Carbon Trust Options Appraisal for building decarbonisation: Summary of results

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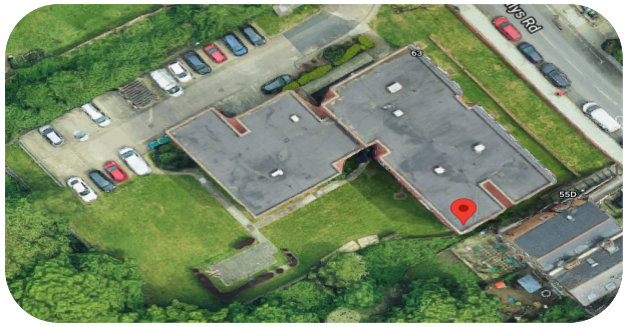
Author: Ruth Tewungwa

Reviewed by: Will Rivers

Summary of current building

PEVENSEY COURT 63 KNOLLYS ROAD SW16 2JD

Domestic	**36 Units**
Floorspace (m2)	**2700**
EPC Rating	**C-E**
Space heating consumption (kWh)	**108,417**
Cooling consumption (kWh)	**0**
Water heating consumption (kWh)	**37,640**
Other electricity use (kWh)	**60,224**
Annual total fuel bill	**£5,840**
Thermal Energy Demand Intensity (kWh per m2 pa)	**49**
Energy Use Intensity (kWh per m2 pa)	**110**
Age of construction	1976 - 1982
Windows	Double glazed windows pre 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)	Average air tightness (7.5 n50)
Radiators / emitters	Existing radiators - double panel, single convector



Description of Options for Appraisal

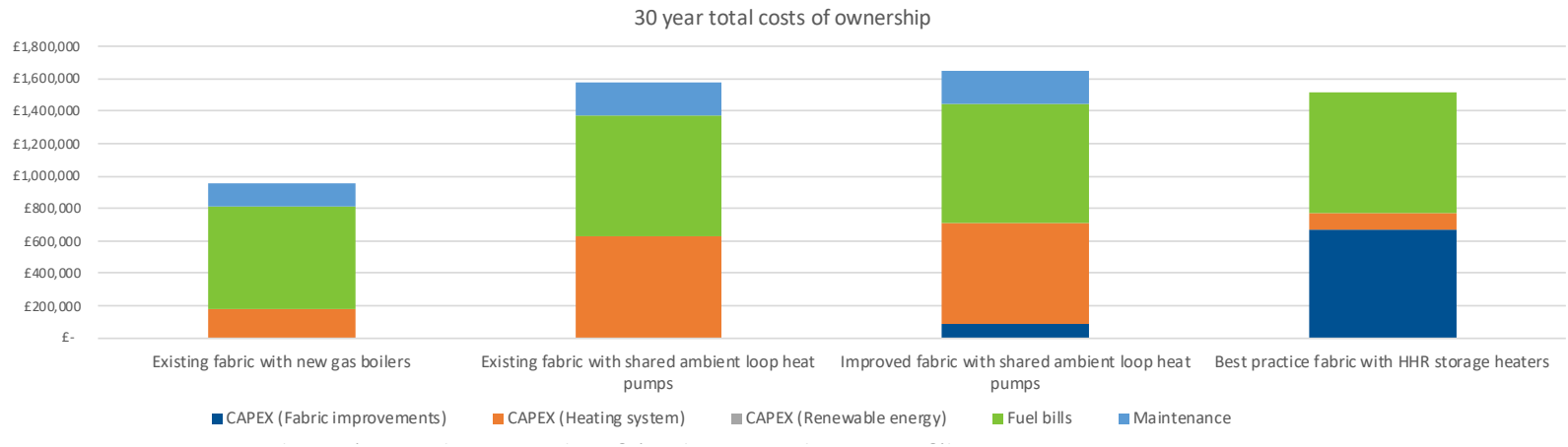
Thermal fabric measures:
1970s block of 36 flats. Walls are assumed to have partial insulation. Windows are double glazed. In scenario 3, we assume that the roof receives improved insulation. In scenario 4, we mode a best practice retrofit including external wall insulation and triple glazing.

Heating systems:
In scenarios 2 & 3 we model the impact of a shared ambient loop with individual heated pumps within each flat. In scenario 4, the very low levels of heat loss would make investment in heat pump solutions not cost effective. Therefore, in scenario 4 we look at the impact of electric HHR storage heaters sed in combination with an Economy 7 tariff.

Summary of options appraisal measures, costs & CO_2 emissions

	Existing fabric with new gas boilers	Existing fabric with shared ambient loop heat pumps	Improved fabric with shared ambient loop heat pumps	Best practice fabric with HHR storage heaters
HVAC system	72kW Individual flat gas boiler, 0, 0, hot water from main system (gas), combi-boiler, 0	72kW Individual flat WSHP (for shared ground loops) , 0, ground loop (communal borehole) , hot water from main system (electric), Hot water cylinder and associated pipework	69kW Individual flat WSHP (for shared ground loops) , 0, ground loop (communal borehole) , hot water from main system (electric), Hot water cylinder and associated pipework	24kW New smart high heat retention storage heaters, 0, 0, New electric immersion heater, Hot water cylinder and associated pipework
	£90,000	**£347,400**	**£344,550**	**£71,880**
Heat emitter and distribution	Existing pipework, Existing radiators - double panel, single convector	New ambient loop installation to existing in-flat pipework , New - Double panel double convector radiators	New ambient loop installation to existing in-flat pipework , New - Double panel double convector radiators	0, 0
	£0	**£49,680**	**£49,035**	**£0**
Thermal fabric measures installed	, , ,	, , ,	, Flat roof insulation , ,	External wall insulation (High price - complex façade), Flat roof insulation , high performance triple glazing , Insulate solid floor
	£0	**£0**	**£86,717**	**£641,445**
Air tightness	Natural ventilation , Average air tightness (7.5 n50)	Natural ventilation , Average air tightness (7.5 n50)	Natural ventilation , Average air tightness (7.5 n50)	MVHR (de-centralised) , AECB airtightness (1.5 n50)
	£0	**£0**	**£0**	**£32,400**
Total CAPEX	**£90,000**	**£397,080**	**£480,302**	**£745,725**
Clean Heat Grant	£0	£0	£0	£0
Net CAPEX	**£90,000**	**£397,080**	**£480,302**	**£745,725**
Electricity tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Treasury Green Book Central Domestic Tariff	Domestic Economy 7 00:00 - 07:00
Annual fuel bills	**£18,543**	**£23,049**	**£22,577**	**£22,858**
Annual fuel bills (per flat)	**£515**	**£640**	**£627**	**£635**
Annual OPEX (maintenance)	£4,644	£6,480	£6,480	£0
30 year total cost of ownership (excluding grant)	**£951,747**	**£1,578,856**	**£1,646,797**	**£1,513,316**
Annual tCO_2 emissions (2021)	**43.8**	**30.9**	**30.3**	**36.8**
Predicted annual tCO_2 emissions (2030)	**34.6**	**14.2**	**13.9**	**16.9**
Predicted annual tCO_2 emissions (2050)	**27.2**	**0.8**	**0.7**	**0.9**

30 year total costs of ownership

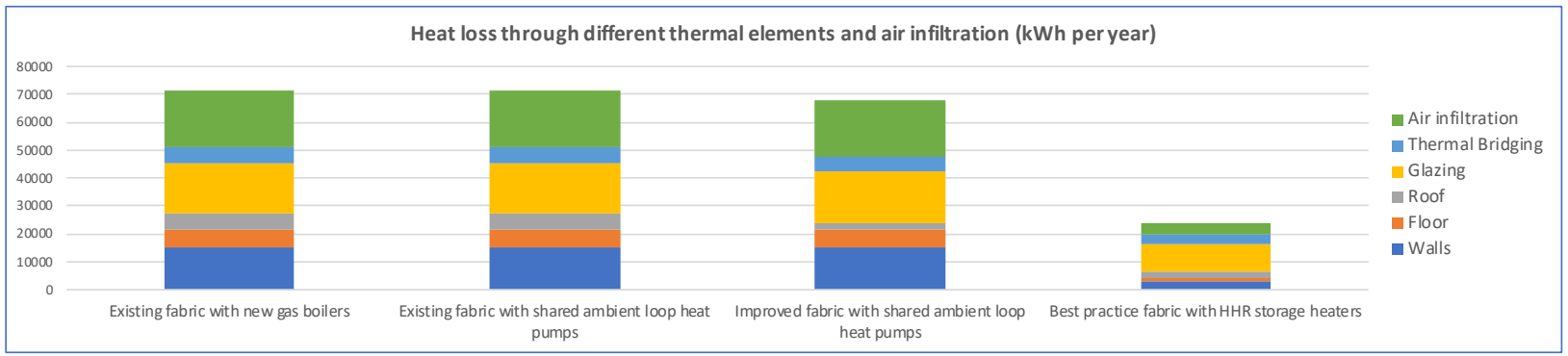


CAPEX
Capex increases significantly under all scenarios due to the high cost of the shared ambient loop system and the thermal fabric measures. However, it should be noted that these costs do not include any planned maintenance and investment for these buildings. For example, in the case of this building, the current state of the fabric suggests that improvements to the windows and roof would be necessary within the 30 year time period. Therefore, investment in the fabric now would result in avoided future capital expenditure.

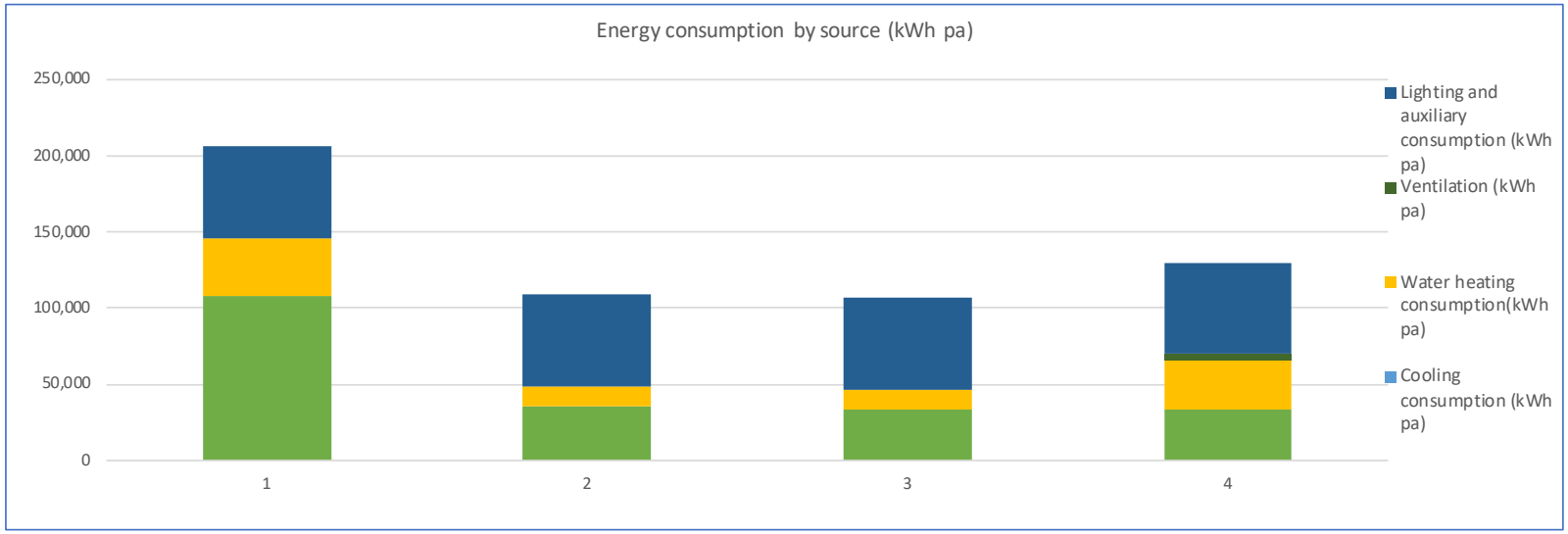
Fuel bills
Fuel bills are projected to increase in all scenarios 2 - 4 by a broadly similar amount.

30 year cost of ownership
Of the electrification scenarios, scenario 4 has the lowest cost of ownership despite having the highest CAPEX. This is because a) the reduction in heat loss means that heating system capacity is much lower b) the

Heat loss through thermal elements



Energy Consumption kWh pa



Heat demand and heating system efficiency

System efficiency

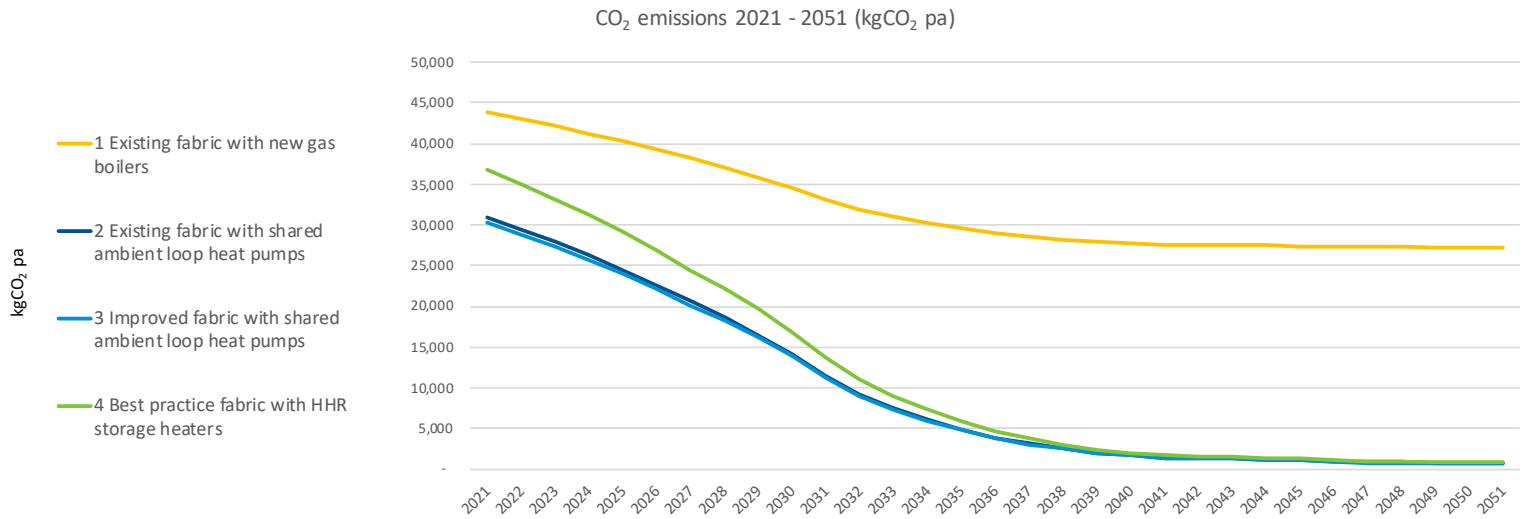
Whilst off-peak electric systems are less efficient than heat pump options, they offer significant advantages in adding no additional electricity load at peak times of day.

	Existing fabric with new gas boilers	Existing fabric with shared ambient loop heat pumps	Improved fabric with shared ambient loop heat pumps	Best practice fabric with HHR storage heaters
Space heating demand (kWh pa)	92,155	92,155	87,810	30,559
Space heating peak demand (kW)	71.5	71.5	68.1	23.7
Space heating peak demand per flat (kW)	2.0	2.0	1.9	0.7
Peak electricity load @ 6:00pm	14.5	34.1	32.9	14.5
Required flow temperatures °C	60	55	53	32
Space heating consumption (kWh pa)	108,417	36,139	33,903	33,037
Cooling consumption (kWh pa)	0	0	0	0
Water heating consumption(kWh pa)	37640	12916	12916	32935
Ventilation (kWh pa)	0	0	0	3780
Lighting and auxiliary consumption (kWh pa)	60224	60224	60224	60224
Assumed heating system Seasonal Performance Factor (SPF)	**85%**	**255%**	**259%**	**93%**
Assumed distribution losses	**0%**	**0%**	**0%**	**0%**
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	**34**	**34**	**33**	**11**
Energy Use Intensity - all energy use (kWh per m2 pa)	**110**	**58**	**57**	**69**

Retrofit package CO_2 emissions

tCO_2 in 2021	44	31	30	37
Predicted annual tCO_2 emissions (2030)	34.6	14.2	13.9	16.9
tCO^2 in 2050	27.2	0.8	0.7	0.9
tCO^2 cumulative 2021 - 2050	967	295	289	351
tCO_2 saved relative to BAU (30 year cumulative)	0	-672	-678	-616
CO_2 saving relative to baseline (30 year cumulative)	0%	69%	70%	64%
Additional cost over BAU scenario (30 years)	£0	£627,108	£695,049	£561,568
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£934	£1,026	£912

30 year predicted CO_2 emissions



CO_2 emissions

All electrification scenarios show a similar reduction in CO_2 although the heat pump options (scenarios 2 & 3) show a larger reduction in CO_2 emissions than the storage heat option (scenario 4). However, 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.

Scenario 4 offers the lowest cost of carbon reduction over the 30 year period.

Potential impact of Solar PV on all scenarios

	Existing fabric with new gas boilers	Existing fabric with shared ambient loop heat pumps	Improved fabric with shared ambient loop heat pumps	Best practice 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	17189	17816	17804	17189
Utilisation on site kWh pa	89%	92%	92%	89%
Exported to grid kWh pa	2083	1456	1468	2083
Assumed system cost £	26000	26000	26000	26000
Net impact on fuel bills £ pa	-£ 3,709	-£ 3,816	-£ 3,814	-£ 4,123

Renewable energy:

For all scenarios, the impact of a PV system was modelled separately. The table above shows the indicative savings on energy consumption and fuel bills that would occur. The relatively high year round use of electricity means that all scenarios could benefit from high on-site utilisation of solar. However, in practice, it would be difficult to split the solar PV generation between tenants.

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