STK Extension Gas Boiler Replacement – Report to PCC December 2023.

Exec Summary

The church buildings consist of the main church buildings to the left of the entrance hall, and an extension built in 1980 consisting of the entrance hall, office, kitchen, toilets, and lounges. See the attached plan. In addition, Lounge A is a further later extension.

All of the 1980s buildings are heated by a ducted, Gas-fired warm-air system consisting of two boilers which each separately heat half of those buildings. The boilers in question are the original 1980s ones, and now obsolete and need replacing.

The risk of not replacing them is that they will fail and repairs will not be possible, due to parts no longer being available. This risk has now become realised in that one of the two boilers has been condemned by Gas fitters who attempted to service it, and the parts to repair it cannot be sourced.

So all of the areas heated by the condemned boiler have no heating except that we are able to heat them to a limited degree using fan heaters, the use of which is limited by the capacity of the extension wiring to supply the power they need.

The replacement of these 40-year-old gas boilers has now therefore become a matter of urgency.

There are only two viable options for replacement heating. They are either to replace the boilers with newer gas warm-air boilers, or to fit Air-to-Air heat pumps, also known as Air conditioning heating units.

The whole life costs of the two options has been analysed, and whilst the capital cost of replacement boilers is significantly lower than for the heat pumps, the running costs of the air to air heat pumps are very much lower. This means that the payback time for the two alternative systems is similar and in fact favours the heat pump option.

In other words, the heat pump option means an additional capital outlay of up to £17,000 more than the gas boiler option, but in round numbers this will result in estimated annual revenue cost savings of between £4,100 and £4,500; compared with annual revenue cost savings for a new gas system estimated at only £1,800. (This comparison uses as baseline the estimated cost of using the existing boilers, at 2024 energy prices.)

Compared directly with new Gas boilers, the heat pump option gives estimated annual savings of between £2,300 and £2,700.

Recent cases demonstrate that it would be difficult to convince the DAC to approve our purchase of a new Gas system, given the National Church's Net Zero aims; and funding by grants would be far less available, if at all.

By contrast, there is a significant number of sources of potential grant funding for the heat pump option, and financial giving within our fellowship and community is also likely to be much more available for this option.

PCC is therefore recommended to approve in principle expenditure of up to £35,000 and the commencement of grant applications and fund-raising for this, assuming approval is granted by the DAC.

Areas affected (See separate document entitled "STK Church Plan and Area V2")

The areas that are now unheated except by fan heaters are: Lounges B, C and part of D plus the toilets. Lounge A is also being heated by fan heaters because the underfloor heating is not suited to use for short discrete periods as it has a very slow warm-up and cool-down time.

The remaining Gas boiler heats the entrance hall and the office, so while this one is still usable we can continue to heat those areas.

New Gas boilers option

As the system has the two boilers which heat separate areas, this arrangement provides for two zones. Each of those zones is either on or off in its entirety and temperature control is possible, in relation to whole zones only. So for example, the office cannot be heated without heating the entrance hall, and vice versa. For the toilets to be heated, lounges B&C would have to be heated.

Similarly, it would not be possible, with a replacement gas system, to heat the toilets without heating lounges B&C, or to heat the Entrance Hall without also heating lounge D, and the Office, and so on.

The heat outlets are some distance from the boilers, so the length of ducting used is significant, and is a source of heat loss. The building does not have cavity walls and the only known insulation is in the roof void. So it is likely that insulating around the ducting is minimal or non-existent. The losses from the ducting are therefore high. This ducting is embedded within the building and not accessible, so improvements to its insulation would be very difficult and potentially uneconomic, but more likely impossible.

Heat pump option

The heat pump option would consist of up to eight separate zones. Each of these would be heated by an independent and separate system, with its own time and temperature control. This means that only the parts of the building that are in use at any given time need to be heated. It also provides resilience in the unlikely event of technical failure. Also, the air-to-air heat pumps that are being considered for this option are not ducted so no ducting losses would be involved.

Although our electricity and gas contracts for January 2024 onwards have a cost ratio of just over 3:1 in favour of gas, this is more than outweighed by the combination of the efficiency of the heat pumps, the absence of ducting losses and the very significant benefits of greatly increased zoning.

Can we trust heat pumps – are they suitable?

Many of you will have concerns about this, which are legitimate and important to address. Air source heat pumps that you will have heard about, perhaps from the media, Dave Locke, or James, are Air-to-Water heat pumps. They are deigned to be used with a “wet” system – i.e. water-filled radiators or underfloor water-filled arrays, with the heat pump used in place of a boiler. For these, the heat pump has to collect the heat, then transfer that heat to the water, before the water is circulated around the radiators or under-floor arrays which heat the room.

Because the pumped heat is distributed indirectly through the intermediary of water, these heat pumps are more complex and less thermally efficient than the Air-to-Air heat pumps (aka air-conditioning heating units) that are being proposed for STK.

Are heat-pumps suited to poorly insulated buildings?

The capacity of a heat source to heat a building does depend on the level of insulation. If you imagine that a room is like a bucket with a hole in it, the bucket will only fill up if you fill it more quickly than the water can escape. The faster the water flows in, the quicker the bucket will fill up.

Similarly, a heat source needs to be able to provide heat at a greater rate than the room’s heat loss, and the greater the difference that the heat source can provide, the quicker the room will heat up. We know that intuitively. We reduce the heat loss in the winter by keeping doors and windows closed.

Air-to-Water heat pumps are limited by the amount of heat that the wet system can give out, dependent on the size of its radiators or underfloor array, and they are handicapped because of the much lower water temperature that they provide compared with a gas boiler, due to the need for water as an additional intermediary, which then needs much larger radiators or underfloor heating arrays. So this limits their ability to heat poorly insulated buildings.

But Air-to-Air heat pumps are not limited by this, as there is no wet system in their way, making them more thermally efficient and a less complex and more effective heat source.

Examples of successful heat pump installations in poorly insulated buildings.

Ings church, built in the 18th century, has an air-to-water heat pump, which due to careful design and use has been found to be entirely successful. See this case study for more:

Ings_St_Anne_Case_Study.pdf (churchofengland.org)

St Kentigern's Church Mungrisdale. This church, also built in the 18th century, has air-to-air heat pumps. They report in the following case study that they turn on the heating 30 minutes before their service, and the church is warm and comfortable by the time the service starts. Their previous system, and under-pew electric system, never succeeded in warming that building, and cost a lot more to run.

Mungrisdale_St_Kentigern_Air_Source_Heat_Pump_Case_Study.pdf (contentfiles.net)

St Catherine's, Boot is another 18th century church. They previously had gas-fired (LPG) warm air heating, but they now have a new heat pump system which heats their church successfully at a far lower cost.

There is no published case study, but a transcript of an email is provided at the end of this document.

This includes the following: "I have nothing but praise for the system: it is reliable, easy to operate and requires an annual service: major reduced headaches from the standpoint of a Churchwarden."

All Saints Church Hethel in Norfolk is a much older building, built in the 11th century. The case study link below says that using an Air-to-Air heat pump system their church is warm within 30-60 minutes of turning it on.

All of these report no issues with noise from their systems, apart from Hethel who say that they turn their system down when their service starts to reduce the sound it makes. Hethel also report having a cold floor at feet level, but neither of these downsides have been reported by the other churches, so it seems safe to assume that this is a problem confined to this building and installation, or to the way it is used. Hethel are nevertheless satisfied with their system.

5. Air-source heat pumps at Hethel Church - All Saints Church, Hethel - A Church Near You

Geoff and Cath Gornall have been given a tour of the Salutation Hotel Ambleside where the Hotel heat their premium rooms using air-to air heat pumps and we can confirm that the sound from these systems is hardly discernible, and that the floors are warm.

Financial Summary (in round numbers)

Capital Costs:

Replacement Gas boilers: quoted cost inc. parts and labour £17,000. An additional nominal sum of £1,000 has been added for Asbestos removal, as the flues of the old boilers are made of Asbestos. **Total** is therefore estimated at **£18,000.**

New Heat Pumps: quoted cost up to £33,000 plus a nominal allowance for necessary electrical and other associated work, of £2,000. **Total** is therefore estimated at up to **£35,000**.

Variance: The additional capital cost of the heat pump systems is therefore estimated at **£17,000** more than for replacement Gas Boilers.

Annual Running cost estimates (assuming similar building and heat use pattern to the present)

- **New Gas boilers** running cost plus continued necessary use of fan heaters due to lack of zoning: **£4,000 per year.**
- **New Heat pump installation running cost**: **£1,300 to 1,700 per year**
- **Running cost savings compared to current boilers**: Annual revenue savings for the heat pump solution compared with the current boilers at 2024 energy prices are estimated at between **£4,100 and 4,500 per year.**
- **Running cost savings compared to new Gas boilers**: Annual revenue savings for the heat pump solution compared to new Gas Boilers are estimated at **£2,300 to** £**2,700 per year**.

Servicing costs are comparable between the two options.

Appendix – Transcript of email conversation with St Catherine's Church Boot

Dear Geoff,

1: Heat up time depends on the volume/area to be heated up.
St Catherine's is a relatively small church with no side aisles: seats approx 100 people.
Between 15-30 minutes to impact on ambient temperature. We do have stratification fans which are used to keep the heat at congregation level rather than up above the trusses/rafters.
We operate the heating twice a month for a total of approximately 24/28 hours
We put the heating on 12'ish hours before a service which not only means the building is thoroughly warm but also contributes significantly to suppressing damp problems.
To further assist with damp we leave the stratification fans on a low setting full time.
2: The new system replaced a propane gas fired blown air system which was both expensive to operate (approx £70 gas cost per service) and ineffective: additionally the boiler was past sell by and we had significant repair/ maintenance costs.
The church was always damp.
I do not have the electricity bill details available (but will ask our treasurer if she can let me have them) but heating costs have ceased to be a budget issue and we now have a much drier church (reduced maintenance required) and a warm welcoming church on Sundays.
3: For the reasons noted above a comparison is not really relevant. We have replaced bottled gas with renewable sourced electricity and no longer need regular gas bottle deliveries - a possible environmental plus.
4: I have nothing but praise for the system: it is reliable, easy to operate and requires an annual service: major reduced headaches from the standpoint of a Churchwarden.
The system offers a variety of operating regimes - we do not make use of these as I do not have the technical skills needed to appropriately programme the system; however I am a tech dinosaur. I am told that we could operate the system 24/7 to effect and possibly more economically in terms of cost per hour.
5: No. Interestingly I was told, when applying for faculty, noise would be a major problem; such has not been our experience - the heater fans are not silent but they are not intrusive when operating; the destratification fans are effectively silent but if operated on a high fan setting do create a down draft that is noticeable.

Hope this gives you something to go with.

Yours

Tony

> On 28 Nov 2023, at 09:58, Geoff G wrote:
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> Hi Tony,
>
> We have an important meeting on Thursday morning at St Thomas' Kendal to decide how to go forward with work towards Net Zero and replace our aging gas warm air heating system.
>
> So I wonder whether you could provide me with the following information? If so, that would be a very great help to us.
>
> - How long does it take to heat up your church from cold?
> - Do you find running costs to be reasonable?
> - How much reduction have you seen in your energy usage since the heat pump was in place compared with your previous system?
> - Is there any aspect of it that is not as good as you hoped for, and conversely anything that is better than you hoped for?
> - Do you have there been any issues at all regarding noise?
>
>
> Thankyou so much,
>
> Geoff