Guernsey Electricity Limited

HEATING GREENHOUSE GAS INTENSITY STUDY 2024

UK0041759.5432_ HEATING STUDY
JULY 2025

PUBLIC

Guernsey Electricity Limited

HEATING GREENHOUSE GAS INTENSITY STUDY 2024

TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. UK0041759.5432

OUR REF. NO. UK0041759.5432_ HEATING STUDY

DATE: JULY 2025

WSP

4th Floor
6 Devonshire Square
London
EC2M 4YE

Phone: +44 20 7337 1700

WSP.com

EXECUTIVE SUMMARY

ContentsThis study compares the greenhouse gas (GHG) emissions intensity of using various domestic heating methods. These methods include Air Source Heat Pumps (ASHP), Ground Source Heat Pumps (GSHP), electric heating via an electric boiler or overnight storage heaters (here on referred to as 'electric heating'), Liquified Petroleum Gas (LPG) condensing boilers, heating oil condensing boilers and hydrotreated vegetable oil (HVO) boilers. HVO is a low GHG intensity biofuel that is supplied by Rubis Channel Islands, a fuel company that serves the Islands of Jersey and Guernsey.

The objective of this study is to estimate the GHG emissions released per kilowatt hour (kWh) of heat provided to Guernsey Electricity Ltd.'s customers (measured in grams of carbon dioxide equivalence (gCO_2e) per kWh of energy provided), accounting for emissions across the full lifecycle of use. It should be noted that only the GHG emissions impacts are considered in this study.

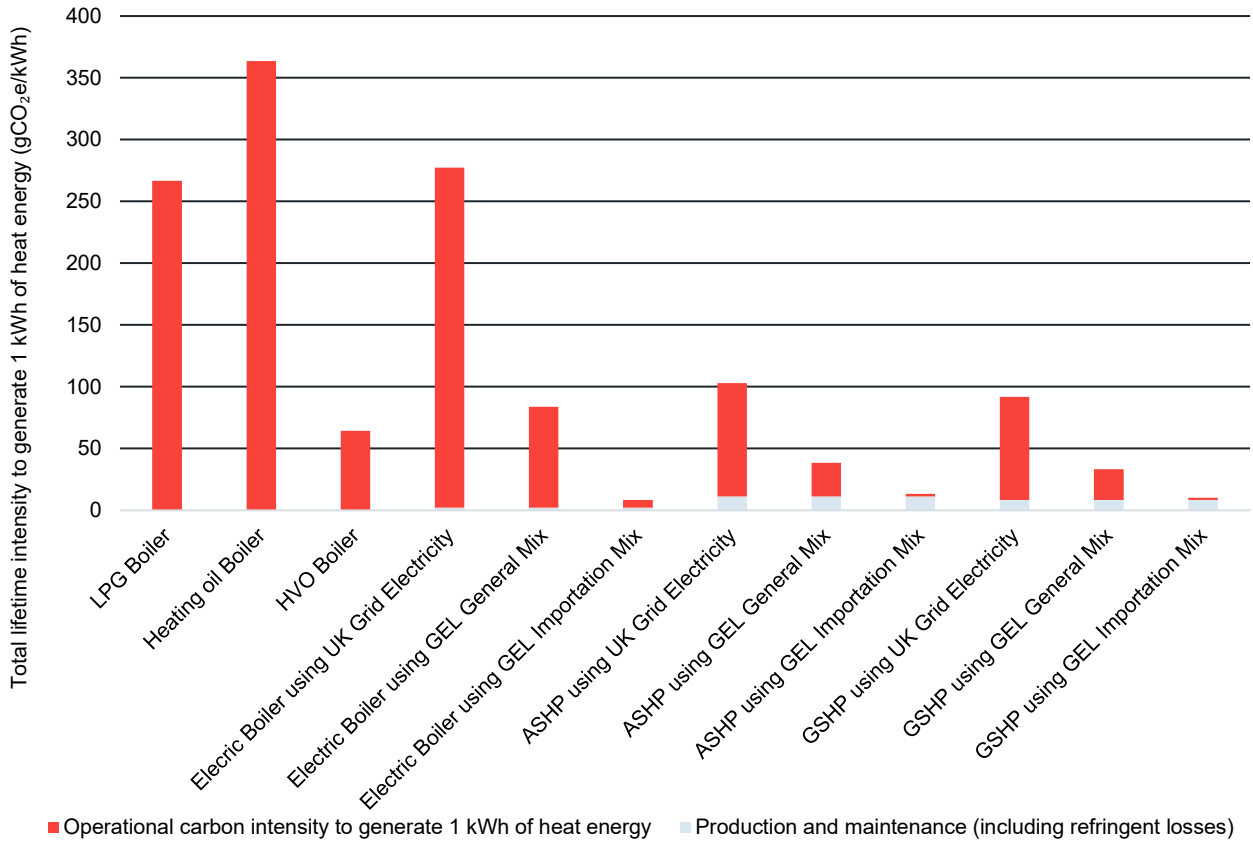


Figure – Greenhouse gas intensity of various heating domestic heating methods

GSHPs, ASHPs and electric heating using GEL Importation Mix have the lowest GHG intensity to generate heat energy when compared to the other domestic heating methods. This is due to the higher efficiency of GSHPs and ASHPs and the GHG carbon intensity of GEL Importation Mix. GSHPs, ASHPs and electric heating also have the highest potential to decrease in GHG intensity in the future as the electricity they are powered by decarbonises. ASHPs, GSHPs and electric heating are the only technologies discussed in this study that can be considered Net Zero as LPG and heating oil boilers use fossil fuels and HVO boilers use a biofuel.

METHODOLOGY

This study compares the greenhouse gas (GHG) emissions intensity of using various domestic heating methods. These methods include Air Source Heat Pumps (ASHP), Ground Source Heat Pumps (GSHP), electric heating via an electric boiler or overnight storage heaters (here on referred to as 'electric heating'), Liquified Petroleum Gas (LPG) condensing boilers, heating oil condensing boilers and hydrotreated vegetable oil (HVO) boilers. HVO is a low GHG intensity biofuel that is supplied by Rubis Channel Islands, a fuel company that serves the Islands of Jersey and Guernsey.

The objective of this study is to estimate the GHG emissions released per kilowatt hour (kWh) of heat provided to Guernsey Electricity Ltd.'s customers (measured in grams of carbon dioxide equivalence (gCO_2e) per kWh of energy provided), accounting for emissions across the full lifecycle of use. It should be noted that only the GHG emissions impacts are considered in this study.

LIFE CYCLE ASSESSMENT STAGES INCLUDED

Figure 1 provides a summary of the lifecycle stages considered for the heating methods.

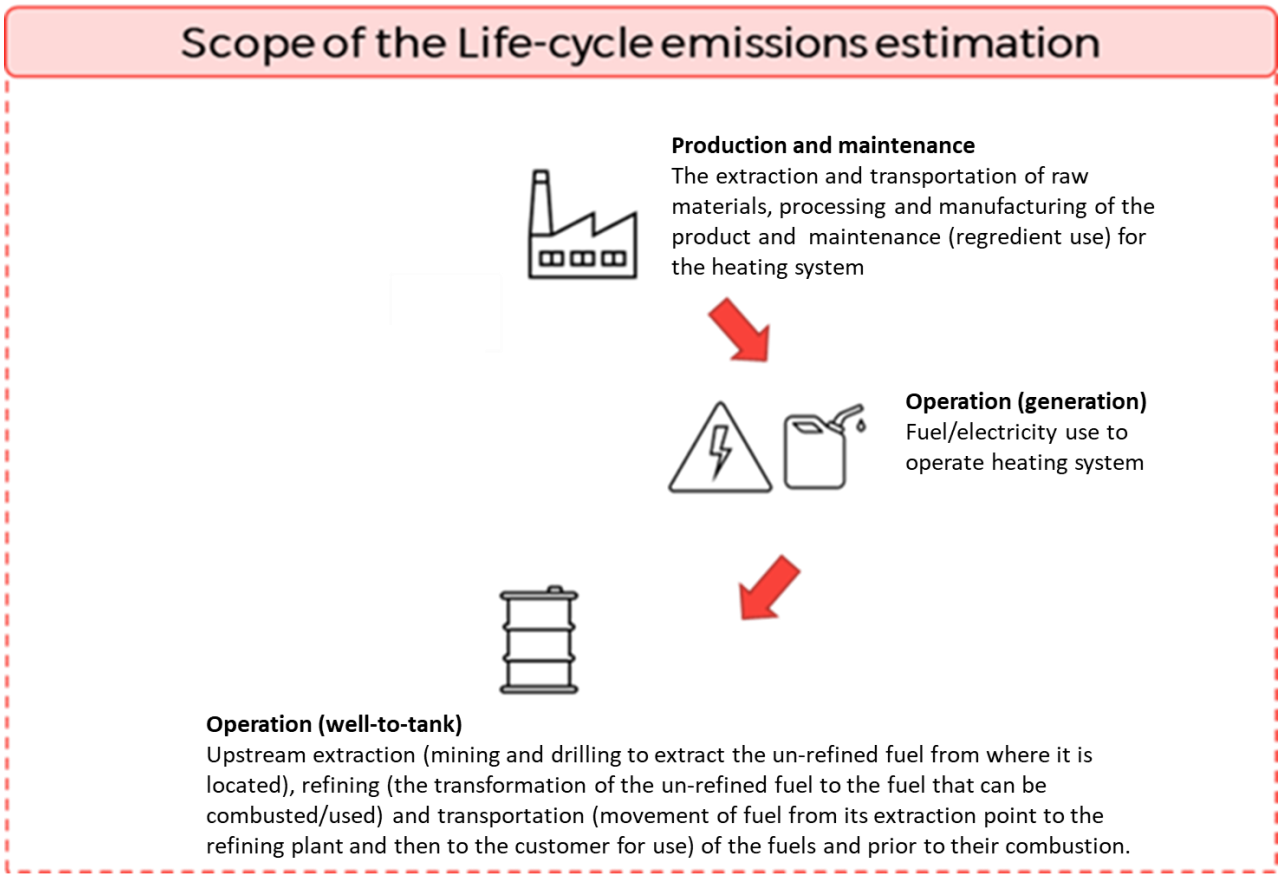


Figure 1 - Scope of the life-cycle emissions estimation

End of life is not considered in this study as it is expected to be negligible compared to other lifecycle stages.

Literature was reviewed to obtain GHG emission values for the production, maintenance (including refrigerant loses) and operation (generation and operation (well-to-tank) of each heating method. The full list of emission values can be found in the Appendix along with the corresponding literature sources.

EFFICIENCY

The objective of this study is to estimate the GHG emissions released per kWh of heat provided to GEL's customers. To be able to do this, the efficiencies of each heating method have to be considered. A literature review was conducted to obtain efficiencies of each type of boiler and Coefficients of Performance for the heat pumps. The full list of emission values can be found in the Appendix along with the corresponding literature sources.

ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations apply to this study are outlined in the appendix alongside the full list of emission values and the corresponding literature sources.

RESULTS AND CONCLUSIONS

The carbon intensity of different heating technologies are described in Figure 2 (overleaf) and Table 1 (in the Appendix). The results (Total lifetime intensity to generate 1 kWh of heat energy (gCO_2e/kWh) accounts for the efficiency of equipment and allows for comparison between different technologies by normalising the result to 1 kWh of heating energy provided by the equipment to GEL's customers (i.e., heating output).

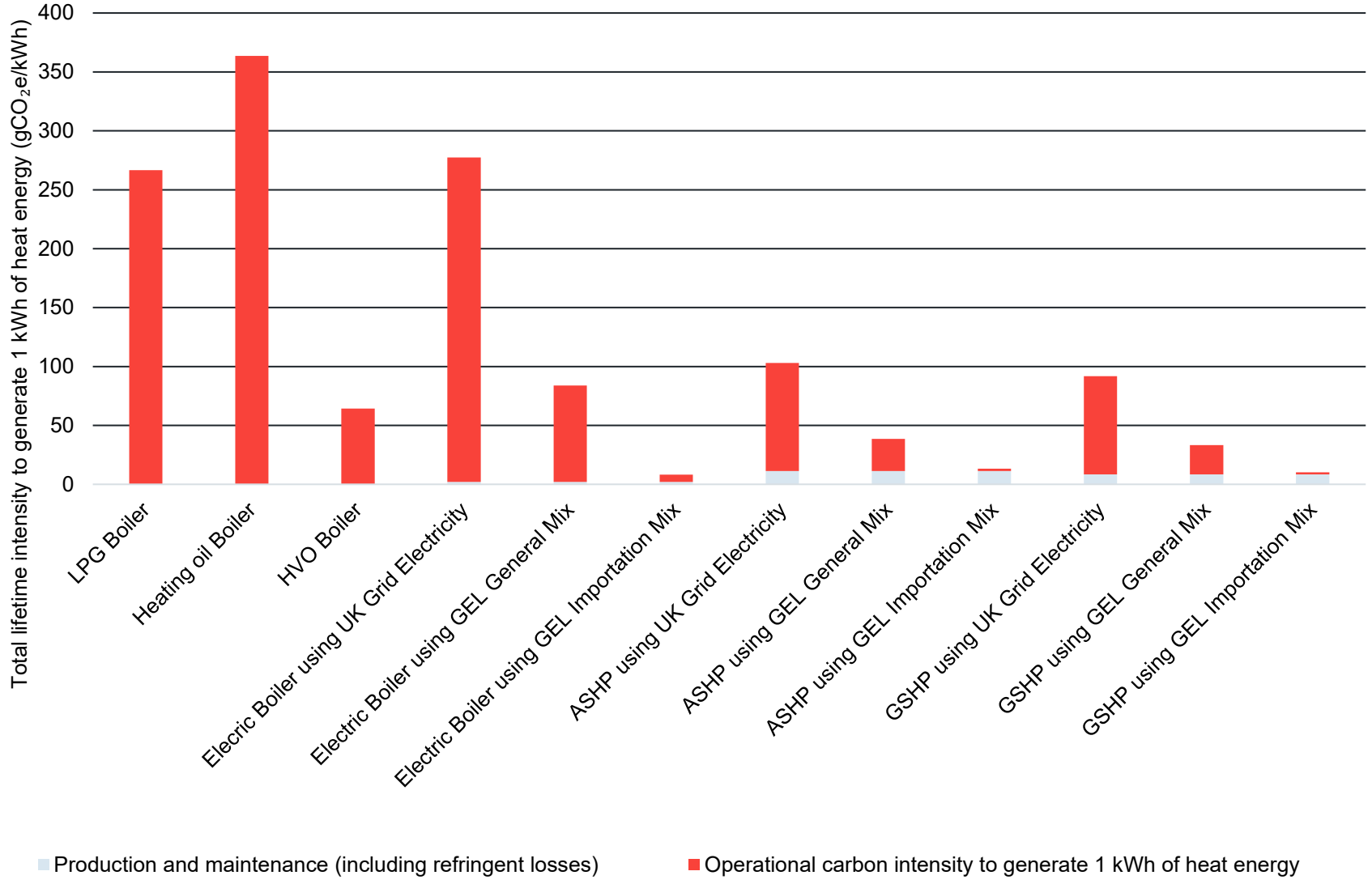
To avoid any misinterpretation of the results, WSP recommends that care is taken when disseminating this data, on the difference between the carbon intensity of the energy inputs per kWh and the carbon intensity of heating energy outputs per kWh.

LPG and heating oil boilers have the highest carbon intensity due to the large quantity of emissions produced upon the combustion of the fuels.

HVO boilers have a lower carbon intensity when compared to electric boilers, GSHP and ASHP that utilise electricity from the GEL General Mix and the UK Grid. However, while HVO's life cycle GHG emissions are considered lower than conventional fossil fuels (circa 90%) this value is not zero due to the production of non-CO_2 GHGs upon the combustion of the biofuel, most notably methane and nitrous oxide. The CO_2 emissions produced upon combustion of biofuels are assumed to be net '0' to account for the CO_2 absorbed by fast-growing bioenergy sources during their growth.

The results show that on a per kWh of heat output basis, GSHPs, ASHPs and electric heating using GEL Importation Mix have the lowest GHG intensity when compared to the other domestic heating methods. This is due to the higher efficiency of GSHPs and ASHPs and the GHG carbon intensity of GEL Importation Mix. GSHPs, ASHPs and electric heating also have the highest potential to decrease in GHG intensity in the future as the electricity they are powered by decarbonises. ASHPs, GSHPs and electric heating are the only technologies discussed in this study that can be considered Net Zero as LPG and heating oil boilers use fossil fuels and HVO boilers use a biofuel.

Figure 2 – Greenhouse gas intensity of various heating domestic heating methods



APPENDIX

Table 1 – GHG intensity of heating methods across the various lifecycle stages

Source	Production and maintenance (including refringent losses) (gCO_2/kWh)	Operation (generation) carbon intensity (gCO_2e/kWh)	Operation (WTT) carbon intensity (gCO_2e/kWh)	Operational efficiency of heating method	Operational carbon intensity to generate 1 kWh of heat energy (gCO_2e/kWh)	Total lifetime intensity to generate 1 kWh of heat energy (gCO_2e/kWh)
LPG Boiler	Excluded – emissions negligible*A	214.50*D	25.48*G	90%*H	266.64	266.64
Heating oil Boiler	Excluded – emissions negligible*A	268.14*D	59.13*G	90%*H	363.63	363.63
HVO Boiler	Excluded – emissions negligible*A	3.47*E	54.48*G	90%*H	64.39	64.39
Electric Boiler using GEL General Mix	2.07*B	81.80*F	WTT included in operation - generation	100%*H	81.80	83.87
Electric Boiler using GEL Importation Mix	2.07*B	6.24*F	WTT included in operation - generation	100%*H	6.24	8.32
Elecric Boiler using UK Grid Electricity	2.07*B	275.22*F	WTT included in operation - generation	100%*H	275.22	277.29
ASHP using GEL General Mix	11.25*C	81.80*F	WTT included in operation - generation	300%*H	27.27	38.52

Source	Production and maintenance (including refringent losses) (gCO_2/kWh)	Operation (generation) carbon intensity (gCO_2e/kWh)	Operation (WTT) carbon intensity (gCO_2e/kWh)	Operational efficiency of heating method	Operational carbon intensity to generate 1 kWh of heat energy (gCO_2e/kWh)	Total lifetime intensity to generate 1 kWh of heat energy (gCO_2e/kWh)
ASHP using GEL Importation Mix	11.25*C	6.24*F	WTT included in operation - generation	300%*H	2.08	13.33
ASHP using UK Grid Electricity	11.25*C	275.22*F	WTT included in operation - generation	300%*H	91.74	102.99
GSHP using GEL General Mix	8.40*C	81.80*F	WTT included in operation - generation	330%*H	24.79	33.19
GSHP using GEL Importation Mix	8.40*C	6.24*F	WTT included in operation - generation	330%*H	1.89	10.29
GSHP using UK Grid Electricity	8.40*C	275.22*F	WTT included in operation - generation	330%*H	83.40	91.80

PRODUCTION AND MAINTENANCE (INCLUDING REFRINGENT LOSSES)

*A Emissions for LPG, heating oil and HVO boilers is negligible.[1]

*B Emissions from electric boilers are from an OSO hot water Environmental Product Declaration.[2]

*C Emissions for ASHP and GSHP have been estimated to account for 5% of the total lifecycle emissions.[1]

[1] MDPI, A Comparative Environmental Assessment of Heat Pumps and Gas Boilers towards a Circular Economy in the UK, Accessed May 2025
[2] OSO Hot water, Environmental Product Declaration, Saga S 200, Accessed May 2025

OPERATION (GENERATION) AND OPERATION WTT

*D Emissions for the combustion of the fossil fuels are sourced from the Department of Energy, Security and Net Zero (DESNZ).[3]

*E Emissions for the combustion of HVO is sourced from Rubis Channel Islands[4] and DESNZ.[3]

*F Emissions for the generation and WTT of electricity used by the electric boiler, ASHP and GSHP depend on the source of the electricity. The emissions for 'General Mix', 'GEL Importation Mix' and 'UK Grid Electricity' are shown in the Table 2 below.

*G Emissions for the upstream extraction, refining and transportation of the fossil fuels and biofuel prior to their combustion (WTT) are sourced from DESNZ.[3]

Table 2 - Emission factors 2023

Emission factors 2024	Emissions factor (gCO_2e/kWh)
GEL General Mix (Lifecycle Emissions Intensity of all GEL's Distributed Electricity)[5]	81.8
GEL Importation Mix (Lifecycle Emissions Intensity of GEL's Imported Distributed Electricity)[5]	6.2
UK Grid Electricity (Lifecycle Emissions Intensity of the UK Grids Distributed Electricity)[3]	275.2

OPERATIONAL EFFICIENCY OF HEATING METHOD

*H The efficiencies of the heating methods are shown in Table 3 (overleaf). The efficiencies of ASHP and GSP are determined by their Coefficients of Performance (COPs). A COP of 3 means that 3kW of heating power is generated while the compressor only needs 1kW of power to provide the associated heat. Figure 3 (overleaf) demonstrates the relationship between the energy input and the heating energy output, considering the efficiencies of boilers, the and the COP of ASHPs and GSHPs.

[3] Department for Energy Security and Net Zero (DESNZ), Greenhouse gas reporting: conversion factors 2024, Accessed May 2025. This figure calculated by WSP and is the sum of the following emission factors:
- UK electricity, Electricity generated, 207.05 gCO_2e/kWh
- Transmission and distribution, T&D- UK electricity, 18.3 gCO_2e/kWh
- WTT- UK electricity, WTT- UK electricity (generation), 45.9 gCO_2e/kWh
- WTT- UK electricity, WTT- UK electricity (T&D), 3.97 gCO_2e/kWh

[4] Rubis, Comparative Running Costs for Home Heating in Guernsey, Accessed May 2025

[5] Guernsey Electricity Ltd, GEL Corporate GHG Emissions 2024_v1.0 15042025.xlsx, Accessed April 2025

Table 3 – Boiler efficiencies used in this study

Boiler Type	Efficiency / COP
LPG boiler (condensing)	90%[6]
Oil boiler (condensing)	90%[6]
HVO boiler	90%[6]
Electric heating	100%[7]
ASHP	3.0[8]
GSHP	3.3[8]

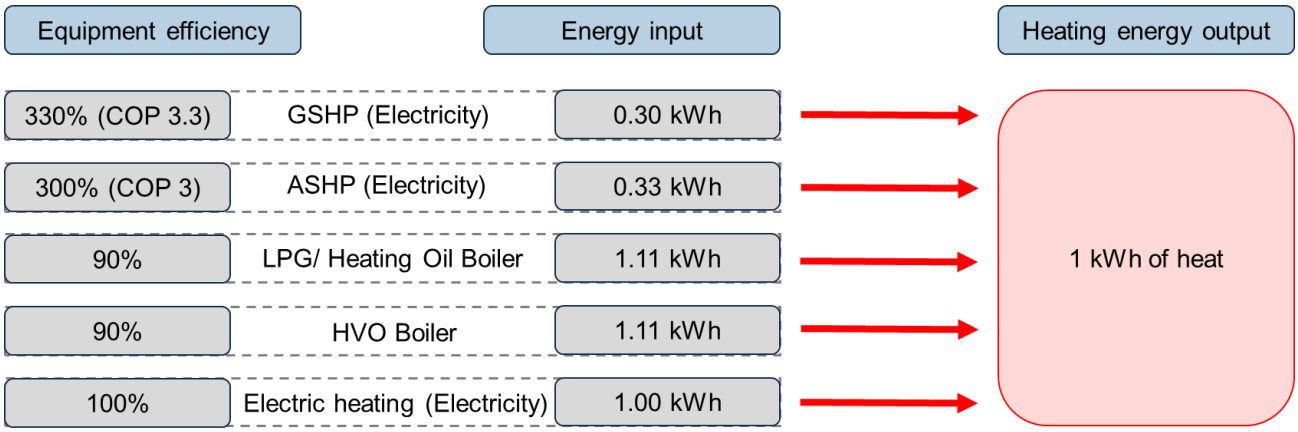


Figure 3 – Relationship between energy input and heating energy output

ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations apply to this study:

1. This study references 'GHG emissions and carbon dioxide equivalents' and it is used as short hand for all of the GHG impacts as identified in the Kyoto Protocol.[9]
2. This study assumes Heating oil, LPG and HVO do not have other embodied impacts, as such contributions would be expected to be negligible relative to operational emissions.[10]

[6] British Gas, How efficient is my gas boiler? Accessed May 2025
[7] Boiler Guide, Electric Boiler Efficiency Explained, Accessed May 2025
[8] DESNZ states an average ASHP performance of 2.94 across 750 homes in the UK. Due to Guernsey's higher ambient temperatures than the UK, GEL confirmed that a COP of 3 is appropriate for use in this study as higher ambient air temperatures lead to higher COPs for ASHPs and GSHPs (KensaHeat Pumps: Fact Sheet). Guernsey's mean daily air temperature was 11.7°C between 1991 and 2020 with only one month (February) having a mean daily air temperature lower than 7°C (Guernsey Met Office). The UK's annual mean temperature between 1991 and 2020 was 9.1°C with five months having a mean temperature below 7°C. (Met Office). GSHPs tend to have a 10% higher COP than ASHPs (UK Collaborative Centre for Housing Evidence). A COP for GSHPs of 3.3 has therefore been assumed for this study. It should be noted that many ASHPs and GSHPs can achieve greater COP and the value is expected to increase as the technology improves.
[9] United Nations Climate Change: What is the Kyoto Protocol?
[10] MDPI, A Comparative Environmental Assessment of Heat Pumps and Gas Boilers towards a Circular Economy in the UK, Accessed May 2025

3. RUBIS state that the heat produced by the HVO fuel they provide is 10.26 kWh/L.[11] A 90% equipment efficiency has also been assumed.[12]
4. Considering the efficiency of the boilers and electric heating means that the results reflect the emissions associated with 1 kWh of heating energy provided to GEL's customers. This is different to the emissions associated with the energy input (kWh) required for heating.
5. A full lifecycle assessment has not been included in this study as only the GHG emissions impacts are considered.

[11] Rubis, Comparative Running Costs for Home Heating in Guernsey, Accessed May 2025
[12] British Gas, How efficient is my gas boiler? Accessed May 2025

4th Floor
6 Devonshire Square
London
EC2M 4YE

wsp.com