LGUK – England Archetype Analysis

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TABLE OF CONTENTS

CONTENTS

1. Executive Summary **3**

2. Introduction **3**

3. Results **5**

3.1 England Archetype 1 5
- **3.1.1 Cost Breakdown** 5
- **3.1.2 Affordability Analysis** 7
- **3.1.3 Consumer Journey** 8

3.2 England Archetype 2 8
- **3.2.1 Cost Breakdown** 9
- **3.2.2 Affordability Analysis** 10
- **3.2.3 Consumer Journey** 11

4. Discussion of Results **13**

5. Summary of Results **17**

1. Executive Summary

This analysis compares the relative suitability of several fossil-fuel and low-carbon domestic heating options across **two English property archetypes**.

The heating technologies assessed include **oil boilers, LPG boilers, 100% bioLPG boilers, air-source heat pumps (ASHP), biomass boilers, hybrid systems, and bioLPG blend boilers**. In this analysis, hybrid systems use ASHPs to deliver 80% of energy demanded, 20% is delivered by bioLPG boilers when electricity prices are at peak. BioLPG blend boilers use a 20:80 blend ratio of bioLPG to LPG.

The suitability of each heating method is assessed according to three factors:

1. **The cost to the consumer**
2. **The consumer's income**
3. **The ease of the transition**

2. Introduction

As the UK works towards a net-zero greenhouse gas emissions by 2050 target, the residential heating sector is required to phase out high-carbon forms of heating and replace with low-carbon heating technologies.

Heat used in buildings accounts for 22% of the United Kingdom's greenhouse gas emissions, with around 26.5 million homes still relying on fossil-fuel-based heating systems, including 24.8 million using mains gas and 1.7 million off-grid homes using high-carbon fuels, primarily oil boilers.[1] The imminent replacement of these systems therefore represents the fastest route to heat decarbonisation.

Other lower carbon intensity fuels are currently in use such as LPG. However, as the UK moves towards its Net Zero ambitions, increasing attention is being given to how heat can be further decarbonised over time and what low-carbon alternatives may be required to support this transition.

A main barrier to adoption of low-carbon alternatives, however, is the high capital cost these systems often require. For low-income households this prohibits their ability to transition to low-carbon systems such as heat pumps.

This raises the question of whether biofuels can be a more affordable route to decarbonisation. Fuels such as bioLPG are produced from sustainable feedstocks offering lower carbon heating with minimal upfront costs. However, these biofuels currently see high fuel prices, presenting a barrier to wider adoption. Biofuel-blend-ready boilers could therefore present an attractive compromise, enable lower-carbon operation while maintain affordability. Such systems may

[1] Department for Energy Security and Net Zero (2025) Open Consultation, Exploring the role of alternative clean heating solutions

provide a more financially feasible pathway for lower-income households to begin the transition towards lower-carbon heating.

The following report outlines analysis which compares the capital, operational and levelised costs of various “carbon intensive”[2] and “low carbon” heating systems to determine which is the most financially attractive to households.

The analysis compares two different English archetype properties and assesses the relative suitability of each heating system. It also considers the ‘consumer journey’, addressing how the hassle of transitioning to a new heating system is also within consumer interest.

[2] Coal boilers have been excluded from the analysis because the UK Government banned the sale of house coal to the public in 2023, making coal no longer a viable heating option.

3. Results

3.1 England Archetype 1

Description

- 1945-1964 Terrace House
- Current heating: oil boiler
- No major renovations (cavity walls uninsulated, loft uninsulated)
- Floor area: 88 m²
- Annual heating demand: 13,165 kWh / year
- There are approximately 7,330 English properties that correspond to this archetype[3-4]

3.1.1 Cost Breakdown

Table 1 – England Archetype 1 cost breakdown

Heating System	CapEx (£)	OpEx (£/yr) [2025]	Levelised Cost (£/MWh) [2025]	Carbon Emissions ($kgCO_2e/yr$) [2025]
Oil Boiler	£3,451	£1,014	£103	6,472
LPG Boiler	£1,981	£1,903	£148	4,187
BioLPG Boiler	£1,981	£2,845	£211	421
BioLPG Blend *	£1,981	£2,092	£161	3,434
ASHP	£9,278	£2,374	£252	310
ASHP (+R) **	£22,120	£1,612	£459	211

[3] TABULA Web Tool: TABULA WebTool (building-typology.eu)

[4] Number of households in England: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2020

Hybrid	£11,259	£1,694	£226	1,086
Hybrid (+R) **	£23,940	£1,151	£439	737
Biomass Boiler	£12,624	£1,413	£220	1,037

*20% bioLPG and 80% LPG blend
**Archetype 1 renovations: loft insulation (£3,115), cavity wall insulation (£894), UPVC double glazing (£8,667) – total capital: (£12,842).

Analysis

- The lowest capital cost heating system is the bioLPG boiler. All other (low-carbon) heating systems require a substantially higher upfront cost, with the next lowest cost system (ASHP), being nearly five times more expensive.
- Among the low carbon technologies, the heating system with lowest operational cost is hybrid + R (with renovations). However, the high upfront cost of this system (nearly £24,000), with additional renovation costs, limit its sale to high income households.
- The heating systems with the lowest levelised cost over its lifetime is the bioLPG blend boiler (£161) followed by the 100% bioLPG boiler (£211). Despite not having the lowest operational costs, their very low capital costs result in bioLPG boilers being the most cost-effective heating system over their lifetime. For this archetype, due to the cost of renovation, the levelised costs for the ASHP/hybrid systems with renovations are higher than without renovations.
- BioLPG boilers also have the third lowest carbon intensity of any of the low-carbon heating systems, with significantly lower emissions than any of the high carbon heating systems.

3.1.2 Affordability Analysis

Figure 1 – England Archetype 1 affordability analysis

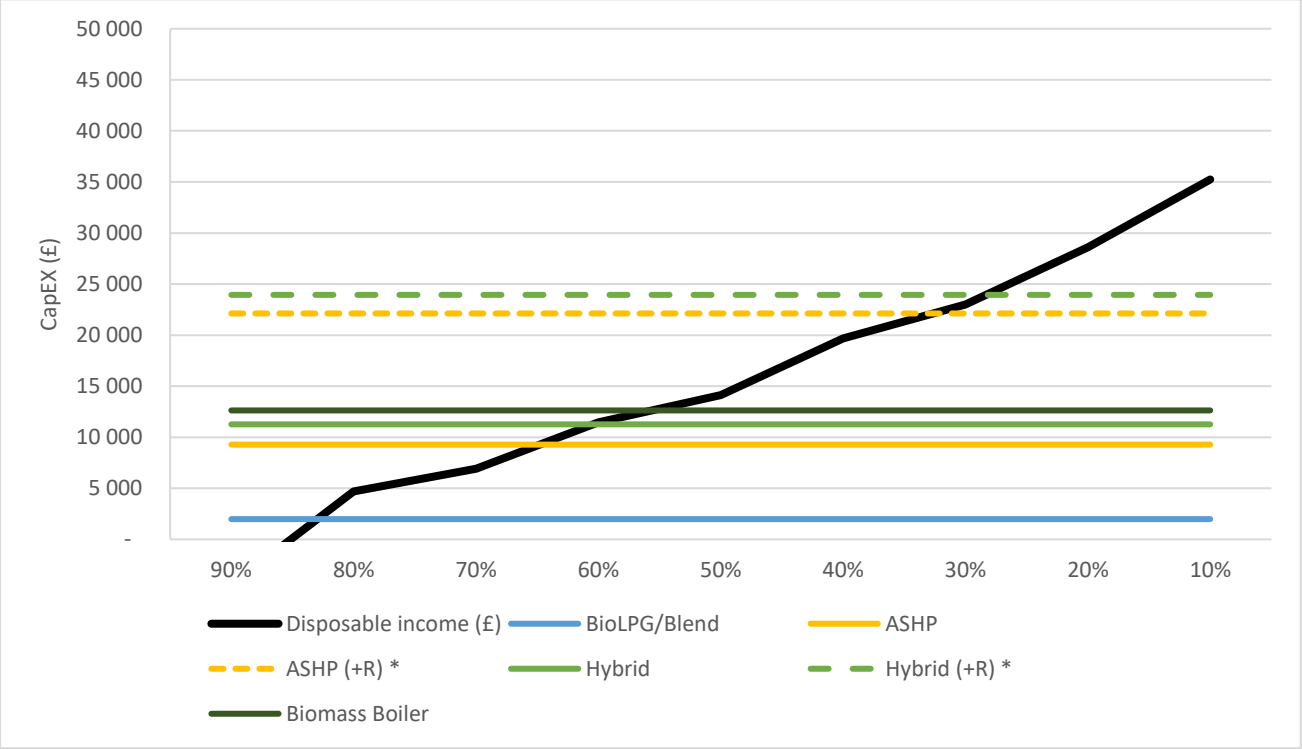

Figure 1: The line graph in black shows the percentage of English households existing within a certain annual disposable income range. The horizontal lines are constants representing the upfront cost of each heating system. The point at which horizontal lines intersect the solid black line indicates how affordable each heating option is, with the percentage of households able to afford the system displayed along the x-axis.

Table 2 – England Archetype 1 affordability analysis

Heating System	CapEx (£)	% households who can afford CapEx
BioLPG/Blend	£1,981	83%
ASHP	£9,278	65%
ASHP (+R) *	£22,120	33%
Hybrid	£11,259	60%
Hybrid (+R) *	£23,940	28%

Biomass Boiler	£12,624	56%

Table 2: Displays the approximate percentage of English households that have an annual disposable income greater than the capital cost of each of the low-carbon heating systems, for the archetype 1 property.

3.1.3 Consumer Journey

Consumer journey measures the amount of time required throughout all stages of the installation process of a new system, indicating the amount of hassle associated with each option.

Table 3 – England Archetype 1 consumer journey

Heating System	**Research, Search and Contact** (hours)	**Pre-Installation** (hours)	**Installation** (Days)	**Post-Installation** (hours)	**Ongoing** (hours per year)	**Approximate Total Time:**
BioLPG/Blend:	4-8	3.5-8	0.5	6-16	1-2	**3.5 – 7.5 days**
Biomass:	10-18	3.5-8	1	7-17	1-3.5	5.5 – 10.5 days
ASHP:	10-18	3.5-14	2-5	7-20	1-3.5	6.5 – 16 days
ASHP + R:	10-18	3.5-14	5-8	7-20	1-3.5	9.5 – 19 days
Hybrid:	10-18	3.5-14	2-5	7-20	1-3.5	6.5 – 16 days
Hybrid + R:	10-18	3.5-14	5-8	7-20	1-3.5	9.5 – 19 days

Table 3: Displays the consumer journey of each heating system for the archetype 1 property.[5]

Archetype 1 – renovation time:
Loft insulation (1 day), cavity wall insulation (1 day) and UPVC double glazing (1 day). Total 3 days.

3.2 England Archetype 2

[5] Holdaway, E., Samuel, B., Greenleaf, J., Briden, A. and Gardiner, A. (2009) "The Hidden costs and benefits of domestic energy efficiency and carbon saving measures" ECOFYS.

Description

- 1919-1944 Detached House
- Current heating: oil boiler
- No major renovations (solid brick uninsulated, loft uninsulated)
- Floor area: 153 m²
- Annual heating demand: 22,338 kWh / year
- There are approximately 42,000 English properties that correspond to this archetype[6]

3.2.1 Cost Breakdown

Table 4 – England Archetype 2 cost breakdown

Heating System	CapEx (£)	OpEx (£/yr) [2025]	Levelised Cost (£/MWh) [2025]	Carbon Emissions ($kgCO_2e$/yr) [2025]
Oil Boiler	£3,707	£1,725	£90	11,012
LPG Boiler	£2,428	£3,188	£140	7,125
BioLPG Boiler	£2,428	£4,792	£204	716
BioLPG Blend *	£2,428	£3,509	£153	5,843
ASHP	£13,818	£3,964	£237	518
ASHP (+R) **	£45,237	£2,527	£527	330
Hybrid	£14,510	£2,847	£197	1,840
Hybrid (+R) **	£45,648	£1,815	£486	1,173
Biomass Boiler	£17,766	£2,405	£199	1,764

*20% bioLPG and 80% LPG blend
**Archetype 2 renovations: loft insulation (£4,198), solid wall insulation (£15,573), double glazing (£11,240) – total capital (£31,419).

[6] TABULA Web Tool: TABULA WebTool (building-typology.eu)

Analysis

- The lowest capital cost heating system is the bioLPG boiler. All other (low-carbon) heating systems require a substantially higher upfront cost, with the next lowest cost system (ASHP), being nearly six times more expensive.
- Among the low carbon technologies, the heating system with lowest operational cost is hybrid + R (with renovations). However, the high upfront cost of this system (over £45,000), with additional renovation costs, limit its sale to high income households.
- The heating system with the lowest levelised cost over its lifetime is the bioLPG and LPG blend (£153), with 100% bioLPG boilers having the fourth lowest levelised cost (£204). Despite not having the lowest operational costs, their very low capital costs result in bioLPG blend boilers being the most cost-effective heating system over their lifetime. For this archetype, due to the cost of renovation, the levelised costs for the ASHP/hybrid systems with renovations are higher than without renovations.
- BioLPG boilers also have the third lowest carbon intensity of any of the low-carbon heating systems, with significantly lower emissions than any of the high carbon heating systems.

3.2.2 Affordability Analysis

Figure 2 – England Archetype 2 affordability analysis

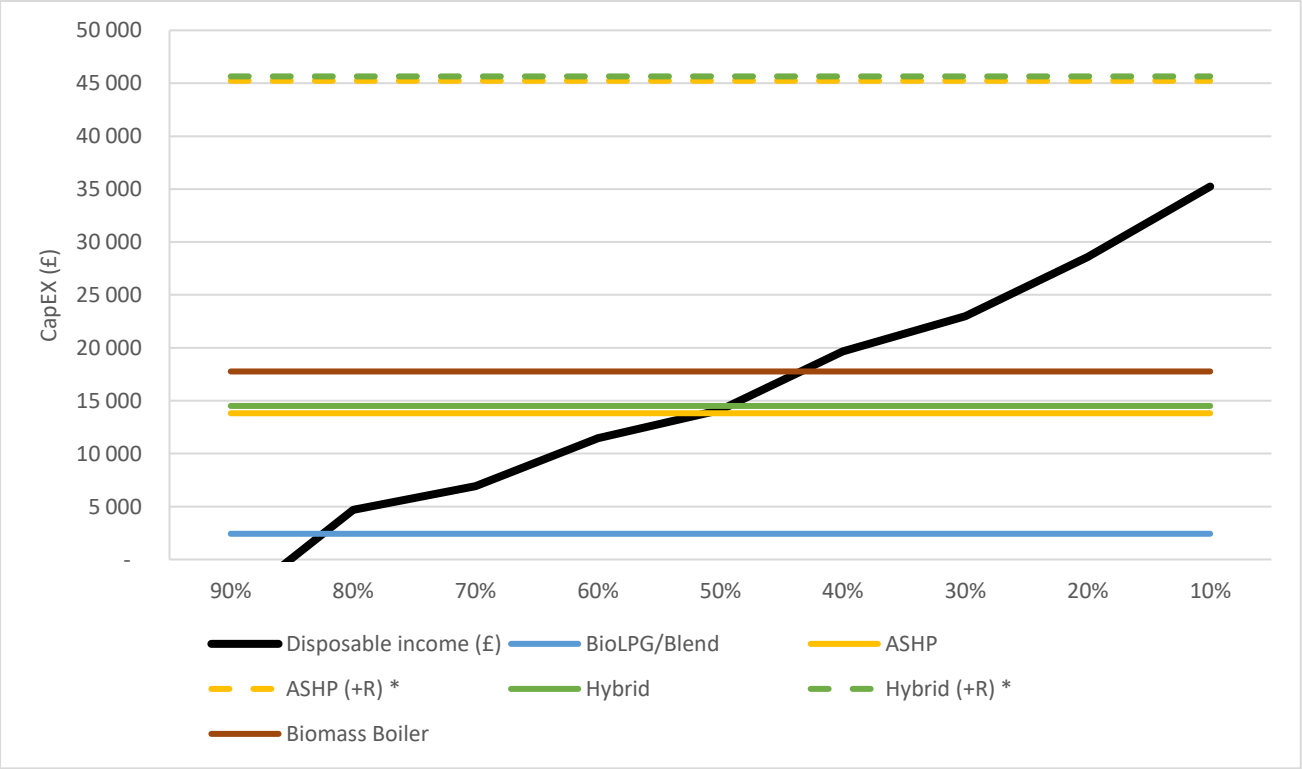

Figure 2: The line graph in black shows the percentage of English households existing within a certain

annual disposable income range. The horizontal lines are constants representing the upfront cost of each heating system. The point at which horizontal lines intersect the solid black line indicates how affordable each heating option is, with the percentage of households able to afford the system displayed along the x-axis.

Table 5 – England Archetype 2 affordability analysis

Heating System	CapEx (£)	% households who can afford CapEx
BioLPG/Blend	£2,428	82%
ASHP	£13,818	51%
ASHP (+R) *	£45,237	0%
Hybrid	£14,510	49%
Hybrid (+R) *	£45,648	0%
Biomass Boiler	£17,766	43%

Table 5: Displays the approximate percentage of English households that have an annual disposable income greater than the capital cost of each of the low-carbon heating systems, for the archetype 2 property.

3.2.3 Consumer Journey

Consumer journey measures the amount of time required throughout all stages of the installation process of a new system, indicating the amount of hassle associated with each option.

Table 6– England Archetype 2 consumer journey

Heating System	Research, Search and Contact (hours)	Pre-Installation (hours)	Installation (Days)	Post-Installation (hours)	Ongoing (hours per year)	Approximate Total Time:
BioLPG/Blend:	4-8	3.5-8	0.5	6-16	1-2	**3.5 – 7.5 days**
Biomass:	10-18	3.5-8	1	7-17	1-3.5	5.5 – 10.5 days
ASHP:	10-18	3.5-14	2-5	7-20	1-3.5	6.5 – 16 days
ASHP + R:	10-18	3.5-14	14-17	7-20	1-3.5	18.5 – 28 days

Hybrid:	10-18	3.5-14	2-5	7-20	1-3.5	6.5 – 16 days
Hybrid + R:	10-18	3.5-14	14-17	7-20	1-3.5	18.5 – 28 days

Table 6: Displays the consumer journey of each heating system for the archetype 2 property.[7]

Archetype 2 – renovation time:
Loft insulation (1 day), solid wall insulation (10 days) and UPVC double glazing (1 day). Total 12 days.

[7] Holdaway, E., Samuel, B., Greenleaf, J., Briden, A. and Gardiner, A. (2009) "The Hidden costs and benefits of domestic energy efficiency and carbon saving measures" ECOFYS.

4. Discussion of Results

Heating system cost:

From a consumer perspective, the cost of a heating system is usually the primary consideration in driving heating system choice.

This cost can be divided into the upfront capital cost of the heating system and the ongoing operational costs. Consumers will pay a higher upfront cost if it results in lower ongoing costs and they are able to break even on their higher initial investment within a sufficiently short time-period.

The levelised cost of the heating system encompasses both the capital and operational cost and is therefore a useful measure of the financial attractiveness of the system, with the lower levelised costs being of greater appeal.

This analysis has found the annualised capital expenditure, the operational expenditure and the resulting levelised cost of various heating systems for two contrasting property archetypes in England.

The heating system types can be divided into ‘carbon intensive’ forms of heating and ‘low carbon’ forms of heating. Often, the carbon intensive forms of heating prove to be more financially attractive than the low carbon alternative, however, in line with net-zero targets, these carbon intensive options are not considered to be a viable option and exist only for the sake of comparison.

For both archetypes defined above, bioLPG boilers are consistently demonstrated to be the cheapest option when defined by both capital cost and levelised cost. This means that they are the most accessible option from an upfront cost point of view, but also prove to be the most affordable low-carbon heating system over their lifetimes.

Renovating the properties to improve their thermal efficiencies, alongside the installation of an air-source heat pump is usually advised. This is to allow them to operate more efficiently and provide lower operational costs. The same is true for a hybrid heat pump system.
However, for the two archetype properties considered here, these renovations, despite lowering heat demand and operational costs, actually resulted in an overall higher levelised cost, (compared with the non-renovation option). This is due to the significant increase in upfront cost included in the renovation options, particularly for archetype 2 – demanding expensive solid wall insulation.

Heating system affordability via household disposable income:

The option of paying a higher capital cost for lower operational costs and long-term financial gain, beyond the breakeven point, is considered differently depending on a household’s level of disposable income. Whilst one heating system may provide a lower levelised cost and greater financial gain over the system’s lifetime, the capital cost may be prohibitive to lower income households. Capital cost is therefore an important metric to analyse in order to determine the heating system’s short term financial accessibility. This was done here by comparing the capital cost with household disposable income.

The household disposable income was derived from the household gross income using the following formula:

Household Disposable Income = *Household Original Income* + *Benefits* – *Taxes* – *Household Expenditure*

Household income data by decile from 2023/2024 was taken from the Office for National Statistics[8]. This dataset included data (by decile) on pre-tax income, benefits and taxes paid by households by income decile. Household expenditure data for the same fiscal year was also taken from the Office for National Statistics[9]. This dataset shows household weekly expenditure by income decile. We treat disposable income as the income left after government transfers and household expenditures.

The affordability of the heating system was then defined based on two assumptions:

1. The household income for each archetype can be represented equivalently by the national income average.
2. If the capital cost of a heating system exceeds the annual disposable income of a household it is deemed 'not affordable'.

Realistically, the household incomes will vary between the three archetypes. A more tailored archetype income analysis would demand a more detailed dataset household income by property type.

The results of the analysis show that bioLPG boilers are a more affordable option to a significantly higher proportion of English households than any other low-carbon heating system.

For archetype 1, bioLPG boilers were found to be affordable to **83%** of households in England, compared to the next most affordable heating system option, an ASHP affordable to 65% of households.

For archetype 2, bioLPG boilers were found to be affordable to **82%** of households in England, compared to the next most affordable heating system option, an ASHP, being affordable to 52% of households.

These results demonstrate bioLPG boilers to consistently have far more accessible upfront costs compared with any other low-carbon heating system option.

Consumer Journey:

The other important consideration from a consumer point of view is the 'consumer journey'. This is here defined by the amount of time required to organise the replacement of the old system, the time required for the installation/renovation process, the ongoing maintenance requirements over the system's lifetime, and the regularity at which the system needs replacing. Effectively, the

[8] ONS (2025): The effects of taxes and benefits on household income, disposable income estimate

[9] ONS (2025): Family spending workbook 1: detailed expenditure and trends

consumer journey measures the convenience of the overall operation, which can also impact on the consumer's choice of heating system.

The amount of time for each stage of the process was estimated for each heating system and for each archetype, based off estimated ranges made in a previous study that considered the consumer journey in detail.[10]

For the heating systems which include renovations (ASHP + R and Hybrid + R), these renovation times were also included.

These renovation times for each archetype varied significantly; three days for archetype 1 and twelve days for archetype 2. These renovation times were determined by adding together the amount of time predicted for each aspect of the renovation process.

For both archetypes, bioLPG boilers prove to have the shortest amount of time required by the consumer throughout the installation process. The operational lifetime of all heating system was assumed to be 15 years.

Overall, bioLPG boilers provide an attractive consumer journey compared with other low- carbon heating system options, with low-labour requirements required over the course of the installation process.

Additional Consideration - costs of electrical supply and network upgrades:

Additional to the direct consumer cost of installing a new heating system, it is important to consider the consumer and network costs associated with upgrading electricity supply.

Single phase electricity supply is more prominent in UK homes. This poses a challenge for the installation of certain larger heat pumps, and needs addressing to prevent malfunctions of other electrical appliances.[11]

Not all installations require connection upgrades, but typically in properties with a large peak heat demand (100-150 W/m² and higher), which require a larger heat pump, upgrades to 3 phase supply are a realistic requirement. This adds to the upfront capex for the consumer, with upgrades varying in price but typically costing more than £3,000 per job.[12]

Additionally, DNOs are facing local network costs associated with the integrating electric vehicles and heat systems. Whilst disruption is less of a challenge and cost in rural areas, analysis suggests that DNOs will need to upgrade over 130,000 km of underground or overground cable – a greater length

[10] Holdaway, E., Samuel, B., Greenleaf, J., Briden, A. and Gardiner, A. (2009) "The Hidden costs and benefits of domestic energy efficiency and carbon saving measures" ECOFYS.

[11] Kensa Heat Pumps (2015) Heat Pumps and Single Phase Power

[12] UK Power Networks (2021) Upgrade electricity: Time and cost.

of network than DNOs serving urban areas.[13]

[13] Vivid Economics and Imperial College (2018) Accelerated electrification and the GB electricity system.

5. Summary of Results

Cost Breakdown

BioLPG boilers consistently demonstrated to have the lowest capital cost of any low-carbon heating system, making them the most accessible low-carbon heating option with the majority of households from each archetype being able to afford the capital.

Despite having slightly higher operational costs, bioLPG boilers have among the lowest levelised cost of any low-carbon heating system, especially the bioLPG/LPG blend option which is almost consistently the most affordable option over the system's lifetime.

Sustainability

ASHPs and ASHPs with renovations see the lowest carbon emissions annually with 100% bioLPG boilers come in at next lowest emitting technology.

Still, 100% bioLPG boilers can lower carbon emissions by around ten times that of the high-carbon heating systems currently in use (oil and LPG boilers). This shows the potential use of bioLPG blend boilers as a transition method to low carbon, if the blend ratio of bioLPG is increased over time these carbon savings can be significantly greater than the current 20% bioLPG blend ratio. With the present-day carbon intensity of electricity supply, 100% bioLPG boilers emit less carbon equivalent emissions than hybrid systems.

Consumer Journey

BioLPG boilers also prove to have the most appealing 'consumer journey' with less time required over the total installation process than any other low-carbon heating system option.

Appendix

Capital Costs:[14]

Heating System:	
Oil Boiler less than 5kW	£2,807
Oil Boiler 6-10kW	£2,923
Oil Boiler 11-15kW	£3,068
Oil Boiler 16-20kW	£3,451
Oil Boiler 21-25kW	£3,451
Oil Boiler 26-30kW	£3,707
Oil Boiler 31-35kW	£3,707
Gas Condensing Boiler less than 5kW	£1,820
Gas Condensing Boiler 6-10kW	£1,892
Gas Condensing Boiler 11-15kW	£1,981
Gas Condensing Boiler 16-20kW	£2,173
Gas Condensing Boiler 21-25kW	£2,428
Gas Condensing Boiler 26-30kW	£2,684
Gas Condensing Boiler 31-35kW	£2,940
LPG Tank Rental	£71/year
Biomass Boiler less than 10kW	£12,831
Biomass Boiler 11-15kW	£11,844
Biomass Boiler 16-20W	£12,624
Biomass Boiler 21-25kW	£14,075
Biomass Boiler 26-30kW	£16,226
Biomass Boiler 31-35kW	£17,766
Biomass Boiler 36-40kW	£19,000
Biomass Boiler 41-45kW	£25,445
ASHP less than 5kW	£7,403
ASHP 6-10kW	£9,278
ASHP 11-15kW	£12,338
ASHP 16-20kW	£13,818
ASHP 21-25kW	£18,753
ASHP 26-30kW	£21,655
ASHP 31-35kW	£21,369
ASHP 36-40kW	£28,850
ASHP 41-45kW	£26,234
Radiator Cost	£393

[14] **Capital costs are modelled from the following sources** – **Oil & Gas Condensing Boilers**: Modelled using Sustainable Energy Authority of Ireland (2022). *Low Carbon Heating and Cooling Technologies: Options, Costs, Performance and Suitability*. & BEIS (2018) Energy Company Obligation – Eco3: 2018-2022, Final Stage Impact Assessment. **LPG Tank Rental**: Provided by LGUK. **ASHP & Biomass Boilers:** DEFRA (2024). *RHI Monthly Deployment data: March 2024 (Annual edition)*. **Radiator cost**: Talan market source, available upon request.

Fuel Costs:[15]

Heating Fuel:	Fuel Price:	Unit:
Electricity	0.2895	£/kWh
Electricity off-peak tariff	0.1737	£/kWh
Conventional LPG	0.1050	£/kWh
BioLPG	0.1590	£/kWh
Wood pellets	0.0667	£/kWh
Oil	0.0513	£/kWh

Heating Lifetimes:[16]

Heating System:	Heating Lifetime (Years)
Oil Boiler	15
Gas Condensing Boiler	15
Biomass Boiler	15
ASHP	15
Hybrid	15

Carbon Intensity Factors:[17]

Heating Fuel:	Carbon Intensity:	Unit:
Electricity	0.0378	$kgCO_2e/kWh$
LPG	0.2400	$kgCO_2e/kWh$
BioLPG	0.0241	$kgCO_2e/kWh$
Heating Oil	0.3273	$kgCO_2e/kWh$
Biomass	0.0489	$kgCO_2e/kWh$

[15] **Fuel costs are from the following sources** – **Electricity:** DESNZ (2023) *Green Book supplementary guidance: Valuation of energy use and greenhouse gas emissions for appraisal. data-tables-1-19.xlsx*. **Conventional LPG:** Provided by LGUK. **BioLPG:** Source available upon request. **Wood pellets:** TALAN market source, available upon request. **Heating oil:** Compass Fuels (2024). *HVO Fuel Price Per Litre UK*. [online] Compass Fuel Oils Ltd.

[16] **Heating lifetimes are from the following sources** – **Oil Boiler & Gas Condensing Boiler:** BEIS (2018) Energy Company Obligation – Eco3: 2018-2022, Final Stage Impact Assessment. **Biomass Boiler:** BEIS (2022) Future Support for Low Carbon Heat: Boiler Upgrade Scheme. **ASHP:** RenewEast (2024) What is the Lifespan of an Air Source Heat Pump?. **Hybrid:** Committee on Climate Change (2019) *Net Zero – Technical Report*. Net-Zero-Technical-report-CCC.pdf

[17] **Carbon intensity factors are from the following sources** – **Electricity**: DESNZ (2023) Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, Data tables 1 to 19: supporting the toolkit and the guidance. **All other fuel types:** DESNZ (2025) UK Government GHG Conversion Factors for Company Reporting

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