Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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Summary of current building

FONTHILL APARTMENTS JEFFREYS ROAD SW4 6QU

Domestic (flats, high glazed area)	41 Units
Floorspace (m2)	4524
EPC Rating	AB

Occupied space heating consumption (kWh)	182,733
Cooling consumption (kWh)	67,863
Water heating consumption (kWh)	116,336
Occupied area electricity use (kWh)	144,773
Annual total fuel bill	£40,790
Annual fuel bill per flat (including share of communal areas)	£995

Occupied area Thermal Energy Demand Intensity (kWh per m2 pa)	34
Occupied area Energy Use Intensity (kWh per m2 pa)	113

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)	Good new build performance (3 n50)
Radiators / emitters	Existing radiators - double panel, double convector

Description of Options for Appraisal

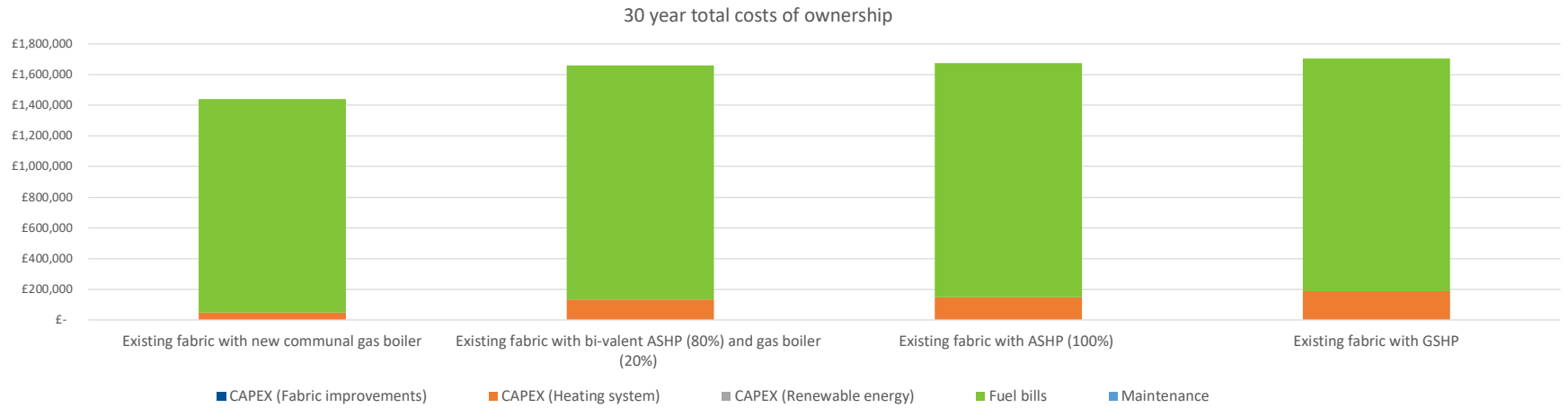
Thermal fabric
This modern building contains a mixture of retail and domestic units. It has a relatively good level of fabric efficiency with modelled Thermal Energy Demand Intensity of only 34kWh per m^2 per year. Therefore, no additional thermal fabric measures were considered in the Options Appraisal.

Heating systems
The building is currently heated by a communal gas boiler. Given the potential efficiency of the communal heating arrangement, scenarios 2 - 4 consider options for replacing the primary centralised heating system.
In scenario 2, we model a bi-valent system with ASHP providing 80% of the heating load and a gas boiler supplying 20% of peak demands.
In scenario 3, we model an ASHP supplying 100% of heat demand
In scenario 4, we model a GSHP supplying 100% of heat demand.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new communal gas boiler	Existing fabric with bi-valent ASHP (80%) and gas boiler (20%)	Existing fabric with ASHP (100%)	Existing fabric with GSHP
HVAC system	71kW New communal gas boiler (n+1), 0, 0, hot water from main system (gas), 0, 0	71kW ASHP (Bi-valent) 80% of heating demand , Gas Boiler (Hybrid system) 20% heating demand, 0	71kW New ASHP (Communal), 0, 0	71kW New GSHP/WSHP (Communal), 0, ground loop (borehole)
	£24,850	**£66,740**	**£74,550**	**£127,800**
Heat emitter and distribution	Existing pipework, Existing radiators - double panel, double convector, hot water from main system (gas), 0	Existing pipework, Existing radiators - double panel, double convector, hot water from main system (electric), 0	Existing pipework, Existing radiators - double panel, double convector, hot water from main system (electric), 0	Existing pipework, Existing radiators - double panel, double convector, hot water from main system (electric), 0
	£0	**£0**	**£0**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, , ,	, , ,
	£0	**£0**	**£0**	**£0**
Air tightness	Natural ventilation , Good new build performance (3 n50)	Natural ventilation , Good new build performance (3 n50)	Natural ventilation , Good new build performance (3 n50)	Natural ventilation , Good new build performance (3 n50)
	£0	**£0**	**£0**	**£0**
Total CAPEX	**£24,850**	**£66,740**	**£74,550**	**£127,800**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£24,850**	**£66,740**	**£74,550**	**£127,800**
Electricity tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff	Treasury Green Book Central Commercial Tariff
Annual fuel bills	**£40,790**	**£46,801**	**£47,047**	**£46,762**
Annual OPEX (maintenance)	£0	£0	£0	£0
30 year total cost of ownership (excluding grant)	**£1,439,704**	**£1,659,194**	**£1,673,669**	**£1,703,477**
Annual tCO_2 emissions (2021)	**115.1**	**93.3**	**88.7**	**88.1**
Predicted annual tCO_2 emissions (2030)	**82.5**	**46.8**	**40.7**	**40.5**
Predicted annual tCO_2 emissions (2050)	**56.4**	**9.5**	**2.2**	**2.2**

30 year total costs of ownership

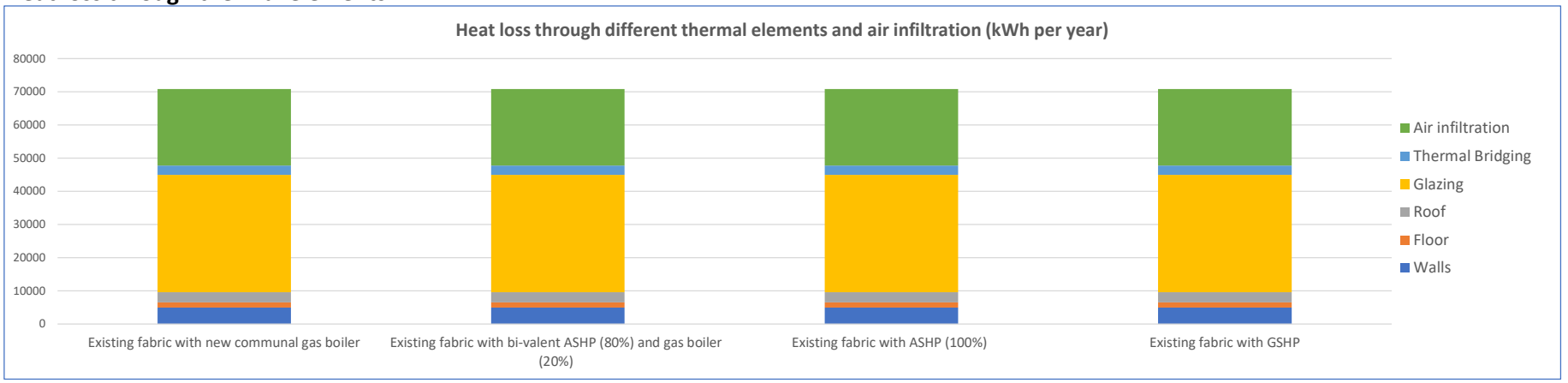


CAPEX
All electrification options would involve higher CAPEX than the BAU gas scenario. In scenario 2, the bi-valent system could potentially bring cost benefits by reducing the size of the heat pump system required. Scenario 4 (GSHP) has the highest CAPEX.

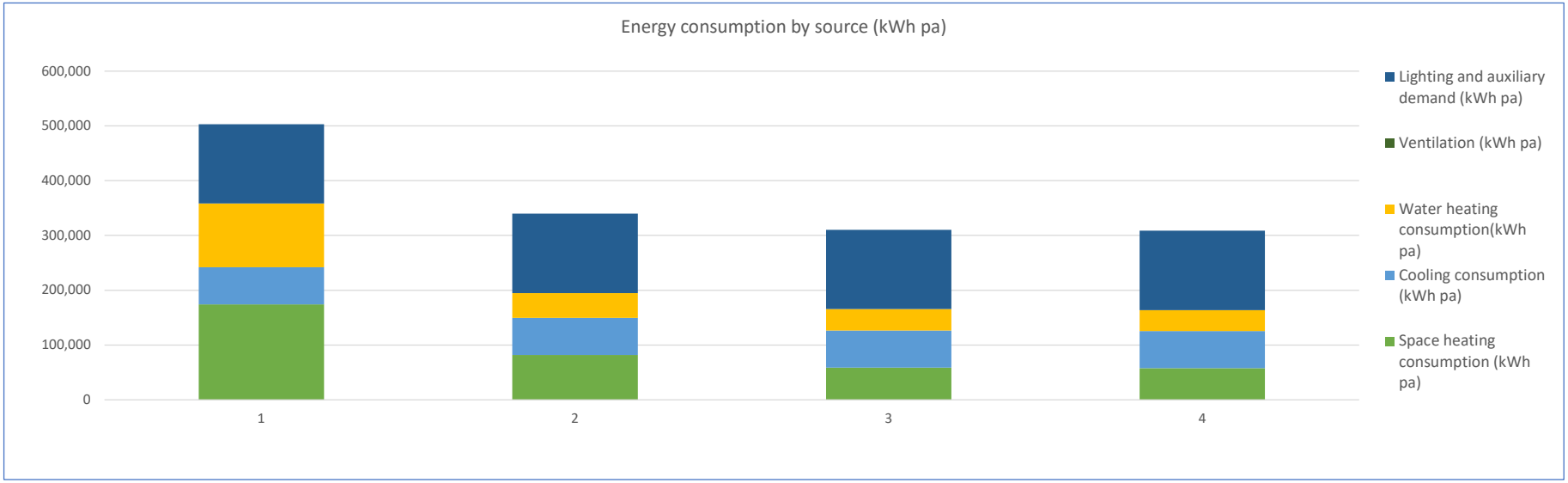
Fuel bills
Fuel bills increase under all scenarios. Scenario 4 (GSHP) has the lowest fuel bills of the electrification scenarios.

30 year costs of ownership
All of the electrification scenarios have broadly equivalent 30 year costs of ownership, with higher CAPEX typically resulting in marginally lower OPEX that balances out.

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

	Existing fabric with new communal gas boiler	Existing fabric with bi-valent ASHP (80%) and gas boiler (20%)	Existing fabric with ASHP (100%)	Existing fabric with GSHP
Space heating demand (kWh pa)	152,278	152,278	152,278	152,278
Space heating peak demand (kW)	70.8	70.8	70.8	70.8
Peak electricity load @ 6:00pm	35.0	51.4	57.1	56.7
Required flow temperatures °C	55	55	55	55
Space heating consumption (kWh pa)	174,032	81,577	58,568	57,463
Cooling consumption (kWh pa)	67,863	67,863	67,863	67,863
Water heating consumption(kWh pa)	116336	45444	39151	38413
Lighting and auxiliary demand (kWh pa)	144773	144773	144773	144773
Assumed primary heating system SPF	**88%**	**240%**	**260%**	**265%**
Assumed distribution losses	**5%**	**5%**	**5%**	**5%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**34**	**34**	**34**	**34**
Energy Use Intensity - all energy use (kWh per m2 pa)	**113**	**76**	**69**	**69**

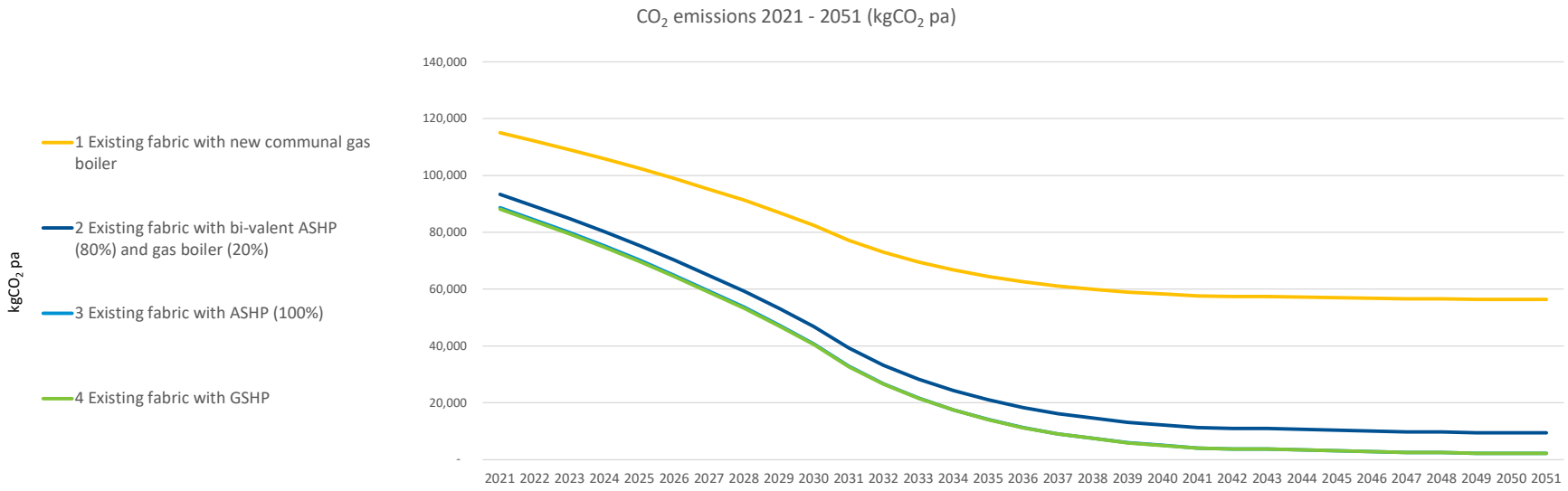
System efficiency
Of the electrification scenarios, scenario 3 has the highest system efficiency. Scenario 2 has the lowest system efficiency. However, the use of the bi-valent system does bring wider benefits in terms of reduced peak load on the grid.

Retrofit package CO_2 emissions

tCO_2 in 2021	115	93	89	88
Predicted annual tCO_2 emissions (2030)	82.5	46.8	40.7	40.5
tCO2 in 2050	56.4	9.5	2.2	2.2
tCO2 cumulative 2021 - 2050	2221	1040	846	841
tCO_2 saved relative to BAU (30 year cumulative)	0	-1180	-1375	-1380
CO_2 saving relative to baseline (30 year cumulative)	0%	53%	62%	62%
Additional cost over BAU scenario (30 years)	£0	£219,490	£233,965	£263,774
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£186	£170	£191

* 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



All scenarios show a significant reduction in CO_2 emissions. However, CO2 emissions remain highest in scenarios 1 & 2 due to the continued use of gas.

Potential impact of Solar PV on all scenarios

	Existing fabric with new communal gas boiler	Existing fabric with bi-valent ASHP (80%) and gas boiler (20%)	Existing fabric with ASHP (100%)	Existing fabric with GSHP
Included in package? (Y/N)	N	N	N	N
System size kW Peak	22.0	22.0	22.0	22.0
System generation kWh pa	21,199	21,199	21,199	21,199
Utilisation on site kWh pa	21199	21199	21199	21199
Utilisation on site kWh pa	100%	100%	100%	100%
Exported to grid kWh pa	0	0	0	0
Assumed system cost £	33000	33000	33000	33000
Net impact on fuel bills £ pa	-£ 3,184	-£ 3,184	-£ 3,184	-£ 3,184

We modelled the impact of a 22kW solar PV array for the building. Due to the relatively high year round consumption of electricity associated with the retail units, on-site consumption of renewable generation was modelled as being high.

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