Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

31 HEMANS STREET SW84SQ

Domestic	**1 Units**
Floorspace (m2)	**80**
EPC Rating	**C**
Space heating consumption (kWh)	**6,870**
Cooling consumption (kWh)	**0**
Water heating consumption (kWh)	**1,600**
Other electricity use (kWh)	**2,560**
Annual total fuel bill	**£339**
Thermal Energy Demand Intensity (kWh per m2 pa)	**75**
Energy Use Intensity (kWh per m2 pa)	**138**

Age of construction	1983 - 1990
Windows	double glazing installed before 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 - double panel, double convector

Description of Options for Appraisal

Thermal fabric measures:
This 1980s terraced house already has a relatively low level of thermal energy demand intensity, due to insulated cavity walls, 150mm of insulation in the loft and full double glazing. In scenario we consider the impact of topping up loft insulation and insulating the floor. In scenario 4 we consider a full best practice retrofit with the addition of external wall insulation and high performance triple glazing.

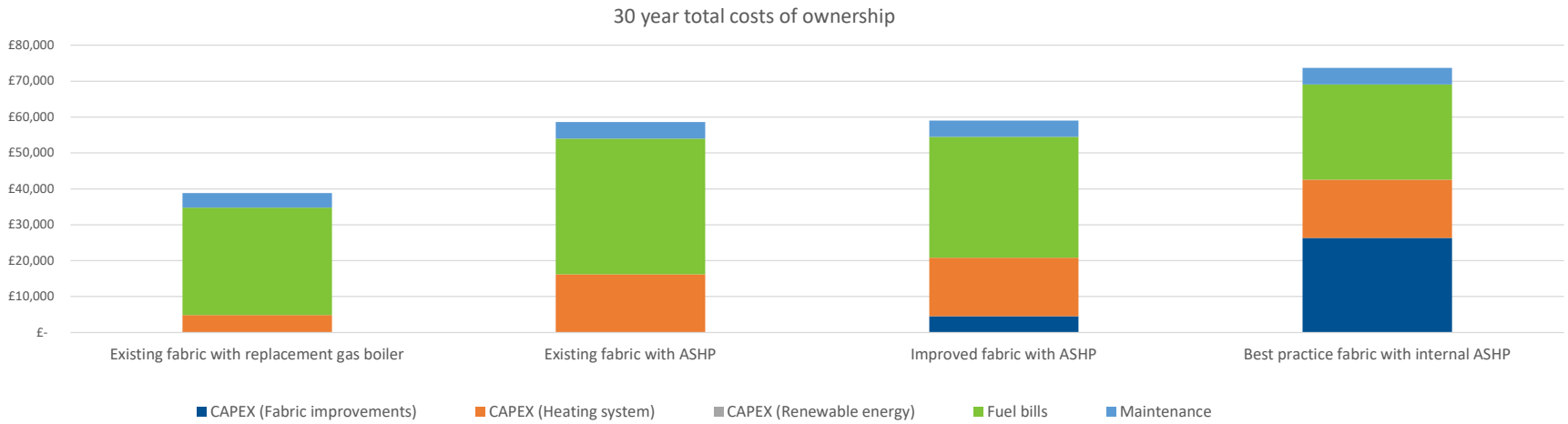
Heating system:
The property is well suited to a heat pump with, existing double panel double convector radiators. We assume that the existing pipework is suitable for heat pumps (although in reality, an installer would need to confirm f micro-bore pipework was present in which case it may need replacing.

In scenarios 2 - 4 we consider the impact of installing air source heat pumps.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with replacement gas boiler	Existing fabric with ASHP	Improved fabric with ASHP	Best practice fabric with internal ASHP
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 New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework
	£2,400	**£8,750**	**£8,750**	**£8,750**
Heat emitter and distribution	Existing pipework, Existing radiators - double panel, double convector	Existing pipework, Existing radiators - double panel, double convector	Existing pipework, Existing radiators - double panel, double convector	Existing pipework, Existing radiators - double panel, double convector
	£0	**£0**	**£0**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, Loft insulation (joists) 100 - 270mm, , Insulate Suspended floor (difficult access)	External wall (Mid price), Loft insulation (joists) 100 - 270mm, high performance triple glazing , Insulate Suspended floor (difficult access)
	£0	**£0**	**£4,160**	**£25,348**
Air tightness	Natural ventilation , Average air tightness (7.5 n50)	Natural ventilation , Average air tightness (7.5 n50)	MEV, Building regs airtightness (5 n50)	MVHR (de-centralised) , AECB airtightness (1.5 n50)
	£0	**£0**	**£400**	**£960**
Total CAPEX	**£2,400**	**£8,750**	**£13,310**	**£35,058**
Clean Heat Grant	£0	£5,000	£5,000	£0
Net CAPEX	**£2,400**	**£3,750**	**£8,310**	**£35,058**
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	**£879**	**£1,165**	**£1,039**	**£819**
Annual OPEX (maintenance)	£129	£148	£148	£148
30 year total cost of ownership (excluding grant)	**£38,832**	**£58,597**	**£59,058**	**£73,670**
Annual tCO_2 emissions (2021)	**2.3**	**1.6**	**1.4**	**1.1**
Predicted annual tCO_2 emissions (2030)	**1.9**	**0.7**	**0.7**	**0.5**
Predicted annual tCO_2 emissions (2050)	**1.6**	**0.0**	**0.0**	**0.0**

30 year total costs of ownership

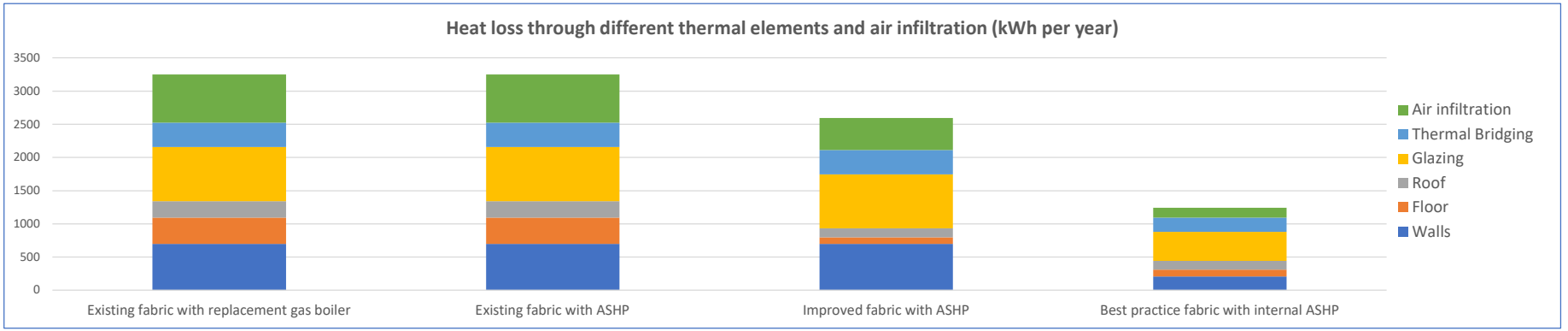


CAPEX
Due to the small size of the heat loss in the property (<4kW) the cost of the heat pumps is assumed to be around the minimum threshold cost.
Due to the relatively simple building facade and shape, external wall insulation in scenario 4 is assumed to be in middle of the cost range.

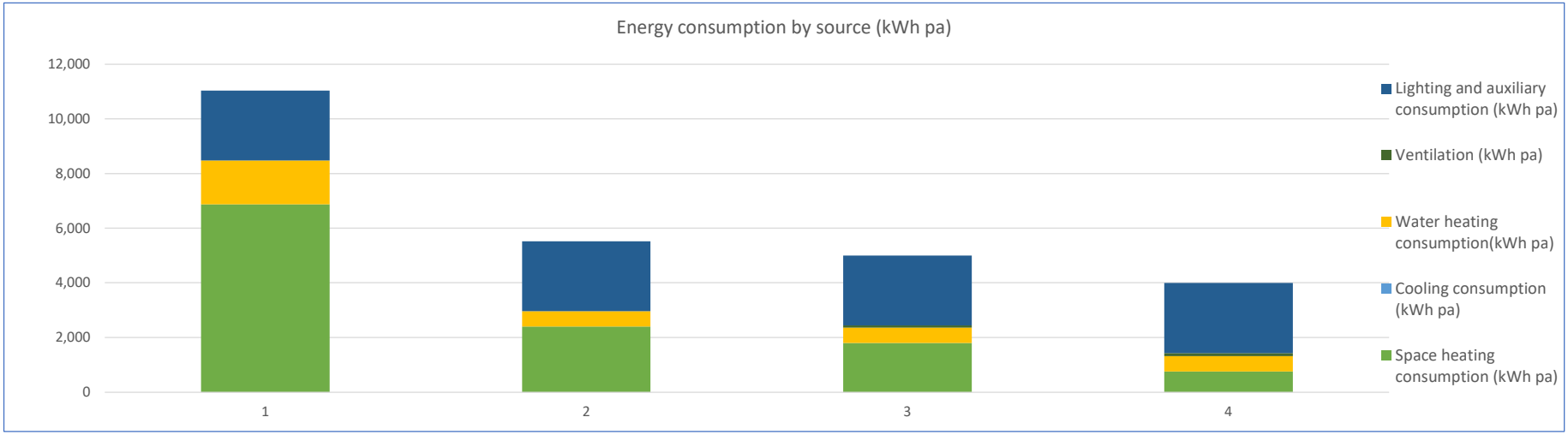
Fuel bills
Annual fuel bills are assumed to increase under scenarios 2 & 3 although the increase is not substantial. In scenario 4, fuel bills decrease, although only marginally. This is because space heating accounts for a relatively small proportion of overall energy consumption in this - so despite significant investment in the thermal fabric, the impact on fuel bills is not large.

30 year cost of ownership
Of the electrification options, scenarios 2 & 3 have the lowest 30 year costs of ownership at around £58,000.

Heat loss through thermal elements



Energy Consumption kWh pa



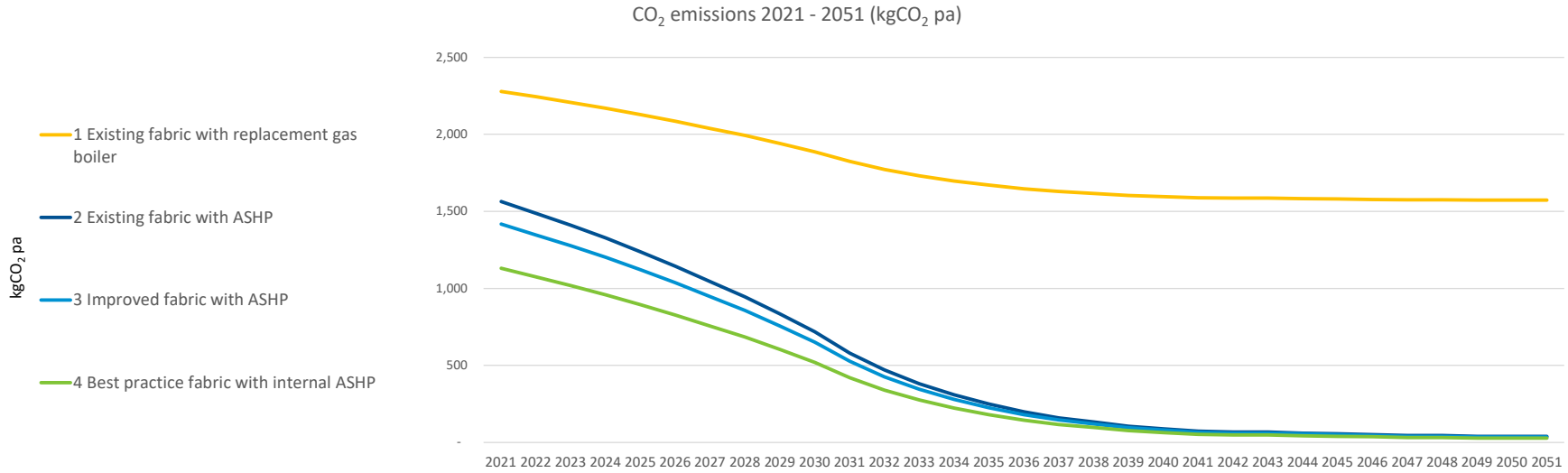
Heat demand and heating system efficiency

	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 New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework
Space heating demand (kWh pa)	6,011	6,011	4,801	2,298
Space heating peak demand (kW)	3.2	3.2	2.6	1.2
Space heating peak demand per flat (kW)	3.2	3.2	2.6	1.2
Peak electricity load @ 6:00pm	0.6	1.9	1.6	1.0
Required flow temperatures °C	55	55	47	29
Space heating consumption (kWh pa)	6,870	2,405	1,805	761
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	1600	560	560	560
Ventilation (kWh pa)	0	0	80	112
Lighting and auxiliary consumption (kWh pa)	2560	2560	2560	2560
Assumed heating system Seasonal Performance Factor (SPF)	**88%**	**250%**	**266%**	**302%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**75**	**75**	**60**	**29**
Energy Use Intensity - all energy use (kWh per m2 pa)	**138**	**69**	**63**	**50**

System efficiency increase significantly as the level of heat loss (and therefore flow temperatures) decreases through scenarios 2 - 4. Thermal Energy Demand Intensity (TEDI) and Energy Use Intensity (EUI) in scenario 3 still fall very close to the LETI and AECB good practice standards, despite only a small investment in the building fabric.

Retrofit package CO_2 emissions

tCO_2 in 2021	2	2	1	1
Predicted annual tCO_2 emissions (2030)	1.9	0.7	0.7	0.5
tCO^2 in 2050	1.6	0.0	0.0	0.0
tCO^2 cumulative 2021 - 2050	54	15	14	11
tCO_2 saved relative to BAU (30 year cumulative)	0	-39	-40	-43
CO_2 saving relative to baseline (30 year cumulative)	0%	72%	75%	80%
Additional cost over BAU scenario (30 years)	£0	£19,765	£20,226	£34,838
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£512	£505	£815



CO_2 emissions

CO_2 emissions savings relative to the BAU are large for all electrification options at between 72% - 82% over the 30 year period. Due to the forecast decarbonisation of the grid, CO2 emissions for scenarios 2 - 4 fall toward zero by 2050.

Potential impact of Solar PV on all scenarios

	Existing fabric with replacement gas boiler	Existing fabric with ASHP	Improved fabric with ASHP	Best practice fabric with internal ASHP
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	1056	1311	1268	1167
Utilisation on site kWh pa	44%	54%	53%	48%
Exported to grid kWh pa	1353	1098	1141	1242
Assumed system cost £	3750	3750	3750	3750
Net impact on fuel bills £ pa	-£ 277	-£ 320	-£ 313	-£ 296

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