ISLE OF MAN HEAT PUMP OPEX AND EMISSIONS STUDY

SAM O'MARA

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Our work was completed in July 2023

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KEY ANALYSIS OBJECTIVES

- Compare the running costs of different heating systems.
- Produce reasonable future price forecasts.
- Assess the lifetime running costs using forecasted prices.
- Analyse the evolution of heat pump price competitivity.

KEY FINDINGS

Click on icon to navigate to section

FUEL PRICE ANALYSIS

There have been significant price increases due to the Energy Crisis with gas prices increasing by 83%.

Oil prices have increased far less than gas and electricity prices due to the Energy Crisis.

Price forecasting analysis shows the potential for long term increases in gas prices.

HEAT PUMP COST SAVINGS

Under the central case assumptions used, heat pumps lower annual consumer bills by £746 per year compared to a gas boiler. Currently, they are less financially competitive for those with oil boilers.

Using “comfy” heating tariffs increases savings by ~£70.

LIFETIME COST SAVINGS

Over the lifetime of a boiler, an air source heat pump could deliver £9,246 in discounted savings compared to a gas boiler and £144 compared to an oil boiler using middle price forecasts.

Savings are greater for GSHPs.

EMISSIONS SAVINGS

Air source heat pumps produce 0.35t CO2e less emissions annually than a gas boiler and 1.47t CO2e less emissions than an oil boiler.

Under the Storming ahead scenario, an average efficiency heat pump produces 8.5 tonnes less CO2e over its lifetime than a gas boiler.

PRICE COMPETITIVENESS

The price competitiveness of heat pumps compared to gas boilers has been volatile during the Energy Crisis, however, heat pumps have been able to deliver savings even at low efficiencies.

Heat pumps cost competitiveness compared to oil boilers has generally improved with time.

SENSITIVITIES

Rationale for including three cases

- There are series of assumptions that will shift the attractiveness of switching to a heat pump.

- The accuracy of these assumptions may differ according to the specific scenario surrounding a decision to install a heat pump.

- To account for this, three “cases” have been developed (detailed further on next slide):
  - **A best case -** Assumptions that are consistent with the highest savings.
  - **A worst case -** Assumptions which correspond to the lowest savings.
  - **A central case -** Assumptions which have been deemed most suitable to the Isle of Man according to relevant literature and prior analysis.

- Many assumptions have been kept consistent across the three cases (as described in annexe 1), to allow for comparison between the sensitivities.

SENSITIVITIES

Differing assumptions under each "case"

Further assumptions, rationales, and details can be found in annexe 1. Rationale for central case included on next slide.

Worst case

- Installed **without** all relevant upgrades so there is a ~10% space heating uplift (please see annexe 6 for further details). Uplift due to greater heating ramp up time and higher average internal temperature.
- Oil purchased in high volumes (900 litres or more).
- No access to flexible electricity tariff
- Heat pump owner still pays gas standing charge

Central case

- Installed **with** some relevant upgrades so there is a ~5% space heating uplift (please see annexe 6 for further details). Uplift due to greater heating ramp up time and higher average internal temperature.
- Oil purchased in average volumes (around 675 litres)
- Access to flexible electricity tariff
- Heat pump owner does not pay gas standing charge (electrical cooking)

Best case

- Installed **with** all relevant upgrades so there is no space heating uplift (please see annexe 6 for further details).
- Oil purchased in low volumes (450 litres or less)
- Access to flexible electricity tariff
- Heat pump owner does not pay gas standing charge (electrical cooking)

SENSITIVITIES

Central case assumptions and rationale

Central assumptions	Rationale
Heat pump space heating demand uplift of 5%.	10% is widely used in impact assessments however the literature that this is based on is not 100% robust and suggests that this would not be the case for all homes. Homes with upgrades to radiators, fabric efficiency (insulation) and smart controls are likely to be able to avoid an uplift. See annexe 6 for further details. 5% has been used to account for homes where some, but not all, relevant upgrades are made.
Heat pumps utilise flexible tariffs.	Increasingly prevalent and will help to balance grid whilst lowering running costs.
Homes do not use gas cooking.	Gas cooking makes no economic sense when not using gas for space heating, as would have to pay standing charge.

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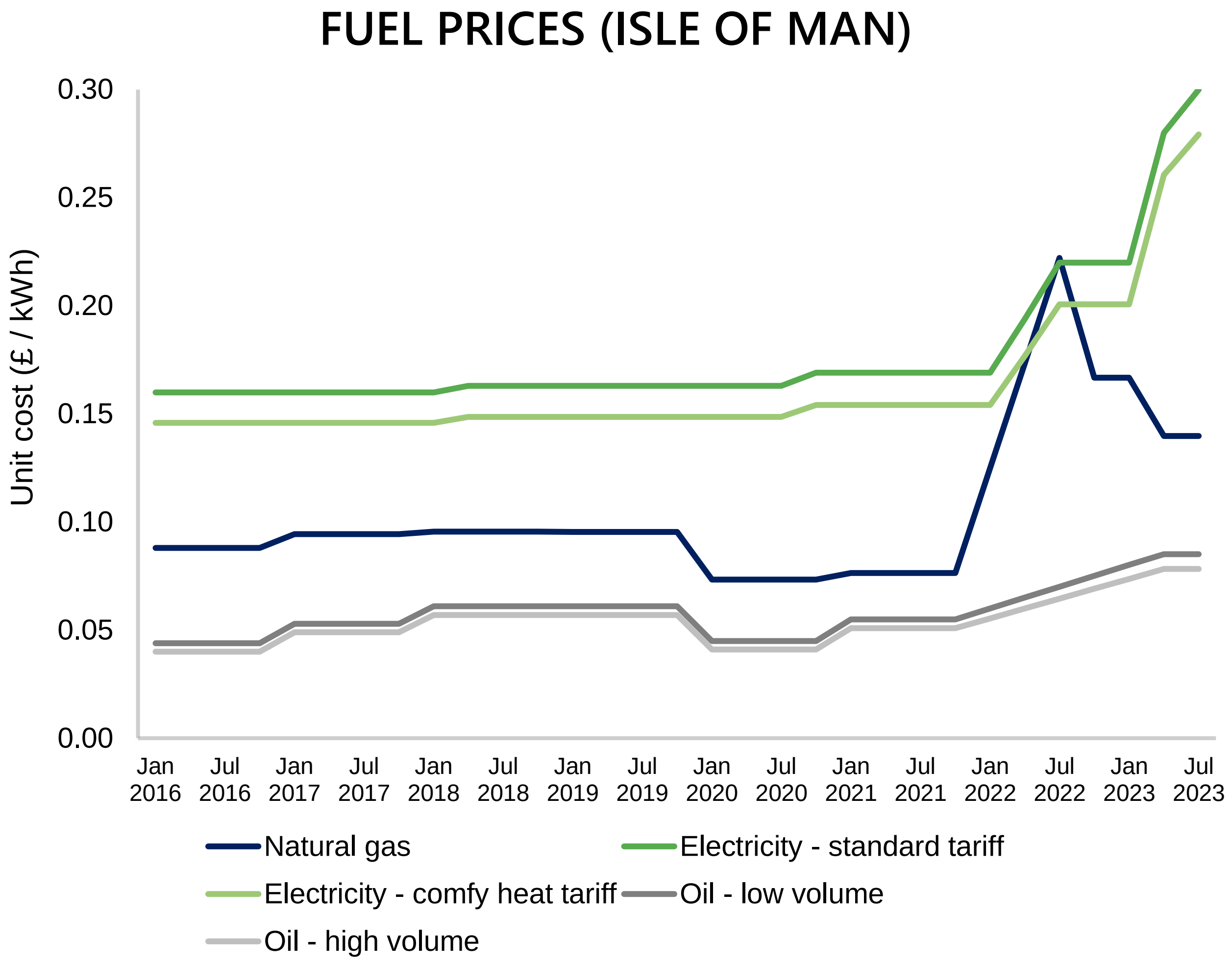
FUEL PRICE ANALYSIS

AND FORECASTED PRICES

FUEL PRICES

Price trends and the Energy Crisis

- Data suggests that oil is currently the lowest cost fuel on the Island per unit of energy.
- Purchasing oil in larger volumes tends to give a discount of between 7% and 10%*.
- Utilising a "comfy" heat tariff can lower the unit of cost of electricity by 7-9%, even without demand shifting. Please see annexe 3 for details on methodology.
- Recent announcements show that electricity prices will increase to 0.30 £/kWh in July, in line with price cap announcements in the UK. This increase is around a third of the original expected increase.



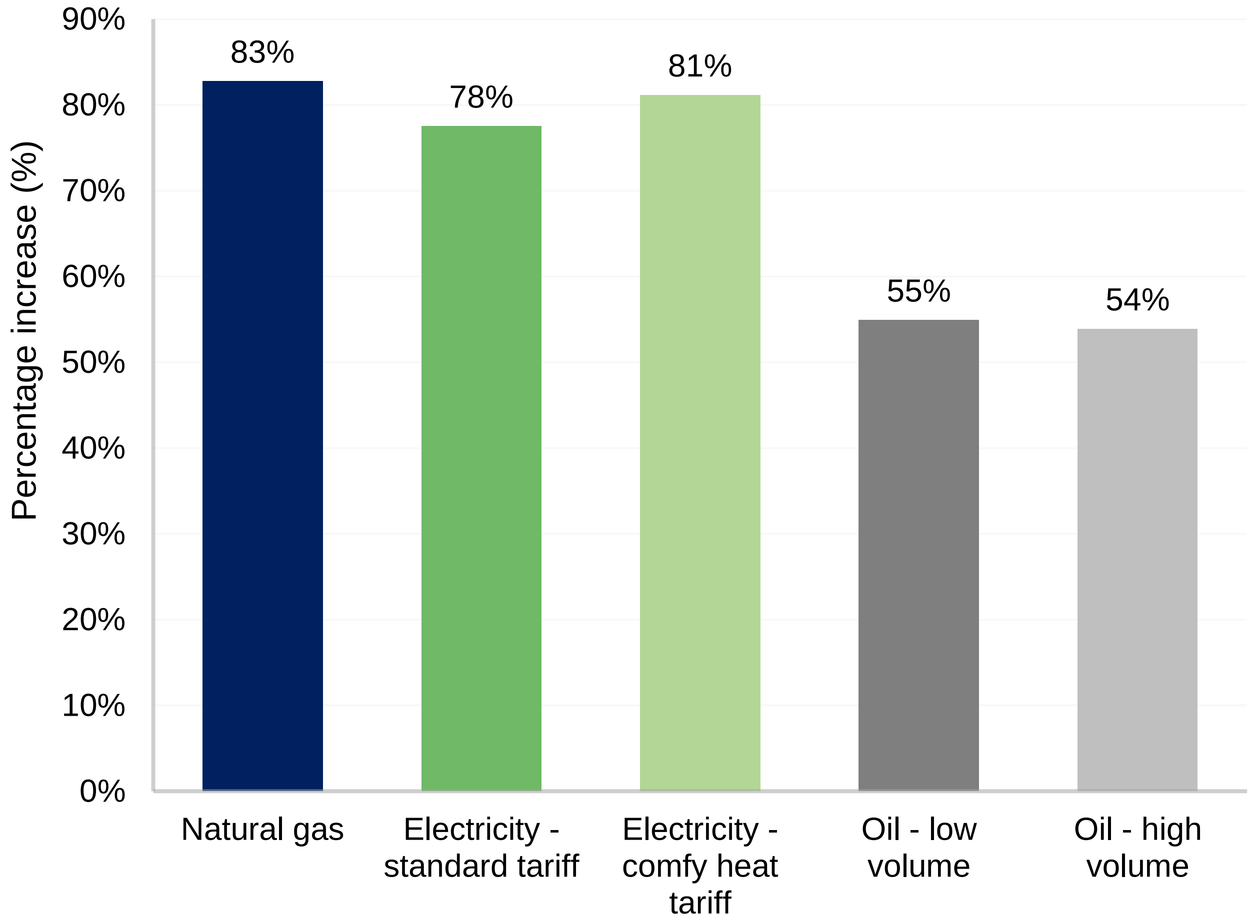
* According to Isle of Man Office of Fair Trading Domestic heating Comparisons. Based on low volume purchases at 450 litres and high volume purchases at 900 litres. This is in line with average domestic oil tank capacity which is between 1,000 and 2,500 litres according to Certas Energy.

FUEL PRICES

Energy Crisis price shocks

- The Energy Crisis has seen price shocks across different fuels however, gas prices have seen the biggest shock.
- Between July 2021 and July 2023, gas prices have increased by 83%, standard electricity prices have increased by 78% and oil prices have increased by 55%.
- The saving available from a comfy heating tariff has decreased from a long run average of 9% to 7% during the Energy Crisis.

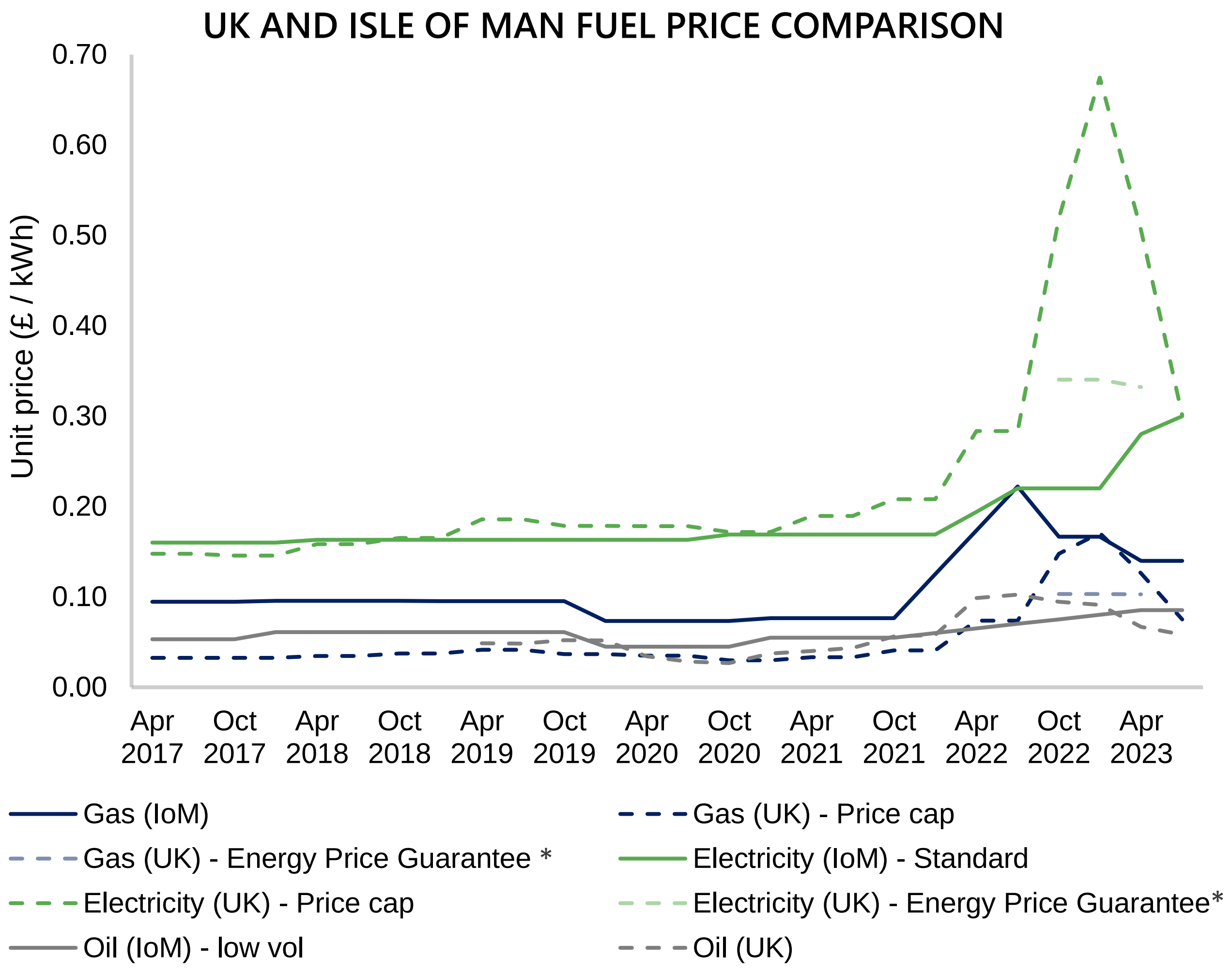
Increase in fuel prices between July 2021 and July 2023



FUEL PRICES

UK and IoM comparison

- Regression analysis was used to forecast forwards fuel prices on the Island. This utilised UK price forecasts and so a comparison of prices was required.
- Electricity prices are largely similar, except for during the Energy Crisis, where prices in the UK have increased by more. Recent price cap announcements have seen this difference decrease.
- Before the Energy Crisis, gas prices are far higher on the Isle of Man, and during the Energy Crisis are similar to non-subsidised UK prices.
- Oil prices are largely similar between the UK and Isle of Man.



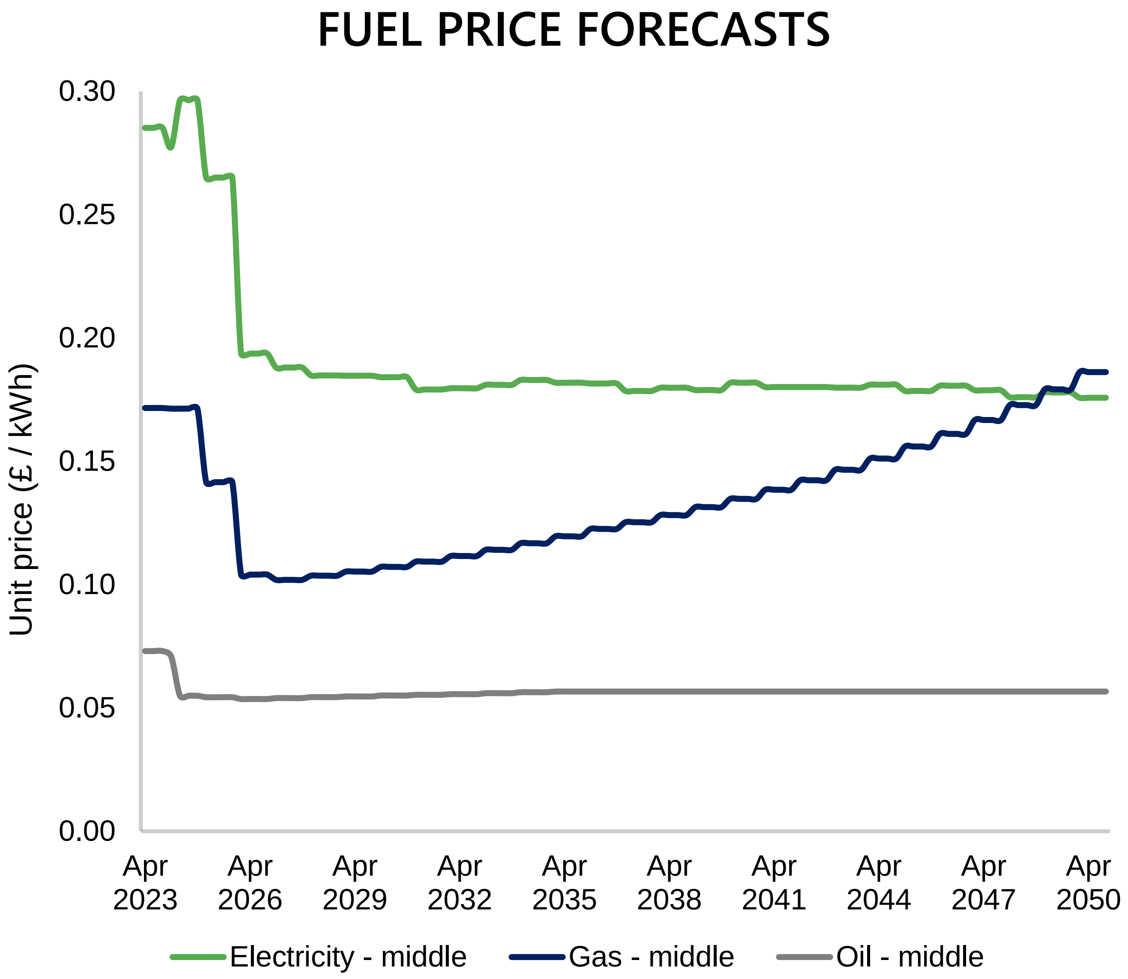
* Note that the Energy Price Guarantee was introduced in the UK in October of 2022 and was put in place until March 2024. The Energy Price Guarantee subsidised fuel prices under the price cap to a set level. As prices under the Ofgem price cap have since gone under Energy Price Guarantee prices, subsidies will no longer be in place as of July 2023. Therefore, Energy Price Guarantee prices are only in practical effect from October 2022 – June 2022.

FUEL PRICES

IoM fuel price forecasts

Please note that all price scenarios are included in annexe 4. Scenario descriptions can be found here.

- Modelling approach to predict future prices (using UK forecasts and controls for the Energy Crisis) had a high degree of corelation, especially for electricity (please see annexe 2 for further details).
- UK based forecasts provided the most suitable available data however, it is worth noting that correlations between UK and IoM prices may change over time. For example, currently, electricity prices on the Isle of Man are predominantly set by combined cycle gas turbine (CCGT) generation and when this is not running, the UK wholesale market. As domestic renewables come online, as well as imports through the interconnector, prices may increasingly be set by the price of domestic production, causing a divergence from UK prices.
- Accounting for increased gas operating costs per customer resulted in an additional uplift to gas prices.
- The Energy Crisis has distorted short term forecasts; however, analysis suggests that gas will be more expensive than electricity per unit of energy by 2048.
- Forecasts suggest that oil prices will remain relatively constant, however, recent developments suggest that some price increases *may* occur. For example, Saudi Arabia recently decided to cut its output of crude oil, causing a 2% price increase.



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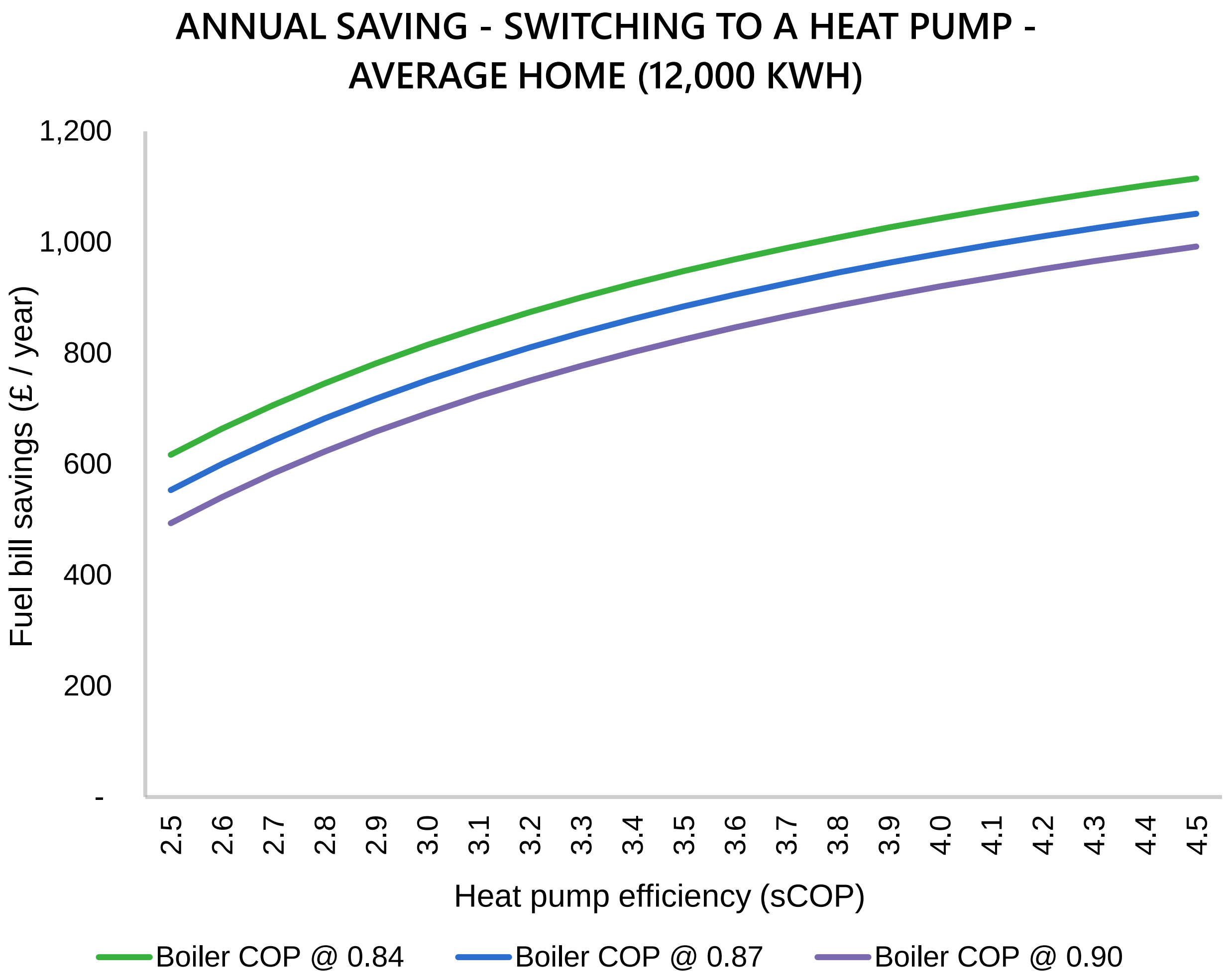
HEAT PUMP COST SAVINGS

RUNNING COSTS UNDER CURRENT PRICES AND CURRENT CARBON SAVINGS

HEAT PUMP COST SAVINGS

Gas – central case

- Assumptions follow those detailed for central case in sensitivities section and prices are as of July 2023.
- Switching from a gas boiler operating at a COP* of 0.84 to a heat pump operating at a sCOP* of 2.8** will save a household £746 per year, under current prices. This would correspond to a space heating efficiency of 2.93 sCOP and domestic hot water efficiency of 2.28.
- This is assuming that households are able to use a comfy heating / flexible tariff for electricity used for heating. Savings are ~£70 lower without the use of a flexible tariff.



* COP (coefficient of performance) shows how efficient inputted energy is converted to outputted heat. sCOP (seasonal coefficient of performance) takes into account variations in COP between different heating periods.

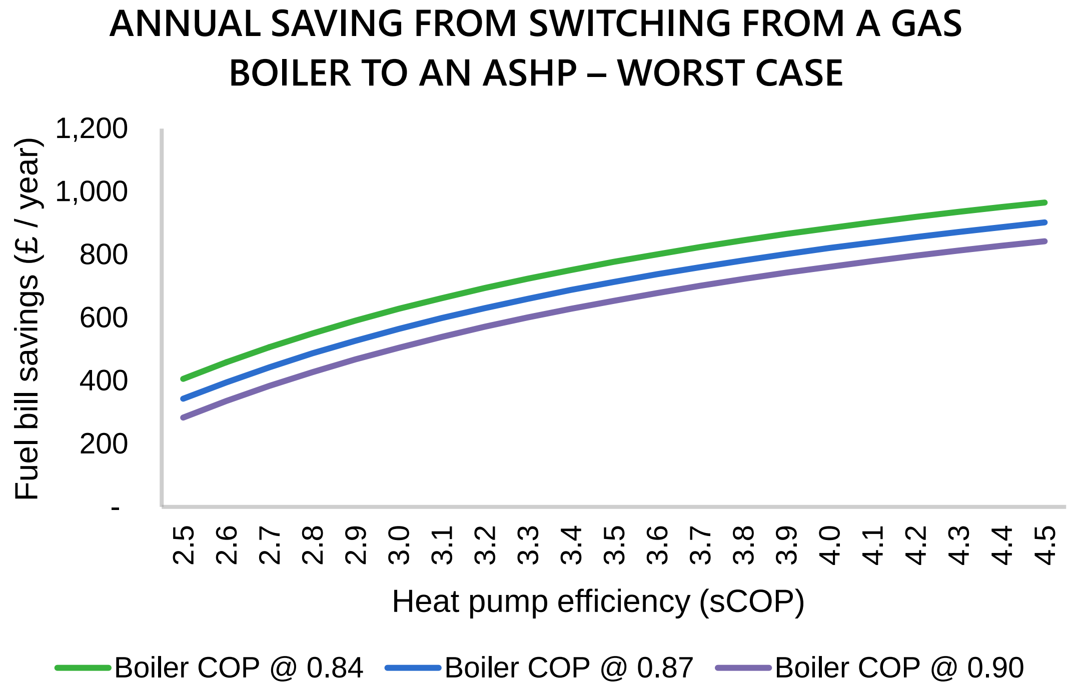
** Please note that these efficiencies have been used in line with current efficiencies used in UK civil service impact assessments. Please see annexe 1 for assumptions. Evidence suggests that heat pumps can reach higher efficiencies and so 2.8 sCOP should be used as benchmark with the savings over different efficiencies (above) showing a full range of potential savings.

HEAT PUMP COST SAVINGS

Gas – sensitivities

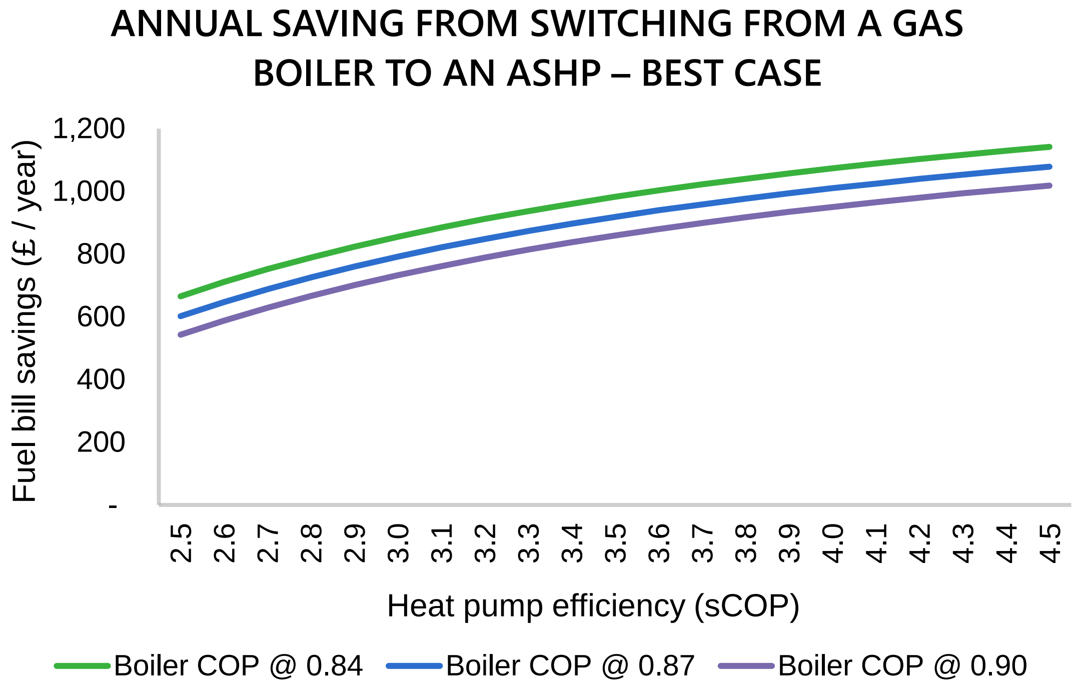
WORST CASE

Switching from a gas boiler operating at a COP of 0.84 to a heat pump operating at a sCOP of 2.8 will save a household £551 per year, under worst case assumptions.



BEST CASE

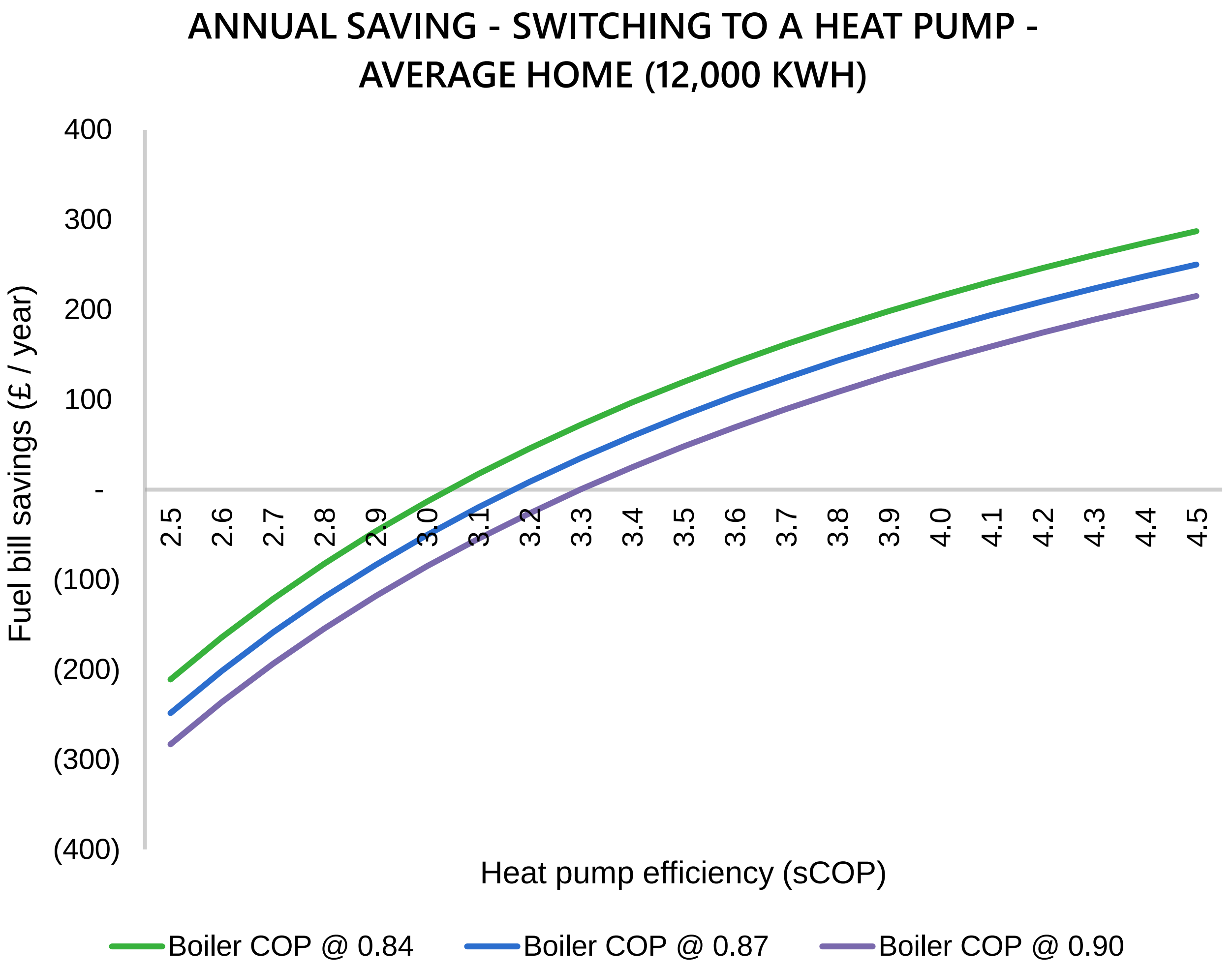
Switching from a gas boiler operating at a COP of 0.84 to a heat pump operating at a sCOP of 2.8 will save a household £789 per year, under best case assumptions.



HEAT PUMP COST SAVINGS

Oil – central case

- Assumptions follow those detailed for central case in sensitivities section and prices are as of July 2023.
- Switching from an oil boiler with efficiency 0.84 COP to a heat pump with efficiency of 2.8 sCOP would currently increase bills by £82 per year.
- However, the impact of the Energy Crisis has been far greater on electricity prices than oil prices. As prices return to long term trends, heat pumps are expected to deliver lifetime savings compared to an oil boiler. This is shown in the lifetime savings section.
- Heat pumps operating at efficiencies of 3 sCOP or higher will deliver savings against an oil boiler operating at a COP of 0.84.



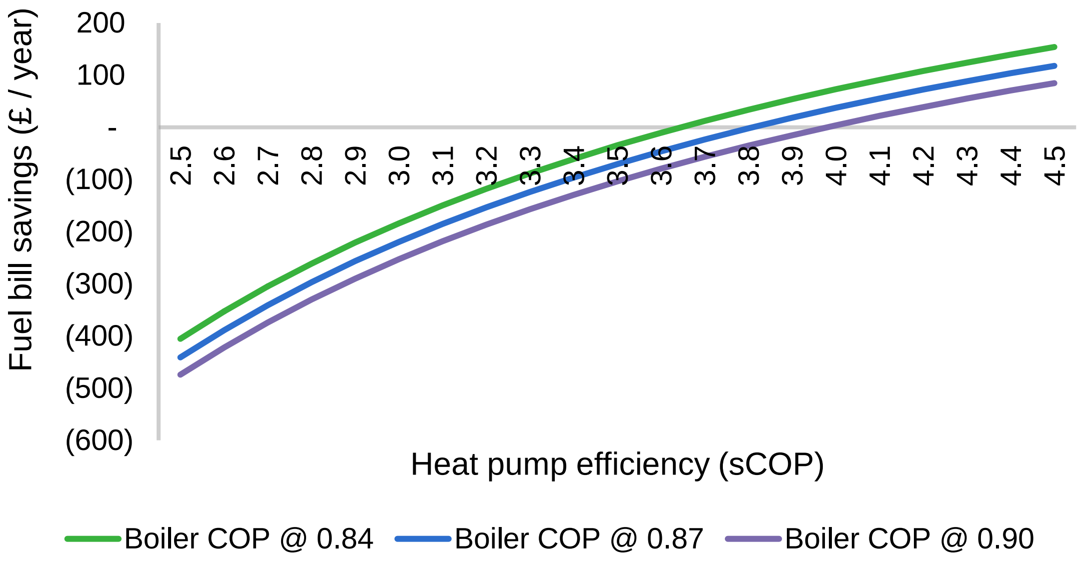
HEAT PUMP COST SAVINGS

Oil – sensitivities

WORST CASE

Switching from an oil boiler operating at a COP of 0.84 to a heat pump operating at a sCOP of 2.8 will increase annual heating bills by £261 under worst case conditions.

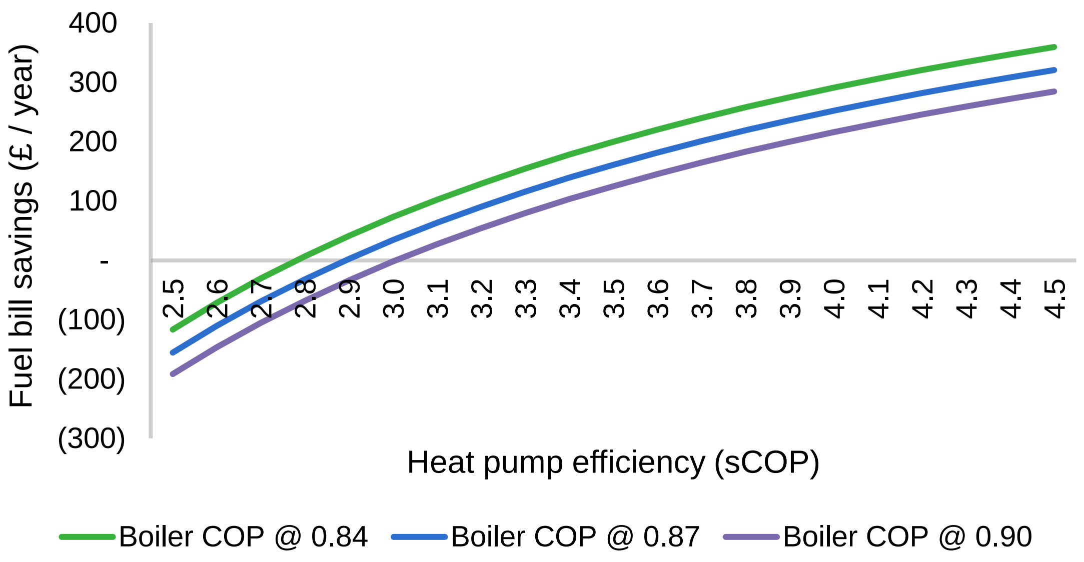
ANNUAL SAVING FROM SWITCHING FROM AN OIL BOILER TO AN ASHP – WORST CASE



BEST CASE

Switching from an oil boiler operating at a COP of 0.84 to a heat pump operating at a sCOP of 2.8 will save a household £7 per year, under best case assumptions.

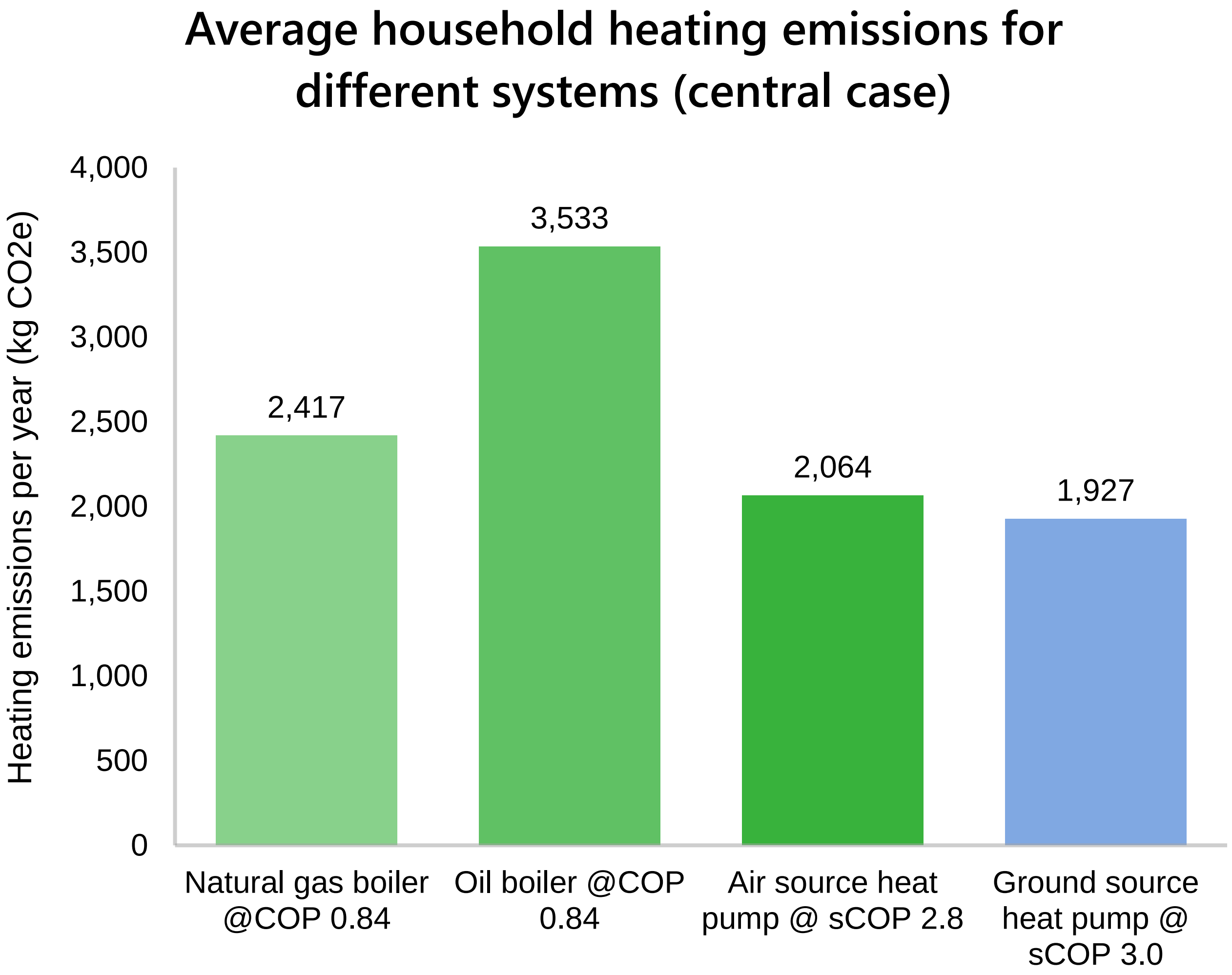
ANNUAL SAVING FROM SWITCHING FROM AN OIL BOILER TO AN ASHP – BEST CASE



HEAT PUMP COST SAVINGS

Current emissions savings

- ***Please note that the emissions factor used for electricity in this analysis is a preliminary value and expected to change significantly by 2030.***
- Heat pumps have lower heating emissions* than both oil and natural gas boilers. In an average household, air source heat pumps produce 0.35t CO2e lower emissions than a natural gas boiler per year and 1.47t CO2e lower emissions than an oil boiler.
- Carbon has a social value which can be quantified by estimating the damage of climate change stemming from an additional greenhouse gas emission**. The savings from a household switching from an oil boiler to a ground source heat pump represent a social value of £405 per year.



* Scope 1 and 2 emissions associated from energy usage for space heating and domestic water heating.

** Based on methodology used to evaluate carbon savings within policy appraisal approach in the UK. Please see here for methodology and further details on carbon values.

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LIFETIME COST SAVINGS

RUNNING COSTS UNDER FORECASTED PRICES AND ESTIMATED LIFETIME EMISSIONS

LIFETIME COST SAVINGS

Scenarios – fuel prices

Please note that all lifetime savings are under central case assumptions and further assumptions detailed in annexe 1.

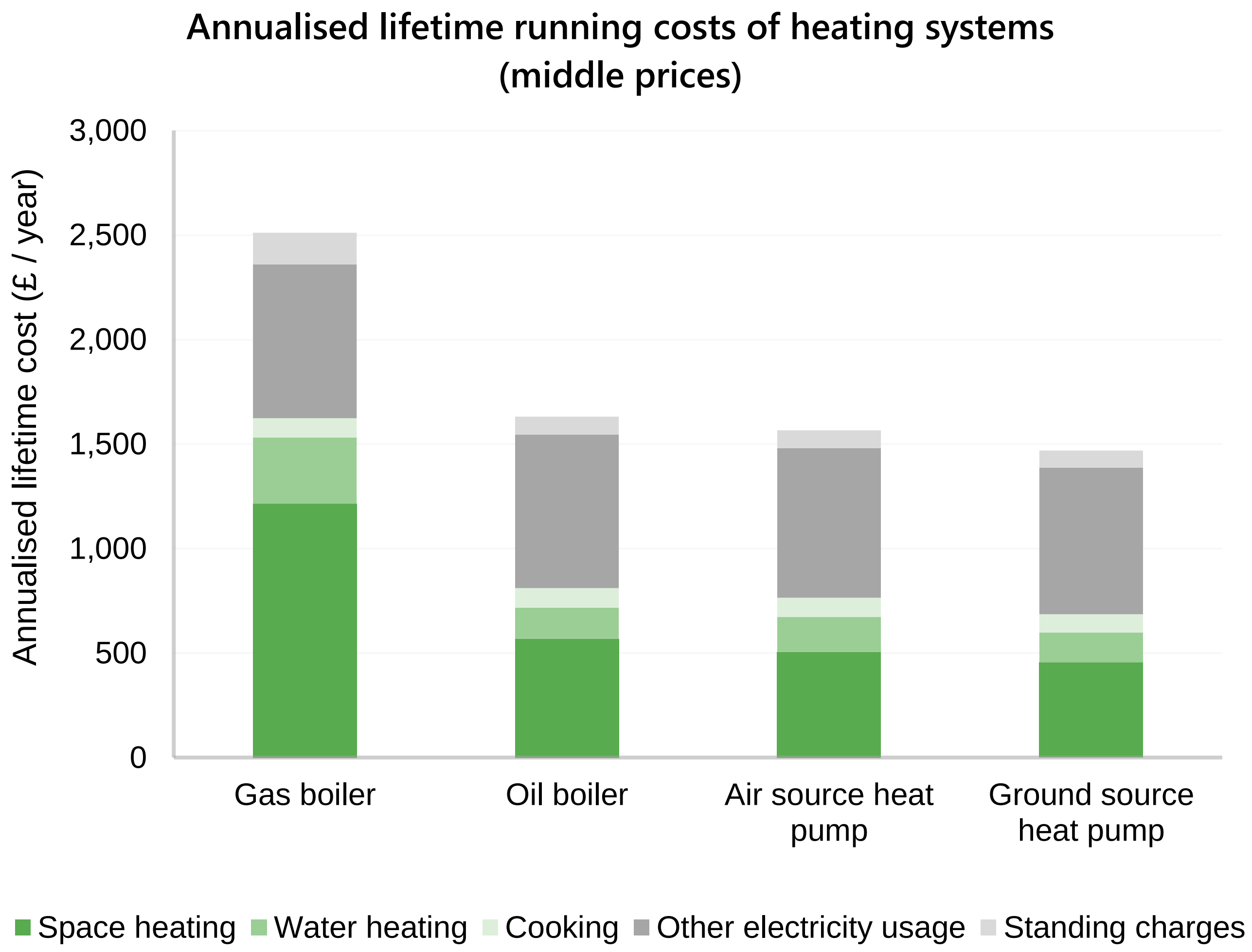
Scenario	Description
Low	All fuel prices rebound to be lower than pre-Energy Crisis levels. Minor impact of increased gas grid operating costs per customer.
Middle	All fuel prices rebound to be in line with long run trends. Average impact of increased gas grid operating costs per customer.
High	Higher end of forecast using long term trends for all prices. Average impact of increased gas grid operating costs per customer.
Energy Crisis (EC)	Long term Energy Crisis impact on gas prices with other fuels returning to average long-term trends. High impact of increased gas grid operating costs per customer.

LIFETIME COST SAVINGS

Further details and assumptions in annexe 1

Lifetime fuel cost breakdown

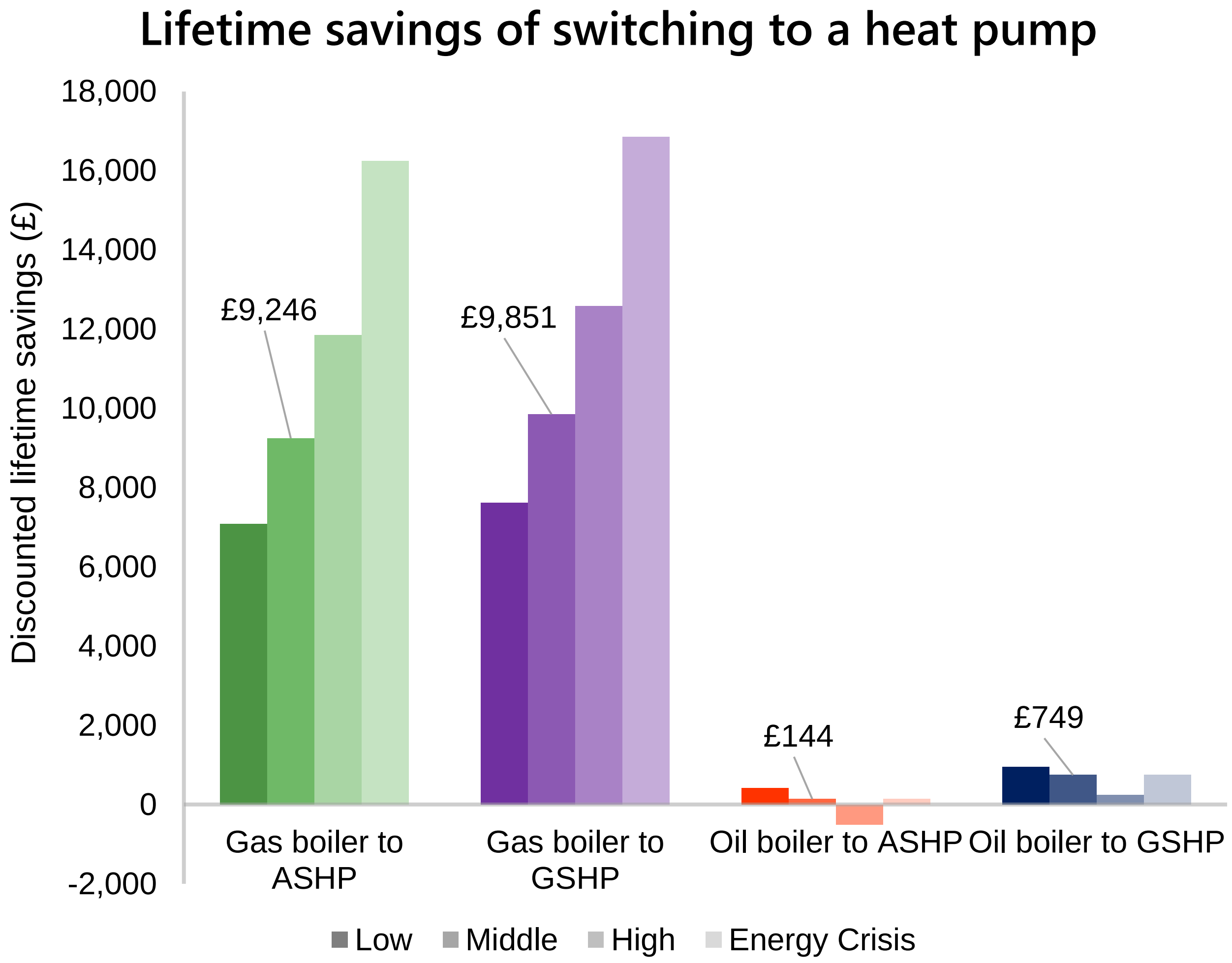
- Fuel bills made up of heating (space heating, water heating, cooking), standing charges (on electricity and gas) and other electricity usage (lighting etc).
- Lifetime costs from standing charges, space heating and water heating can all be reduced by switching to a heat pump from a gas boiler.
- Lifetime costs are annualised to take into account the different lifespans of each heating system.
- Under the middle price scenario, and using central case assumptions, the annualised lifetime fuel costs of a home with an air source heat pump are £945 lower than a household with a gas boiler and £66 lower than a household with an oil boiler.



LIFETIME COST SAVINGS

Discounted lifetime running cost savings

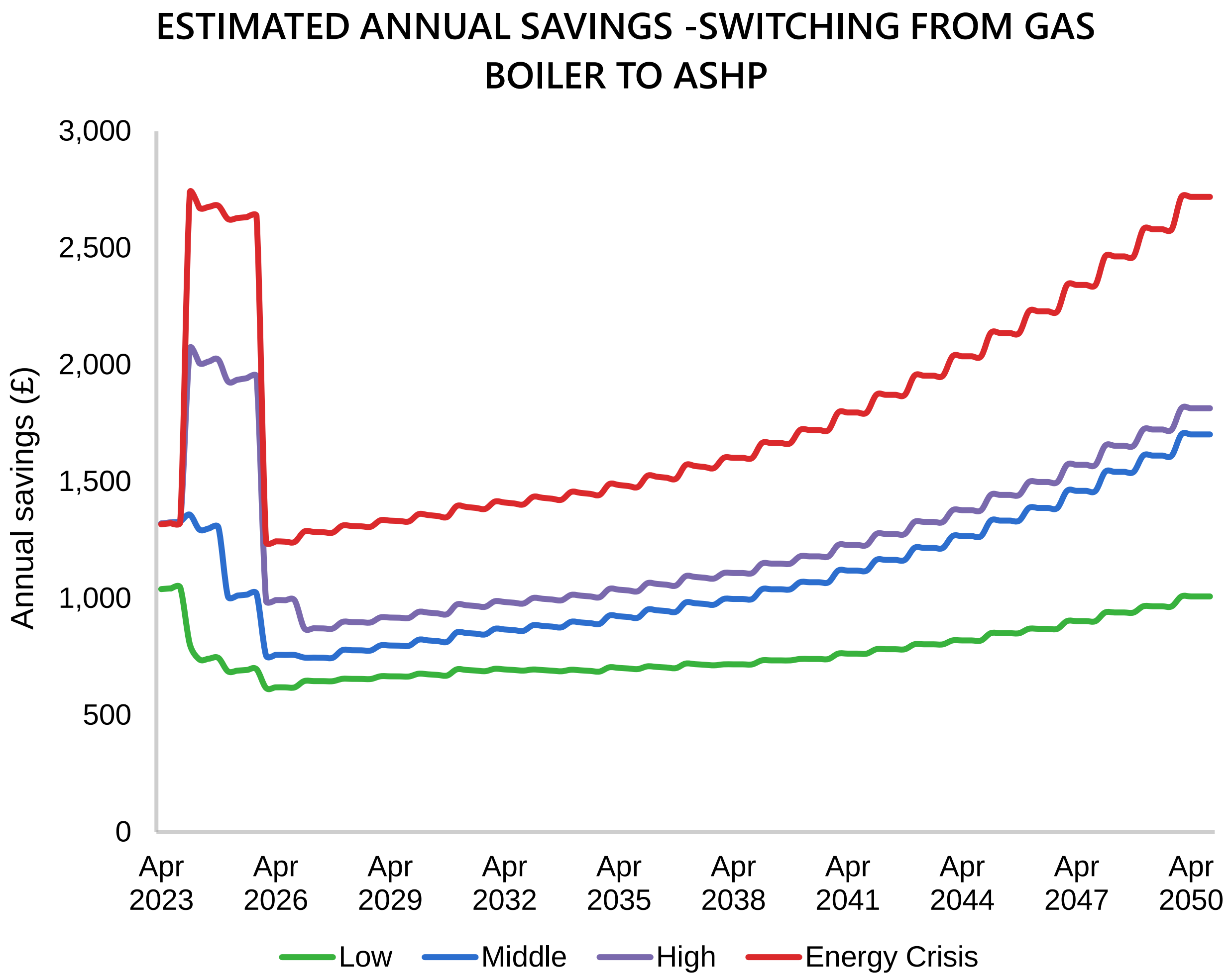
- Costs have been time discounted according to BEIS discount factor assumptions. Also note that savings are over 12 years according to the lifetime of the counterfactual systems (gas/oil boiler).
- Both air source and ground source heat pumps offer significant lifetime savings compared to a gas boiler, and minor lifetime savings compared to an oil boiler.
- The only exception to this is under the high price scenario. Due to greater uncertainty, the variance between low and high electricity prices is greater than for oil prices. Therefore, switching to an ASHP from an oil boiler results in lifetime running cost losses of £502. See annexe 4 for further details.
- Lifetime savings are most significant under the Energy Crisis scenario, where high long term gas prices mean that air source heat pumps delivers £16,243 in fuel cost savings compared to a gas boiler.



LIFETIME COST SAVINGS

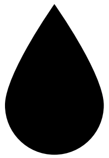
Estimated annual running cost savings - gas

- Price shock from Energy Crisis increases potential savings from switching to a heat pump in the short term.
- As less people use the gas grid, operating costs are mutualised across fewer consumers and so gas prices increase. As the grid decarbonises, and there is no longer demand for gas from combined cycle gas turbines (CCGT), the natural gas customer base will decrease further. Currently, gas-to-power facilities make up around 80% of the gas demand on the Isle of Man.
- Increased gas grid operating costs per customer mean that heat pump savings increase with time across all scenarios.
- By 2050, annual savings are between £1,008 and £2,719.

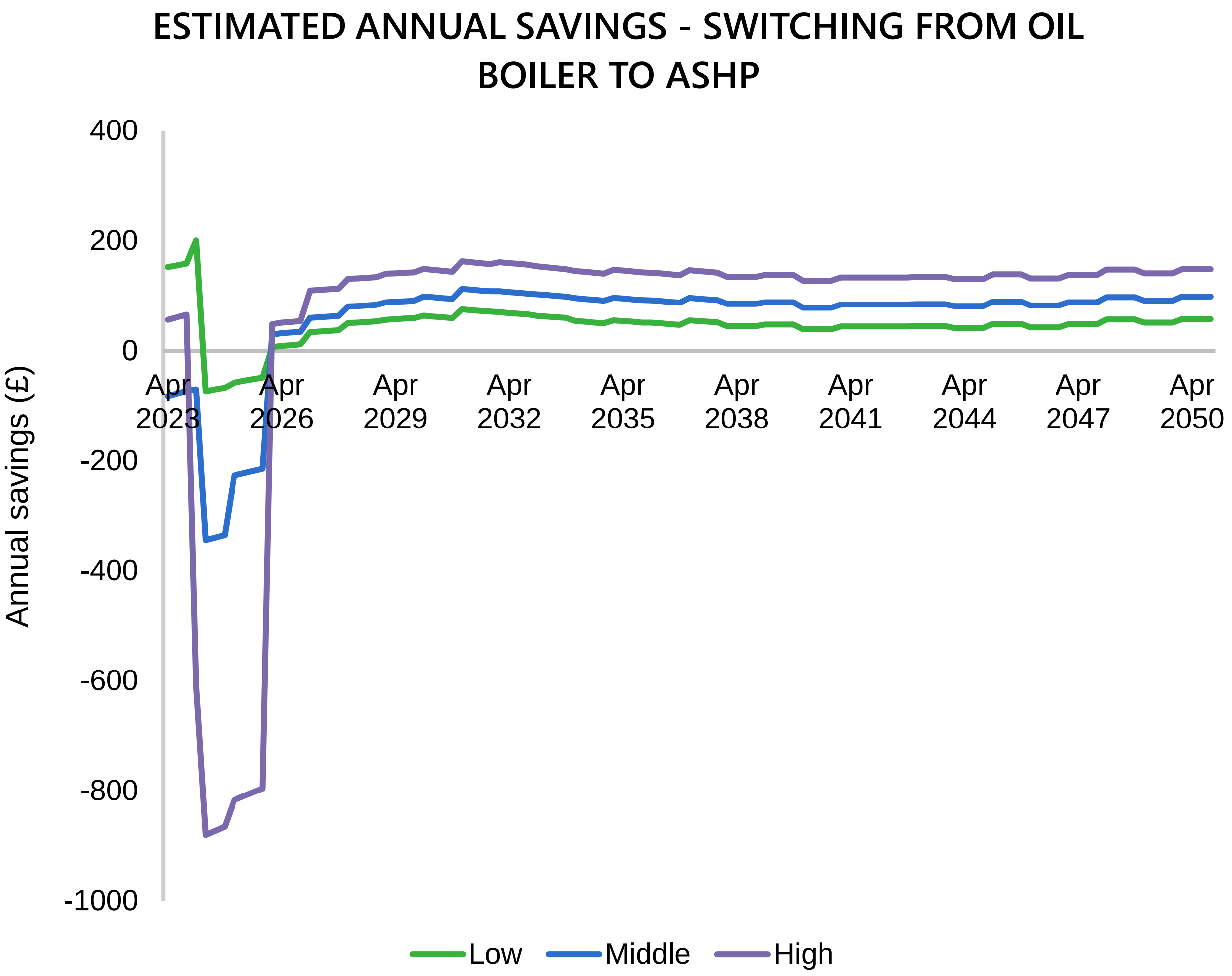


LIFETIME COST SAVINGS

Estimated annual running cost savings - oil



- In the short term, without subsidised electricity prices, oil boilers are expected to have lower running costs than air source heat pumps.
- Under both the middle and high forecasts, electricity prices did not come down until after January 2026 whereas oil prices were lower in the medium forecast than the high forecast. This causes the surprising result of initial savings for a heat pump under the low and high forecasts and losses under the medium forecast. See annexe 4 for further details on price forecasts.
- As prices return to long term trends and heat pump efficiencies increase, heat pump savings increase.
- By 2035, air source heat pumps are estimated to deliver between £58 and £148 in annual savings. Under higher assumed heat pump efficiencies, larger savings could be expected. Some evidence suggests that the efficiency forecasts used in the CCC modelling (and in this analysis) could be conservative estimates.



LIFETIME EMISSIONS SAVINGS

Lifetime emissions analysis – heating system sensitivities

The emissions associated with electrical heating can vary depending on the quality of the installation and the technology used.

Recognising potential variations because of this, three sensitivities were applied to the analysis of lifetime emissions for heat pumps.

No sensitivities were applied to either gas or oil boilers.

The heating system cases assessed are detailed to the **right**.

Heating system sensitivity description

Split electric – Assumes that half of all homes use direct electric heating, and half use heat pumps (2.8 sCOP). Results are aggregated down to the relative emissions for one household.

Average efficiency HP – Assumes that household has a heat pump installed to average efficiency levels (2.8 sCOP) in line with findings from Electrification of Heat project.

High efficiency HP – Assumes that household has a heat pump installed to high efficiency levels (3.5 sCOP), assuming all relevant home and fabric upgrades are made.

Gas boiler – Assumes that household has a gas boiler installed to average efficiency levels (0.84 COP) in line with assumptions used in UK Government impact assessments.

Oil boiler – Assumes that household has an oil boiler installed to average efficiency levels (0.84 COP) in line with assumptions used in UK Government impact assessments.

LIFETIME EMISSIONS SAVINGS

Please note that lifetime emissions analysis utilises central case assumptions.

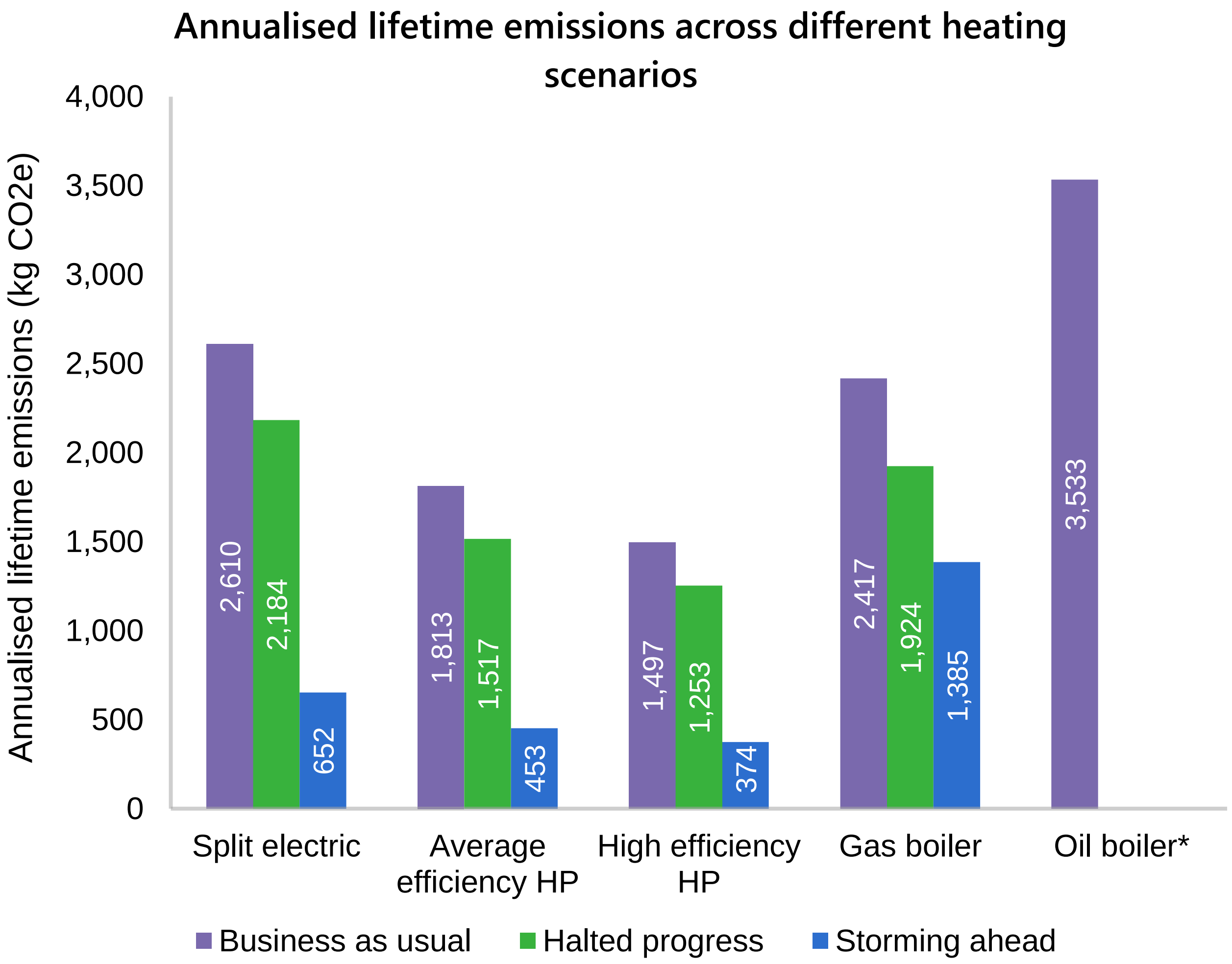
Annualised lifetime emissions

Business as usual – No gas or electricity grid decarbonisation.
Halted progress – Current planned major electricity grid decarbonisation efforts only. Gas grid emissions reduced by 50% by 2035.
Storming ahead – Carbon neutral electricity grid by 2030. Gas grid is 100% biogas by 2035.

Recognising that heat pumps have a longer lifetime than gas/oil boilers (15 years compared to 12 years), lifetime emissions were annualised for a comparable metric.

Assuming that the grid is decarbonised by 2030, all electrical heating scenarios have significantly lower annualised lifetime emissions than gas and oil boilers.

Even without any additional electricity grid decarbonisation, heating emissions are lower under the 100% heat pump scenario than the Halted progress and Business as usual scenario for a gas boiler.



* No decarbonisation of oil assumed so only Business as usual scenario assessed

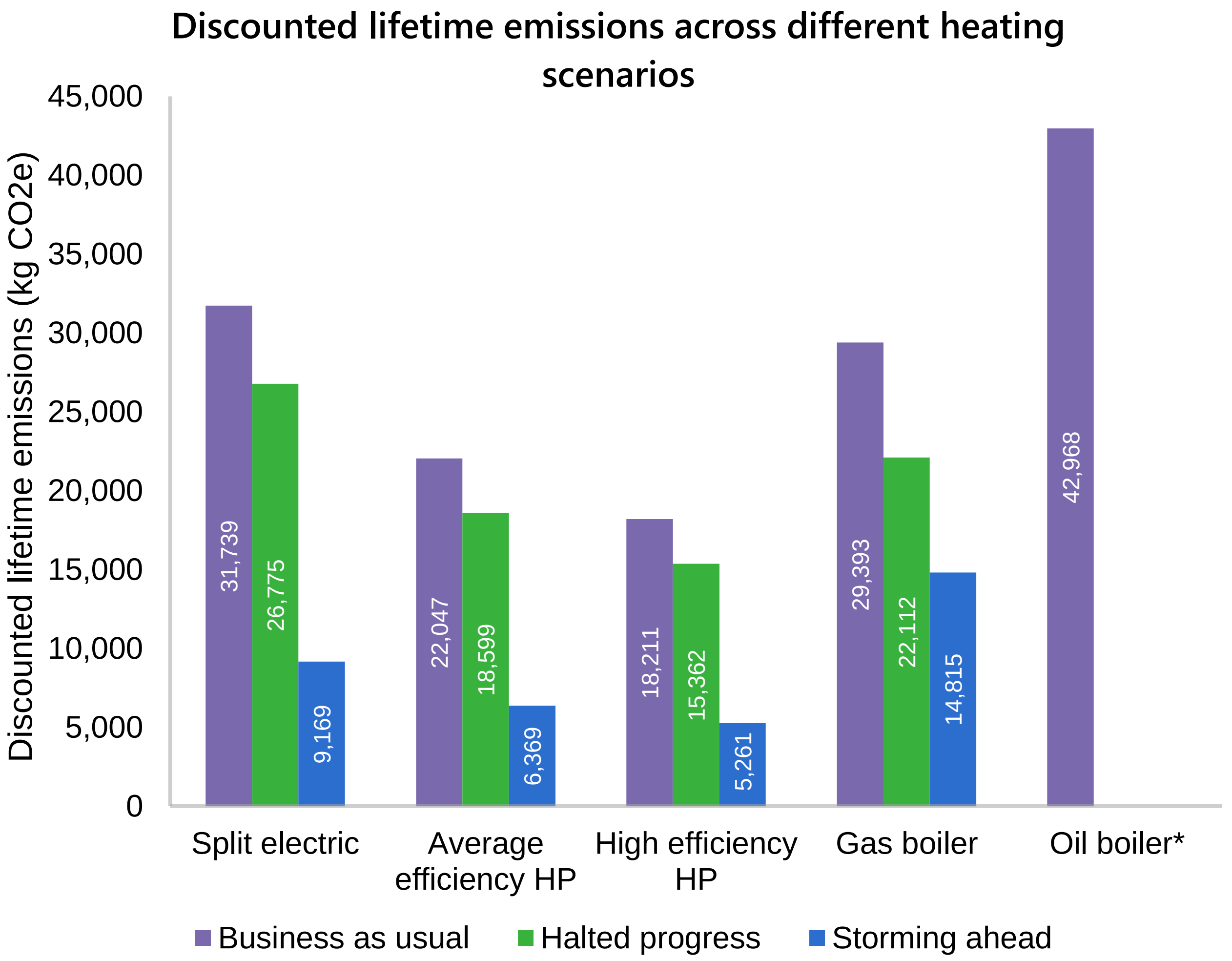
LIFETIME EMISSIONS SAVINGS

Time discounted lifetime emissions

Emissions were discounted according to Green Book time discounting assumptions and analysed over a **15-year time period** for all heating scenarios.

Under the Storming ahead scenario, an average efficiency heat pump produces 8.5 tonnes less of CO_2e over its lifetime than a gas boiler, even when assuming very ambitious decarbonisation of the gas grid.

These savings represent £2,300 in social value per household**.



* No decarbonisation of oil assumed so only Business as usual scenario assessed.

** Carbon has a social value which can be quantified by estimating the damage of climate change stemming from an additional greenhouse gas emission. Analysis based on methodology used to evaluate carbon savings within policy appraisal approach in the UK. Please see here for methodology and further details on carbon values.

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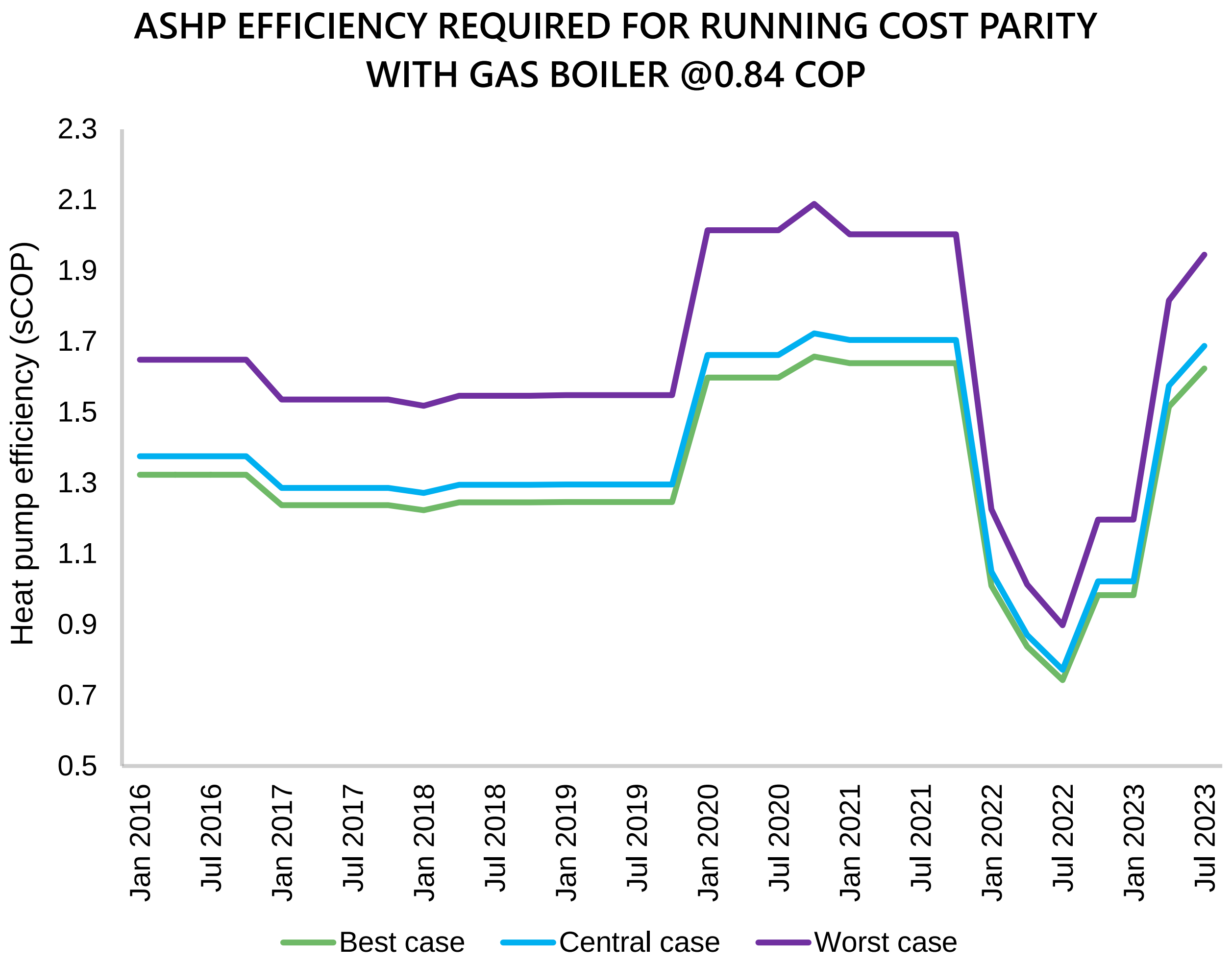
PRICE COMPETITIVENESS ANALYSIS

HISTORICAL PRICES AND FORECASTED PRICES

PRICE COMPETITIVENESS ANALYSIS

Historic trends - gas

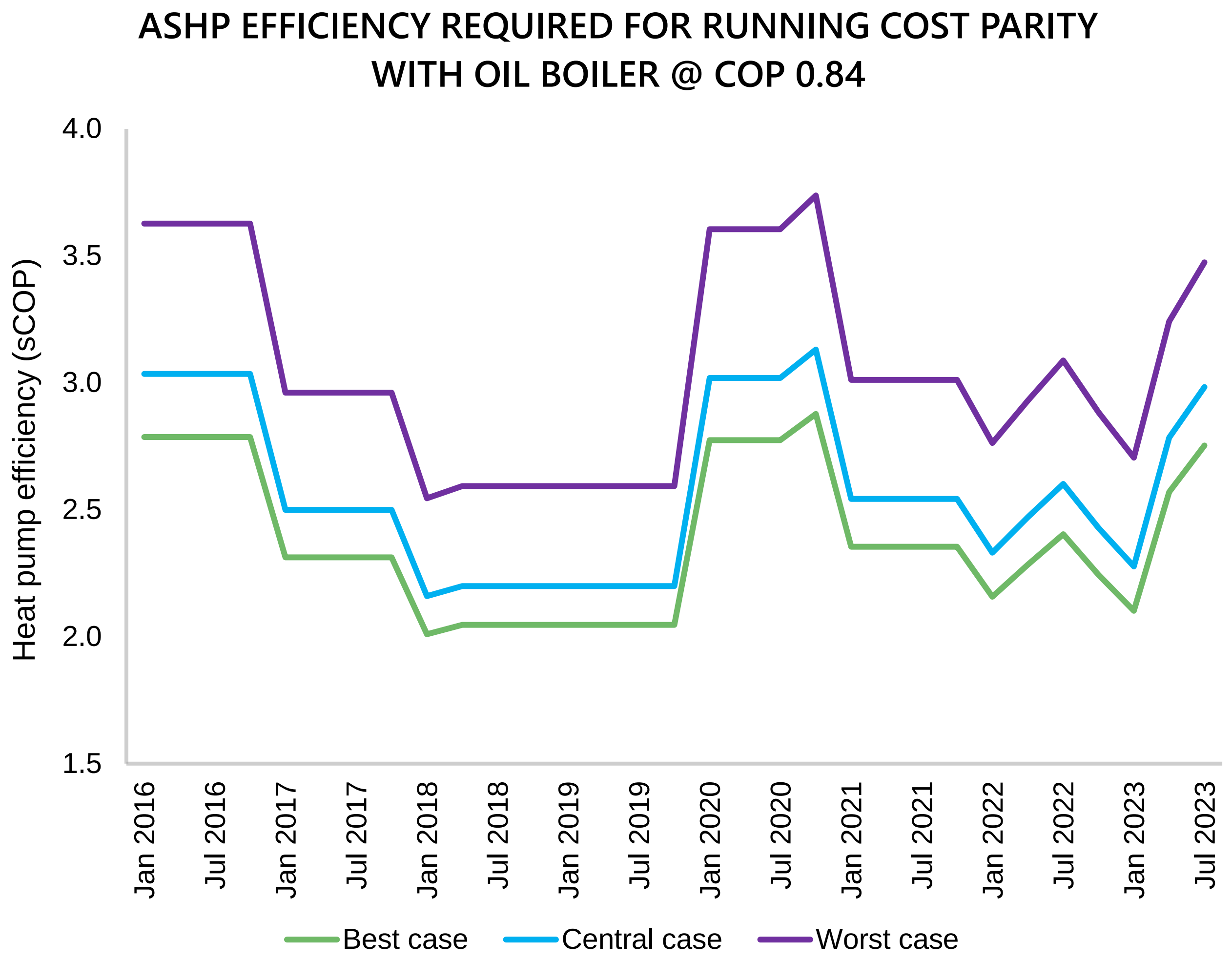
- The inverse of the required efficiency shows the price competitiveness of heat pumps. **The lower the required efficiency, the more competitive a heat pump is.**
- Before the Energy Crisis, an efficiency of between 1.25 and 2.09 was required to deliver running cost savings compared to a gas boiler.
- The Energy Crisis has seen large fluctuations in price competitiveness, enhanced by the different sizes and timings of subsidy efforts on the Isle of Man.



PRICE COMPETITIVENESS ANALYSIS

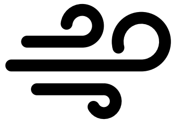
Historic trends - oil

- The central case suggests that generally an efficiency of between 2.16 sCOP and 3.13 will deliver running cost savings compared to an oil boiler.
- Price competitiveness has been relatively stable over this time. Pre-Energy Crisis, the general trend suggested that heat pumps are becoming more cost competitive compared to oil boilers over time.

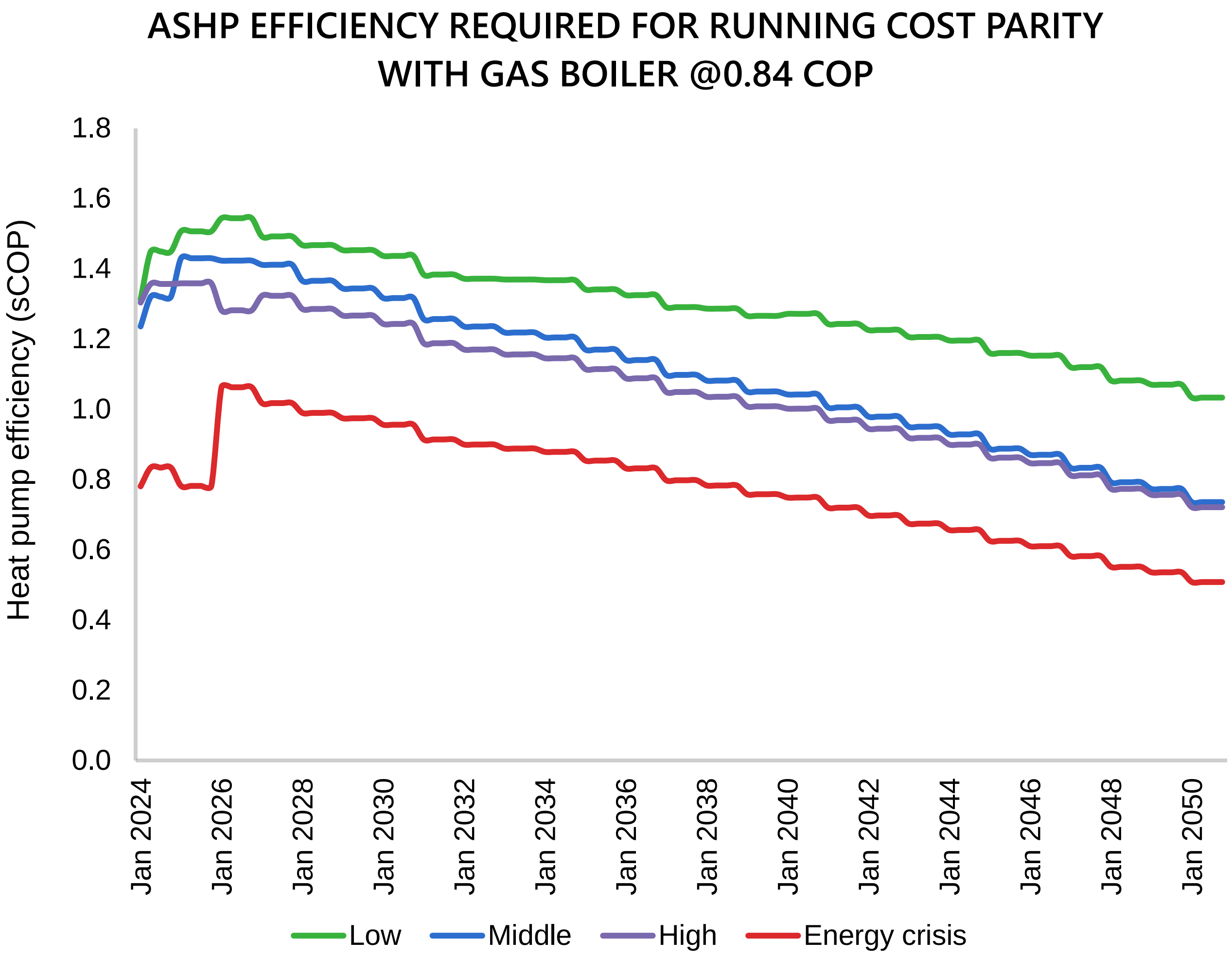


PRICE COMPETITIVENESS ANALYSIS

Forecasted prices - gas



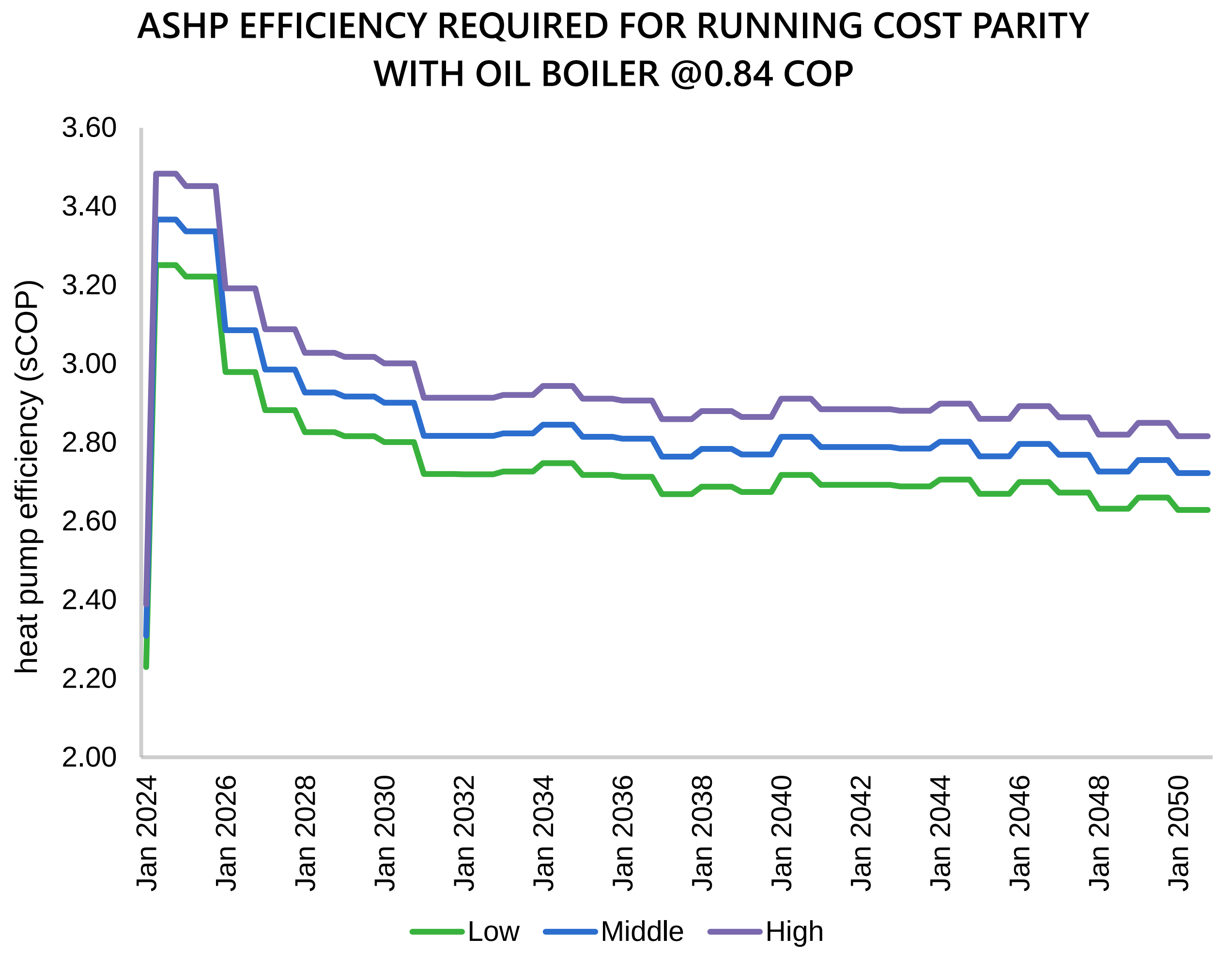
- Using price forecasts shows that heat pump cost competitivity compared to gas boilers is expected to increase with time.
- This is especially the case under the Energy Crisis price scenario, where a heat pump efficiency of 0.5 sCOP is expected to deliver savings by 2050.



PRICE COMPETITIVENESS ANALYSIS

Forecasted prices- oil

- As price subsidies are relaxed and the impact of the Energy Crisis is maintained, the cost competitiveness of heat pumps compared to oil boilers is expected to decrease in the short term.
- The initial shock is due to the assumption used in the price forecast analysis to control for Energy Crisis subsidies on the Isle of Man. Further information is in annexe 4.
- However, in the long term, heat pump cost competitiveness is expected to increase slightly compared to oil.



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CONCLUSIONS AND SUGGESTIONS

CONCLUSIONS

Heat pumps have been shown to be able to deliver significant running cost savings compared to gas boilers, both now and in the medium to long term.

Savings are lower when compared to oil boilers, however, heat pumps are estimated to deliver lifetime running cost savings.

Results were impacted by sensitivities and changes in assumptions.

Access to flexible tariffs and space heating demand uplifts made big differences to savings.

Generally, emissions were lower under electrical heating scenarios, especially when all homes switched to heat pumps.

SUGGESTIONS

Encourage the usage of flexible tariffs and relevant home upgrades to maximise the emissions and running cost savings from heat pumps.

Explore ways of financing heat pumps to offset the initial installation cost and allow for longer term running cost savings.

Continue efforts to decarbonise the electricity grid via large- and small-scale renewables to ensure long term emissions savings from electrical heating.

THANK YOU FOR YOUR TIME

ANY QUESTIONS?

To find out more please contact:

T: +44 (0)121 709 5587

E: bd@gemserv.com

W: www.gemserv.com

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Low Carbon Business Unit

Birmingham Office:

The Counting House

3 Mary Ann St

St Paul's Square

Birmingham B3 1BG

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ANNEXE

1 – ASSUMPTIONS AND KEY DATA SOURCES

2 – PRICE FORECASTING REGRESSION RESULTS

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4 – FUEL PRICE FORECASTS - ADDITIONAL INFORMATION AND CAVEATS

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Fuel prices

- Historic UK prices – gas and electricity (Ofgem / BEIS), Oil (Boiler Juice)
- UK price forecasts (BEIS)
- IoM prices – oil (Office of Fair Trading), gas (IoM Energy), electricity (MU)
    - Note that archived data accessed through the Internet Archive Wayback Machine was used for historic gas and electricity prices

Emissions factors

- Gas and oil (DESNZ)
- Electricity (MU) – Preliminary value

Other heating inputs

- Efficiencies - Heat pumps over time (CCC), heat pumps currently (ESC), boilers (BEIS)
- Space heating demand uplift (DESNZ)
- Heating demand (Ofgem)
- Heating splits by space heating, cooking and water heating (BRE)

Please contact Samuel.o'mara@gemserv.com for further notes on assumptions and methodology

ANNEXE 2

Price forecasting regression results

Please note that regression model used was in the format:
y = A + BX1 + CX2
where y = isle of man prices, X1 = UK prices, X2 = EC flag

Fuel	A coefficient	B coefficient	C coefficient	Coefficient of determination (R^2)
Electricity	0.110	0.317	0.023	0.831
Natural gas[1]	0.045	1.302	0.000	0.652
Oil	0.041	0.235	0.016	0.789

1 – Please note that an additional adjustment factor of 0.892 was applied to regression results to best align with historic trends

ANNEXE 3

Flexible heating tariff analysis

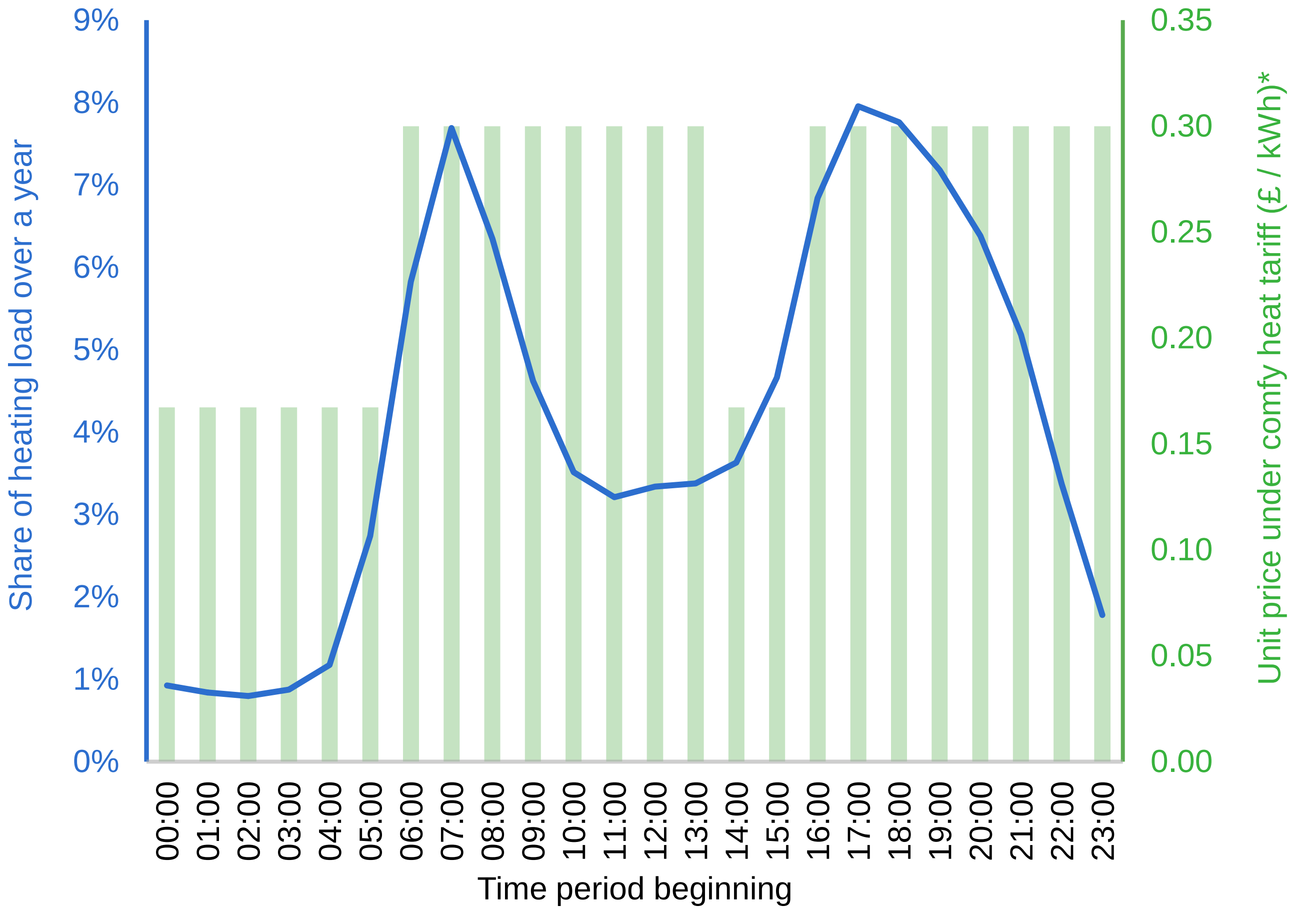
To calculated a weighted unit price for a flexible tariff, prices from the Manx Utility comfy heat tariff were weighted by the share of the yearly heating load that occurs in each hour over the course a day.

For example, between 2 PM and 3 PM (see green bar) the price is lower than at peak times and is weighted by 3.6% (see blue line) as 3.6% of the average heating load occurs in that time slot over a year.

This delivers savings of 7-9% compared to a standard tariff however consumers could increase these savings further by intentionally heating their home during times of low prices.

Flexible tariffs like these can also be used to encourage consumers to help alleviate grid constraints, consuming energy when supply is high. This is especially advantageous when considering the intermittency of many renewable sources.

Flexible tariff unit prices and heating load



* Comfy heat tariff prices are not yet available for July 2023 and so April 2023 prices have been scaled up according to increase in standard tariff prices.

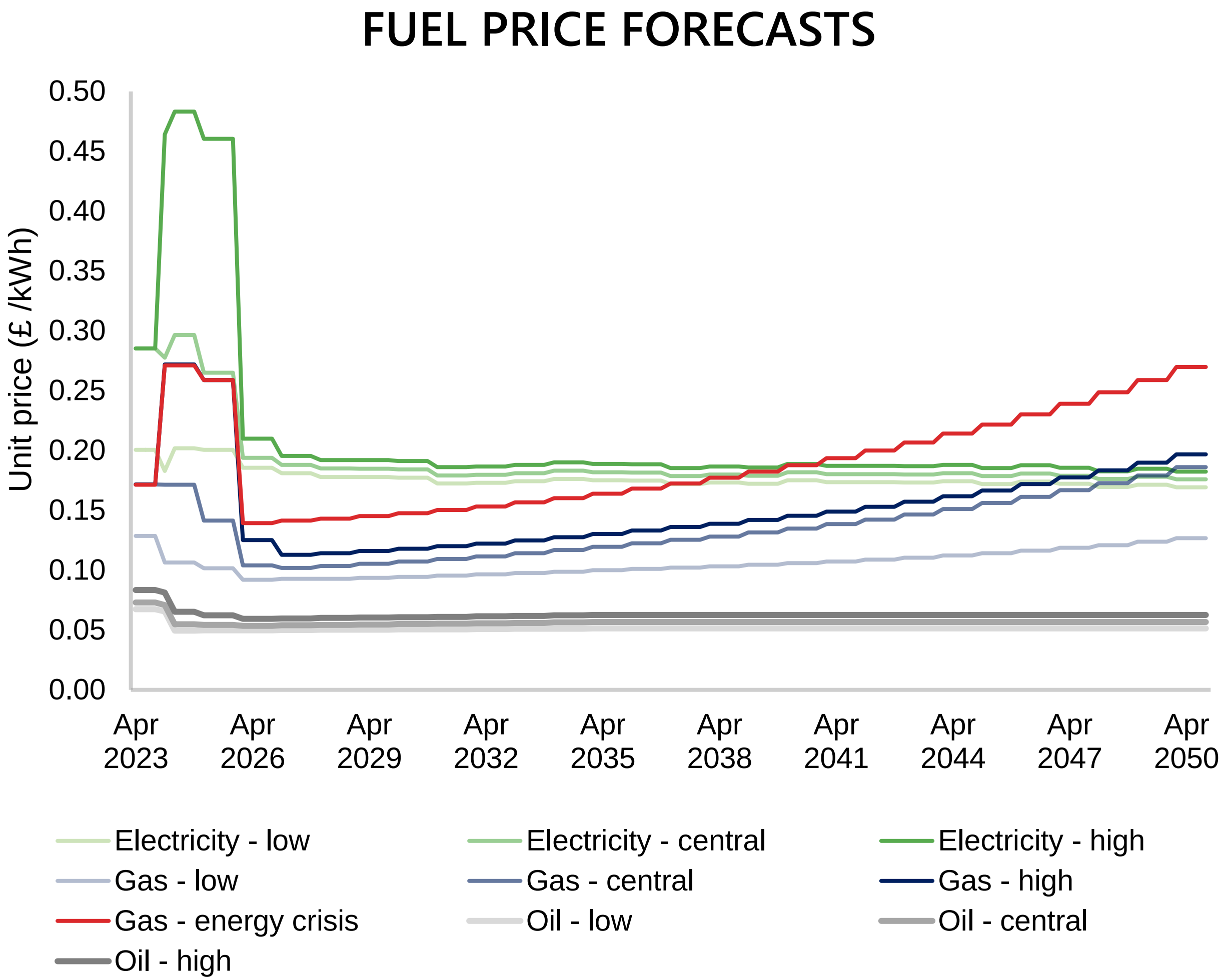
ANNEXE 4

Fuel price forecasts – additional information and caveats

For gas and electricity price forecasts, a control was used for Energy Crisis price subsidisation. It was assumed that price subsidy was dropped in April 2024, causing significant distortions to some of the results. This assumption was in line with the proposed end to Energy Price Guarantee support in the UK.

Oil prices are largely derived from international markets and prices were less effected by the Energy Crisis than electricity and gas. This means that uncertainty around oil prices is far lower, meaning that the variation between low and high price forecasts is lower than for electricity and gas.

Under the BEIS forecasts which were used as a basis for these forecasts, the middle and high electricity forecasts were the same until they diverged in January 2024. Similarly, the BEIS forecasts for gas were the same under the high and Energy Crisis scenarios until divergence in January of 2026. This, combined with the fact that **all** oil forecasts diverged from one another, caused some distortions to results.



ANNEXE 5

Preventing space heating demand uplift

Graphical demonstration of heat pump ramp up and resulting space heating demand uplift compared to gas boiler