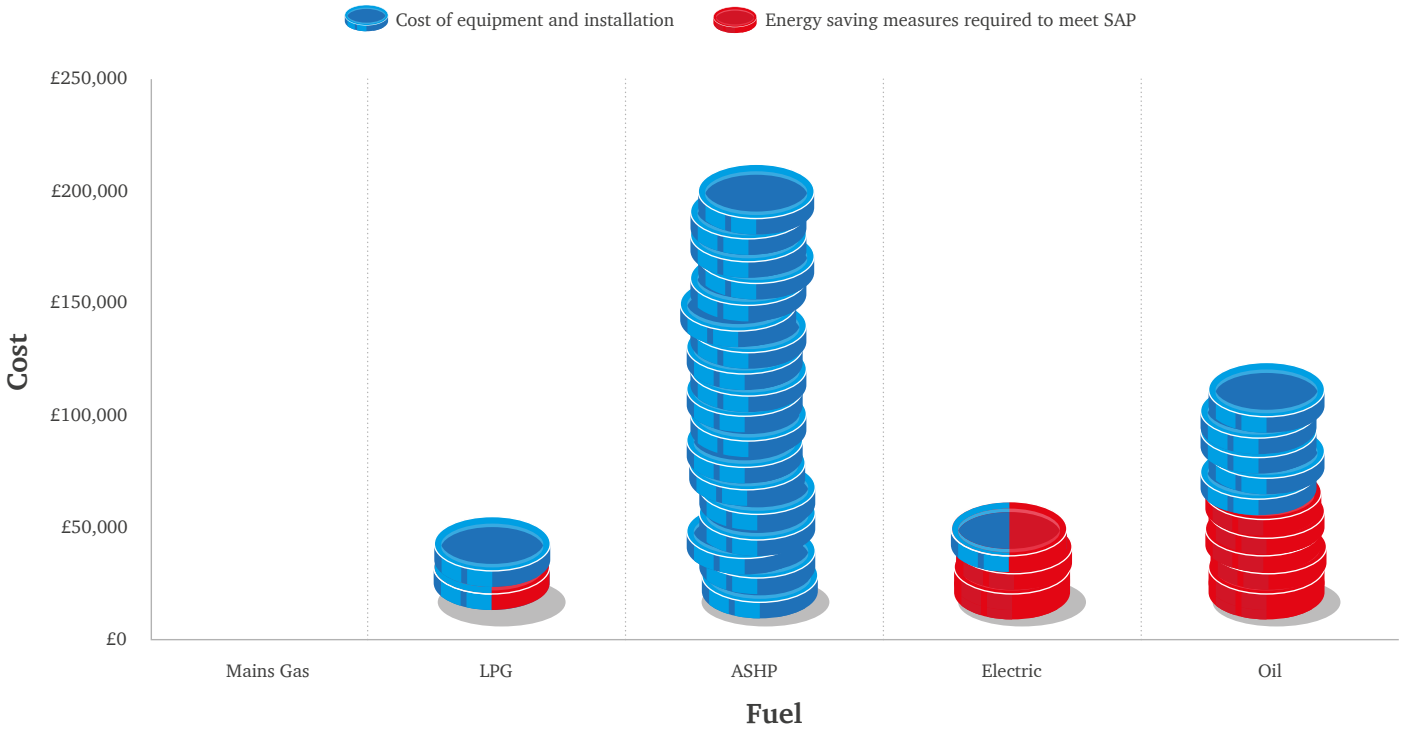
CALOR

How LPG makes a cost-effective choice for rural off-grid housebuilders

A report by BriaryEnergy

Introduction



The above graph illustrates the difference in build cost for a typical 30 home development, consisting of 4 x 5 bed detached, 8 x 4 detached, 10 x 3 bed semi detached, 8 x 2 bed mid terrace houses

A recent independent study has revealed that housebuilders could save approximately £500,000 on build costs on a typical 100 plot development if they choose to install LPG heating. The report by respected energy analysts Briary Energy highlights the significant difference in build costs for housebuilders developing sites where connecting to mains gas is not viable, and therefore another form of heating is required. In these circumstances significant savings can be achieved by housebuilders installing an LPG metered supply. Based on a typical 5 bedroom home, LPG could save approximately £5,000 per property on average, compared to air source heat pumps (ASHP). In addition, LPG offers a proven, reliable and affordable heating option, with comparable running costs to other technologies.

The study examines all the heating options that a rural new build developer will consider for a site where it's not possible to connect to the mains gas grid. The four fuel choices under consideration are:

1. LPG boilers

2. Air source heat pumps

3. Electric heating

4. Oil boilers

After establishing a base specification for the Building Regulations based on natural gas boilers, the analysis includes both system and combi LPG gas boilers and compares these fuels. The base specification and others can be reviewed in the Appendices, at the end of this report.

The research considers the following house types, based on minimum floor areas and a typical fabric specification using gas heating systems with radiators:

- 2 bed mid terrace
- 2 bed semi detached
- Large 3 bed semi detached, with bath and en-suite shower
- 4 bed detached, with bath and en-suite shower
- Large 5 bed, 3 storey detached

The cost of energy throughout this report is based on prices in January 2017, via the Sutherland Tables.

LPG vs. Air Source Heat Pumps

Fabric specification

Choosing ASHP – an all-electric system – does mean there's a penalty to pay in terms of emissions. However, the Target Emission Rate under SAP will rise to offset some of this penalty.

The efficiency of an ASHP system is high, and therefore there is often a temptation to reduce the quality of the insulation because of the improved efficiencies. However, in reality, it is necessary to maintain the same levels as the base specification.

For comparison purposes, a standard ASHP (non-hybrid) system has been used for this analysis, which requires a hot water cylinder inside the dwelling. This can cause a space issue on smaller dwellings or require expensive modifications to the standard house design. The ASHP also needs to be located on an external wall, usually to the rear of the property.

To all intents and purposes, opting for an ASHP system does not mean any additional spend is needed on the base specification to ensure it meets the Building Regulations requirements.

Did you know?

Mains gas and LPG boilers offer flow temperatures of up to **65 degrees**. In comparison, ASHP typically only offer flow temperatures of around **35 degrees**. This means the developer has to break from standard designs to compensate for this.

Other considerations

However, a number of other factors will impact on cost. Both air source and LPG boilers also require maintenance and servicing, albeit in different ways. The set-up and commissioning of ASHP is critical in terms of efficiency and should not be tampered with, as this can considerably increase running costs. In both systems, controls are important, but it is worth considering that to deliver the best efficiency levels ASHP work best at low temperatures over a larger surface area.

This means most installations will require underfloor heating or large radiators. In poor designs the domestic hot water is boosted by the immersion heater, which is costly compared to the LPG boiler route. There are certain factors to consider in order to calculate the total ASHP running costs. These include:

- The efficiency of the heat pump
- The amount of heat required
- The temperature of the heat source

While the efficiency of domestic pumps varies among manufacturers, there are some commonalities. Generally, the COP value is between 3.0 and 4.3. However, the heat pump's actual efficiency is dependent on the amount of work it has to do and the difference between the inside and outside temperature. The closer the two temperatures are, the less work the heat pump has to do to meet the desired temperature.

For heating only, when the outside temperature is 7°C then an average ASHP will run at COP 3.2 when distributing heat to an underfloor system. Using Met Office data, the average UK temperature from November to March is consistently below 7°C, with the monthly average ranging from 4.2 to 6.9°C. This means the COP will be lower than usual, with an average COP of 2.8 once these variations in outside temperature have been taken into account.

How does this affect running costs? In short, because of the lower COP, the ASHP would need 3,928 kWh of electricity for space heating, which would cost £628, plus another £547 to produce domestic hot water. This results in a running cost of £1,175 a year.

Physics determines that there is no way around this issue. Furthermore, if the ASHP is being used to produce domestic hot water, then the running costs can increase too. This is because it is a low temperature system relying on the immersion heater to boost the hot water.

It is important to note that trying to reduce insulation would mean the dwelling would likely fail the fabric energy efficiency requirement in SAP. It would also mean a greater flow temperature will simply increase the workload for developers and reduce the efficiency of the ASHP system. More often than not, it is when developers try to cut these corners that ASHP systems often fail.

As a result, the additional costs of installing an ASHP system for a property can be anywhere between **£5,000** to **£8,000**.

MET Office UK Data 2019
https://www.metoffice.gov.uk/climate/uk/summaries

Nov 2018 = 7.3°C
Dec 2018 = 5.8°C
Jan 2019 = 3.7°C
Feb 2019 = 6°C
Mar 2019 = 6.8°C

Therefore average UK temperature Nov-Mar is consistently below 7°C.

LPG vs. Electric Heating

Fabric specification

Next, how does electric heating delivered through high retention panel heaters stack up against LPG when it comes to a property's fabric specification?

Choosing an all-electric system does mean there's a penalty to pay in terms of emissions. However, the Target Emission Rate under SAP will rise to offset some of this penalty.

Similar to dwellings with an oil boiler, electric panel systems require photovoltaics (PV) to meet the requirements established in the Building Regulations, but there also needs to be upgrades to floor and roof insulation, the installation of hi-therm lintels and a waste water heat recovery system. This was the case for all properties analysed, no matter the size.

The amount of PV that can be installed is limited by the amount of roof space, particular with the smaller dwellings. Nevertheless, even with the 5 bed, 3 storey dwelling, there is the issue of dormers and orientation to contend with. And once again with PV, there is the associated cost of hiring the scaffolding and the extra two weeks in time that need to be spent on construction design and management.

Briary Energy considered including mechanical heat ventilation recovery to help reduce the cost of PV, however the dwellings air tightness level would need to be considerably lower than system 3 ventilation, adding to the construction costs.

It is important to bear in mind that electric is a more expensive fuel than LPG, even though off-peak tariffs can help and the level of control on electric heating is difficult. Additionally, for a larger development a sub-station upgrade may well be required, which will add to the cost.

So how does the cost uplift for the fabric specification for houses with electric heating compare with LPG?

In short, electric heating proves to be considerably more expensive than LPG. For a 2 bed mid terrace property, the additional fabric specification costs are £1,956 with electric heating, which is £1,583 more than LPG. The cost increases exponentially as the size of the dwellings get bigger. A large 3 bed semi detached property would cost £2,375 for electric heating, which is £1,965 more than LPG Meanwhile, a large 5 bed, 3 storey detached property on electric heating would cost £2,820, over £2,400 more than LPG.

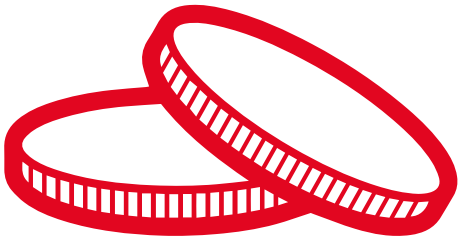
Other considerations

Electricity prices are about two and a half times higher than LPG prices per kWh after taking into account boiler efficiency. It's important to consider that electricity prices are also rising and likely to stay high.

As most electricity in the UK is generated in gas-fired power stations, any increase in the price of gas will also be reflected in the cost of electricity. The daytime rate on Economy 7 or Economy 10 tariffs is higher than on standard single rate electricity tariffs.

This means that, while cheaper heating is possible, should appliances need to be run during the day then this could be expensive – particularly if an electric heater is used to provide extra heat. Furthermore, the homeowner does not have instant control over storage heaters, whereas an LPG system works in exactly the same way as a gas-fired system.

Domestic hot water is usually via an instantaneous electric hot water boiler or immersion heater, with a hot water cylinder in the dwelling. In properties up to 4 bedrooms, LPG can be used for a combi boiler, which provides instant heat and hot water with far more control. However, the LPG boiler will then require more maintenance and servicing.



Electricity prices are about **two and a half times higher** than LPG

LPG vs. Oil

Fabric specification

Although the main focus of environmental performance is now based on carbon usage, it is still important to consider the thermal performance of the building fabric as a contributing factor.

When compared against the base specification, smaller dwellings – 2 bed mid terrace and semi detached properties – fuelled by LPG would require an increase in loft insulation and the installation of hi-therm lintels to meet the Building Regulation's requirements. Then, with larger properties of 3 beds and up, it becomes more cost effective to install a waste water heat recovery system, omitting the additional loft insulation and hi-therm lintels. As a result, the increased cost for LPG when compared with the base specification rises from £361 for a 2 bed property, to £410 for larger properties with waste water heat recovery installed.

In contrast, how does a property with an oil boiler fare? First of all, it is not possible without considerable costly fabric upgrade for oil to pass without the use of photovoltaics (PV). However, available roof space on smaller properties is an issue, which means additional capital needs to be spent on both floor and roof insulation. Furthermore, smaller dwellings would need to be fitted with a waste water heat recovery system and hi-therm lintels in order to meet the standards required.

In addition, the cost of PV technology does not end once it is fitted. It is important to note that only 37 per cent of the total cost can be attributed to the PV array. The PV's inverter, which converts the variable direct current output of the array into an alternating current that can then be used by the local, off-grid electrical network, will need replacing every ten years. This replacement cost needs to be factored in.

Again, Briary Energy considered including mechanical heat ventilation recovery to help reduce the cost of PV, however the dwellings air tightness level would need to be considerably lower than system 3 ventilation, adding to the construction costs. Indeed, ensuring an airtight fabric specification requires additional labour resource and accuracy, and may actually increase costs even further.

Another cost is the actual price of the oil boiler, which – on average – tends to be £500 more expensive than LPG. What is the cost uplift on the fabric and PV specification with an oil boiler, then? For a 2 bed mid terrace house, the cost is £2,283, which is over £1,900 more than opting for an LPG boiler. For a 2 bed semi detached house, the cost is £2,363, which is just over £2,000 more per dwelling than LPG. The cost for installing an oil boiler and meeting the Building Regulations in a large 3 bed semi detached, 4 bed detached and 5 bed detached comes to £1,500, which is £1,090 more than the same houses fitted with an LPG boiler.

Installation costs

The cost of installing an LPG metered estate for a new development is about £500 per plot.

This is based on a 30 home development, and covers the LPG tank, installation, connections, pipework and meters all being fitted on site.

There is also the additional excavation cost for siting the LPG tank, which typically needs to be at least three metres from the nearest dwelling. On multiple dwelling developments, the tank will be sited on a green area.

However, it's worth also noting that this means the tank will be hidden underground, maintaining the rural aesthetics of many new developments built in a rural location. This is not the case for oil, for example, which typically requires a large – often unsightly – oil tank to be installed in the garden of a property.

However, the actual process of installing an oil boiler costs significantly more, between £1,800 to £2,500.

This includes siting the oil tank and its concrete base, the oil pipe trench and pump, and the associated groundworks. There is also a need to hire scaffolding and spend two weeks' extra time on construction design and management because of the PV array, all of which adds to the overall build costs. In addition, because LPG boilers are the same size and have the same flue clearance as standard gas boilers, there is no need to redesign standard property layouts to accommodate larger, floor-standing oil boilers, all of which may come at an extra cost.

Other considerations

LPG produces the least amount of carbon emissions out of all the fossil fuels available for those based off the mains gas grid, emitting 20% less CO_2 per kWh than oil[1]. Burning also produces less sulphur, nitrogen oxides and soot.

It also completely eliminates the risks associated with fuel spills or theft from an oil tank. Even if LPG escapes, it does not contaminate the ground or water, unlike oil, as it evaporates harmlessly into the atmosphere.

Other factors to be taken into consideration include the fact that LPG boilers tend to be much quieter than their oil counterparts, and while the cost of oil is fairly volatile, the price of LPG is far more stable.

[1]LPG's Carbon Footprint Relative to Other Fuels – A Scientific Review, p.6 http://bit.ly/2VBHS1E

Conclusion

To summarise, the research undertaken by Briary Energy demonstrates that LPG can be a more cost-effective solution than oil, electric heating and air source heat pumps.

When looking at the changes required to the fabric specification in new houses to meet Part L1A of the Building Regulations with LPG, Briary Energy has looked at the changes and their associated costs that would have the least impact overall.

The aim of this has been to try and keep any changes as straight-forward as possible for designers and builders. It is important to note that, due to 'group deals' and special prices, our price assumptions are based on an average figure, without taking into account site conditions or access.

Gary Nicholls, Director at Briary Energy

BriaryEnergy

Final thought from Calor

The findings by Briary Energy make it clear that LPG is the most cost-effective solution, in terms of build costs, for housebuilders developing homes in a site where mains gas connection is not viable. As the closest alternative, no deviations from standard housing designs are required as LPG boilers are the same size and flue clearance as mains gas boilers, and only a few, low costs 'energy saving' bolt-ons are required in order to achieve regulation compliance.

LPG can already offer up to 20 per cent lower carbon emissions than oil.[1] In support of the transition to non fossil fuel, low carbon products, Calor has brought BioLPG to market - a renewable fuel that can dramatically cut carbon emissions further still. In line with recent official government statements regarding the "end of fossil fuel heating systems in new builds by 2025," this renewable product supports the continued use of the existing high performing boiler technology by decarbonising the gas.

BioLPG from Calor is currently available to rural homeowners and the transport sector, with plans underway to increase supply to support more consumers and businesses in the future, such as rural housing developers.

The fuel is created from a mix of renewable and waste materials and can reduce a customer's carbon footprint by up to 38 per cent compared to heating oil (in the current 40 per cent blend). What's more, no retrofitting is required, meaning any LPG boilers installed now can be fuelled by a 100 per cent BioLPG product in the future.

Calor has a vision to improve air quality and dramatically lower carbon impact by offering 100 per cent renewable energy solutions to our customers by 2040, and BioLPG is our first step on the journey. It is classed as a drop-in fuel, so it's compatible with current LPG heating systems and appliances, and the system requires no additional upgrades or adjustment.

Finally, developers looking to partner with Calor on a rural house building project have the confidence that they are dealing with the UK's leading LPG supplier, with over 80 years' experience in the LPG market and the first supplier to have a dedicated team to the house-building sector.

Ian Digby
Specifier Sales Manager

[1]-Atlantic Consulting 2009

BioLPG is not currently recognised by BRE/Breem and therefore no incentive can be claimed on building regulations.

For more information about LPG for new off-grid housing developments, please email **contactcalor@calor.co.uk,** call **0800 121 7827** or visit **www.calor.co.uk/business/building-with-lpg**