Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

70 SOUTH LAMBETH ROAD SW8 1RL

Office with natural ventilation and cooling	1 Units
Floorspace (m2)	2252
EPC Rating	C
Occupied space heating consumption (kWh)	105,288
Cooling consumption (kWh)	0
Water heating consumption (kWh)	30,885
Occupied area electricity use (kWh)	213,940
Annual total fuel bill	£4,033
Annual fuel bill per flat (including share of communal areas)	£4,033
Occupied area Thermal Energy Demand Intensity (kWh per m2 pa)	43
Occupied area Energy Use Intensity (kWh per m2 pa)	155
Age of construction	2012 onwards
Windows	Double glazed windows post 2002
Wall	Cavity as built
Roof	Flat roof
Floor	Insulation unknown or as-built
Primary heating	Existing - condensing gas boiler
Air tightness (ACH @ ambient pressure)	Building regs airtightness (5 n50)
Radiators / emitters	New - Fan coil units

Description of Options for Appraisal

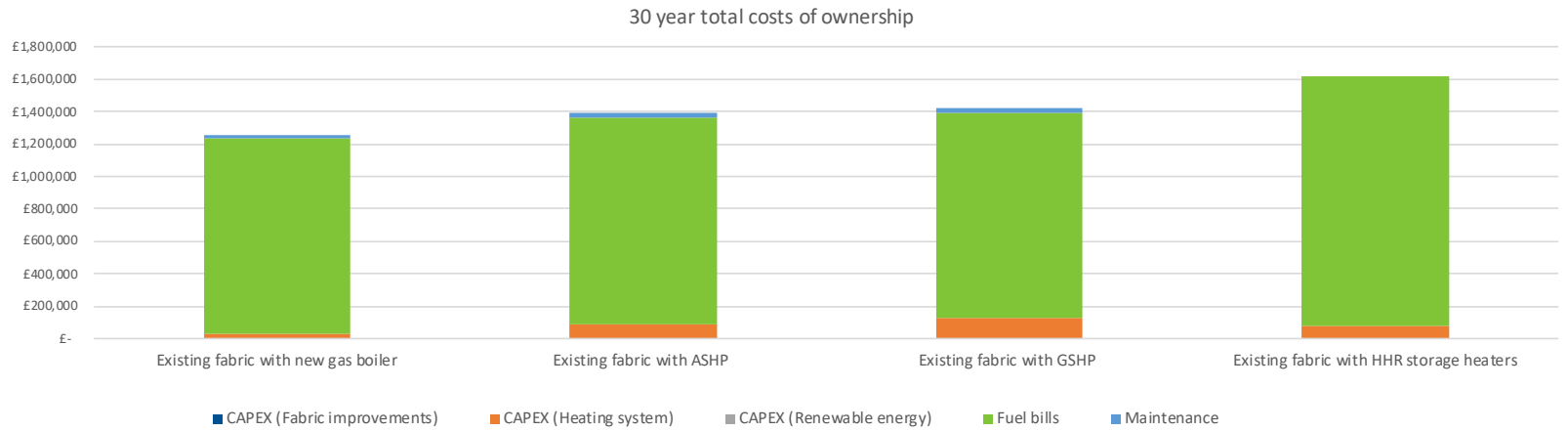
Thermal fabric measures:
Constructed post 2012, this building already has a relatively low demand for heating and cooling. No further additional fabric measures are considered in the scenarios.

Heating systems:
The existing heating system is a gas boiler. In scenarios 2 - 4 we consider replacing this with 2) an Air Source Heat Pump 3) Ground Source Heat Pump and 4) Electric storage heaters.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new gas boiler	Existing fabric with ASHP	Existing fabric with GSHP	Existing fabric with HHR storage heaters
HVAC system	53kW New Condensing gas boiler, 0, 0, hot water from main system (gas), Hot water cylinder and associated pipework , 0	53kW New ASHP Air to water <55°C, 0, 0, hot water from main system (electric), Hot water cylinder and associated pipework	53kW New GSHP/ WSHP <55°C, 0, ground loop (borehole) , hot water from main system (electric), Hot water cylinder and associated pipework	53kW New smart high heat retention storage heaters (large project greater than 24kW), 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
	£14,500	**£46,300**	**£91,350**	**£39,240**
Heat emitter and distribution	0, Existing fan coil units	0, Existing fan coil units	0, Existing fan coil units	0, Existing fan coil units
	£0	**£0**	**£0**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, , ,	, , ,
	£0	**£0**	**£0**	**£0**
Air tightness	Natural ventilation , Building regs airtightness (5 n50)	Natural ventilation , Building regs airtightness (5 n50)	Natural ventilation , Building regs airtightness (5 n50)	Natural ventilation , Building regs airtightness (5 n50)
	£0	**£0**	**£0**	**£0**
Total CAPEX	**£14,500**	**£46,300**	**£91,350**	**£39,240**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£14,500**	**£46,300**	**£91,350**	**£39,240**
Electricity tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Business Economy 7 tariff
Annual fuel bills	**£36,161**	**£39,169**	**£38,792**	**£47,440**
Annual OPEX (maintenance)	£650	£950	£1,050	£0
30 year total cost of ownership (excluding grant)	**£1,250,763**	**£1,390,059**	**£1,420,692**	**£1,614,537**
Annual tCO_2 emissions (2021)	**85.5**	**73.8**	**73.1**	**98.0**
Predicted annual tCO_2 emissions (2030)	**52.8**	**33.9**	**33.6**	**45.0**
Predicted annual tCO_2 emissions (2050)	**26.5**	**1.8**	**1.8**	**2.4**

30 year total costs of ownership



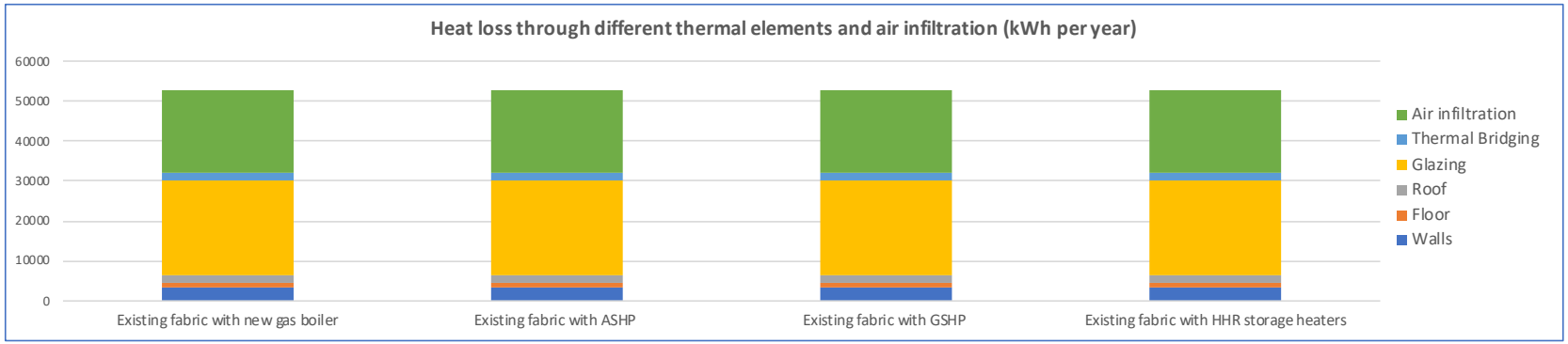
CAPEX
CAPEX is higher for all electrification scenarios. However, the lack of need for fabric measures means that the additional CAPEX of all electrification options is relatively low for this building.

Fuel bills
Fuel bills increase under all electrification options, although this increase is relatively marginal for the two scenarios involving heat pumps, 2 & 3. The greatest increase in fuel bills is shown in Scenario 4 where HHR storage heaters are assumed. The lower cost of the Economy 7 tariff is not sufficient to compensate for the lower efficiency of the storage heaters relative to the heat pump options.

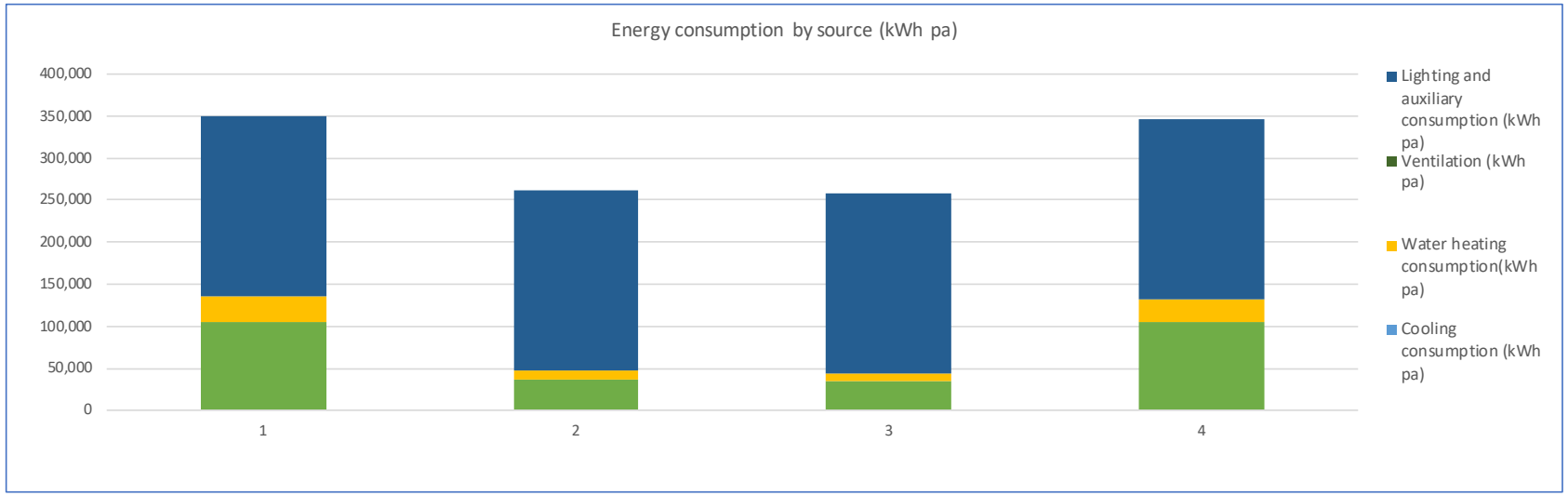
However, it is possible that scenario 4 (HHR storage heaters) could in future benefit from lower overnight tariffs and flexible time of use tariffs that may offer better value than the assumed Business Economy 7 tariff used in this analysis. This scenario may also bring benefits in terms of avoided need for network and connection upgrades as there is no additional peak load on the grid at 06:00pm.

30 year cost of ownership
All electrification options have a higher 30 year cost of ownership than the BAU. However, for scenarios 2 & 3, this increase in costs is relatively small.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

System efficiency
Thermal Energy Demand Intensity is already low in the BAU scenario. Energy Use Intensity improves significantly in scenarios 2 & 3 where heat pumps are utilised.

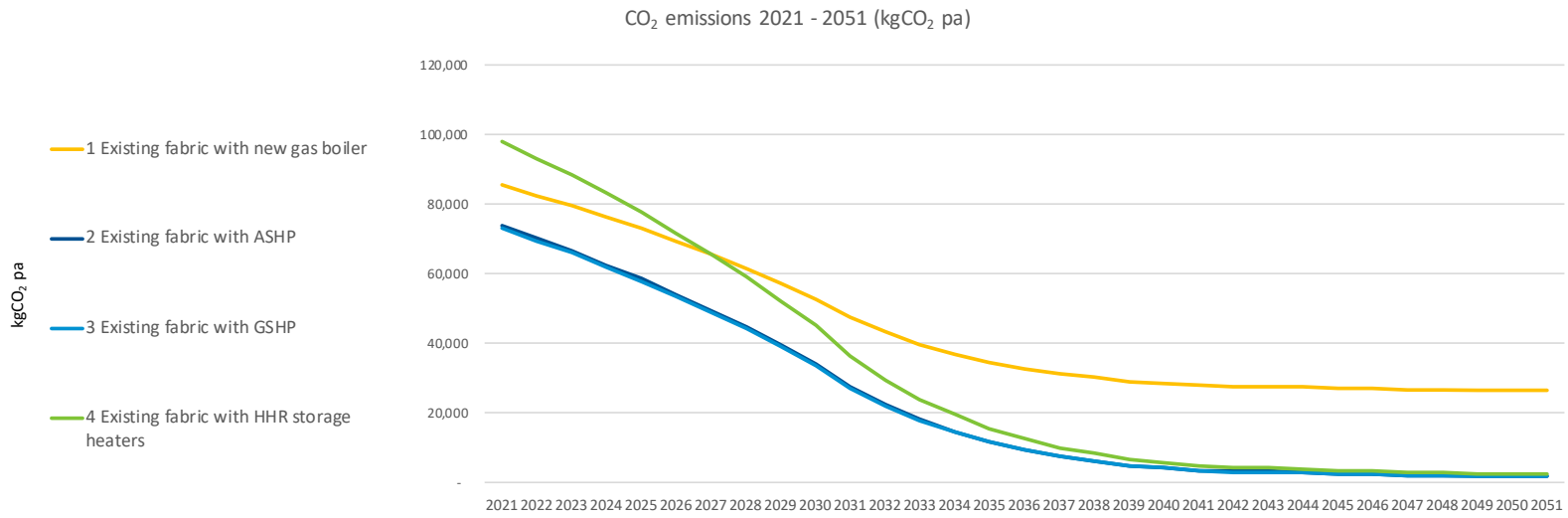
	Existing fabric with new gas boiler	Existing fabric with ASHP	Existing fabric with GSHP	Existing fabric with HHR storage heaters
Space heating demand (kWh pa)	97,392	97,392	97,392	97,392
Space heating peak demand (kW)	52.6	52.6	52.6	52.6
Space heating peak demand per flat (kW)	52.6	52.6	52.6	52.6
Peak electricity load @ 6:00pm	51.7	65.6	64.9	51.7
Required flow temperatures °C	45	45	45	45
Space heating consumption (kWh pa)	105,288	36,071	34,173	105,288
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	30885	10810	10198	27024
Ventilation (kWh pa)	0	0	0	0
Lighting and auxiliary consumption (kWh pa)	213940	213940	213940	213940
Assumed heating system Seasonal Performance Factor (SPF)	**93%**	**270%**	**285%**	**93%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**43**	**43**	**43**	**43**
Energy Use Intensity - all energy use (kWh per m2 pa)	**155**	**116**	**115**	**154**

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	86	74	73	98
Predicted annual tCO_2 emissions (2030)	52.8	33.9	33.6	45.0
tCO^2 in 2050	26.5	1.8	1.8	2.4
tCO^2 cumulative 2021 - 2050	1327	704	697	935
tCO_2 saved relative to BAU (30 year cumulative)	0	-623	-630	-392
CO_2 saving relative to baseline (30 year cumulative)	0%	47%	47%	30%
Additional cost over BAU scenario (30 years)	£0	£139,296	£169,929	£363,774
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£224	£270	£927

30 year predicted CO_2 emissions



CO_2 emissions

CO_2 emissions decline significantly in all scenarios. This is due to the high proportion of energy use that is already electricity and the relatively low proportion of energy use from gas. The largest reductions in CO2 emissions come from scenarios 2 & 3 where heat pumps are utilised. Scenario 4 has higher CO2 emissions compared to 2 & 3. However, the use of storage heaters could bring significant benefits to a low carbon energy system and has the

Potential impact of Solar PV on all scenarios

	Existing fabric with new gas boiler	Existing fabric with ASHP	Existing fabric with GSHP	Existing fabric with HHR storage heaters
Included in package? (Y/N)	N	N	N	N
System size kW Peak	20.0	20.0	20.0	20.0
System generation kWh pa	19,272	19,272	19,272	19,272
Utilisation on site kWh pa	19272	19272	19272	19272
Utilisation on site kWh pa	100%	100%	100%	100%
Exported to grid kWh pa	0	0	0	0
Assumed system cost £	30000	30000	30000	30000
Net impact on fuel bills £ pa	-£ 2,894	-£ 2,894	-£ 2,894	#N/A

Renewable energy:
Due to the high year round requirement for electricity (primarily for lighting and cooling) solar PV utilisation on-site would be high under all scenarios with assumed 100% utilisation. This would lead to significant reductions in fuel bills.

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