



Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

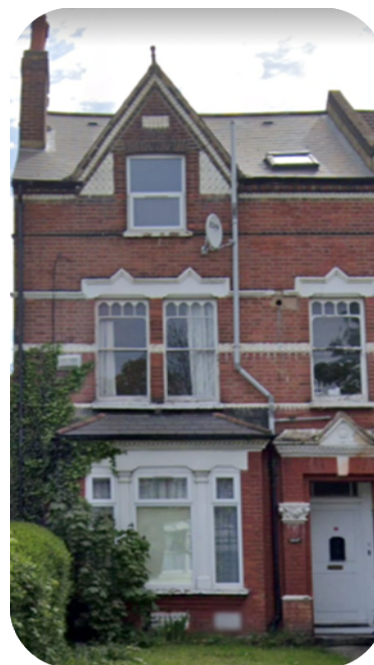
Mid Floor Flat, 311 NORWOOD ROAD SE24 9AQ

Domestic	1 Units
Floorspace (m2)	55
EPC Rating	DE

Space heating consumption (kWh)	10,575
Cooling consumption (kWh)	0
Water heating consumption (kWh)	1,100
Other electricity use (kWh)	1,760
Annual total fuel bill	£467

Thermal Energy Demand Intensity (kWh per m2 pa)	163
Energy Use Intensity (kWh per m2 pa)	244

Age of construction	1900 - 1929
Windows	Single glazed windows
Wall	Solid brick, as built, no insulation (assumed)
Roof	Another dwelling above
Floor	Another dwelling below
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

This small mid-floor flat has a relatively high level of heat loss due to single glazing, un-insulated solid walls and a high external wall area due to being an end of terrace. In scenarios 3 & 4 we therefore consider upgrades to the windows and walls to reduce heat loss.

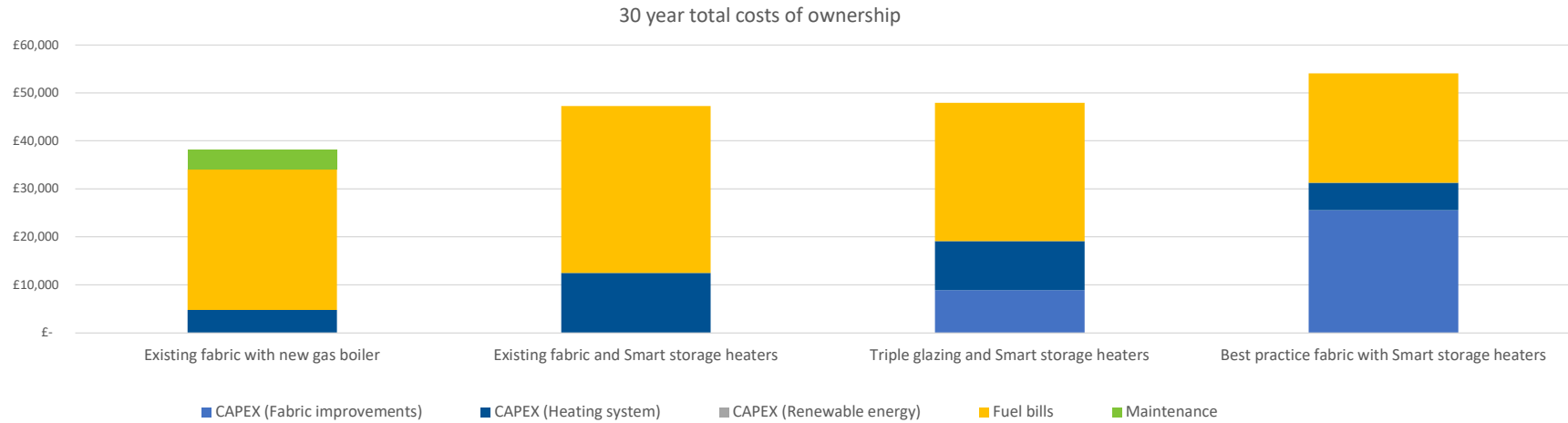
Energy systems

There are limited options for siting a heat pump at the property, and with neighbouring windows in very close proximity an air source heat pump may not receive planning permission due to noise concerns. Therefore, due to the relatively small heat load, we have considered electric storage heaters as the primary option for this flat, paired with a very low overnight tariff at approximately £0.06 per kWh.

Summary of options appraisal measures, costs & CO₂ emissions

	Existing fabric with new gas boiler	Existing fabric and Smart storage heaters	Triple glazing and Smart storage heaters	Best practice fabric with Smart storage heaters
HVAC system	5kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	5kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	4kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	2kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
	£2,400	£6,850	£5,730	£3,490
Heat emitter and distribution	Existing pipework, Existing radiators - single panel single convector	0, 0	0, 0	0, 0
	£0	£0	£0	£0
Thermal fabric measures installed	, , high performance triple glazing ,	Internal wall insulation (High price - complex interior), , high performance triple glazing ,
	£0	£0	£8,623	£25,279
Air tightness	Natural ventilation , Poor performing airtightness (10 n50)	Natural ventilation , Poor performing airtightness (10 n50)	MEV, Average air tightness (7.5 n50)	MEV, Building regs airtightness (5 n50)
	£0	£0	£275	£275
Total CAPEX	£2,400	£6,850	£14,628	£29,044
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	£2,400	£6,850	£14,628	£29,044
Electricity tariff	Treasury Green Book Central Domestic Tariff	Domestic low overnight Tariff 01:30 - 06:30	Domestic low overnight Tariff 01:30 - 06:30	Domestic low overnight Tariff 01:30 - 06:30
Annual fuel bills	£838	£1,074	£890	£703
Annual OPEX (maintenance)	£129	£0	£0	£0
30 year total cost of ownership (excluding grant)	£38,107	£47,262	£47,941	£54,077
Annual tCO₂ emissions (2021)	2.6	3.5	2.6	1.8
Predicted annual tCO₂ emissions (2030)	2.4	1.6	1.2	0.8
Predicted annual tCO₂ emissions (2050)	2.2	0.1	0.1	0.0

30 year total costs of ownership



CAPEX

CAPEX increases significantly for the thermal fabric retrofit measures in scenarios 3 & 4.

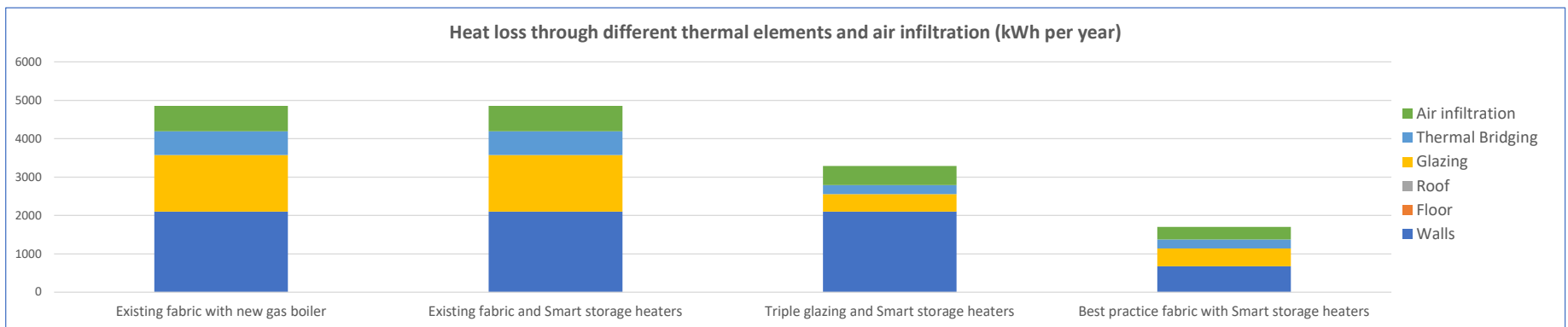
Fuel bills

Fuel bills are higher than BAU in scenario 2. However, they reduce compared to BAU in scenarios 3 & 4.

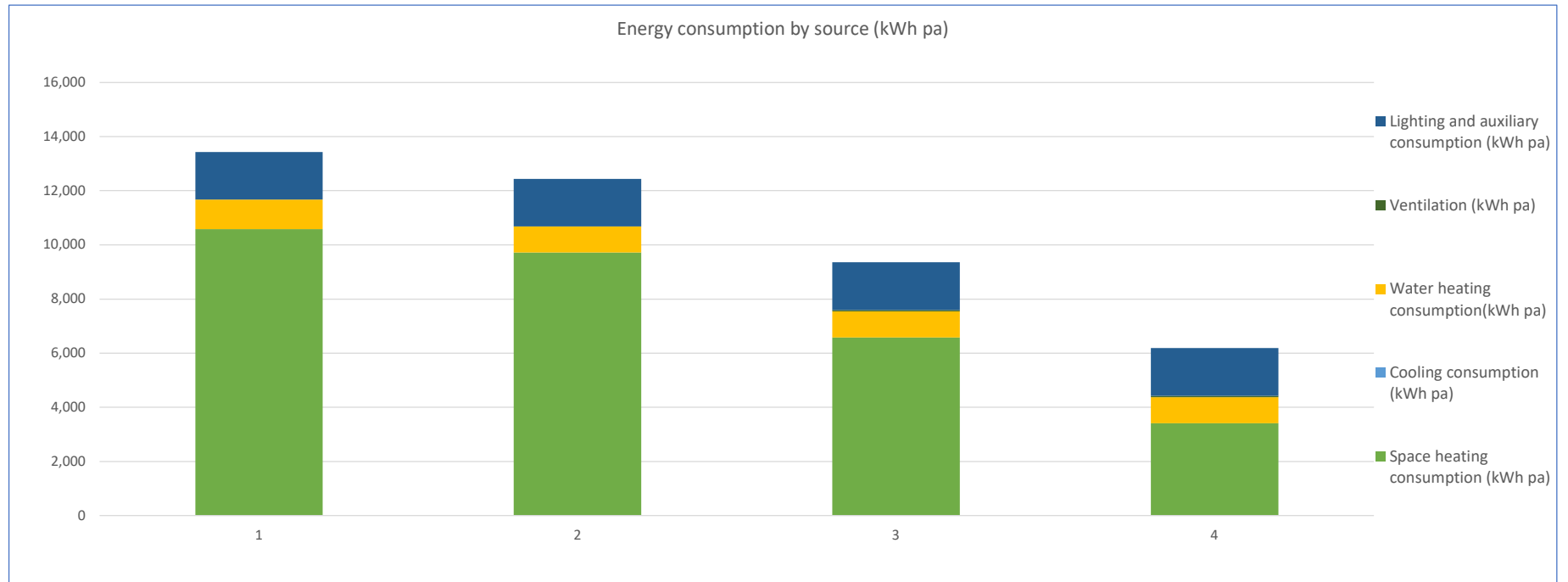
30 year costs of ownership

of the electrification options, scenarios 2 & 3 have a broadly equivalent total cost of ownership suggesting that the high performance glazing upgrade would be highly worthwhile given the additional comfort and noise benefits it would bring.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

	5kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	5kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	4kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	2kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
Space heating demand (kWh pa)	8,989	8,989	6,086	3,154
Space heating peak demand (kW)	4.9	4.9	3.3	1.7
Space heating peak demand per flat (kW)	4.9	4.9	3.3	1.7
Peak electricity load @ 6:00pm	0.4	0.4	0.4	0.4
Required flow temperatures °C	60	60	46	33
Space heating consumption (kWh pa)	10,575	9,717	6,579	3,410
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	1100	963	963	963
Ventilation (kWh pa)	0	0	55	55
Lighting and auxiliary consumption (kWh pa)	1760	1760	1760	1760
Assumed heating system Seasonal Performance Factor (SPF)	85%	93%	93%	93%
Assumed distribution losses	0%	0%	0%	0%
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	163	163	111	57
Energy Use Intensity - all energy use (kWh per m2 pa)	244	226	170	113

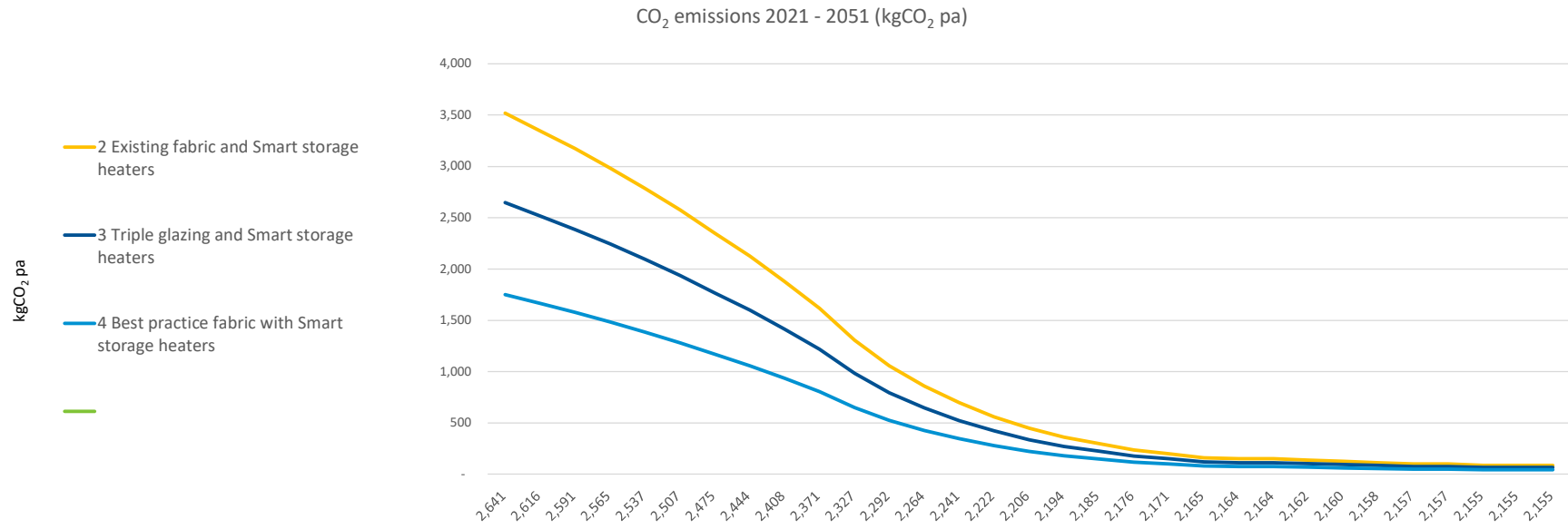
Whilst off-peak electric systems are less efficient than heat pump options and show as having a higher Energy Use Intensity (EUI), they offer significant advantages in adding no additional electricity load at peak times of day. Whilst electric heating systems are typically assumed to be 100% efficient, storage options are inherently less directly controllable than direct electric systems, which is reflected here in a lower overall system efficiency.

Retrofit package CO₂ emissions

tCO ₂ in 2021	3	4	3	2
Predicted annual tCO ₂ emissions (2030)	2.4	1.6	1.2	0.8
tCO ₂ in 2050	2.2	0.1	0.1	0.0
tCO ₂ cumulative 2021 - 2050	69	34	25	17
tCO ₂ saved relative to BAU (30 year cumulative)	0	-35	-44	-52
CO ₂ saving relative to baseline (30 year cumulative)	0%	51%	63%	76%
Additional cost over BAU scenario (30 years)	£0	£9,155	£9,834	£15,971
£ per tonne of CO ₂ reduction (30 year cumulative)	NA	£258	£225	£305

* 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 CO₂ emissions



CO₂ emissions

Electric storage system offer relatively low savings of CO₂ emissions in the near term. However, these savings increase substantially in the medium to long term due to predicted decreases in grid carbon storage options here offer CO₂ savings of 52% - 77% over the 30 year period. Furthermore, storage systems offer significant benefits in the context of an overall low carbon energy system, helping to minimise infrastructure upgrade costs and providing a valuable short term storage resource.

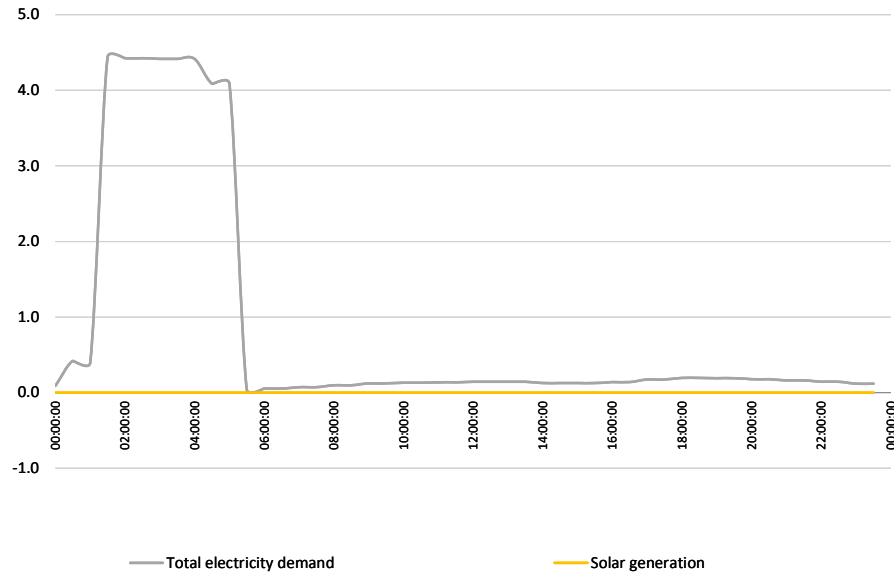
Potential impact of Solar PV on all scenarios

	5kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	5kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	4kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework	2kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
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

Average January day half hourly generation & consumption profile (option 4)



Average July day half hourly consumption & demand profiles (option 4)

