Carbon Trust Options Appraisal for building decarbonisation: Summary of results

2nd November 2021

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Summary of current building

139 VALLEY ROAD SW16 2XT

Health centre / clinic with natural ventilation and cooling	1 Units
Floorspace (m2)	378
EPC Rating	C
Occupied space heating consumption (kWh)	44,262
Cooling consumption (kWh)	0
Water heating consumption (kWh)	15,120
Occupied area electricity use (kWh)	26,460
Annual total fuel bill	£784
Annual fuel bill per flat (including share of communal areas)	£784
Occupied area Thermal Energy Demand Intensity (kWh per m2 pa)	100
Occupied area Energy Use Intensity (kWh per m2 pa)	227
Age of construction	1983 - 1990
Windows	Double glazed windows pre 2002
Wall	Cavity as built
Roof	Pitched roof with insulation at joists
Floor	Insulation unknown or as-built
Primary heating	Existing - condensing gas boiler
Air tightness (ACH @ ambient pressure)	Average air tightness (7.5 n50)
Radiators / emitters	Existing radiators - single panel single convector

Description of Options for Appraisal

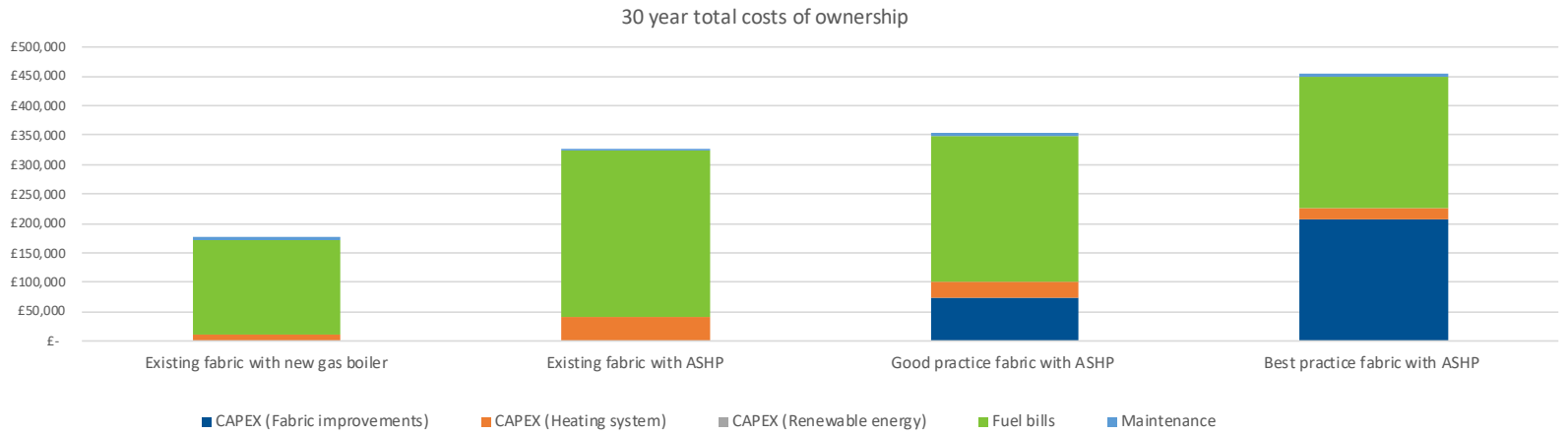
Thermal fabric
The current thermal fabric has some areas for improvement including increasing loft insulation and replacing windows with higher performing modern triple glazed units. Scenario 3 includes these measures. Scenario 4 looks at a best practice retrofit including external wall insulation to the entire building.

Energy systems
The building's current energy systems include a gas boiler for space and water heating. No cooling or ventilation systems are listed. Therefore, in scenarios 2 - 4, Air Source Heat Pumps are considered for each different level of

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new gas boiler	Existing fabric with ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
HVAC system	21kW New Condensing gas boiler, 0, 0, hot water from main system (gas), Hot water cylinder and associated pipework , 0	21kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	14kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	9kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework
	£6,500	**£19,100**	**£13,150**	**£8,900**
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	Existing pipework, New - Double panel double convector radiators
	£0	**£4,515**	**£3,010**	**£1,935**
Thermal fabric measures installed	, , ,	, , ,	, Loft insulation (joists) 100 - 270mm, high performance triple glazing ,	External wall insulation (High price - complex façade), Loft insulation (joists) 100 - 270mm, high performance triple glazing , Insulate solid floor
	£0	**£0**	**£71,755**	**£206,028**
Air tightness	Natural ventilation , Average air tightness (7.5 n50)	Natural ventilation , Average air tightness (7.5 n50)	MEV, Building regs airtightness (5 n50)	MEV, Good new build performance (3 n50)
	£0	**£0**	**£1,890**	**£1,890**
Total CAPEX	**£6,500**	**£23,615**	**£89,805**	**£218,753**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£6,500**	**£23,615**	**£89,805**	**£218,753**
Electricity tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff
Annual fuel bills	**£4,757**	**£8,372**	**£7,366**	**£6,641**
Annual OPEX (maintenance)	£129	£148	£148	£148
30 year total cost of ownership (excluding grant)	**£175,943**	**£327,960**	**£354,389**	**£454,673**
Annual tCO_2 emissions (2021)	**18.4**	**13.2**	**11.7**	**10.5**
Predicted annual tCO_2 emissions (2030)	**14.3**	**6.1**	**5.4**	**4.8**
Predicted annual tCO_2 emissions (2050)	**11.1**	**0.3**	**0.3**	**0.3**

30 year total costs of ownership

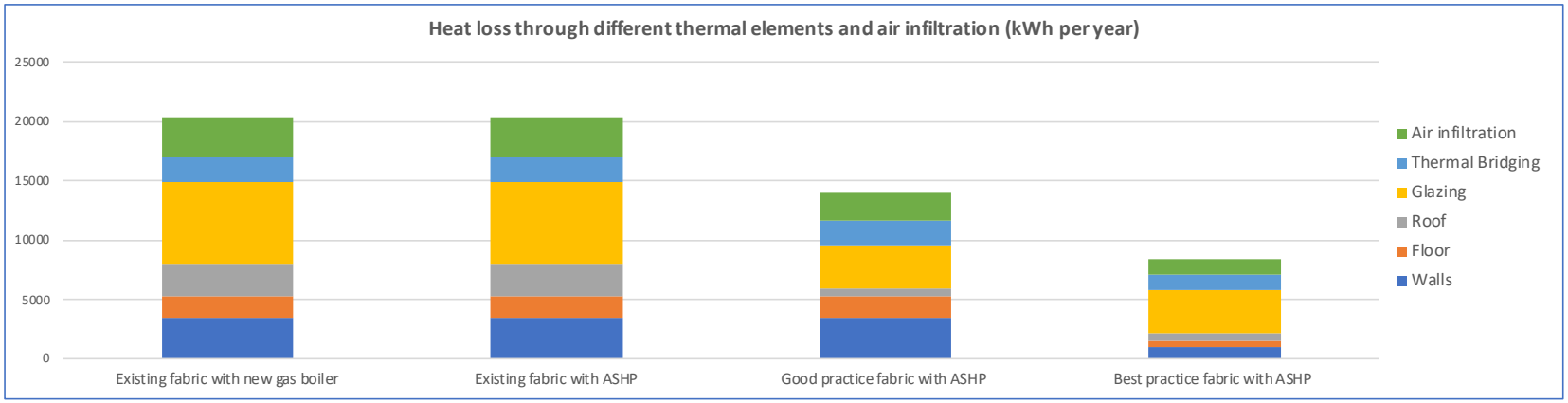


CAPEX
All electrification options show a significant increase in CAPEX relative to BAU. However, the scenarios that include glazing and external wall insulation (scenarios 3 and 4) shows a far larger increase in CAPEX again.

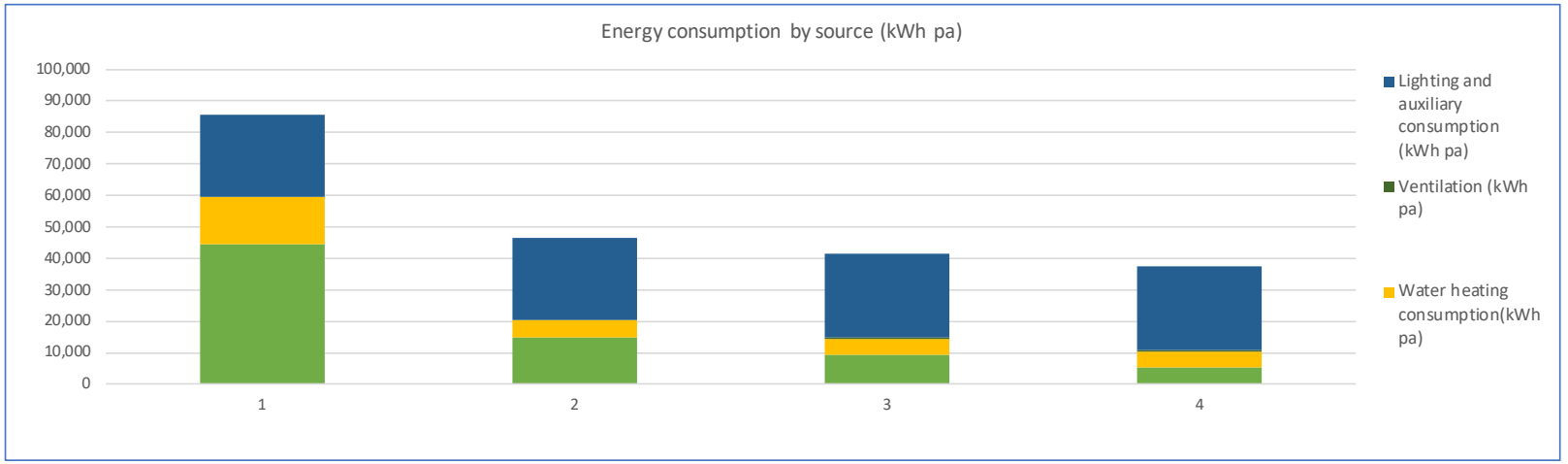
Fuel bills
Fuel bills increase in scenarios 3 & 4, although this increase is relatively marginal. Fuel bills decrease in scenario 4 due to the much lower demand for heat, however, again this decrease is relatively marginal due to the high proportion of overall energy use from sources other than heat.

30 year total costs of ownership
30 year total costs of ownership are higher in all electrification scenarios, with the additional CAPEX spent on fabric improvements not yielding a positive payback within 30 years.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

Energy consumption reduces significantly in scenarios 2-4 due to the high efficiency of the heat pump and also the reduction in demand for heat in scenarios 3 and 4. The fabric efficiency measures also decrease the impact on the electricity grid at the 06:00pm peak.

Heating system efficiency increases significantly in scenarios 3 and 4 as the required flow temperatures reduce with the lower heat loss. The use of high capacity triple panel, triple convector radiators in scenarios 2-4 ensure that all heat pump scenarios are able to operate at flow temperatures below 55°C.

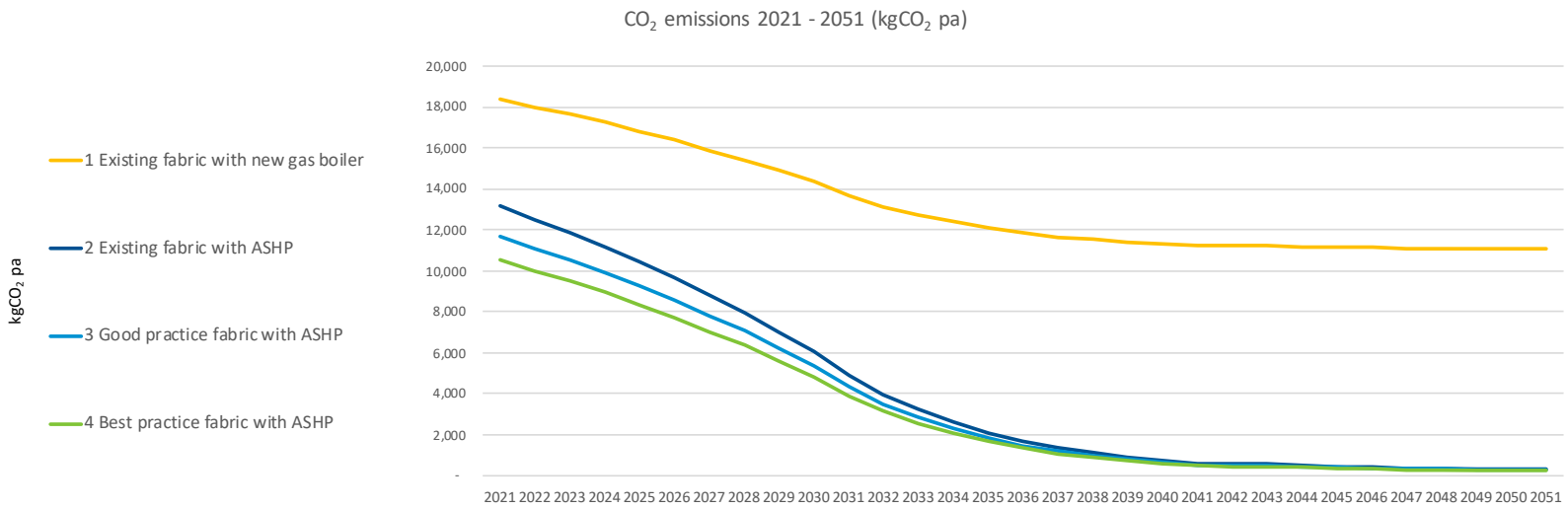
	Existing fabric with new gas boiler	Existing fabric with ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
Space heating demand (kWh pa)	37,622	37,622	25,812	15,566
Space heating peak demand (kW)	20.3	20.3	14.0	8.4
Peak electricity load @ 6:00pm	0.0	6.4	12.1	9.9
Required flow temperatures °C	60	53	39	28
Space heating consumption (kWh pa)	44,262	14,812	9,153	5,121
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	15120	5292	5292	5292
Lighting and auxiliary consumption (kWh pa)	26460	26460	26460	26460
Assumed heating system Seasonal Performance Factor (SPF)	**85%**	**254%**	**282%**	**304%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**100**	**100**	**68**	**41**
Energy Use Intensity - all energy use (kWh per m2 pa)	**227**	**123**	**109**	**99**

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	18	13	12	11
Predicted annual tCO_2 emissions (2030)	14.3	6.1	5.4	4.8
tCO^2 in 2050	11.1	0.3	0.3	0.3
tCO^2 cumulative 2021 - 2050	398	126	111	101
tCO_2 saved relative to BAU (30 year cumulative)	0	-273	-287	-298
CO_2 saving relative to baseline (30 year cumulative)	0%	68%	72%	75%
Additional cost over BAU scenario (30 years)	£0	£152,017	£178,446	£278,730
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£558	£622	£936

30 year predicted CO_2 emissions



CO_2 emissions

CO_2 emissions reduce immediate and significantly for scenarios 2-4 due to the high efficiency of the heat pumps systems and low carbon intensity of grid electricity. Scenario 2 delivers the lowest cost of carbon reduction per tCO_2.

Potential impact of Solar PV on all scenarios

	Existing fabric with new gas boiler	Existing fabric with ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
Included in package? (Y/N)	N	N	N	N
System size kW Peak	5.0	5.0	5.0	5.0
System generation kWh pa	4,818	4,818	4,818	4,818
Utilisation on site kWh pa	4818	4818	4818	4818
Utilisation on site kWh pa	100%	100%	100%	100%
Exported to grid kWh pa	0	0	0	0
Assumed system cost £	7500	7500	7500	7500
Net impact on fuel bills £ pa	-£ 724	-£ 724	-£ 724	-£ 724

The potential impact of a solar PV array was modelled separately for each of the 4 scenarios. The table above shows the potential on-site utilisation and reduction in fuel bills associated with the max size system for the roof.

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