Net Zero Carbon 2030

Church Heating - your questions answered!

The Church of England in Essex and East London Diocese of Chelmsford

The Church of England Diocese of Ely

The Church of England Diocese of Norwich

Diocese of St Albans

The Church of England Suffolk

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Is heating good for the building?

- Can be both – heating is neither inherently good or bad!
- Impact of heating depends on the impact it has on the indoor climate.
- Relative humidity is generally considered the most important environmental factor from a conservation standpoint.
- Heating can cause large, rapid fluctuations in relative humidity.
- Generally, average relative humidity is higher but amplitude of variations in relative humidity is smaller in unheated buildings.
- Heating can be designed to improve indoor climate for conservation but may compromise on thermal comfort and be energy intensive.
- Heating should not be used to control or mask the effects of damp – the root cause of damp should be investigated and resolved.
- Various standards and guidelines for rate of change of relative humidity and temperature.
- Forming a multidisciplinary team to design a new or alter an existing heating system can help ensure all complexities are considered.

Heating in itself is neither good nor bad for a building. What is important is the kind of system, how it is used, and the impact it has on the indoor climate of the building. Heating can have a significant impact on both the temperature and relative humidity within a building, and it is the scale, frequency and speed of these changes in internal environmental conditions that can negatively impact historic fabric and artefacts. For comparison, unheated buildings may generally have higher relative humidity than a heated building, but with smaller fluctuations. Materials within even poor-quality environments can become acclimatised to those conditions over extended periods of time, meaning the introduction of heating into an unheated building requires careful consideration of the needs of historic materials in that building.

“Conservation heating” uses heat to improve the indoor climate for conservation, aiming to keep relative humidity at a stable and appropriate level throughout the year as well as avoiding condensation or frost. Note this strategy can only reduce relative humidity, not increase it.

It is important to stress that heating should not be used to control or mask the effects of damp. Where damp is present, the root cause of the issue should be found so that appropriate remedial action can be carried out. This will save energy and safeguard the building fabric.

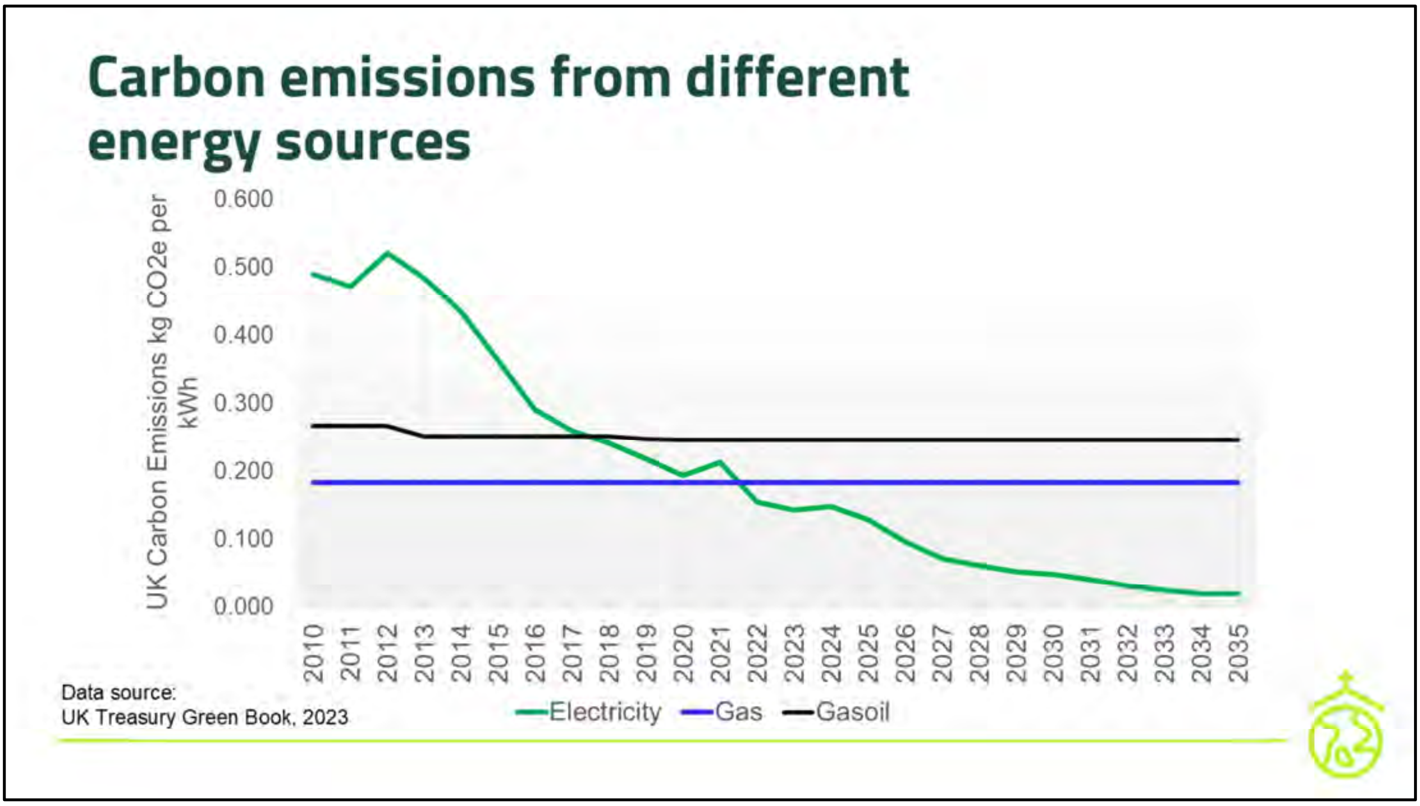
One of the challenges to answering this question is that there are various different standards and guidelines for what an “acceptable” temperature & relative humidity is for conservation. This is why expert advice, such as from a conservation architect and the DAC, is key to ensure appropriate environmental conditions are identified and specified as part of a heating system design that is considering building conservation. I would strongly encourage early engagement with your DAC if you are starting to design or consider a new heating system.

BS EN 15759-1:2011 provides guidance for heating places of worship and examines the impact of different heating strategies and heating systems, such as infrared, pew heating etc. on conservation and thermal comfort.

Is heating good for the building?

Risk factor	Potential impact
Relative humidity fluctuations	Internal stress due to contraction & expansion, causing cracking, swelling and salt efflorescence
High relative humidity	Mould growth, oxidation and corrosion of metals
Low relative humidity	Reduction of moisture content of hygroscopic materials (e.g. wood) causing shrinkage & inducing internal stress
Moisture condensation	Exacerbates risks caused by high relative humidity. Condensed water vapour on stained glass can cause flaking of enamel
Water evaporation	Can cause capillary rise and salt crystallisation

Here I've summarised some of the risks to cultural heritage (that is, historic buildings and artefacts) from changes in relative humidity. This is purely to highlight the complexity and potential impact an inappropriate heating strategy and system can have on a historic building and artefacts.



As we move forward we are hoping that when your current gas and oil boilers reach the end of their life that electric solutions will be implemented. This graph shows why we are keen to change to electricity for heating. Carbon emissions per kWh of electricity used have fallen so they're now just 40% of what they were 12 years ago, and emissions from electricity are now lower than per kWh than natural gas. With the last governments policies the carbon emissions per kWh should continue to fall, to be around 10% of current emissions in 2035, and then to 1% of current emissions, or 2g per kWh in 2050. Gas will continue with the same emissions factors (183g/kWh), as will oil (~247g/kWh depending on the oil), so even if we use the same quantity of energy as previously, our carbon emissions will fall.

A different view of heating costs

	Gas 	Oil 	Electric heat the people 	Heat Pumps 
Cost	£4786	£1476	£1086	£2730
Energy use (kWh/m2)	89	45	14	25
Tonnes CO_{2e} (2024)	11.2	6.0	1.4	2.9
Tonnes CO_{2e} (2030)	8.2	3.6	0.3	0.5
Less than Weekly	£ 815.56	£ 590.82	£ 358.73	£ 1,688.96
Weekly	£ 2,070.64	£ 1,152.15	£ 953.94	£ 1,820.00
2-4 days/week	£ 3,519.05	£ 2,167.57	£ 1,603.08	£ 1,003.99
5-7 days/week	£ 5860.50	£ 3,832.16	£ 4,084.12	£ 4,531.11

Thank you to everyone who completed the energy footprint tool. It has been used to help us understand the costs and carbon emissions associated with running and heating our churches with different fuels, and these results are based on more than 1100 entries for 2024.

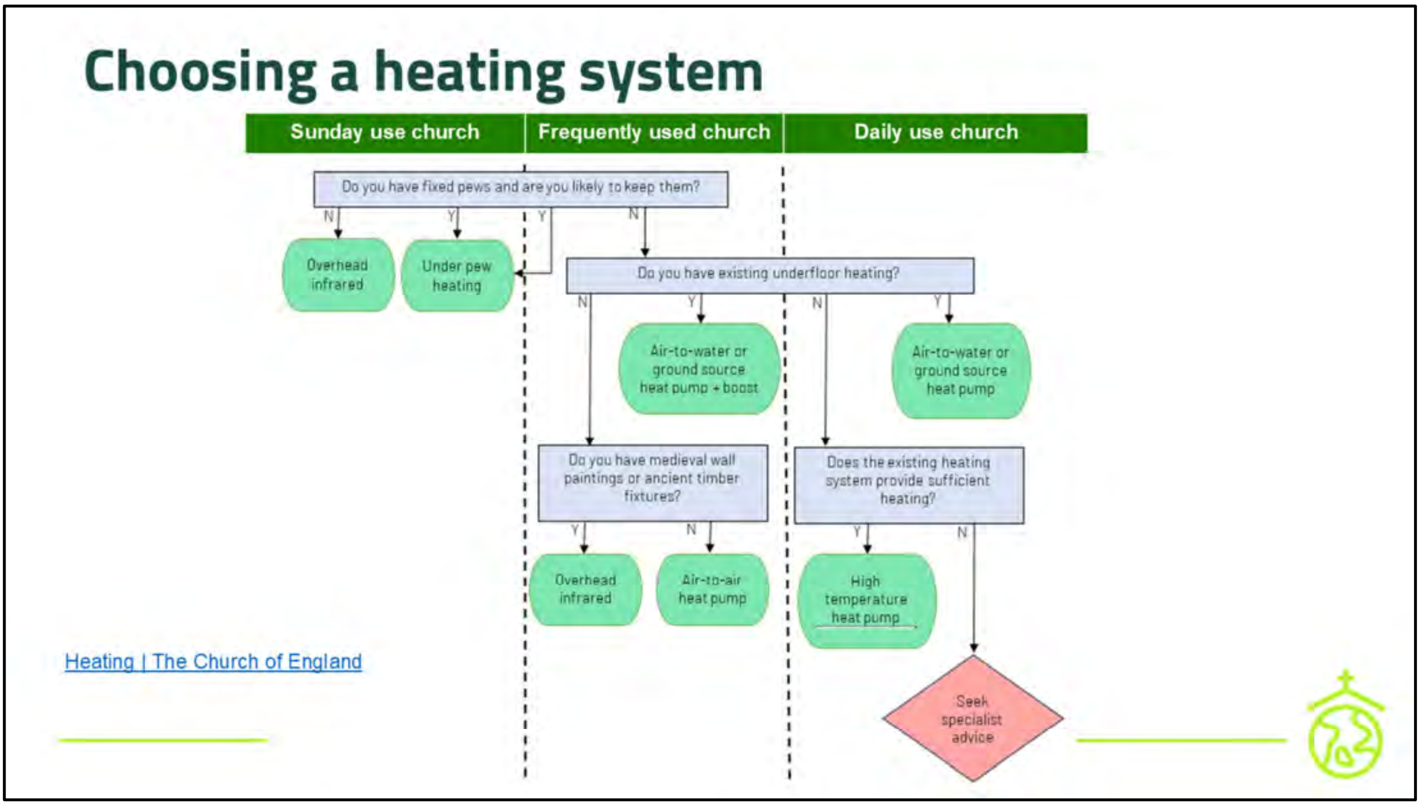
The first line shows the average cost of heating a church with each gas, oil, with direct electric, or using a heat pump. The average gas heated church costs 3 times as much to run as an oil heated church, or 4.5 times as much to run as an electrically heated church, and 40% more than a church heated with a heat pump.

When looking at energy efficiency we have looked at the energy used per square metre of church, to account for different sizes. Here you can see that a gas heated church uses 3.7 times as much energy as a church heated with a heat pump, twice as much as an oil heated church, and 6.5 times as much as an electrically heated church.

The carbon emissions show a similar picture, with carbon emission from gas being twice as high as from oil, four times as high as with a heat pump, and 8 times higher than an electrically heated church.

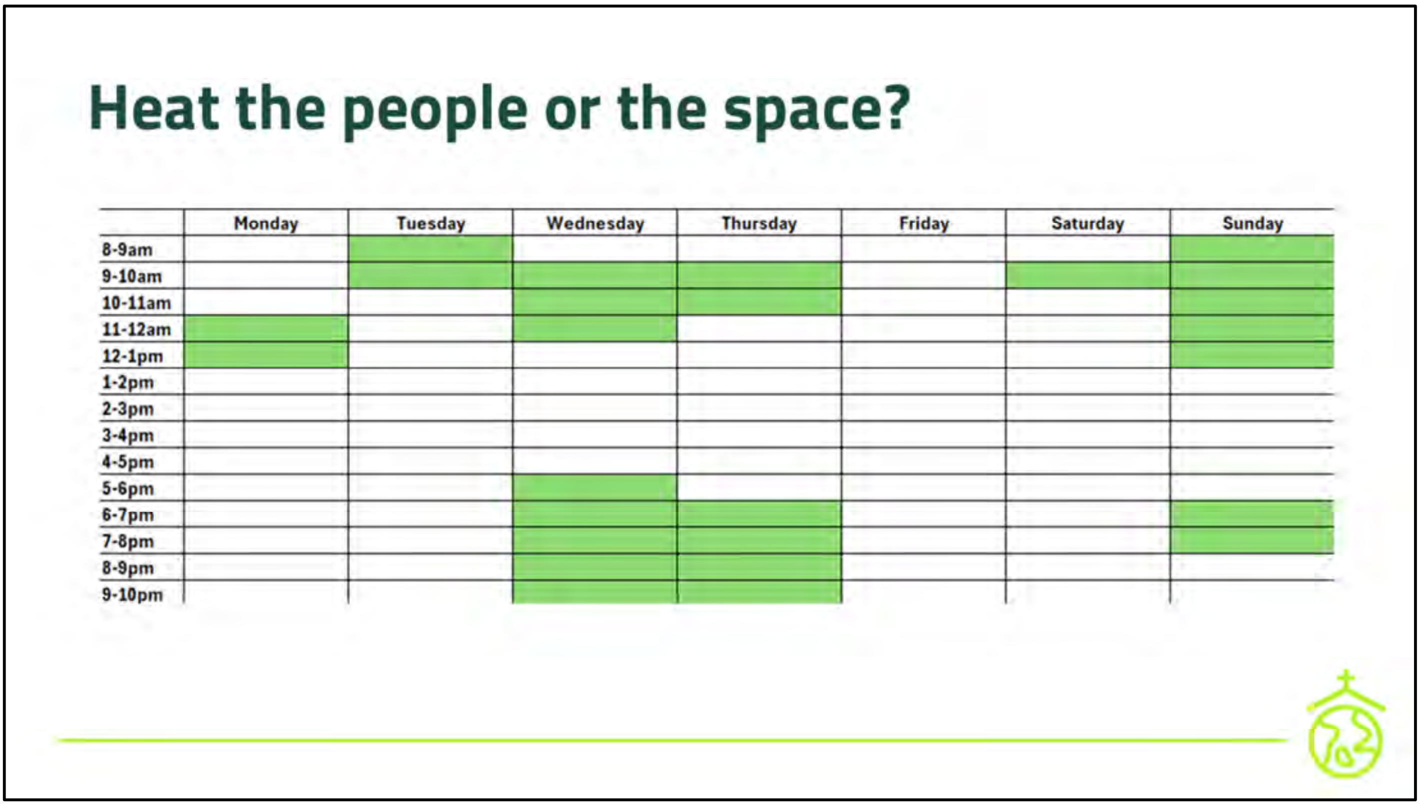
As the grid decarbonises there will be an impact for all churches to their carbon emissions. While emissions from our gas and oil heated churches will fall as a significant proportion of their emissions are related to their electricity usage, the relative falls for those heated by electricity or heat pumps is even higher. In 2030 a gas heated church will be responsible for 20 times the emissions of a church heated with a heat pump, and 27 times the emissions of an electrically heated church.

I've also included some running cost information based on usage which you can read when you receive the slides, but they show that electrically heated churches generally cost less than half as much to run as a gas heated church, and about 20% less than an oil heated church.



Choosing a heating system starts with how often you are using the building, and how you use your building. The flow chart on the screen is to help you identify the most likely type of heating to form the base of an effective system that is affordable to run, but hybrid solutions where different types of electric heating are in place in different parts of the building are common, so mapping out your church, and how often you use different areas, and what activities take place in each area is a really useful start point to help you define who and what your heating system needs to heat, when, and how long for. The Church of England website has a page dedicated to heating advice, and of particular use is the heating checklist to help structure your thoughts. This can then be submitted with any Faculty application so that the DAC and Chancellor can also see how you reached your proposal. For those in St Albans there is an editable version of the checklist available on our website, which those in other dioceses are also welcome to use.

Today we're going to talk about solutions people submitted questions about. This will include infrared and under pew heating to heat the people, and underfloor heating and ground source heat pumps to heat the space. We haven't planned to talk about air source heat pumps which come in two flavours, air to air and air to water. Ait to water are similar to ground source heat pumps but use air as the heat source rather than the ground. Air to air heat pumps are essentially air conditioning systems run in a heating mode. With an air-to-air system there are usually fan convectors inside the building that work in a similar way to fan convectors attached to a gas or oil boiler. For air-to-air systems they can be mounted in a variety of positions, including at the base of the wall and close to the ceiling, and can be coloured to match the materials, so if you currently have fan convectors that haven't caused any issues from the rapid warming and cooling of the air in the church then this could be a good low carbon solution as they can quickly warm the air in the building, and the air warms up much faster than the fabric. They may be particularly relevant if it is not clear whether a heat the people, or space heating solution is the most appropriate.



So, should you heat the people or the space? That is a decision that only you as church wardens and vicars, in conjunction with your PCCs and congregations can make, and it will influence your running costs for the lifetime of your heating system.

The start point is understanding how you currently use your church, and how long for, and if you are expecting any changes. Generally speaking, the more that a space is used, the more likely it is to suit space heating. But sitting down and understanding the detail of how you use your church is important.

If I was presented with this chart of when the church is used, I would be immediately thinking it looks like a candidate for space heating. It's in use most days of the week, for several hours at a time.

Heat the people or the space?

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8-9am		School Service					Service
9-10am		School Service	Service	Morning Prayer		Organ Lesson	Service
10-11am			Service	Tea			Service
11-12am	Funeral		Tea				Service
12-1pm	Funeral						Service
1-2pm							
2-3pm							
3-4pm							
4-5pm							
5-6pm			Evening Prayer				
6-7pm			Tea	Choir Practice			Service
7-8pm			Bell Ringing Practice	Choir Practice			Tea
8-9pm			Bell Ringing Practice	Choir Practice			
9-10pm			Bell Ringing Practice	Tea			

Adding in the detail of what's happening would make me think a little more. The funeral is an occasional event. How many do you have a year, so should I factor it in? The bell ringing practice and choir practice probably don't need the whole church heating, and neither would the organ lesson.

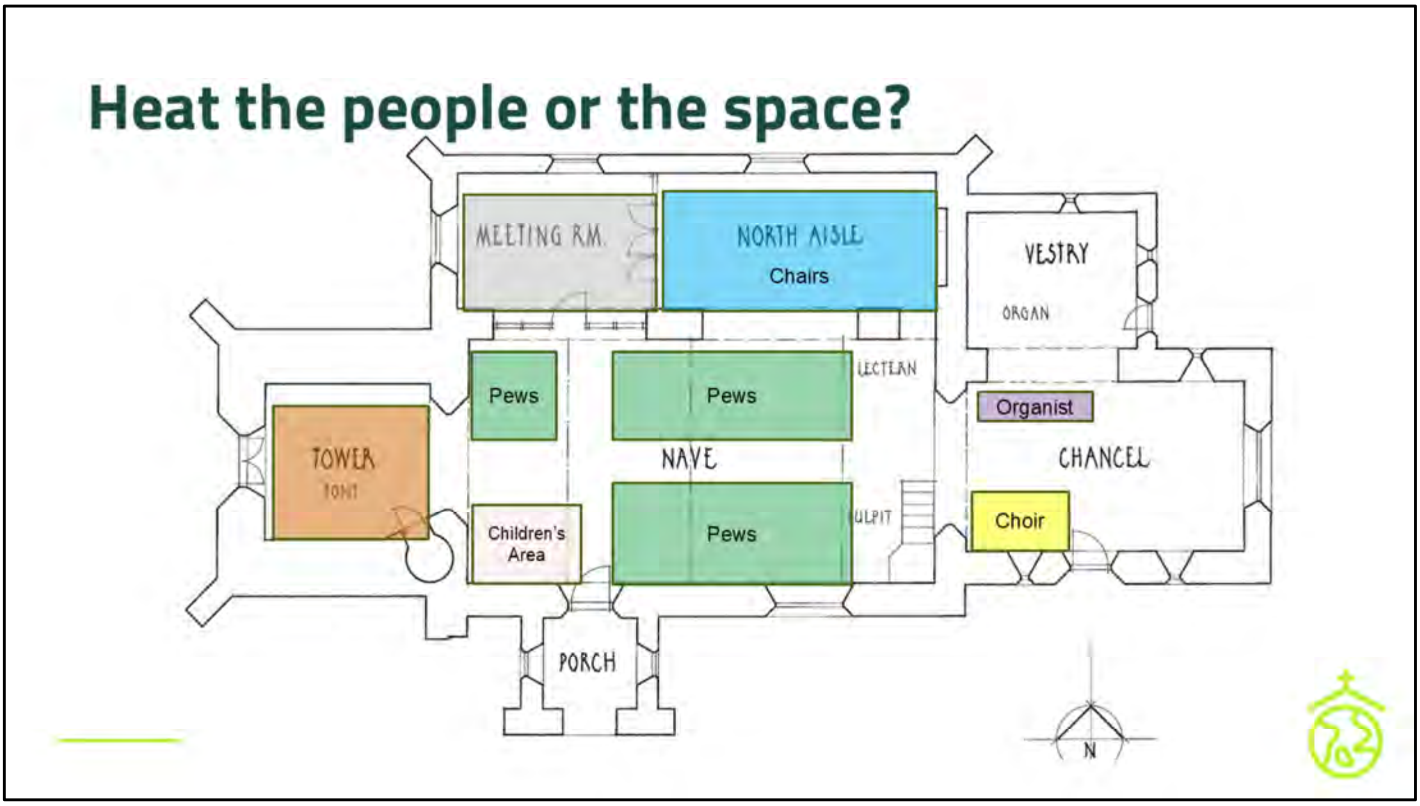
How big are the congregations for morning and evening prayer, and the midweek service, and does the whole space need heating for tea?

Heat the people or the space?

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8-9am		School Service					Service
9-10am		School Service	Service	Morning Prayer		Organ Lesson	Service
10-11am			Service	Tea			Service
11-12am	Funeral		Tea				Service
12-1pm	Funeral						Service
1-2pm							
2-3pm							
3-4pm							
4-5pm							
5-6pm			Evening Prayer				
6-7pm			Tea	Choir Practice			Service
7-8pm			Bell Ringing Practice	Choir Practice			Tea
8-9pm			Bell Ringing Practice	Choir Practice			
9-10pm			Bell Ringing Practice	Tea			

Whole Church
Lady Chapel
Tower
Choir Stalls
Organist
Tea/Kitchen Area

Moving on to more detail again and I can see that the whole church is used a lot less, especially if weddings and funerals are a few times a year rather then a couple of times per month. I know I'll need to heat the tower on a Wednesday and Sunday, the choir stalls on Thursday, and the North Aisle and meeting room a few times per week.



If I have that information on a plan of the church, and I know the furniture I've got in different spaces then I can start to develop my thinking further.

I could still heat the whole space, if I use it enough, or I could have pew heaters in the nave, maybe with infrared for the children's area. The North Aisle and Meeting Room are both flexible spaces with chairs, so maybe some infrared heaters here. But the meeting room is glassed in and has a low ceiling and carpet. Infrared, or convector heaters could both work in this space. The organist and choir could be treated to heated seat cushions, or under pew heaters, or the chancel could have infrared heaters for the space. The tower could have infrared, but lower output due to the physical exertion.

Or you could keep your space heating for the big services, or to maintain the background, and install heat the people solutions to reduce your running costs and carbon emissions for the smaller services and provide contingency in case your boiler fails.

There is no one size fits all solution as every church and congregation is different in its needs, wants, and resources.

Heat the people or the space? 27 hours/ week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8-9am		School Service					Service
9-10am		School Service	Service	Morning Prayer		Organ Lesson	Service
10-11am			Service	Tea			Service
11-12am	Funeral		Tea				Service
12-1pm	Funeral						Service
1-2pm							Tea
2-3pm							
3-4pm							
4-5pm							
5-6pm			Evening Prayer				
6-7pm			Tea	Choir Practice			Service
7-8pm			Bell Ringing Practice	Choir Practice			Tea
8-9pm			Bell Ringing Practice	Choir Practice			
9-10pm			Bell Ringing Practice	Tea			

Heat the people

	Heaters (kW)	Hours/week	kWh/Week
Whole Church	69	9	621
North Aisle	12	5	60
Tower	3	3	9
Choir Stalls	9	3	27
Organist	2	1	2
Meeting Room	6	6	36

755 kWh/week
22,650kWh/year
£5,889 / year, Electric @ £0.26/kWh

Heat the Space

Space Heating	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Pre-heat	5	5	5	2		5	5
Use	2	2	3	2		1	5
Pre heat			2	2			2
Use			5	4			2
Effective hours	6	6	11	7	0	5.5	10.5
kWh	420	420	770	490	0	385	735

3,220 kWh/week
96,600 kWh/year
£5,796/year for gas @ £0.06/kWh

This is an example of a frequently used church. It has pews in the nave, and doesn't have underfloor heating.

If you look in the top right you can see that I've assumed 9kW of heating in the choir for 3 hours per week, consuming 27kWh.

The heat the people option is shown as the heating on in the relevant space for the scheduled time. Adding a 15-minute pre-heat time for each space would increase energy use and costs be about 10%

The Space heating approach is 5 hours pre-heat with the boiler at full power, 70kW for this example, then running at half output for the usage period.
27 hours of use, and 33 hours warming up.

With current gas and electricity rates it would be marginally cheaper to space heat rather than heat the people.

Heat the people or the space? 15 hours/ week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8-9am		School Service					
9-10am		School Service	Morning Prayer			Organ Lesson	
10-11am			Tea				Service
11-12am							Service
12-1pm							Service
1-2pm							Tea
2-3pm							
3-4pm							
4-5pm							
5-6pm							
6-7pm				Choir Practice			Service
7-8pm			Bell Ringing Practice	Tea			Tea
8-9pm			Bell Ringing Practice				
9-10pm							

Heat the people

	Heaters (kW)	Hours/week	kWh/Week
Whole Church	69	5	345
North Aisle	12	2	24
Tower	3	2	6
Choir Stalls	9	1	9
Organist	2	1	2
Meeting Room	6	4	24

410 kWh/week
12,300 kWh/year
£3,198 / year, Electric @ £0.26/kWh

Heat the Space

Space Heating	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Pre-heat		5	5	5		5	5
Use		2	2	2		1	3
Pre heat			2				2
Use			2				2
Effective Hours	0	6	9	6	0	5.5	9.5
kWh	0	420	630	420	0	385	665

2,520 kWh/week
75,600 kWh/year
£4,536/year for gas @ £0.06/kWh

At this level of usage it is still a frequently used church.

Roughly halving the use down to 15 hours per week, and for this example the we would be using around one sixth of the amount of energy for heating, and it would save around 30% of the energy bill compared to space heating, so £3,000 to heat the people rather than £4,500 to heat the space.

For space heating around 2/3 of the energy would be consumed bring the building up to temperature.

Heat the people or the space? 4 hours/ week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8-9am							
9-10am				Morning Prayer			
10-11am				Tea			Service
11-12am							Tea
12-1pm							
1-2pm							
2-3pm							
3-4pm							
4-5pm							
5-6pm							
6-7pm							
7-8pm							
8-9pm							
9-10pm							

Heat the people

	Heaters (kW)	Hours/week	kWh/Week
Whole Church	69	1	69
North Aisle	12	1	12
Tower	3	0	0
Choir Stalls	9	0	0
Organist	2	0	0
Meeting Room	6	2	12

93 kWh/week
2,790 kWh/year
£725 / year, Electric @ £0.26/kWh

Heat the Space

Space Heating	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Pre-heat				5			5
Use				2			2
Pre heat							
Use							
Effective Hours	0	0	0	6	0	0	6
kWh	0	0	0	420	0	0	420

840 kWh/week
23,100 kWh/year
£1,386 /year for gas @ £0.06/kWh

How much energy would it use and what would it cost to run?

When heating the people for 4 hours per week the running costs would fall to around £700 a year compared to almost £1400 per year to heat the space. And use just over 10% of the energy.

In this example just 140kWh of the energy consumed would be keeping you warm, the other 700kWh was warming the space while you weren't using it.

Heat the people or the space?

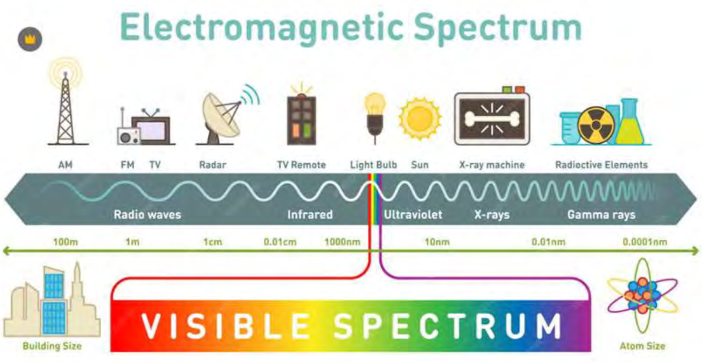
	27 Hours / week		15 Hours / week		4 Hours / week		1 Hour / week		
	Space	People	Space	People	Space	People	Space	People (Nave)	People (North Aisle)
Weekly Fuel Consumption (kWh)	3,220	755	2520	410	840	93	385	69	12
Weekly Fuel Cost	£193	£196	£151	£107	£50	£24	£23	£18	£3
Annual Fuel Cost	£5796	£5889	£4,536	£3,198	£1,512	£725	£693	£538	£94

This is a summary of the figures on the previous slides, It is just an example. Your heating may require more or less time to warm up, but it's to give you an idea of how the costs can vary. The more you use the different parts of your church, the more space heating becomes the most appropriate option.

And all of these costs exclude maintenance and servicing. Electric heating generally requires minimal servicing, if any, beyond the electrical safety inspections that you already have undertaken, and if a heater fails you can replace the heater, rather than the entire system so it can be much more resilient.

Infrared Heating – Radiant heating using electromagnetic energy to directly heat people & surfaces

Infrared (**IR)** is electromagnetic radiation (EMR) with wavelengths longer than that of visible light but shorter than microwaves.
Short Wave or Near IR – close to visible light
Far or Long wave IR – close to microwaves and used in IR thermal imaging



Infrared energy is part of the electromagnetic spectrum and sits between visible light and microwave radiation. Far long infrared heaters (IRH) work by use infrared heaters to directly heat objects and people. Because of FAR Infrared's particular wavelength, it also interacts with water and carbon dioxide molecules partially warming the air as well as people and surfaces. Consequently, Far IRH has the characteristics of both Direct and Space Heating technology.
Far infrared energy is generated by an internal heating element, typically Kanthal™, the trademark for a family of iron-chromium-aluminium (FeCrAl) alloys or Graphene (carbon) and aluminium paste printed onto thermoplastic Polyethylene terephthalate (PET) films. As the panel heats up, it emits gentle, long-wave infrared radiation that travels through the air and is absorbed by people and objects, which then re-radiate the heat back into the room.
Far IRH Panels have the appearance of anonymous 'whiteboards which can be printed or coloured to match the background wall. The panels operate at 80-90°C and are typically located high on walls or ceiling reducing the risk of contact. Kanthal IRH units are covered with a precautionary Fire & Intumescent Retardant (FIR) Coating.
Near or Shortwave InfraRed Heating (IRH) uses high-intensity, radiant heat to warm people and objects directly, similar to sunlight, Near Infrared is closer to the visible light spectrum than the appropriately named Far infrared. Unlike convection heaters

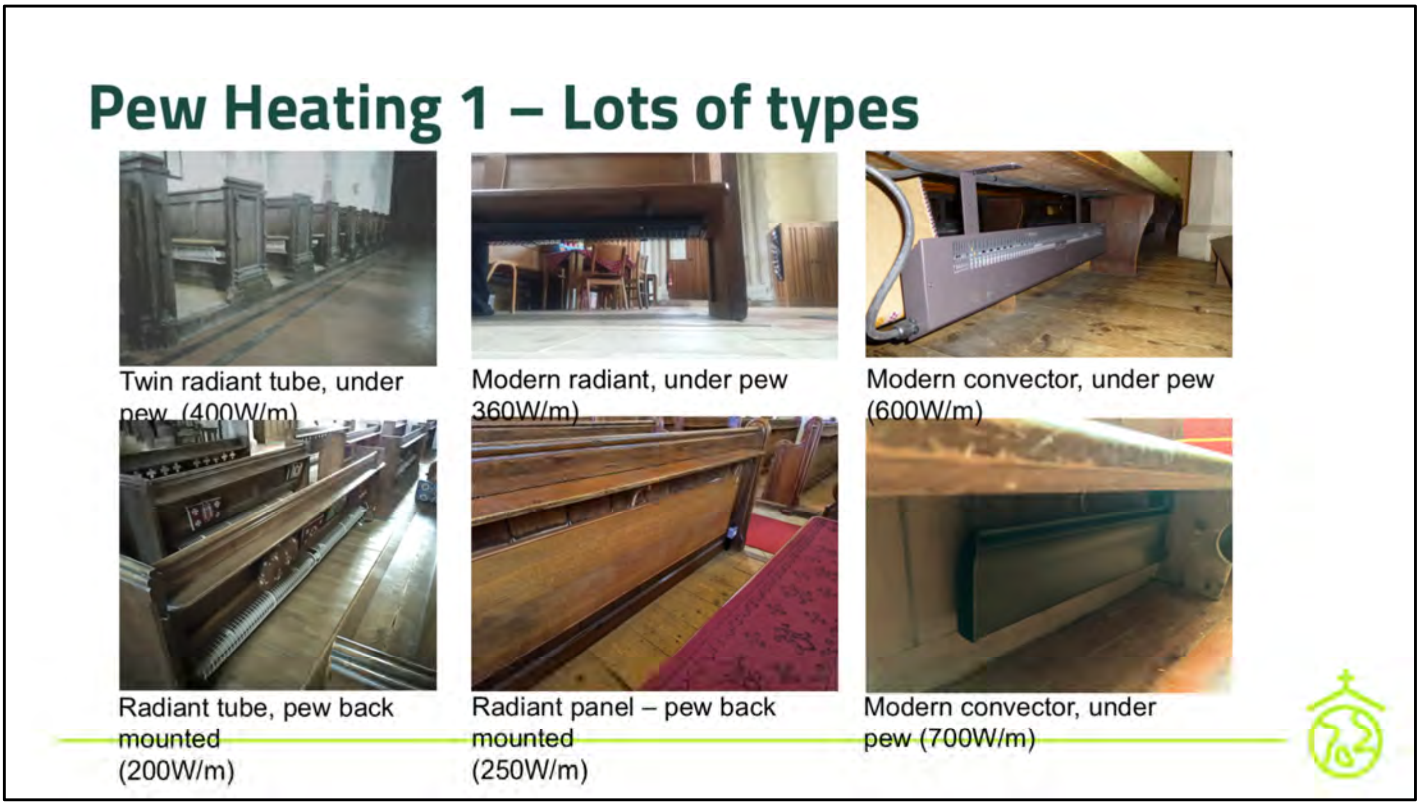
that warm the air, shortwave IR energy travels through the air and is absorbed by surfaces in its path, providing instant, effective heat even in open or breezy areas. Shortwave heaters typically feature a tungsten filament insulated inside a quartz tube with an inert gas and a small quantity of halogen, which heats to very high temperatures usually operating at 1,800 ^{o}C to 2,700^{o}C to produce the intense, short-wavelength radiation. The high temperatures are normally accompanied by a strong red or amber glow, though recent bulb coating technology involving gold and platinum can substantially reduce the impact of this glow.

Infrared Heating (IRH) – heater types

- **Infrared** (**IR)** generates IR heat by using electrical resistance in heating elements
- Near/S hort Wave IRH – Heats comes from Quartz bulbs with Nichrome or Tungsten elements or
- Far/Long Wave IRH – Kanthal® Iron/Aluminium/Chrome Alloy panels
- Electrically powered heat transmitters are attached to walls, ceilings or chandeliers at carefully set distances to project heat towards the congregation, often aided by parabolic reflectors
- -

Infrared Heating – Pros and Cons

Pros (positive	Cons (negatives)
Highly reactive providing instant targeted warmth with very quick heat-up times	Cannot project heat around obstructions. Little residual warmth effect, once IRH is switched off.
High energy efficiency near 100% and ability to zone heat minimising heating wastage.	May require upgrading of your electricity supply to meet the increased electrical load.
Health benefits around minimising the circulation of allergens.	Safety concerns around heater surfaces with high touch temperatures.
No moving parts leads to low maintenance costs, apart from replacing Near IRH bulbs/elements.	High initial capital cost and separate water heating technology required.
Silent inobstrusive heating , with Far IRH panels able to mimic church materials or paintigs.	Hear IRH bulbs produce a red glow that does not always secure public approval.



There are lots of different types of pew heating, and they can work in a variety of ways. One thing they have in common is that they only heat the area with pews in. You may need to add additional heaters for areas such as the chancel, or the tea area.
Not all pew heaters are created equal, and they have different outputs, and because they are working in different ways they also need different pre-heat periods, and they may make your church feel different.
Radiant tubes can be mounted in a variety of positions, and I have seen up to 3 mounted next to each other. The more you have, the greater the potential warmth, but the higher the running costs.
You need enough radiant tubes to be effective. One is not enough.
The radiant pew heaters need to be run for long enough to warm their surroundings, and the warm-up time will differ depending on the materials in your church, particularly the floor, and the quantity and output of each heater. A wooden or carpeted floor is likely to be faster to warm up than a stone floor.

A couple of example convective pew heaters are on the right. These can provide noticeable output in less than 5 minutes.
Convective pew heaters can provide a fairly instant warmth in around 5 minutes, but comfort can be improved by giving them a longer warm-up period, especially on colder days. This enables the pews to absorb some of the warmth, which then re-radiates to the surroundings. So while these types of pew heated don't need much of

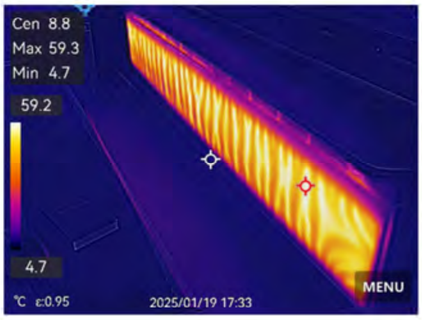
a warm-up period to work, you can improve the comfort in the depths of winter if you have a longer warm-up.

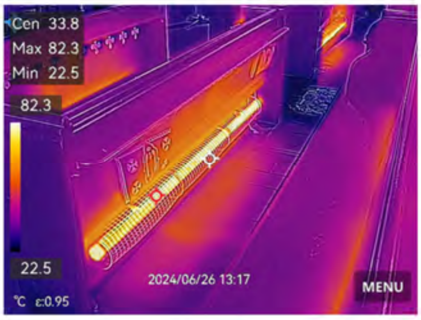
Pew Heating 2 – Poor placement

Convective pew heaters create a current of warm air, and that means where they are positioned is important. If they are not under the seat, with a way for the warm air to flow around you they won’t be very effective. This is an example where the heaters have been attached to the back panel in the kick space, which is where previously radiant tubes were mounted which saved money on installation. The warm air sticks to the pew back, warms the shelf, and escapes to the ceiling, mostly missing the congregation, which means these ones are turned on a long time before a service as they are mostly working as space heaters.

This images show how it should work. In the photo on the left you can see where I set up some black card so that I could use a thermal imaging camera to help visualise where the warm air flows, and give an indication of the temperatures you would experience. In this example the pews don't have a lower panel separating them so in the bottom left of the central image you can see a bright white area which is the casing of the heater. This is at just over 60C, much lower than the surface temperature of a radiant tube. The warm air travels up both the front and back of the pew, and you can see that the temperatures are 17-20C at knee height, and about 15C at shoulder height. I've sat above one of these pew heaters for about 3 hours, so they can be used for concerts if required. I did get cold feet after an hour or so but I also got cold feet in a church constantly heated to 17C after about 40 minutes. In the photo on the right you can see that the pew back had warmed to 16.6C, and where I had been sitting was 21.6C. This image would be different if the pews had backboards as all of the warm flow of air would have flowed around the front of the pew seat.

Pew Heating 4 – Radiant Panels & Tubes





This is an example of a radiant panel heater and a radiant tubular heater. You can see that the tubular heater has a much higher temperature, and I have seen some at above 100C, which is why there are often guards around them.

The radiant panel heater in the photo is not normally used anymore as the church has had an air-to-air heat pump since 2013.

One tube just won't be enough, 2, with enough warm-up time may be adequate, and a radiant panel on its own will struggle to provide adequate comfort.

Electrical Supply

How much do you need?

Phase	Amps	Max kWs
Single	100	24
Three	60	42
Three	80	56
Three	100	69

Need more?

- Three phase over 100A – large increase in network costs up to £6k per annum

Upgrade your supply

- Fuse upgrade lower cost
- 1 phase to 3 phase – new cables
- Higher costs, very site dependent
- UKPN will provide free quote
- Look to do own groundworks if possible

Be smarter

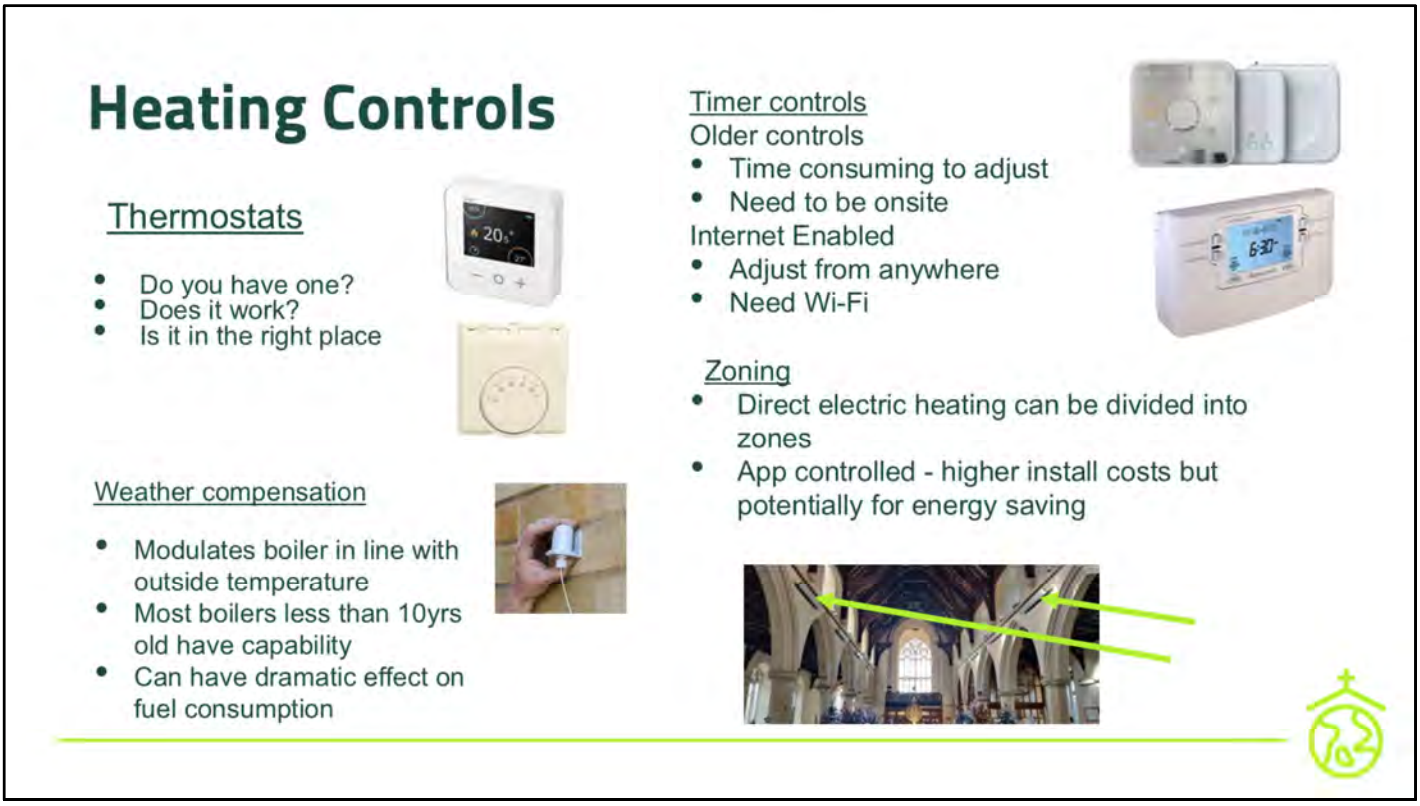
- Priority distribution boards
- Automatically switch off circuits when demand exceeds supply

Moving your heating from fossil fuel to electric places a greater load on your electrical supply so a key piece of work to do at the outset is to understand the limits of your supply, both what it is now and what it may be possible to upgrade to.
The first thing to establish is whether you have single phase or three phase electricity. This can be done by looking at the number of mains fuses you have – normally near by your meter. If you have three fuses, double check that there is a cable coming out of all of them – in rare instances churches may have a two phase supply which significantly reduces the supply potential.
Next look at the amps rating of the fuses- normally found on the side of the fuses. This will usually be either 60, 80 or 100 amps. The table top left gives a ballpark figure for how much total load (not just heating) can be supplied for the different fuse ratings. To put those numbers in a bit of context, a typical high level infrared heater is around 2 to 3kw and a typical under pew heating solution is around half a kw per meter length of pew.
100 amps per phase is the upper limit for standard single and three phase supply – higher rated three phase supplies are expensive to install and incur higher standing charges.
Upgrading your fuses to a higher amp rating can, in many instances, be done relatively inexpensively but the incoming cable may limit how big a fuse is possible. Upgrading from single phase to three phase will require a new cable to be run from the local network and a new distribution board. The costs of this are very site

specific. As you may imagine, running new cables through church yards is rarely a simple endeavour.

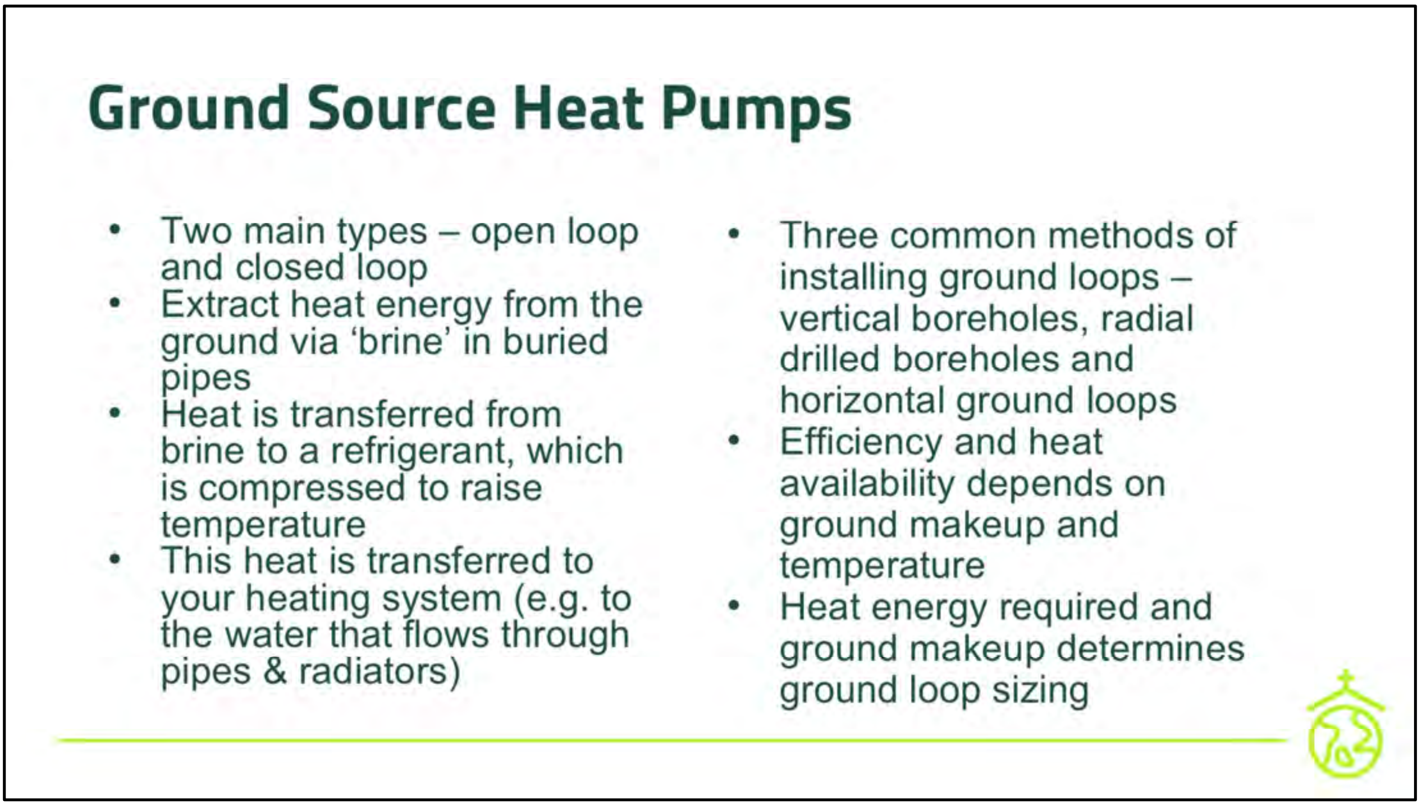
UKPN will provide a free quote but be wary of being asked to pay the full amount for local network upgrades. Doing as much of the groundworks as possible yourself is one way to save on cost so if you are lucky enough to have a farmer or builder in your congregation try to get them involved

If upgrading is not feasible and/or too expensive, another option is a priority distribution board that will temporarily disconnect a circuit if the load becomes too high. This avoids overloading the main fuses. Bear in mind that it is unusual for everything electrical to be on at full power at the same time so a building’s theoretical maximum load is rarely achieved in normal day to day operation.



Heating controls can make a huge difference to your heating bills.
Starting with the basics – having a thermostat that works, is communicating properly with the boiler, and is in the right place (not by a window or a door) is essential.
Heating timers come in many shapes and sizes and have pros and cons. The older style are fine but tend to be set up and left to run. Probably not a big problem in a less and predictably used building but can cause issues in a building that is used more and with greater variability as the heating may be coming on when not actually being used.
Internet enabled versions make it much easier to adjust the timings to suit shifting usage but require internet access which is not always possible.
Most boilers less than 10 years old can use weather compensation which will modulate the output of the boiler depending on external temperatures. This can make a considerable difference to energy consumption over a heating season
Switching your heating to infra red heating does open up the possibility of zoning your heating as Tom referred to earlier. The ability to only heating the areas of the church that are in use at any given time instead of the whole church can make a considerable difference to the energy consumption. Zoning can be achieved quite simply with manually operated switches for each heater or zone. It can also be done in a more sophisticated way using internet enabled switches controlled by an app. Inevitably, this solution comes at an extra installation cost but that cost may be seen as worth it depending of the usage patterns of your building. Typically having fewer

people in charge of when the heating is turned on and off leads to better energy hygiene.



There are two main types of ground source heat pump – open loop and closed loop. Open loops extract heat directly from groundwater by pumping it from an acquifer, while closed loop systems uses buried pipes that contain a heat carrier fluid. Closed loop systems are typically used and are the only type I am covering in this presentation – the two types are highlighted as you may come across these terms when looking at ground source heat pumps.

The basic mode of operation of a GSHP is that pipework is buried below ground which have a heat transfer fluid (usually called brine) flowing through them which absorbs heat energy from the ground. This heat is transferred via a heat exchanger to a refrigerant, which is then compressed to raise its temperature. Finally, this heat is transferred to your heating system for delivery (e.g. around the building).

There are three common methods to install pipes below ground. Vertical boreholes are simply vertical shafts with typical depths of 50m to 200m with a pipe loop within, radial drilled boreholes consist of a single borehole from which separate holes are drilled, which branch off from the central borehole, and horizontal ground loops which are trenches with loops of pipe buried at a typical depth of around 1.2m to 2.0m. Horizontal ground loops usually require more ground surface area than the other methods.

The local ground temperature, makeup, groundwater level etc. will determine the thermal conductivity of the ground, and thus the maximum power that can be extracted per unit length of borehole or horizontal ground loop. This means two buildings with identical heat requirement in two different parts of the country may need different numbers and/or depths of boreholes.

Ground Source Heat Pumps: Pros & Cons

Pros (Fors)	Cons (Against)
Generally higher efficiencies and longer lifespan than air source heat pumps	Very high capital costs
Consistent performance throughout the year (if designed correctly)	Requires groundworks that could disturb items of archaeological interest
Ground loops have a long design life (50+ years)	Initial groundwork can be disruptive and have a significant visual impact during works and in the short term
Minimal visual intrusion externally in the long term – heat exchangers concealed below ground and plant can be housed in a dedicated plant room	All groundwork has to be done within the boundaries of your own land. If encroaching on neighbouring land, express permission of landowner(s) needed with formal agreement
Correct system may be able to use existing pipework and emitters (some additional emitters may be required)	High degree of engineering complexity in design and implementation
Low noise levels as no external fan unit necessary – similar noise levels to a boiler	Refrigerants can have very high global warming potential, meaning leaks can negate savings in CO_2

I've summarised the main positives and negatives of ground source heat pumps here.

Firstly, positives – GSHPs generally have higher efficiencies and longer service life than ASHPs. Service life of 20 to 25 years typically quoted, with the ground loops themselves having an anticipated design life of 50+ years.

Because ground temperatures stay relatively stable throughout the year, it means that GSHPs generally have consistent performance and efficiency throughout the year.

They are less visually intrusive than ASHPs in the long term, with heat exchangers concealed below ground and plant able to be housed in a plant room/within the building. There is also less of an issue with noise, since plant is concealed within the building and noise levels are likely to be similar to a conventional boiler.

The correct system may be able to use the existing heat distribution of a building. GSHPs that use CO2 as a refrigerant, for example, can achieve temperatures and flow rates that may be compatible with existing radiators & pipework.

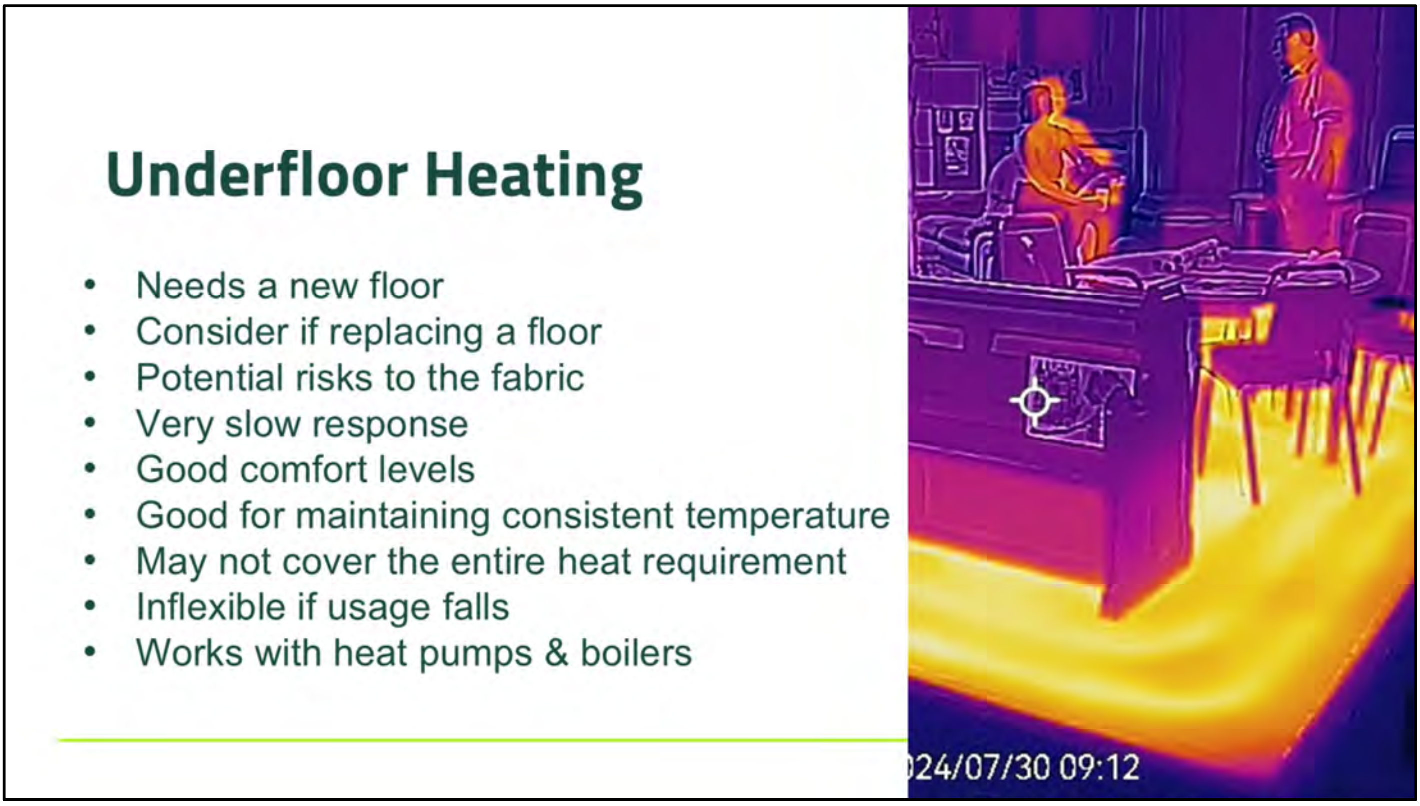
In terms of negatives, the most obvious one is that GSHPs typically have very high capital costs, which can be much higher than installing an ASHP.

A GSHP requires groundworks that could disturb items of archaeological significance, burials etc. so this must be carefully considered to minimise impact. The groundwork itself will also be disruptive and visually intrusive, and the ground may take some time to recover vegetation etc.

GSHP systems are complex, therefore good, robust design and installation are critical for the system to function well and as intended.

The refrigerants used in some GSHPs have a very high global warming impact, with a kg of some being the equivalent of hundreds or thousands of kg of CO_2. Leaks of these refrigerants can negate the carbon savings of GSHPs in some cases. Choosing a GSHP that uses a refrigerant with a low global warming potential helps to avoid this.

Hopefully shows that determining whether a GSHP is viable / the right option for a particular building requires a great deal of investigation, and will depend on building usage, land availability & makeup, capital and running costs etc. A Historic England report on GSHPs in historic buildings gives a great amount of detail on how well GSHPs have performed in several different contexts and is worth reading if considering a GSHP as a potential heating option.



Underfloor heating is available as both electric and water based. I am going to focus on water-based solutions. I will start by saying that if you're considering replacing the floor of your church then I would definitely give serious consideration to both including insulation and an underfloor heating loop. Insulation will help the users of your building feel warmer as it will slow down the rate of heat loss from their feet to the floor, so it will take longer for them to get cold feet. An underfloor heating loop, even if you have no plans to use it now will open up options for future generations as none of us know how the use of our churches will change over time.

Having said that, a new floor may change the way you building works, particularly how moisture moves around the different parts of the fabric and this brings risks with it, more so if the floor is heated, so engage with your professional advisor or architect early so that any risks can be identified and mitigated.

Wet underfloor heating is a slow response heating system – it takes a long time, and a lot of energy, to warm up as you are warming all of the water in the heating system, the concrete and screed the pipes are in, and the floor covering. This means that underfloor heating can be very good at maintaining a constant level of warmth, which is most appropriate if your building is either used a lot, or has a conservation heating requirement where you are trying to maintain a constant background temperature or humidity.

Underfloor heating can provide for a comfortable environment as there is a massive radiant surface which is warming the air above it, and also reduces the heat lost through people's feet. It is generally designed with a low water temperature. It may not be able to meet the entire heating needs of the space.

To have underfloor heating as your only heat emitter you will be looking to maintain a fairly constant temperature in the building throughout the heating season. This means your energy consumption will be pretty much fixed as you will not be able to rapidly heat your building if you wish to. This also means that if you have a historic church it will be subject to a very different environment to most of its life, unless you have been maintaining a fairly constant temperature with your existing heating system.

UFH is well suited to heat pumps but can be run off gas or oil boilers.

If you don't want, or can't afford, maintain a nice steady 17C in your church then you will need to consider additional heat emitters. These could run off the same heat source if you installed fan convectors or radiators, or you could consider supplementing the UFH with something like infrared heating to provide a boost. You need to make sure you have appropriate controls including a floor temperature sensor and thermostat or humidistat, and weather compensation would work well.

Underfloor Heating Pros and Cons

Pros (Fors)	Cons (Against)
Maintains a stable environment in the church	Very slow response to heat demand
Cheap to install if you're replacing the floor anyway.	Expensive to install as a standalone project
Air temperatures can be lower with the same comfort level, reducing energy use	Inflexible to reductions in use of the space (your energy use will not reduce much)
Capable of providing good comfort levels	May not be able to heat the entire space
Works well/efficiently with heat pumps (and condensing boilers)	May require additional heat emitters / sources
	Damage takes a long time to show
	Leaks are difficult to find, and costly to rectify
	Disruptive to install

We would definitely recommend speaking to your heating advisor and professional advisor for their opinion on the benefits and risks for your church.

Eco Church and heating

- Buildings and Energy survey
- Actions to reduce energy consumption
  - Building maintenance, pipe insulation, draught proofing...
- Renewable energy tariff
- Your heating system
  - Decarbonisation plans, efficiency measures

GRANTS

Church heating comes up in the Buildings and Energy Survey of Eco Church. So what do they ask?

The survey initially has around five questions about the actions you may have taken to reduce energy consumption in your church buildings, such as whether you carry out regular roof and gutter maintenance, have you insulated heating pipes, done draught proofing, roof insulation, double or secondary glazing.

It also asks about reducing the impact of your energy consumption – so whether you have a renewable energy tariff.

It then asks some questions about your heating system – whether you have plans to decarbonise your heating or to reduce your need for space heating, the rating of your current boiler, whether you have heating controls, and whether you have a heat pump or electric boiler...

You don't need to answer 'yes' to every question, but your answer will feed into your score and as you progress through the Bronze, Silver and Gold awards, you'll need to answer 'yes' to more questions to score the points you need for each award...
You may not have begun your Eco Church journey yet and you could be thinking it isn't relevant to you, BUT, when you're looking at how to fund your heating project, bear in mind that many grants now expect organisations to be able to demonstrate

their engagement with good environmental and net zero practices, including the National Lottery Heritage Fund. So I would recommend, if you haven't already, that you take a look.

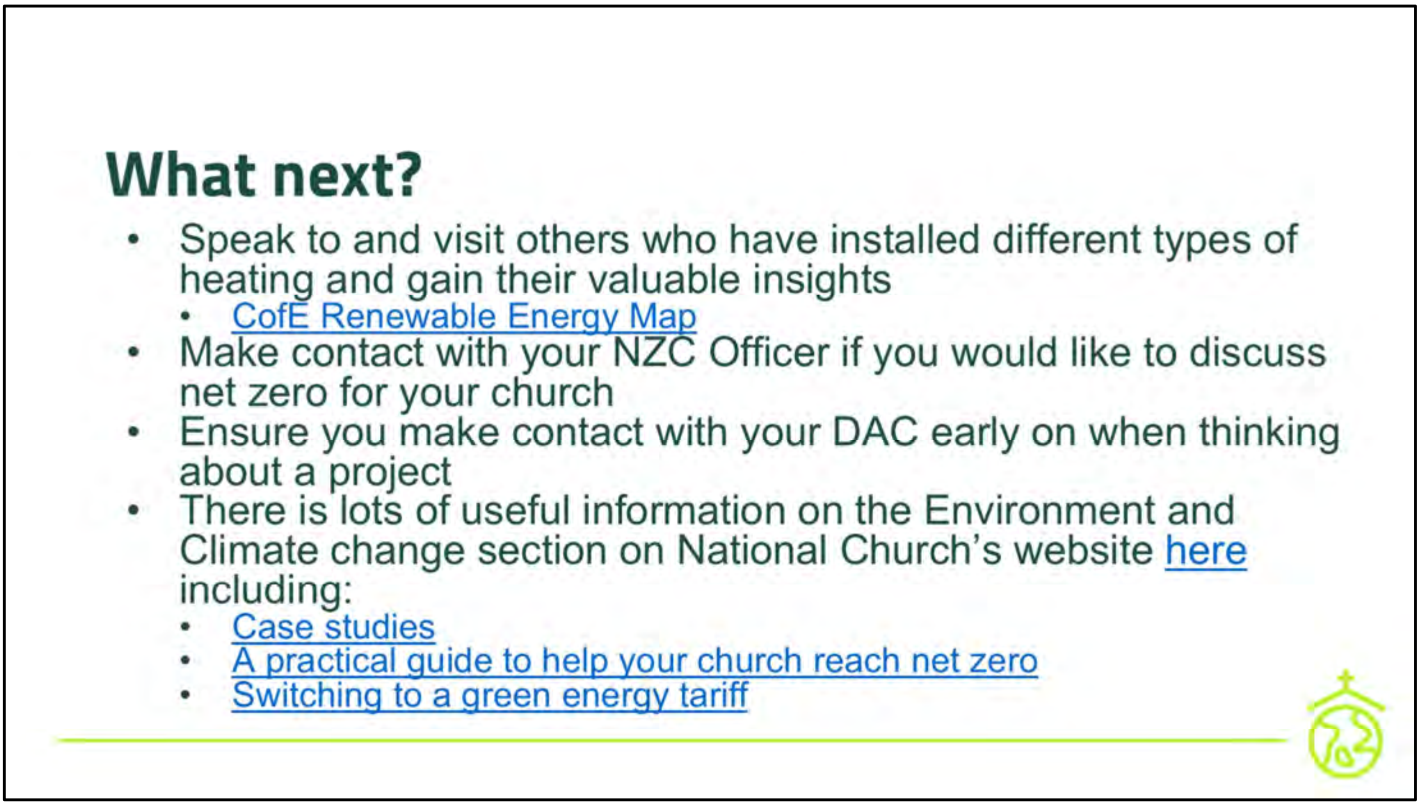
Funding

- Grants from National Church
  - Energy Footprint Tool
  - Registered with Eco Church
- External grants – National Lottery Heritage Fund to smaller local grant funds
- Cornerstone Grants Database
  - Over 650 grants which can be filtered by purpose
  - Free for all churches to use
  - Contact your Diocesan Giving Advisor for details on how to access the platform

One of the key questions that I expect you will be wanting to ask is where can I access funding to help fund our church heating project?

National Church has a number of grants to help churches with net zero projects. To access these grants the completion of the energy footprint tool and being registered with Eco Church are prerequisites so if you have not completed your EFT or registered with Eco Church these are two steps you can take. We are now coming to the end of the Church's Triennia (3-year funding period) and the grant support which will be available for churches from 2026-2028 is now being finalised. A few of the existing grants from this Triennia are still open so if you have a project please do speak to your NZC Officer to see if support is available.

Outside of National Church there are various grants that can be applied for from large grant funds such as the National lottery heritage Fund down to smaller localised grants. To help you access these grants the National Giving Team has developed Cornerstone a free online generosity tool, which includes a grants database with over 650 grants that you can access for all types of support. It is a searchable, filterable database which is updated weekly and has the biggest range of grants currently available to churches. Each grant is described and there is a link to the grant making body so you can read further and apply. If you don't have access already to Cornerstone please contact your Diocesan Giving Advisor for details on how to access the platform.



So, what next
It is really good to understand the technologies that you may be thinking of installing. One of the best ways to do this is to speak to and visit others who have already done so to gain their valuable insights and hints and tips.

The Church of England has a map of churches which have renewable energy installed including heat pumps.

If you have an idea and would like to discuss net zero I would encourage you to make contact with your diocesan NZC Officer.
When starting a project please do ensure that you make contact with your DAC from the beginning for their advice as this will be valuable for your project's development.

In terms of supporting information there is a wealth of information on National Church's website including lots of case studies, guides on how to help your church reach net zero along with practical church heating checklists and information on switching to a green energy tariff.

Net Zero Carbon 2030

Thank You

The Church of England in Essex and East London Diocese of Chelmsford

The Church of England Diocese of Ely

The Church of England Diocese of Norwich

Diocese of St Albans

The Church of England Suffolk