Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

Mid floor flat, 23 OFFLEY ROAD SW9 0LR

Domestic	**1 Units**
Floorspace (m2)	**44**
EPC Rating	**C**

Space heating consumption (kWh)	**4,149**
Cooling consumption (kWh)	**0**
Water heating consumption (kWh)	**700**
Other electricity use (kWh)	**1,120**
Annual total fuel bill	**£194**

Thermal Energy Demand Intensity (kWh per m2 pa)	**101**
Energy Use Intensity (kWh per m2 pa)	**171**

Age of construction	Pre 1900
Windows	Double glazed windows pre 2002
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

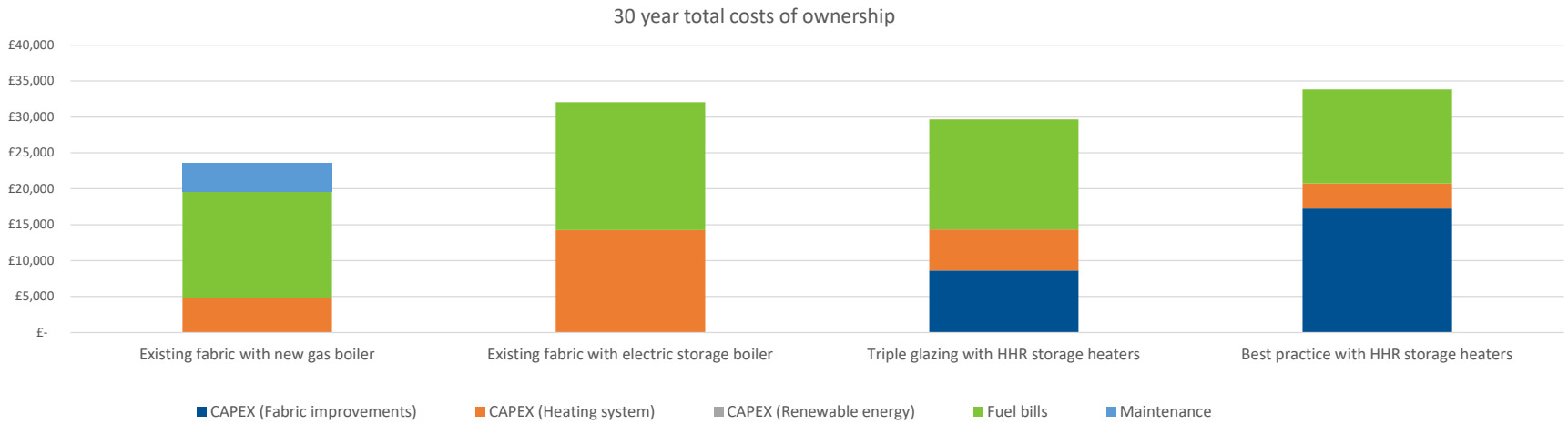
Thermal fabric
This mid Floor flat has a relatively small heat demand, due to its small size and mid floor, mid terrace form factor. Nevertheless, in scenario 3 we look at the impact of upgrading to high performance triple glazing. In scenario 4 we look at the impact of also installing internal wall insulation.

Heating systems
Although this flat has a small patio to the rear of the property, the close proximity of neighbouring windows (including a basement flat) mean that we discounted heat pump options. Therefore, in scenario 2 we consider an electric storage boiler. In scenarios 3 & 4 we consider HHR storage heaters. Both paired with very low overnight tariffs.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new gas boiler	Existing fabric with electric storage boiler	Triple glazing with HHR storage heaters	Best practice with HHR storage heaters
HVAC system	3kW New Condensing gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	3kW New electric storage boiler (e.g. Tepeo) , 0, 0, hot water from main system (electric), 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	1kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
	£2,400	**£7,750**	**£3,490**	**£2,370**
Heat emitter and distribution	Existing pipework, Existing radiators - single panel single convector	Existing pipework, Existing radiators - single panel single convector	Existing pipework, 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**	**£8,403**	**£17,058**
Air tightness	Natural ventilation , Poor performing airtightness (10 n50)	Natural ventilation , Poor performing airtightness (10 n50)	MEV, Building regs airtightness (5 n50)	MEV, Enerphit airtightness (1 n50)
	£0	**£0**	**£220**	**£220**
Total CAPEX	**£2,400**	**£7,750**	**£12,113**	**£19,648**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£2,400**	**£7,750**	**£12,113**	**£19,648**
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	**£430**	**£549**	**£473**	**£403**
Annual OPEX (maintenance)	£129	£0	£0	£0
30 year total cost of ownership (excluding grant)	**£23,631**	**£32,055**	**£29,675**	**£33,831**
Annual tCO_2 emissions (2021)	**1.2**	**1.6**	**1.2**	**0.9**
Predicted annual tCO_2 emissions (2030)	**1.0**	**0.7**	**0.6**	**0.4**
Predicted annual tCO_2 emissions (2050)	**0.9**	**0.0**	**0.0**	**0.0**

30 year total costs of ownership

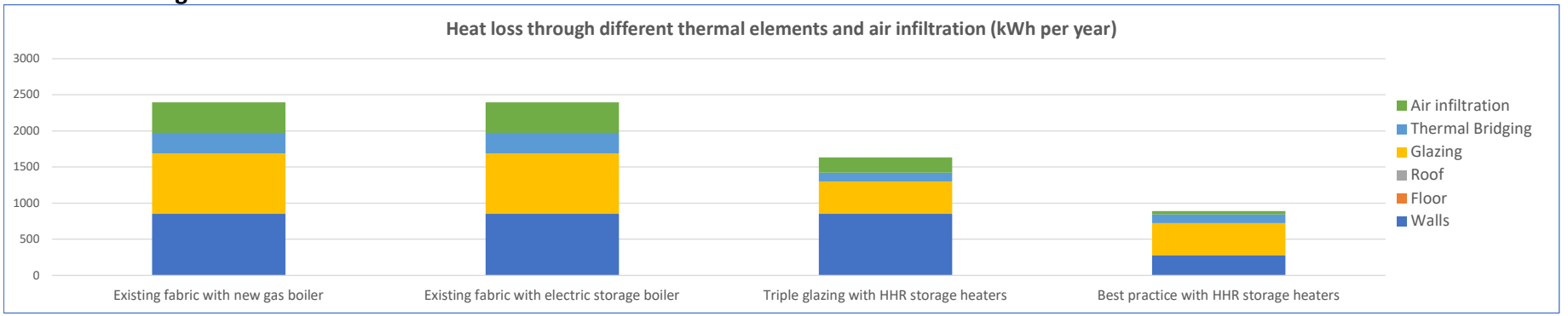


CAPEX
The electric storage boiler is assumed to have the highest CAPEX. Due to the reduction of heat demand in scenarios 3 & 4, the cost of the storage heaters is relatively small and similar to the BAU gas boiler cost.
The cost of internal wall insulation in scenario 4 is assumed to be high, due to the high likelihood of heritage features that would ideally be preserved.

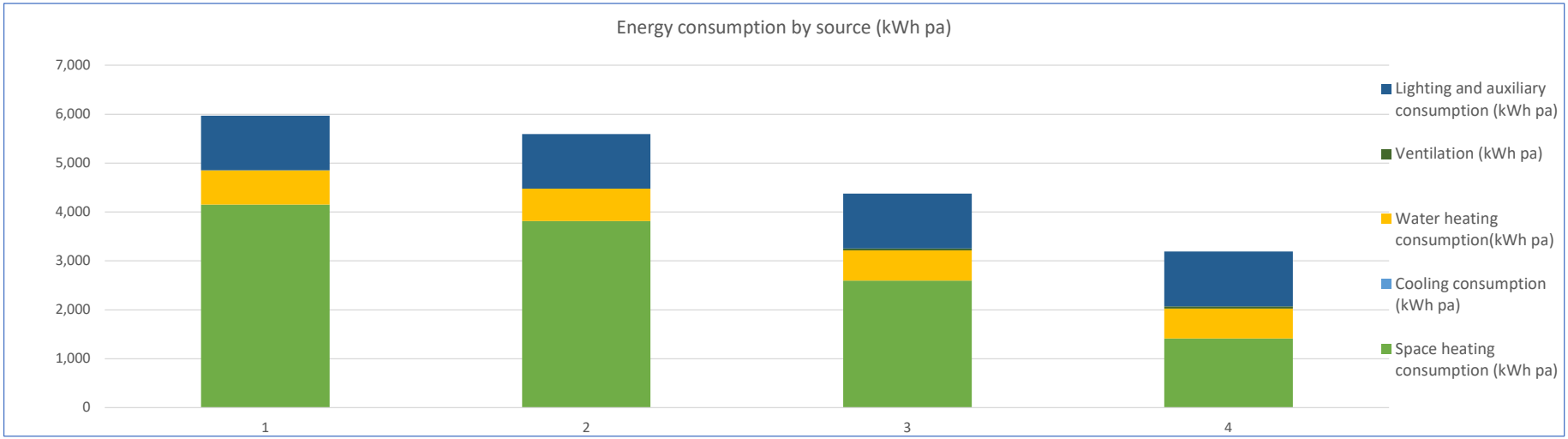
Fuel bills
Scenario 2 sees fuel bills increase. However, in scenarios 3 & 4 fuel bills are broadly equivalent to the BAU. in Scenario 2 - 4, we assumed that the storage boiler and heaters could benefit from very low 01:30 - 05:30 tariff rates at approximately £0.06 per kWh. It should be noted that standard Economy 7 tariffs would see costs nearly double compared to these very low tariffs.

30 year costs of ownership
Of the electrification options, scenario 3 has the lowest cost of ownership.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

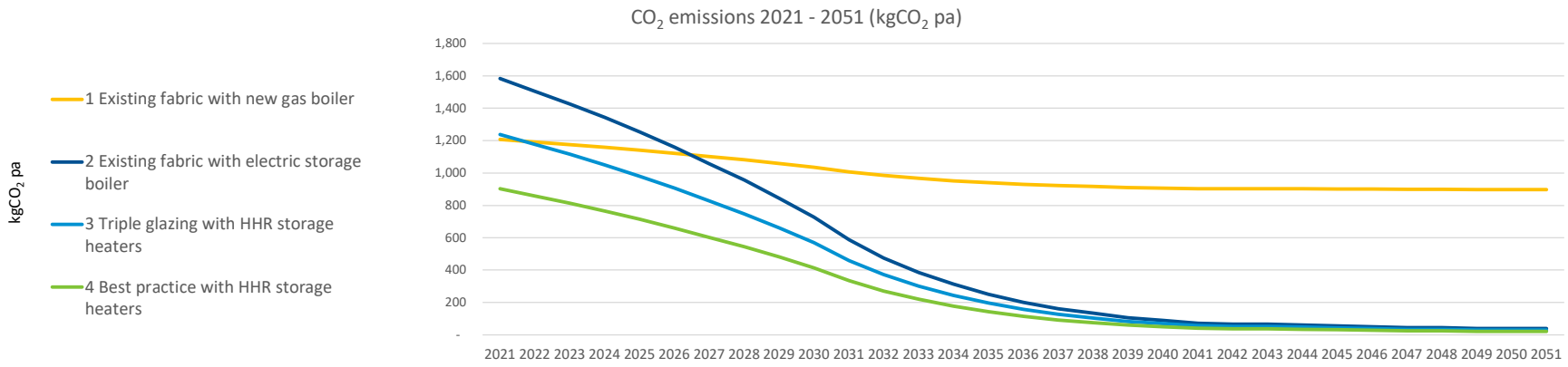
	Existing fabric with new gas boiler	Existing fabric with electric storage boiler	Triple glazing with HHR storage heaters	Best practice with HHR storage heaters
Space heating demand (kWh pa)	3,527	3,527	2,404	1,307
Space heating peak demand (kW)	2.4	2.4	1.6	0.9
Space heating peak demand per flat (kW)	2.4	2.4	1.6	0.9
Peak electricity load @ 6:00pm	0.3	0.3	0.3	0.3
Required flow temperatures °C	60	60	47	34
Space heating consumption (kWh pa)	4,149	3,813	2,599	1,413
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	700	662	613	613
Ventilation (kWh pa)	0	0	44	44
Lighting and auxiliary consumption (kWh pa)	1120	1120	1120	1120
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)	**80**	**80**	**55**	**30**
Energy Use Intensity - all energy use (kWh per m2 pa)	**171**	**160**	**125**	**91**

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 CO_2 emissions

tCO_2 in 2021	1	2	1	1
Predicted annual tCO_2 emissions (2030)	1.0	0.7	0.6	0.4
tCO2 in 2050	0.9	0.0	0.0	0.0
tCO2 cumulative 2021 - 2050	30	15	12	9
tCO_2 saved relative to BAU (30 year cumulative)	0	-15	-18	-21
CO_2 saving relative to baseline (30 year cumulative)	0%	49%	60%	71%
Additional cost over BAU scenario (30 years)	£0	£8,425	£6,044	£10,200
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£576	£338	£483

30 year predicted CO_2 emissions



Electric storage system offer relatively low savings of CO_2 emissions in the near term. However, these savings increase substantially in the medium to long term due to predicted decreases in grid carbon intensity. The storage options here offer CO_2 savings of 49% - 71% 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

	Existing fabric with new gas boiler	Existing fabric with electric storage boiler	Triple glazing with HHR storage heaters	Best practice with HHR storage heaters
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