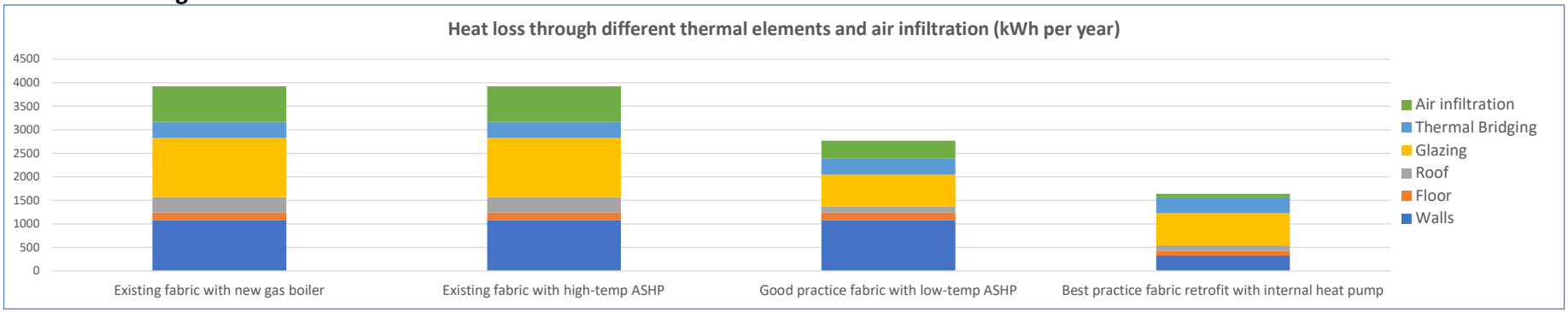
CAPEX
CAPEX is significantly higher in scenarios 3 and 4 due to the inclusion of high performance triple glazing and, in scenario 4, external wall insulation. However, in scenario 4, the CAPEX associated with the heating system is lower than in scenarios 2 & 3.

Fuel bills
Fuel bills are lows in scenario 4, due to the combination of low demand for heat, plus efficiency operation of the heat pump system at low flow temperatures.

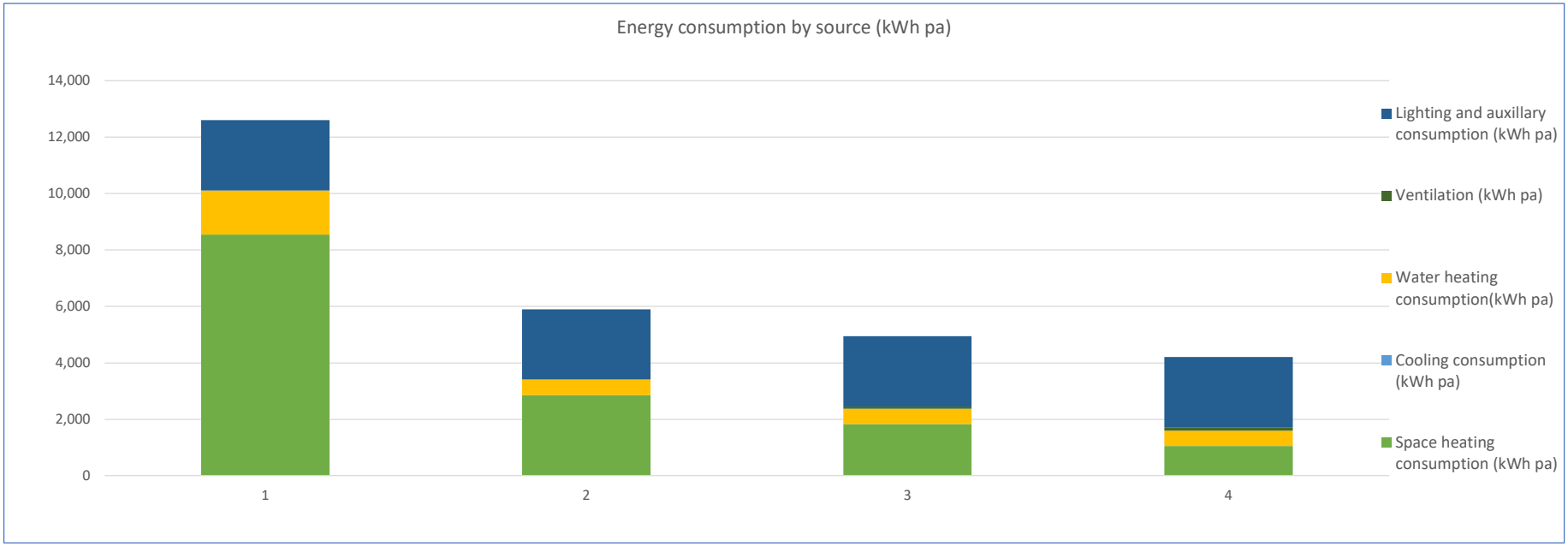
30 year cost of ownership
Of the electrification options, scenario 2 has the lowest overall cost of ownership. This suggests that, despite the benefits of the thermal fabric measures, these do not have a positive payback to the building owner within 30 years.

Please note that no grants or other avoided costs have been included in this analysis.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

	4kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	4kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	3kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	2kW 2.8kW max internal ducted ASHP (integrated cylinder) , 0, 0, hot water from main system (electric), 0
Space heating demand (kWh pa)	7,261	7,261	5,117	3,033
Space heating peak demand (kW)	3.9	3.9	2.8	1.6
Space heating peak demand per flat (kW)	3.9	3.9	2.8	1.6
Peak electricity load @ 6:00pm	0.6	2.1	1.6	1.2
Required flow temperatures °C	60	53	40	36
Space heating consumption (kWh pa)	8,542	2,859	1,828	1,053
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	1560	546	546	546
Ventilation (kWh pa)	0	0	78	109
Lighting and auxillary consumption (kWh pa)	2496	2496	2496	2496
Assumed heating system Seasonal Performance Factor (SPF)	**85%**	**254%**	**280%**	**288%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**93**	**93**	**66**	**39**
Energy Use Intensity - all energy use (kWh per m2 pa)	**162**	**76**	**63**	**54**

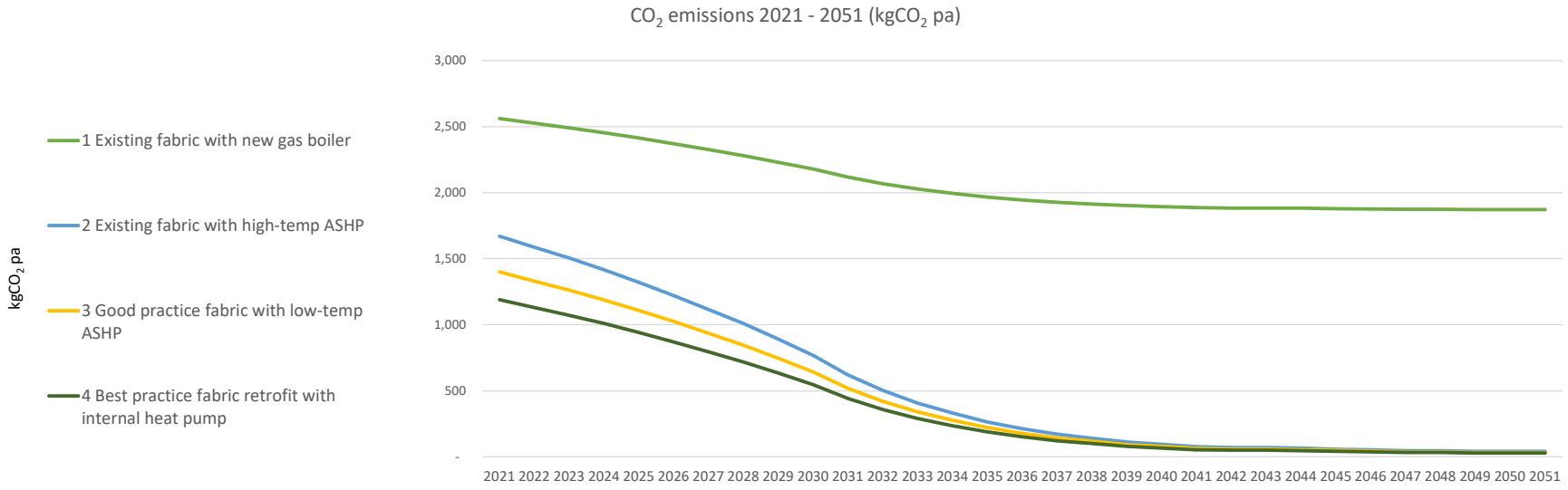
System efficiency is highest in scenario 4, due to the lower flow temperatures required.

Retrofit package CO_2 emissions

tCO_2 in 2021	**3**	**2**	**1**	**1**
Predicted annual tCO_2 emissions (2030)	**2.2**	**0.8**	**0.6**	**0.5**
tCO^2 in 2050	**1.9**	**0.0**	**0.0**	**0.0**
tCO^2 cumulative 2021 - 2050	**62**	**16**	**13**	**11**
tCO_2 saved realtive to BAU (30 year cumulative)	**0**	**-46**	**-49**	**-51**
CO_2 saving relative to baseline (30 year cumulative)	**0%**	**74%**	**79%**	**82%**
Additional cost over BAU scenario (30 years)	**£0**	**£19,217**	**£25,885**	**£36,356**
£ per tonne of CO_2 reduction (30 year cumulative)	**NA**	**£414**	**£528**	**£713**

* 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 emissions
CO_2 emissions reduce significantly for all electrification options with reduction of 74% - 82% cumulatively over the 30 year period. Scenario 2 offers the lowest cost of CO2 reduction at £414 per tCO_2 reduction.

Potential impact of Solar PV on all scenarios

	Existing fabric with new gas boiler	Existing fabric with high-temp ASHP	Good practice fabric with low-temp ASHP	Best practice fabric retrofit with internal heat pump
Included in package? (Y/N)	N	N	N	N
System size kW Peak	2.5	2.5	2.5	2.5
System generation kWh pa	2,409	2,409	2,409	2,409
Utilisation on site kWh pa	1036	1322	1253	1182
Utilisation on site kWh pa	43%	55%	52%	49%
Exported to grid kWh pa	1373	1087	1156	1227
Assumed system cost £	3750	3750	3750	3750
Net impact on fuel bills £ pa	-£ 273	-£ 322	-£ 311	-£ 298

Renewable energy:

We modelled the impact of installation 2.5kW of solar PV under all scenarios. Due to the relatively low year round use of electricity, on-site utilisation of the PV was relatively low.

Impact of Solar PV on Scenario 2 - typical summer and winter days