Kensa Heat Pumps
A KENSA GROUP COMPANY

GREEN STREET G40
CITY OF GLASGOW

THE REAL GREEN STREET

This ground-breaking 'green-print' for an integrated urban energy system is modelled on real flats, houses and buildings in a real community in and around a real Green Street in central Glasgow G40.

Post code grouping	Location	Cluster	Flat				House					Commercial	Total buildings
			Top	Mid	Ground	Total	End Terraced	Mid Terraced	Semi Detached	Bungalow	**Total**	**Total**	
1/2 2HL+2JS+2RS	Green Street	Cluster 1	24	22	34	80	0	0	0	0	**0**	**0**	**80**
1/22HN+1/22RR+2RW	Green Street	Cluster 2	20	19	39	78	0	0	0	0	**0**	**1**	**79**
2TG+2TF+1AG+2RH	Green Street	Cluster 3	10	3	19	32	7	7	2	1	**17**	**5**	**54**
2RT+2JR	Back of cluster 1 & 2	Cluster 4	27	22	26	75	0	0	0	0	**0**	**0**	**75**
1/22RR+2RU+2DX	Back of cluster 2 & 3	Cluster 5	19	28	25	72	0	0	0	0	**0**	**1**	**73**
2SA+2RZ	Back of cluster 4 & 5	Cluster 6	24	28	27	79	0	0	0	0	**0**	**5**	**84**
1/2HL+2JT+1/2 2SQ+2HH	Front of cluster 1	Cluster 7	13	15	24	52	1	5	0	0	**6**	**0**	**58**
1/2HN+1/22SQ+2LW	Front of cluster 2	Cluster 8	22	19	29	70	0	0	0	0	**0**	**0**	**70**
2HX+2LG+2LT	Close to City Centre Project	Cluster 9	10	7	21	38	15	13	14	0	**42**	**0**	**80**
2DW+2HY	Close to City Centre Project	Cluster 10	13	7	22	42	3	15	0	0	**18**	**0**	**60**
2NG+2HA+2JH+2AS	Front of cluster 7	Cluster 11	17	0	18	35	12	27	1	1	**41**	**0**	**76**
	New build near London Road & Green Street	New Build 1				48							**48**
	New build Tureen Street	New Build 2				38				6	**6**		**44**
	Total		**199**	**170**	**284**	**739**	**38**	**67**	**17**	**8**	**130**	**12**	**881**

We broke the surrounding streets into similar clusters of architypes, and understood that within a diverse collection of properties there are sub-sets of similar dwelling types. We assessed groupings, understanding that Mid level, Top floor and Ground Floor flats have different levels of heat loss, and we assessed the age and fabric styles, in order to give us confidence in the results of a general collective study that consists of real individual buildings.

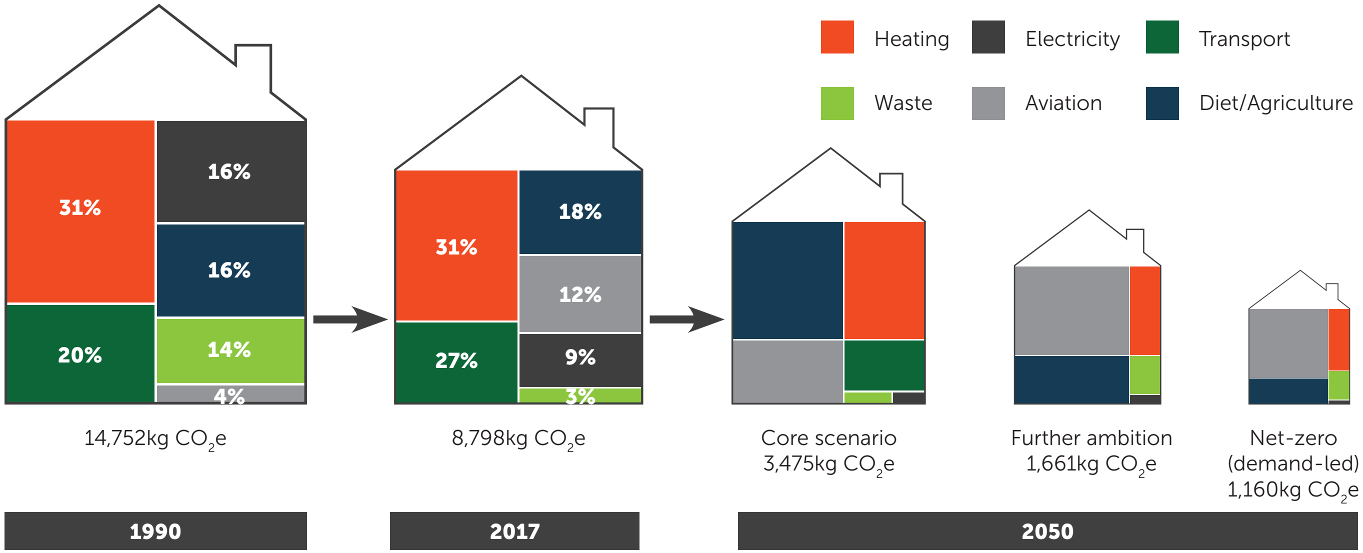
We found that the existing houses and flats on Green Street and immediately surrounding amounted to 880 dwellings and that they require approximately 10GWh per year of heat, hot water and electrical power.

We identified the grid distribution assets on Green Street and had discussions with Scottish Power to enable us to understand how consideration of future load will be managed.

These figures do not include the electrical power that will be required for Transport, as all vehicles become electric vehicles that will be charged up at home.

	Annual electricity demand (GWh)	Annual space heating demand (GWh)	Annual direct hot water (GWh)	Total annual thermal demand (GWh)	Total annual energy demand (GWh)
Existing flats	2.35	4.33	1.17	5.49	7.84
Houses	0.67	1.40	0.24	1.63	2.30
Total	**3.01**	**5.72**	**1.40**	**7.13**	**10.14**

We looked to the Energy Systems Catapult "Living Carbon Free – Exploring what a net-zero target means for households" to understand how the total energy demand for individuals living on Green Street is likely to evolve.



We found that the annual emissions from Green Street are 4,000 Tonnes of CO_2 per year for Heating, Hot Water, Power and Transport.

	Annual emission from space heating fuel demand (tonnes)	Annual emission from direct water fuel demand (tonnes)	Total annual emission from thermal fuel demand (tonnes)	Annual emission from electricity fuel demand (tonnes)	Total annual emission from transport fuel demand (tonnes)	Total annual emission from all three (tonnes)
Existing flats	1135.53	306.70	1442.23	319.50	1551.528	3313.26
Houses	366.44	61.78	428.22	90.47	294.624	813.32
Total	**1501.97**	**368.48**	**1870.45**	**409.97**	**1846.15**	**4126.58**

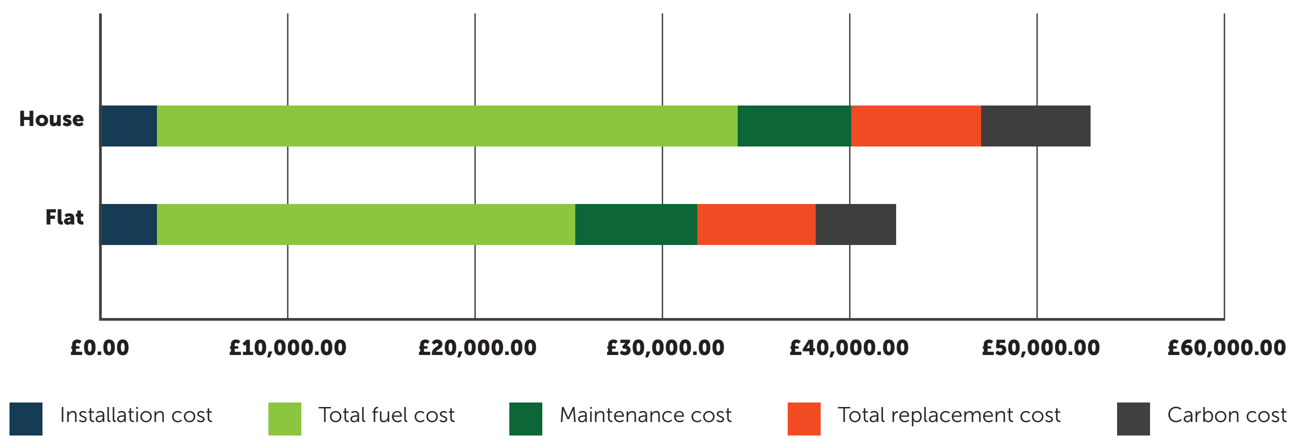
In order to understand the true cost of the heating system we calculated the "whole life" cost. We considered 40 years to be an appropriate amount of time to consider to include for the lifecycle of plant and equipment, maintenance requirements and long term returns on choices.

Over 40 years the 880 buildings require approximately 350GWh of energy for heating and hot water, and – on today's technologies – and will emit around 73 kilotonnes of CO_2.

	Total space heating fuel demand (GWh)	Total direct hot water fuel demand (GWh)	Emission from space heating demand over whole life cycle (kt)	Total emission from direct hot water over whole life cycle (kt)	Emission from thermal fuel demand over whole life cycle based on gas (kt)
Existing flats	216.29	58.42	45.42	12.27	57.69
Houses	69.80	11.77	14.66	2.47	17.13
Total	**286.09**	**70.19**	**60.08**	**14.74**	**74.82**

We then considered the costs associated with owning a heating system for the life of the heating system. This includes the cost of replacing the boiler when it next breaks down, and replacing it a few times during the 40 year "whole life,"it includes regular maintenance and servicing and fuel run cost. We considered a nominal cost of carbon at £50 a tonne, although we found that this was only a small component of the whole life cost. We showed that the typical flat spends approximately £1,000 per year on average across the life of the heating system.

Whole life cost of different dwelling type based on gas heating



Cost to be paid over the whole life cycle for a typical flat and house based on gas heating

	Installation cost	Total fuel cost	Maintenance cost	Total replacement cost	Carbon cost	Total cost
Flat	£2,250.00	£23,212.19	£6,000.00	£6,750.00	£4,244.19	**£42,456.38**
House	£2,250.00	£31,745.52	£6,000.00	£6,750.00	£6,083.34	**£52,828.87**

Figures are indicative and in today's value of money.

We found that over a 40 year "whole life" "whole cost" assessment, Networked Heat Pumps were similar to Gas and over 1/3 lower cost than stand alone Air Source Heat Pumps.

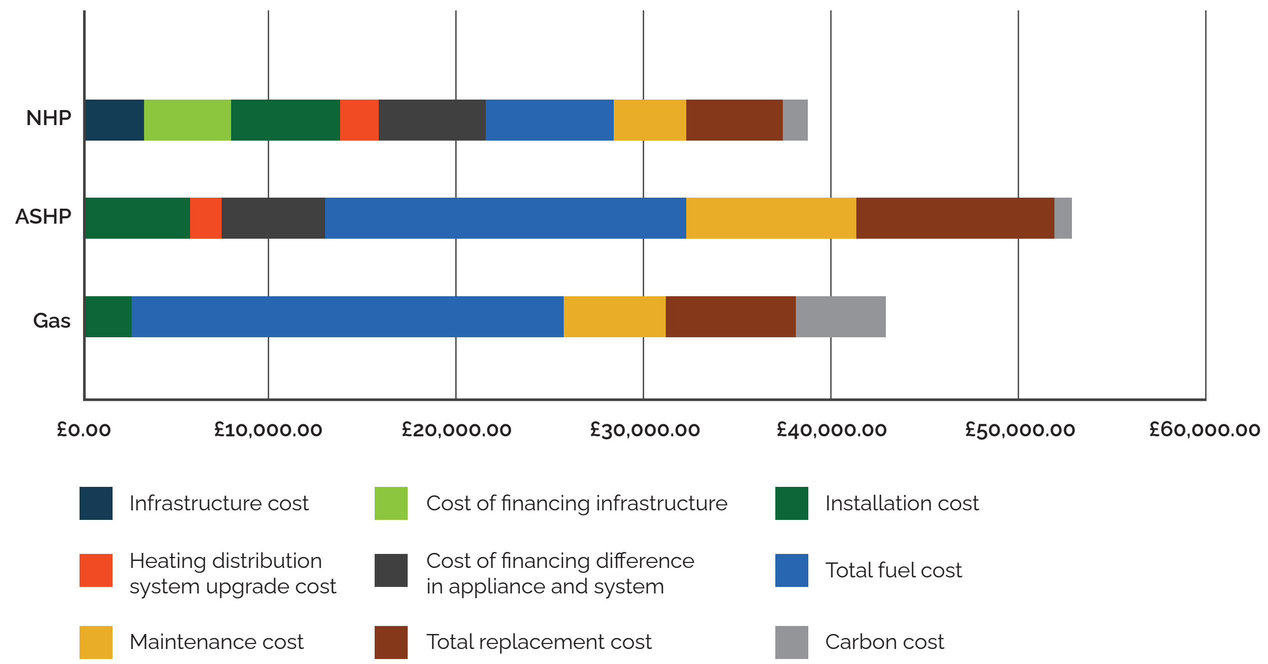
Our "whole cost" assessment included the costs of financing the installation. We separated the ground – infrastructure – side of the installation, the heating appliance installation and any internal heating distribution system upgrades required.

With regards to the heating appliance, we considered the substitution cost – i.e. the difference in cost - compared to replacing the existing gas boiler.

We used standard Air Source Heat Pump operating data, and we considered Networked Heat Pumps operating from an Ambient Loop maintained at temperatures between 10 and 15 degrees, although in reality we would anticipate temperatures to be between 15 and 20 degrees.

We considered heating costs based on existing fabric heat losses. We conducted a cost benefit analysis on upgrading fabric, and for the purpose of this study, identified that replacing the heating system with low carbon heating was more cost effective than expensive solid wall insulation. Further, for the purpose of comparison, if solid wall insulation was deemed suitable, then it would be applied regardless of technology, and the costs would cancel out.

Whole life cost comparison for a typical Green Street flat



The use of Networked Heat Pumps shows the lowest Energy requirement, 45% lower than an Air Source Heat Pump. Using SAP 10.1 Carbon Emissions Network Heat Pumps offer a 90% reduction over gas, with the added benefit that as the Electricity grid is decarbonised fully, the emissions from Network Heat Pumps are fully eliminated.

We allowed for savings through load shifting. We included more savings for load shifting with Network Heat Pumps since they can run at the coldest of times with no loss of efficiency, and through the night with no concerns over noise.

We considered different business models for financing the ground side as a utility and found that this requires scale, and we recommend that this is the focus for Government assistance. We found that with an annual connection charge to pay for the financing of the installation over the long term, Network Heat Pumps are an affordable solution.

This analysis does not include the significant additional cost required for grid upgrade to support the increased requirement of air source heat pumps. We have also not taken into account lower performance or strain on grid capacity of air source heat pumps at the coldest of times.

Fuel consumption and emission over whole life for a typical flat

	Gas (kWh)	Electricity (kWh)	Emission (Tonnes)
NHP		76549	10.41
ASHP		138390	18.82
Gas	492305		103.38

NHP – SPF 5.15 DHW-SPF 4.85; Flex saving 35%
ASHP – SPF 3.1 DHW-SPF 2.1; Flex saving 10%

Emissions based on SAP 10.1.

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