Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

106 GIPSY ROAD SE27 9RE

Domestic	**1 Units**
Floorspace (m2)	**88**
EPC Rating	**F**
Space heating consumption (kWh)	**28,028**
Cooling consumption (kWh)	**0**
Water heating consumption (kWh)	**1,760**
Other electricity use (kWh)	**2,816**
Annual total fuel bill	**£1,191**
Thermal Energy Demand Intensity (kWh per m2 pa)	**255**
Energy Use Intensity (kWh per m2 pa)	**371**
Age of construction	1900 - 1929
Windows	Single glazed windows
Wall	Solid brick, as built, no insulation (assumed)
Roof	Pitched roof with insulation at joists
Floor	Insulation unknown 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

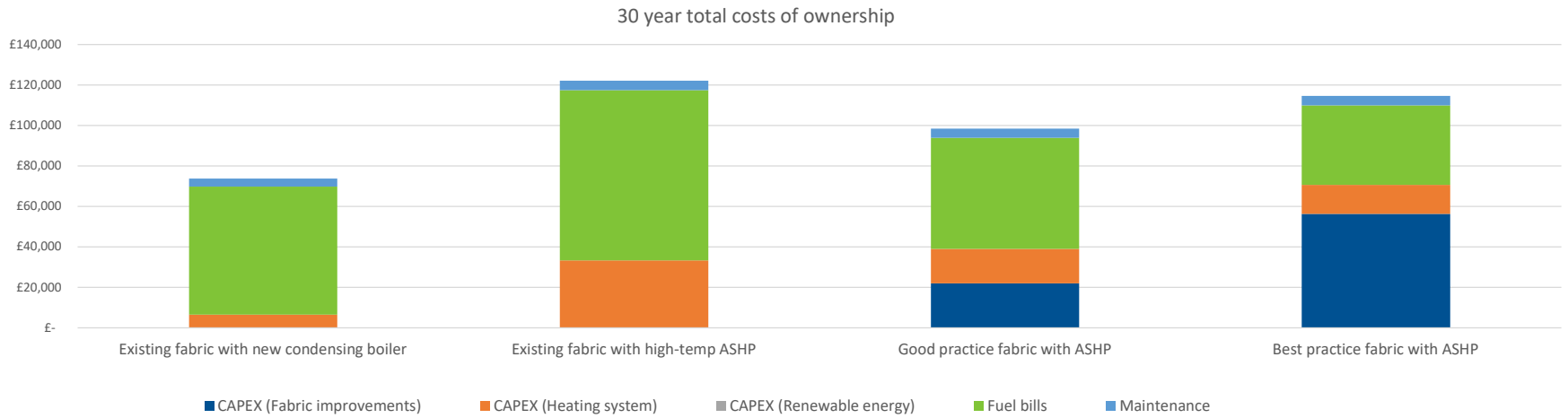
Thermal fabric measures:
This 1900 - 1929 End terrace house currently has poor thermal fabric efficiency and a low EPC Rating of F die to having solid walls, un-insulated floor, un-insulated loft and single glazing. The building is in a conservation area which is likely to impact the types of measures that can be installed. In scenario 2 we assume the fabric remains the same. In scenario 3 we include loft insulation, floor insulation and high performance wooden sash double glazing. In scenario 4 we additionally include internal wall insulation.

Heating system:
In scenario 2, model the impact of a high temperature heat pump alongside new triple panel convector radiators and new pipework. We assume that new pipework would be required due to the high flow rates and volumes required for the larger capacity radiators.
In scenario 3, heat loss has reduced to the extent that a standard temperature heat pump could be utilised alongside double panel double convector radiators. Again, we assume that pipework would need replacing.
In scenario 4, we assume hat heat loss has reduced sufficiently to enable the retention of the existing radiators and pipework.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new condensing boiler	Existing fabric with high-temp ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
HVAC system	13kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	13kW New Hi-temp ASHP Air to water >55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	7kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	4kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework
	£3,250	**£14,900**	**£7,750**	**£7,750**
Heat emitter and distribution	Existing pipework, Existing radiators - single panel single convector	New in-home distribution pipework to radiators, New - triple panel triple convector radiators	New in-home distribution pipework to radiators, New - Double panel double convector radiators	Existing pipework, Existing radiators - single panel single convector
	£0	**£4,765**	**£2,825**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, Loft insulation (Joists) 0 - 270mm, Double Glazing (Wooden sash) , Insulate Suspended floor (difficult access)	Internal wall insulation (High price - complex interior), Loft insulation (Joists) 0 - 270mm, Double Glazing (Wooden sash) , Insulate Suspended floor (difficult access)
	£0	**£0**	**£21,483**	**£55,319**
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) , AECB airtightness (1.5 n50)
	£0	**£0**	**£440**	**£1,056**
Total CAPEX	**£3,250**	**£14,900**	**£29,673**	**£64,125**
Clean Heat Grant	£0	£5,000	£5,000	£0
Net CAPEX	**£3,250**	**£9,900**	**£24,673**	**£64,125**
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	**£1,785**	**£2,598**	**£1,695**	**£1,214**
Annual OPEX (maintenance)	£129	£148	£148	£148
30 year total cost of ownership (excluding grant)	**£73,833**	**£122,092**	**£98,503**	**£114,538**
Annual tCO_2 emissions (2021)	**6.3**	**3.5**	**2.3**	**1.7**
Predicted annual tCO_2 emissions (2030)	**5.8**	**1.6**	**1.1**	**0.8**
Predicted annual tCO_2 emissions (2050)	**5.5**	**0.1**	**0.1**	**0.0**

30 year total costs of ownership

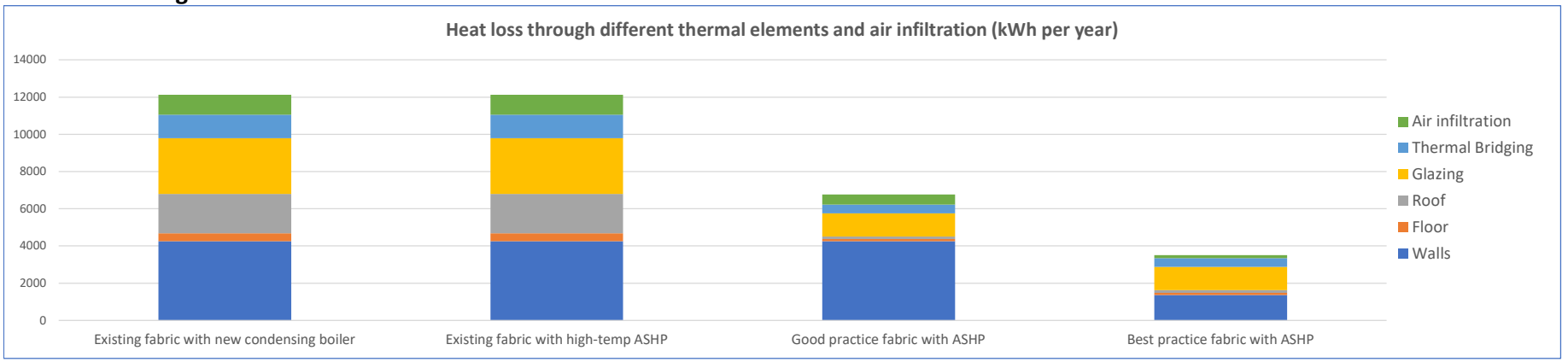


CAPEX
The CAPEX for the thermal fabric measures is assumed to be relatively high due to the heritage features of the property. Heating system CAPEX is very high in scenario 2. This is due to a) the large size of the heat pump unit required and b) the need to replace all pipework and radiators with high capacity triple panel radiators. The investment in fabric efficiency in scenario 3 reduces the CAPEX of the heating system significantly by reducing the size of both the heat pump and the radiators required to deliver the heat demand.

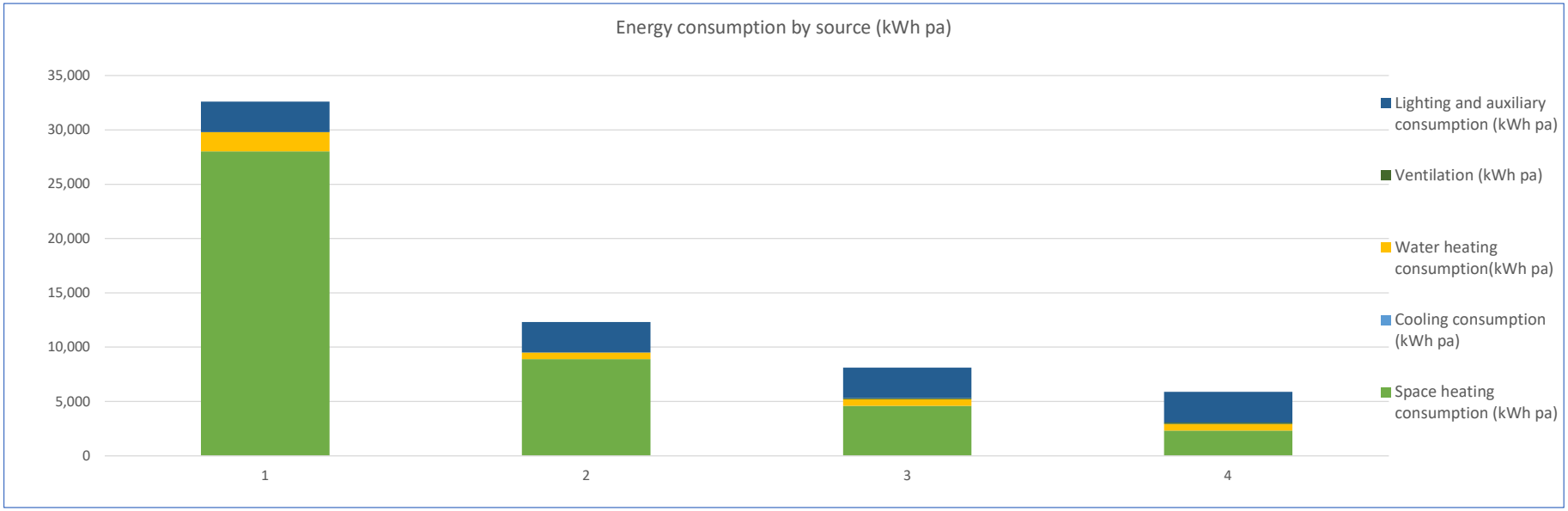
Fuel bills
Fuel bills increase significantly in scenario 2, due to the relatively poor efficiency of the heat pump in delivering the required higher flow temperatures. However fuel bills in scenario 3 are broadly equivalent to current bills and scenario 4 sees bills decrease below BAU.

30 year cost of ownership
All electrification options have a higher cost of ownership than the BAU. Scenario has the lowest cost of ownership of the electrification options suggesting that investments in loft and floor insulation and improved glazing are highly

Heat loss through thermal elements



Energy Consumption kWh pa



	Existing fabric with new condensing boiler	Existing fabric with high-temp ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
Space heating demand (kWh pa)	22,423	22,423	12,520	6,501
Space heating peak demand (kW)	12.1	12.1	6.8	3.5
Space heating peak demand per flat (kW)	12.1	12.1	6.8	3.5
Peak electricity load @ 6:00pm	0.7	5.5	3.2	1.9
Required flow temperatures °C	70	56	44	40
Space heating consumption (kWh pa)	28,028	8,898	4,603	2,322
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	1760	604	616	616
Ventilation (kWh pa)	0	0	88	123
Lighting and auxiliary consumption (kWh pa)	2816	2816	2816	2816
Assumed heating system Seasonal Performance Factor (SPF)	**80%**	**252%**	**272%**	**280%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**255**	**255**	**142**	**74**
Energy Use Intensity - all energy use (kWh per m2 pa)	**371**	**140**	**92**	**67**

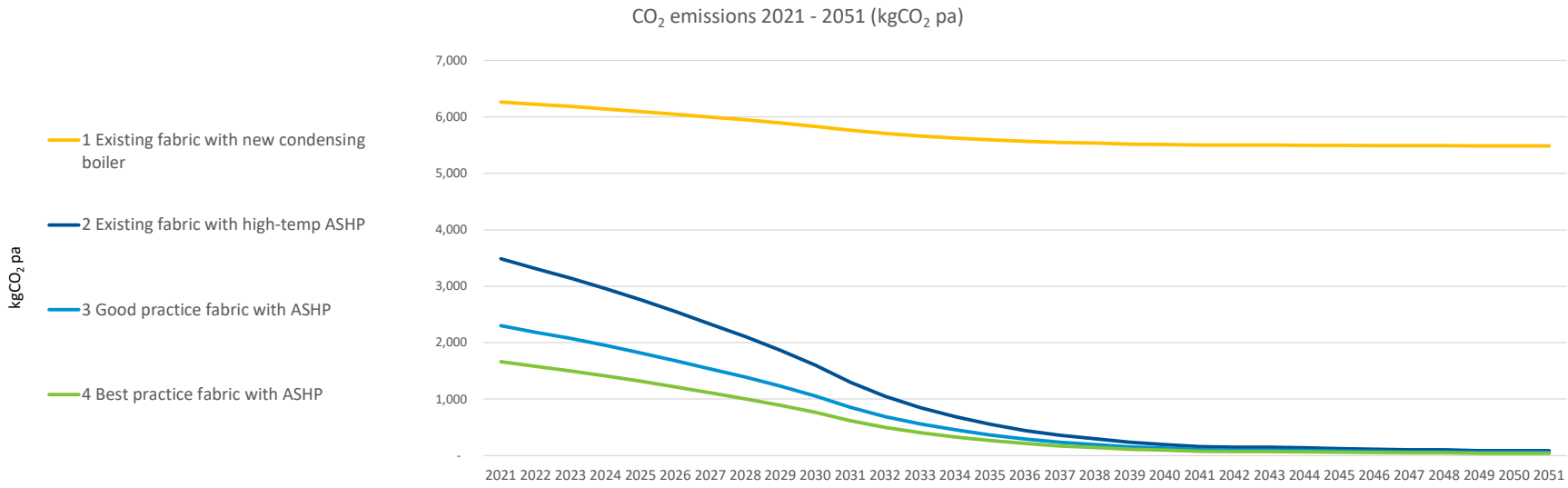
System efficiency is relatively low in scenario 2, due to the high flow temperatures required for the building without insulation.

Retrofit package CO_2 emissions

tCO_2 in 2021	6	3	2	2
Predicted annual tCO_2 emissions (2030)	5.8	1.6	1.1	0.8
tCO^2 in 2050	5.5	0.1	0.1	0.0
tCO^2 cumulative 2021 - 2050	172	33	22	16
tCO_2 saved relative to BAU (30 year cumulative)	0	-138	-150	-156
CO_2 saving relative to baseline (30 year cumulative)	0%	81%	87%	91%
Additional cost over BAU scenario (30 years)	£0	£48,260	£24,671	£40,705
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£349	£165	£261

* 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 in all electrification scenarios. Scenario 3 is by far the most cost effective in terms of £ per tonne of CO_2 saved.

Potential impact of Solar PV on all scenarios

	Existing fabric with new condensing boiler	Existing fabric with high-temp ASHP	Good practice fabric with ASHP	Best practice fabric with ASHP
Included in package? (Y/N)	N	N	N	N
System size kW Peak	2.0	2.0	2.0	2.0
System generation kWh pa	1,927	1,927	1,927	1,927
Utilisation on site kWh pa	1061	1369	1313	1245
Utilisation on site kWh pa	55%	71%	68%	65%
Exported to grid kWh pa	867	558	614	682
Assumed system cost £	3000	3000	3000	3000
Net impact on fuel bills £ pa	-£ 258	-£ 311	-£ 302	-£ 290

Renewable energy:

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