



St Mary's Church, Embsay with Eastby
Comparison of the effectiveness of the current gas boiler system with
person-focussed electric heating approaches.
December 2022 - February 2023



Background

The St Mary's community is committed to achieving a carbon neutral church by 2025. We have gained Eco Church Silver and are very close to the Gold award. The current gas heating generates around 10 tonnes of carbon dioxide each year and we have undertaken a review since 2020 to determine how best to replace that system. As part of the Towards Carbon Neutral Churches in Craven group of five parishes, we were fortunate to receive funding in 2021 from the Rural Communities Energy Fund which financed feasibility studies in each church. St Mary's has taken the wealth of information produced by that study and continued to investigate options.

The church is a high Victorian building with a large volume of open space below the roof which coupled with the pattern of usage for around six hours/week spread over three or four occasions, makes space heating of the whole church inefficient. Consequently, the PCC decided to investigate person-focussed heating approaches powered by electricity.

It was agreed that there should be thorough consultation with church members before proceeding and, therefore, that we should survey people's judgement of their comfort levels under the existing gas system as well as under various electric options. We have been able to use RCEF Stage 2 funding to part-fund this exercise and have installed five contrasting electric heating units for evaluation. The trial was approved by the Archdeacon of Richmond and Craven who has been supportive of the project.

Executive Summary of the Findings

- **The existing gas fired, water-pipe and radiator system is expensive to run as a full space-heating approach for the three occasions each week when services may be held. It increases atmospheric carbon and does not provide adequate heating in cold weather. The boiler is between 15 and 20 years old and may be expected to fail before long.**
- **The alternative approach of person-focussed heating, powered by electricity could provide as good or better heating for the congregation. It would be more controllable, permitting zoning of the church and not requiring a long warm-up period. It would, however, still leave people feeling a bit cold on the coldest days as it warms the lower half of the body. People would need to be warmly dressed. Careful buying of electricity from a genuinely green source would eliminate our present carbon emissions from the existing boiler.**
- **The installation of curtains to reduce draughts would improve people's comfort.**
- **Radiant wall heaters were not favoured for the pew areas. Wall-mounted units failed to reach the whole sitting area while suspended panels were not favoured for aesthetic reasons. Radiant units (both fixed and portable), however, are likely to provide the best solution in other areas of the church – the North Aisle, the Chancel, Choir and kitchen.**
- **The installation of a keyboard heater in the organ is already being undertaken.**
- **Electric heating would require new circuits throughout the church as well as an upgrading of the supply.**

A. Traditional water-based heating using a gas-fired boiler.

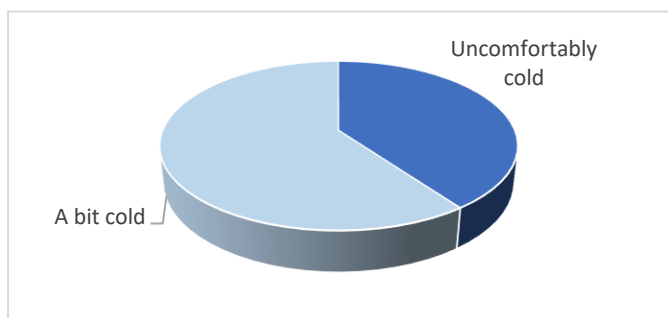
The first set of surveys followed three Sunday services in December 2022/January 2023 and focussed on the gas heating alone. The heating had been running for one and a half hours before the first Sunday and two and a half hours before the second and third trials. The outdoor temperatures were 5°C, -5°C and 7°C respectively. Temperature within the church was between 10 and 13°C on the first occasion, between 9 and 10°C on the second and around 11°C on the third trial.

Thirty-nine responses were completed on the first Sunday, twenty-six on the second and 32 on the third occasion. More than half of the responders were present on all occasions.

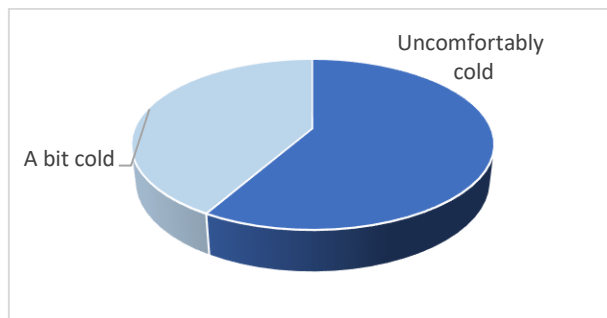
Almost everybody was wearing outdoor clothing and retained it throughout the services.

Findings

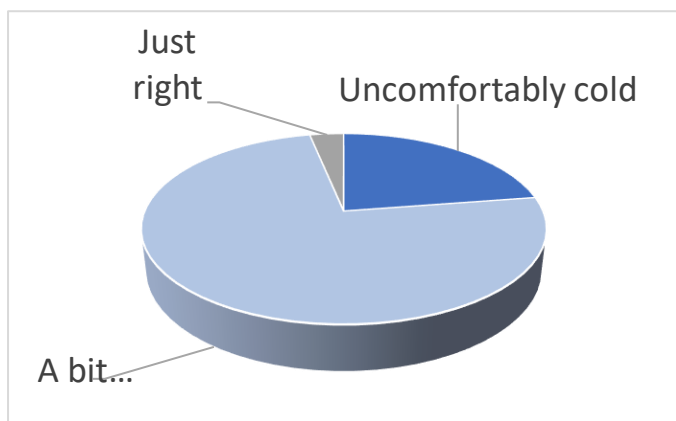
- The main message was consistent, people felt uncomfortably cold throughout both services as illustrated by the first graph below, with only 5% recording that they felt “just right”; nobody ticked the “A bit warm” or “Uncomfortably warm” boxes.



December 4th 2022, 5°C Outdoors

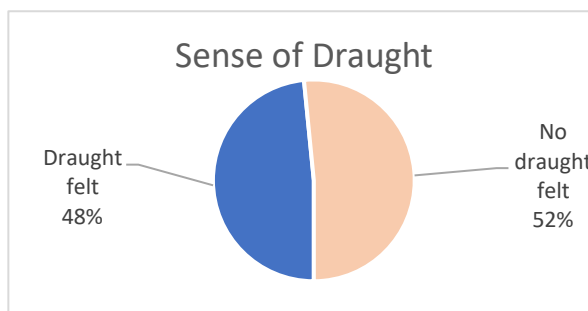


December 11th 2022, -5°C Outdoors

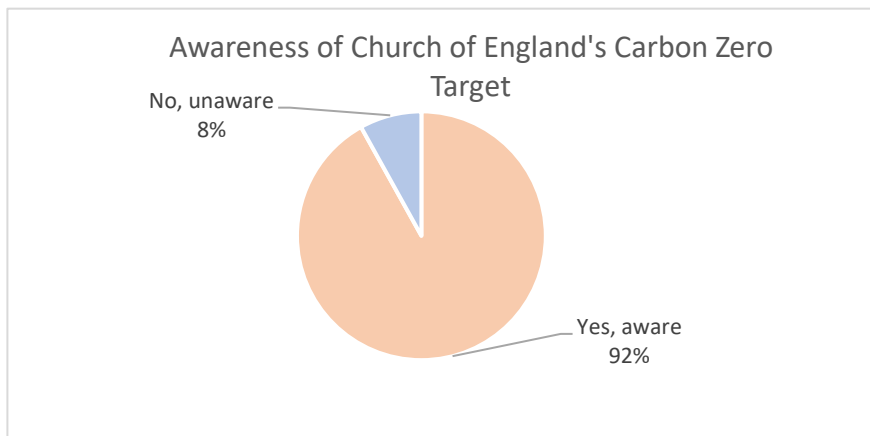


January 29th 2023 – Outdoor temperature 7°C
Indoor temp. 11°C

- Almost half of those present recorded that they felt a draught, some remarking that it was particularly chilling.



- There appears to be some correlation between experiencing draughts and where people were sitting, with intermittent draughts felt to the rear of the church, especially on the North (kitchen) side. Further investigation and discussion suggest that this is caused by the fan assisted radiator units themselves. While these units generate heat in their proximity, their very nature causes air circulation which appears to bring bodies of cold air to certain parts of the church.
- Some of the people sitting adjacent to the South door also recorded occasional draughts.
- There is a difference in heating effect between the pews on the South side of the church where the heating pipes run along the wall as well as under some pews and the central block of seats which are distant from any heating source. People in the central block tended to feel colder, especially in the central and rear sections.
- There are some areas of the church which are entirely unheated. The choir is the main example, the kitchen and toilet are others. All those sitting in the choir and organ areas commented on this.
- Few people noticed the noise from the heating fans although one or two individuals found them to be quite audible in quiet moments of a service.
- It was reassuring to learn that the great majority of those present were aware of the Church of England's 2030 target for becoming carbon neutral.



B. Person-Focussed Heating Approaches

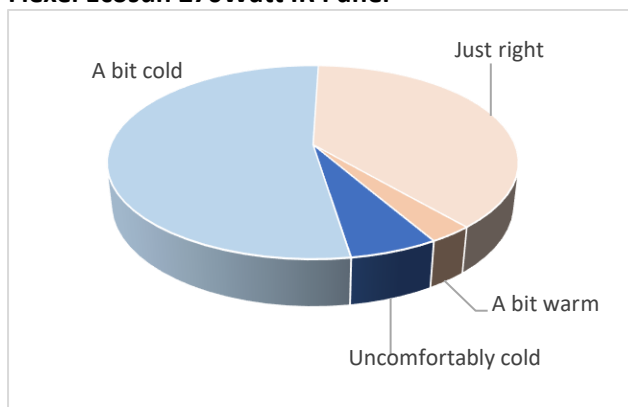
The second series of surveys investigated people's assessments of the effectiveness of a range of person-focussed appliances, powered by electricity. Details of the five types of unit are given in Appendix 1. Seventeen people participated in the first trial which took place on a day in January when the gas heating had not been running for more than 72 hours. Outdoor temperature was -1°C, temperature inside the church at the start of the exercise was 5°C.

People spent five minutes seated in the different electrically heated zones and judged comfort on the same scale as with the earlier exercise.

Findings

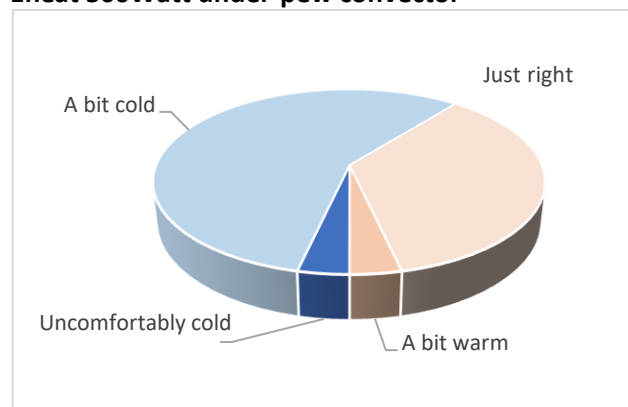
- The majority of people tended to feel "A bit cold", which was not surprising given the outdoor temperature, but the pew units, in particular, scored better on "Sense of Comfort" than the gas heating had achieved with around a third of people judging them "Just right".

Flexel Ecosun 270Watt IR Panel



January 19th, 2023, -1°C Outdoors

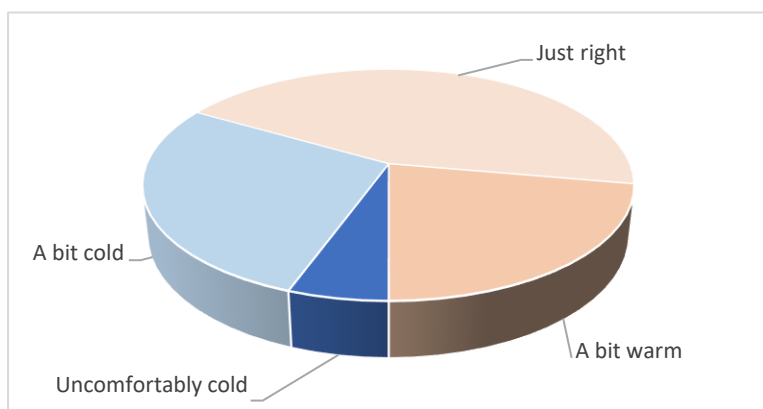
Eheat 500Watt under-pew convector



January 19th, 2023, -1°C Outdoors

- Both the pew heating systems were judged good for feet and legs but tended to leave the upper body and head cold, especially when standing. People commented, however, that it was easier to dress the upper body warmly than the lower extremities.
- The wall mounted radiant units had very different impacts. The Tansun 3000W infra-red gave good heat to the upper parts of people’s bodies but tended to leave legs and feet feeling cold. There was a sharp delineation of the area covered, however. People were aware of the bright colour of the elements but did not, typically, feel negative about that. The older style 2000 Watt halogen unit was judged to have little effect mounted at the height at which it was set.

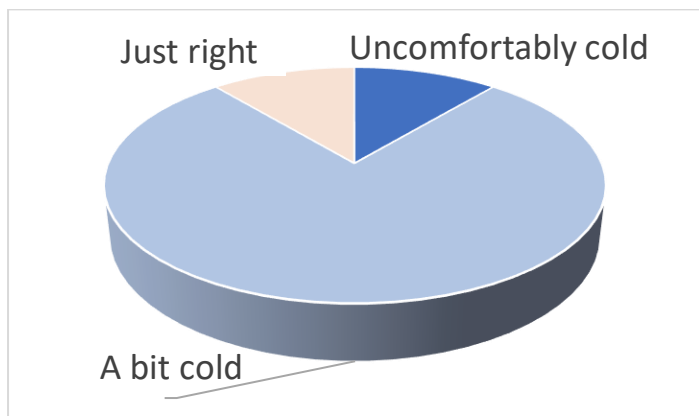
Tansun IR 3000Watt wall heater



January 19th, 2023, -1°C Outdoors

- The fifth unit was a Flexel Ecosun overhead infra-red radiant panel. Mounted at the height necessary to be above sight lines, it was judged to be ineffective at heating people sitting at ground level. It should be considered, however for a space such as the kitchen.
- In parallel with these heating trials, St Mary’s has been monitoring relative humidity in the church over the winter months. Readings have been taken at hourly intervals and logged showing a record of humidity from September 2022. A sample record is included as Appendix 4.
- The energy used by the various electric devices varies considerably, as is shown in Appendix 1. The infra-red pew heating panels use approximately half the energy of the under-pew convectors. The Tansun wall unit consumes around six times the energy of a pew of IR panels but covers a larger area.

The second trial of electric heating took place on February 9th, 2023, with nine participants. The purpose was to obtain views on the effectiveness of the two types of pew heating over a longer period. Outdoor temperature was 5°C, indoor temperature was 8°C and the gas heating had been off for seventy-two hours. A 35 minute service was held, and the judgements of the group are shown below.



February 9th, 2023, – Outdoor temp. 5C,
Indoor temp. 5-8C

The participants were asked whether “this pew heating is sufficient for us to be able to use it as a replacement for the gas heating”? Seven individuals answered “yes” and two “no”. In both the “No” cases the people were sitting close to the entry door and commented on the draughts which made them feel progressively colder as the service progressed. Elsewhere half the people responded that as time passed their lower bodies, legs and hands, felt some increase in the warmth they were experiencing. People sitting in pews with the infra-red panels commented that it “took a little time” to begin to feel the benefit of the radiant heat whereas those sitting in pews with the convectors felt the benefit almost immediately. In both cases the units had been switched on 30 minutes before the start of the service.

Participants commented on the fact that the service was being held on a very cold day. There were several comments that wearing warm outdoor clothing (including a hat) on such a day was reasonable in church and with pew heating on legs and hands it was just adequate.

C. Overall Study Findings.

- St Mary’s current gas-fired heating does not enable people to be comfortable during services in cold weather, even when being run for around five hours in order to attempt to provide some prior warming-up of the building.
- The existing heating is expensive and contributes around 10 tonnes of carbon to the atmosphere each year.
- The size and height of the building make space heating an inefficient way of providing a reasonable degree of comfort on the four or so occasions each week when people are in attendance.
- Electric pew heating was as effective or better than the gas heating, even in the coldest weather. Nonetheless, people still felt “a bit cold” when the ambient temperature was low.
- There was no overall preference for one or other of the two types of pew heating although individuals tended to express strong personal preferences.
- It is not reasonable to expect church heating to match the temperatures in centrally heated, domestic spaces. Several participants in the surveys voiced sentiments such as “Wrap up warm to come to church” and “There was no heating when most of our churches were built”.

- A historic issue exists with the organ keys losing their smoothness of operation in winter. It has been decided, in conjunction with the organ tuner, to install a low wattage heating bar over the key mechanism, to run continuously through the damper months.
- The issue of draughts could be tackled by installing an insulated curtain over the South door which would be closed as the service began. Secondly, the opening between the back of the nave and the Crossley Room, below the tower, could be closed by a similar curtain.

Conclusions.

1. Heating St Mary's by the continued use of the gas-fired water system, is inefficient and uneven in heat distribution, generates chilly draughts, fails to keep people warm on the coldest days, and is expensive to run. Above all, it releases 10 tonnes of carbon dioxide into the atmosphere. At 15 years old, the boiler is nearing the end of its expected life.
2. A system of person-focussed, electrically powered heating is a viable alternative for the pew areas. Although the heating effect is mainly experienced by the lower portions of the body, it was found to score as well as or better than the existing gas system in our user trial. Such a system would be flexible, permitting zoning of heated areas or switching off individual pews and capable of being remotely controlled on a phone app. It would have lower running costs at present energy prices than the existing gas system and maintenance costs would be extremely low compared with the present. Careful buying of electricity from a genuinely green source would eliminate the present 10 tonne of CO₂/year carbon footprint.
3. Comfort in church could be improved by the installation of insulated curtains across the entrance and vestry doors as well as between the Crossley Room and the nave.
4. The areas without pews would need a hybrid installation of wall-mounted, overhead and portable free-standing radiant units, tailored to their particular contexts.
5. An electric conversion of this kind would require the installation of new electrical circuits as well as the upgrading of the church's supply.
6. Should a decision be made to proceed with an all-electric installation, the next stage would be to commission the preparation of a detailed proposal by a specialist based on the lessons learned from this trial. It would include a full specification for the electrical upgrade work required. Once these specifications have been obtained, they would be submitted to the diocesan faculty process while initial fund-raising began. The target of installation and therefore achieving carbon neutrality by the end of 2024 remains realistic.
7. Humidity in the building has been monitored through the winter months and levels have been broadly stable (Appendix 5), indicating that the reduced gas heating regime has not been detrimental to date.

The carbon-neutral review at St Mary's has benefitted from the active engagement and support of the PCC and full church community, not least for the heating trial which was made worthwhile by the willing participation of church users on several very cold days. We appreciate their contribution which will enable us to evaluate heating options more objectively. Ideas have been vigorously challenged, suggestions made, and new angles contributed. Our intention is that the final heating strategy will reflect this commitment while recognising that some ideas are mutually exclusive and that we need to work within our budget.

**Full details of the Towards Carbon Neutral Churches in Craven project can be found on our webpages:
<https://www.stmaryembsay.org.uk/churches-in-craven-carbon-neutral/>**






This project has benefitted from funding provided by the Rural Communities Energy Fund operating through Tees valley Combined Authority.

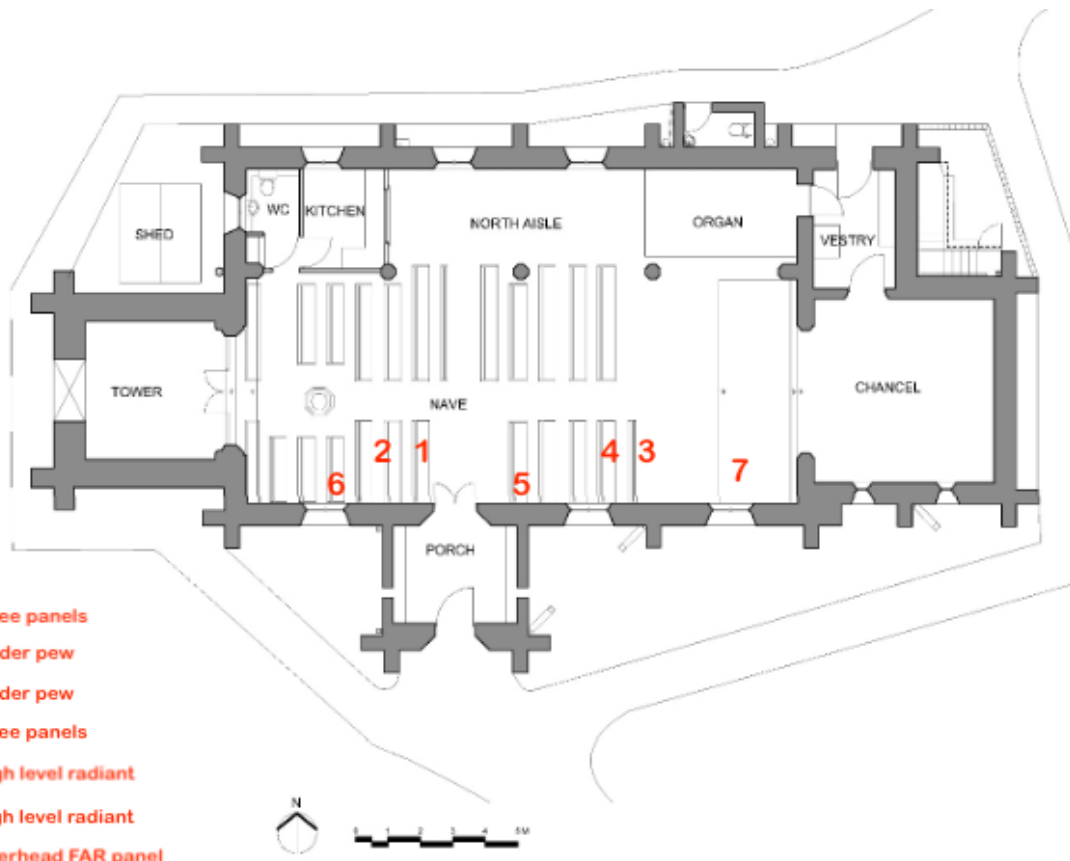


Appendix 1. Details of the types of electric heating used in the trial.

 St Mary's Embsay with Eastby Heating Trial 2023.

As part of our move towards being net carbon zero, we are planning to install electric heaters to replace our gas-fired boiler. Today we are holding a trial of a number of different types of heaters, so that our congregation can judge which they find most effective, taking into consideration our building and its usage, as well as the appearance of the units.

Image	Description	Location See the plan on the reverse of this sheet	Energy use
	Flexel Ecosun panels are infra-red radiant sources which provide gentle steady heat to the body in front of them. The surface is safe to touch.	Pew heaters, positions 1 and 4 on your plan	540 watts per "short" pew i.e. 3-4 people.
	Eheat 500 units are convector heaters which provide gentle heat from below the pew. The surface is safe to touch.	Pew heaters, positions 2 and 3 on your plan	1000 watts per "short" pew i.e. 3-4 people.
	Tansun Infrared wall unit will direct heat on to bodies below. It does not heat the air space.	Wall mounted above the entrance door, position 5 on your plan	3000 watts per heating unit
	Radiant halogen heater of unknown manufacture.	Wall mounted over rear pews, position 6 on your plan	2000 watts per heating unit
	Flexel Ecosun overhead unit is a source of infra-red heating suitable for overhead use. n.b. it is mounted too high here to be effective.	Suspended over the vicar's pew, position 7 on your plan.	1800 watts per heating unit



**Proposed changes to the heating system at St Mary's
in order to get to net carbon zero.**

**First congregation survey of gas heating. Date 11/12/2022 &
04/01/2023**

You may have heard that we are consulting on changes to the heating system in the church. We need to stop using fossil fuels (particularly our gas boiler) in order to reduce our carbon emissions. At St Mary's, our plan is to be carbon net zero by 2025.

We are planning to trial 4 types of electric heating over the winter months. As part of the trial, we want to involve our congregation directly and we will ask the congregation members for their feedback. This will play an important part in helping us to decide our preferred means of heating the church in future. So please assist us by answering our questions. First, we want to find out what people feel about the heating which we have been using up until now.

Please answer the questions about how you feel TODAY.

We need to know how you feel, so please do not discuss your answers with those sitting nearby.

Conditions around the church vary so would you please mark where you are sitting today with a cross on the plan at the end of the survey.

1 How have you felt about the temperature in church today?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

2 Do you feel strong draughts during the service, where you are sitting?

Yes No If yes, where from?.....

3 What warm clothes are you wearing through the service today ?

1. An overcoat or other outdoor clothing.
2. Extra warm layers in your normal clothing.
3. Your normal indoor clothing only.

4 Are you sometimes aware of the noise of the fans during the service from the existing, white fixed heaters at the front?

Yes No

5 Do you think the existing white fan heaters at the front spoil the historic character of the church?

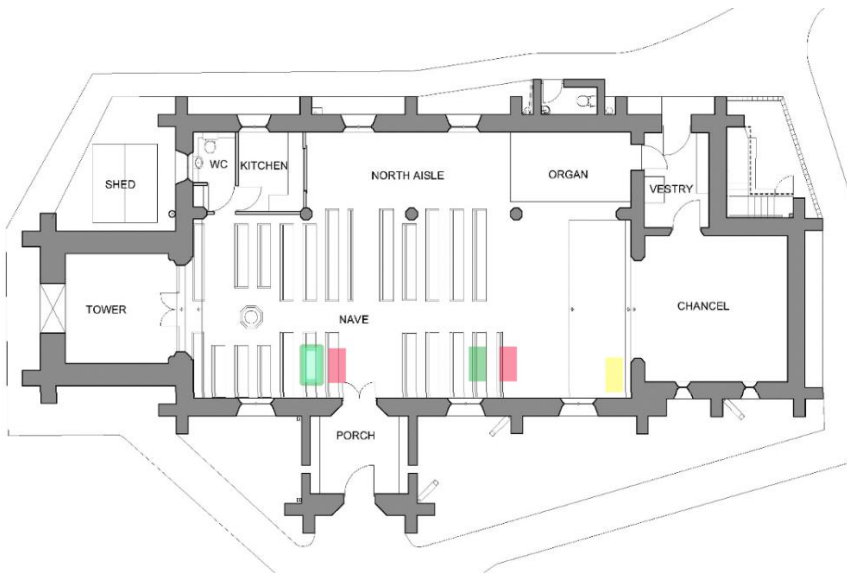
Yes No I haven't thought about it

6 How would you describe the heating in church today to a non-churchgoing friend?

.....
.....
7 Do you have any further comments you wish to make?

.....
.....
8 Do you know that the Church of England has a target to be carbon net zero by 2030?
Yes No

9 Please mark with a cross where you are sitting today, on the plan below.



**Thank you for taking
part in our survey!**

**Proposed changes to heating system at St Mary's
in order to get to net carbon zero
Second congregation survey. Date 19/01/2023**

You may have heard that we are consulting on changes to the heating system in the church. We need to stop using fossil fuels (particularly our gas boiler) in order to reduce our carbon emissions. At St Mary's, our plan is to be carbon net zero by 2025.

We are planning to trial 5 types of electric heating over the winter months. As part of the trial, we want to involve our congregation directly and we will ask the congregation members for their feedback. This will play an important part in helping us to decide our preferred means of heating the church in future.

Please note that the North aisle, the organ, kitchen and chancel area will need particular solutions and we are taking further advice on these.

Please answer the questions about how you feel TODAY.

We need to know how you feel, so please do not discuss your answers with others. There are 7 places to sit in the church to try out the new heaters, each marked with a number, shown on the church plan below.

Pew heater 1

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 2

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 3

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 4

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 5

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 6

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

Pew heater 7 (choir stalls)

a) How have you felt sitting in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

b) How have you felt standing in this pew?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

c) Were some parts of your body comfortable while others were unacceptably cold?

Yes No

If you have answered "Yes", please give some more details

d) Do you think this heater spoils the historic character of the church?

e) Do you have any comments about this heater?

4 What warm clothes are you wearing for church today ?

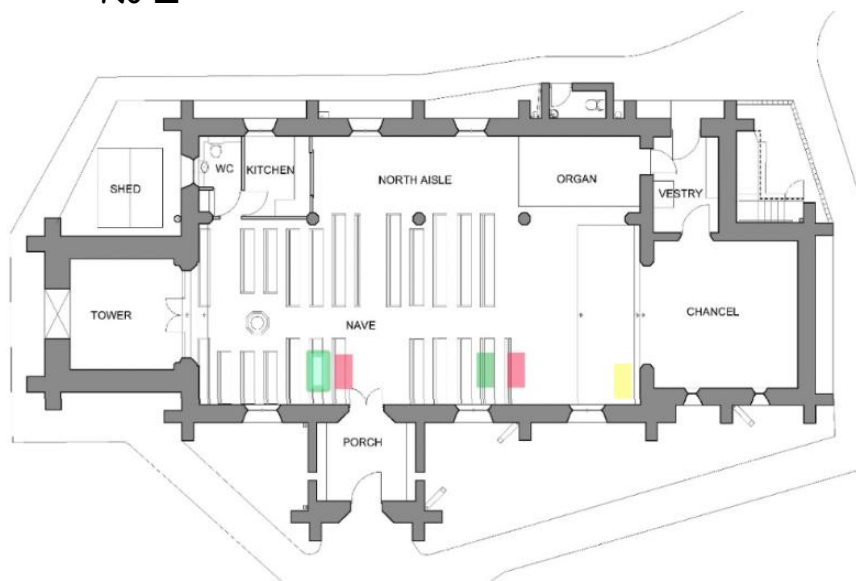
- 4. An overcoat or other outdoor clothing.
- 5. Extra warm layers in your normal clothing.
- 6. Your normal indoor clothing only.

5 Do you have any further comments you wish to make?

.....

.....

6 Do you know that the Church of England has a target to be carbon net zero by 2030?
Yes No



Thank you for taking part in our survey!

Appendix 4. Survey record sheet for pew heating over a service duration.

**Proposed changes to the heating system at St Mary's
in order to get to net carbon zero**

Trial service using pew heating - 9th Feb 2023

In this final trial we are looking for your views on the two types of pew heating when they are experienced for the time of a short service.

Please answer the questions about how you feel TODAY.

1 How have you felt about the temperature in church today?

Uncomfortably cold A bit cold Just right A bit warm Uncomfortably warm

2 Did that impression change as time passed during the service?

Yes No If yes, how?.....
.....

3 Do you think that this pew heating is sufficient for us to be able to use it as a replacement for the gas heating?

Yes No Comments.....
.....

Please mark with a cross where you are sitting today, on the plan below.



**Thank you for taking
part in our survey!**

Appendix 5. Sample of the humidity and temperature log for parts of December 2022 and January 2023

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● CH1-Temperature(°C) ● CH2-Humidity(%RH)

