CHURCH HEATING APPROACHES

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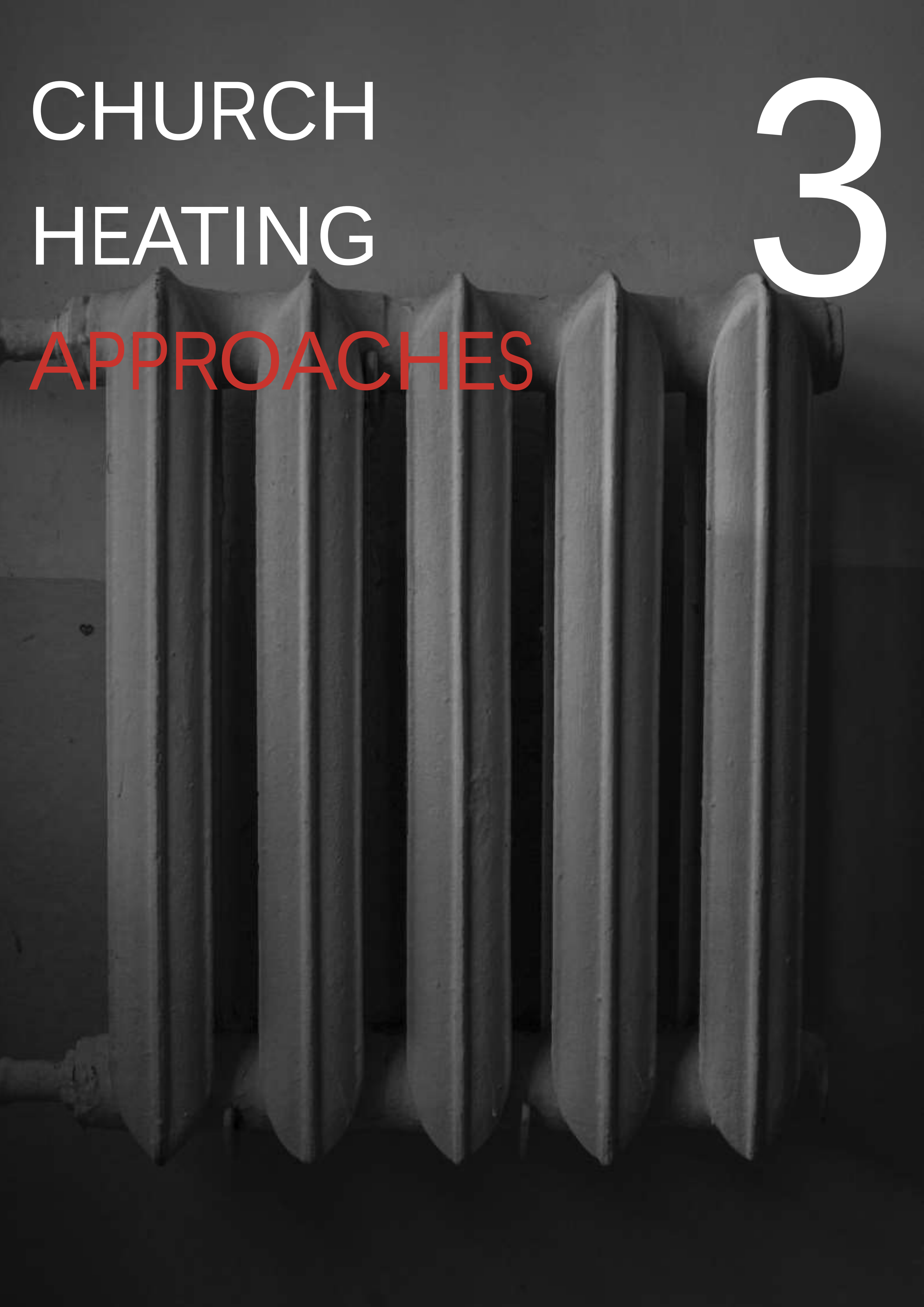

CHURCH HEATING

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APPROACHES

3a First thoughts

There are a wide range of approaches to heating, right through from space heating the whole church to no heating at all. They combine different objectives, different heat sources (such as oil, gas, and electricity) and different heat emitters (such as radiators, panels, and underfloor heating).

Each combination has different pros and cons, and will be suitable in different circumstances. There is no 'one-size-fits-all'. Before choosing a new system it is vital to think through the possibilities, using an options appraisal (see Section 7).

Before making your decision, tackling *heat loss* and making your *existing* system as efficient as possible will help cut your energy use. See other guidance on this: on Energy Efficiency and the Net Zero Carbon Church.

This short overview sets out the main heating approaches a church can consider. Where possible, it links to case studies. We are continuing to update these, so please do keep checking back to our website.

3b Different approaches

Space heating

- Approach:
  - ◊ Aims to warm the air of the church, so that the whole space is warm
  - ◊ Can be either gas, oil, or electric, and can use radiators, fan convectors, trench heaters, or underfloor heating. Most commonly, a gas- or oil-fired boiler drives a wet radiator system. Underfloor heating can be fed by boilers or heat-pumps, or occasionally can be electric.
  - ◊ For an intensively used church running the heating for enough hours, everything eventually reaches the same temperature. A church in frequent daily use, every day of the week, can be maintained at a comfortable temperature where heat input equals heat loss.
- Pros: simple and well-understood technology, relatively inexpensive to maintain. People can move around within the space and remain warm.
- Cons: often very inefficient (and therefore expensive to run) because the warm air rises and so heating has to run for many hours; a particular problem with warm air systems, and with 'wet' radiator systems and fan convector heating. Many churches utilise their space heating irregularly, with long heat up times in winter (up to 8-12 hours for an undersized system). High greenhouse gas emissions, due to inefficiency. Can damage fabric through cycles of warming and cooling, including through condensation etc.
- Note: Underfloor heating can be a relatively efficient form of space heating for well-used buildings, since the heat is delivered closer to the people, with less heat wasted at high level, but it requires lifting the floor. Underfloor heating combined with air or ground source heat pumps can be even more efficient.
- Case Study: St Mary the Virgin, Willesborough underfloor space heating

Background / Setback Heating

- Approach:
  - ◊ This is a form of space heating, simply with different controls; it aims to warm the air of the church, so that the whole space is warm, but in a smoother way. Background heating maintains a church at a minimum temperature (10-12ºC) at all times and then boosts it when required.
  - ◊ This retains some heat in the large thermal mass of a stone church. It may be useful, for example, if the church receives a lot of visitors during the week, so it is comfortable to walk around wearing a coat.
  - ◊ It is compatible with underfloor heating and/or heat pumps, both of which work relatively efficiently when delivering constant, low grade heat from warm water (rather than hot water supplied by a boiler).
  - ◊ The 'boost" can be provided by a traditional wet central heating or by under pew / overhead radiant systems.
- Pros: uses the thermal mass of the church to our advantage; avoids the significant energy demands of heating the church from a very low temperature in winter. For a regularly used church, costs are comparable to conventional space heating, and there can be operational benefits because the building is usable more quickly.
- Cons: the cost and energy used to maintain the background temperature for long periods when the church is not occupied. As for space heating, there is wasted energy, because you are heating air that rises. Unless there is a compelling fabric preservation driver, background heating should not be used in a church only used once or twice a week; the rest of the time, heat is being wasted.

'People Heating'

- Approach:
  - ◊ Aims to keep people comfortable, where they are.
  - ◊ Heating is installed near to where the people sit, which may include under pew, portable, and/or overhead far-infra-red radiant heating panels.
  - ◊ Heating is typically zoned so that all of it does not have to be switched on at once - this allows for different occupancy patterns and different seasons and weather. Separate rooms (e.g. meeting rooms, side chapels, vestries, tower rooms, etc) are heated separately.
- Pros: energy efficient and therefore (potentially) inexpensive to run, due to much shorter warm up times and heat directed where it is needed. With radiant heating, surfaces are warmed not air, so heat does not rise. A 'people heating' approach is easier to combine with electric heating and 'green' electricity, radically cutting green-house gas emissions.
- Cons: Currently, electricity is more expensive per unit than gas, so the new system needs to be much more efficient, or operating costs will rise. (However, see the pros: if well-designed, it *will* be much more efficient.) In a poorly designed system, if people move away from the heated areas they will be cold (for example, children running around). Electric heating requires the church to have a sufficient and reliable electricity supply.
- Case Study: St Mary's Chalgrove, Electric Heating System.

Conservation Heating

- Approach:
  - ◊ Aims at preserving historic interiors susceptible to damage through environmental changes. This is similar to background heating, but controlled by a humidistat, keeping the humidity within a defined range to prevent condensation and damaging swings in relative humidity.
  - ◊ Historic buildings housing vulnerable collections such as National Trust properties are often heated this way, but their occupancy is very different from a typical church - visitors will be walking through, usually with their coats on if it is winter.
  - ◊ Heating can be programmed for comfort heating when needed, e.g. with boosts for services, which provides some flexibility.
- Pros: can help to preserve historic interiors
- Cons:
  - ◊ As for background heating, there is considerable energy usage, and it doesn't work well in large spaces.
  - ◊ On cold, dry winter days, conservation heating will not kick in, and so to get to a comfortable temperature for church users you would need to override the conservation heating, and expend a lot of energy warming the building from a low level.

Frost prevention

- Approach: A heating system aiming to prevent water freezing in the pipes and frost damage within the building, which is set to come on (normally) when the thermostat reaches (say) 5 or 7oC.
- Pros: prevents the frost damage, low cost to run.
- Cons: building is not warm and welcoming in winter.
- Note: Frost prevention can be combined with another heating approach.

'Winter church'

- Approach: Aiming to create a space within the church which can be kept warm enough to use during winter, without needing to warm the whole space. This can be a chapel, aisle, or transept. The space is partitioned off in some way, and heated, whilst the rest of the space is left unheated or on frost prevention.
- Pros: reduces energy usage and costs, by creating a smaller, usable space. Can allow churches to be used all year, which might otherwise be unusable in winter.
- Cons: if there are historic interiors in the zones left unheated, then they may deteriorate. There is reduced usage of the main church space during winter.

No heating

- Approach: Some churches, particularly in isolated rural locations, have no functioning heating, and generally very little winter use. Some, generally medieval churches, were designed without heating. In these churches, the use of 'soft" changes such as blankets and door curtains, and reducing draughts, may increase comfort somewhat. (Door curtains need to be in fire-proof materials, and should not obscure fire doors.)
- Pros: no energy use, no cost.
- Cons: not warm and welcoming, risk of deterioration to historic interiors. Potentially unusable in winter.

3c Different energy sources

Oil

The 'dirtiest' of fuels, both in terms of the carbon dioxide emissions and air pollution. Moving away from oil is a real priority if we are to work towards net zero carbon by 2030. However, the way to do this can be difficult. There are different types of oil:

- 28-second kerosene ('burning oil'), which burns much more cleanly.
- 35-second 'red diesel' ('heating oil'), which has more heating power per unit volume, but is more expensive.
- 'Biodiesel' is starting to become available, which reduces emissions considerably, if the source is local. Biodiesel is created either from plant oil, such as rapeseed, or from animal fats. These can be waste products or from specifically grown crops. Biodiesel blends can be used as a heating oil.
- Case Study: St Andrew's Chedworth switching from oil to electric heating

Gas

This is the standard fuel that most churches use, and is 'cleaner' than oil, but still a fossil fuel and therefore contributing to global heating and the climate crisis. There are two types of gas, using different boilers:

- Mains gas is (mostly) methane (CH4)
- LPG is usually propane (C3H8).
- Bio-methane or 'green gas" is now available and is blended with fossil fuel derived natural gas, to reduce the fossil fuel content. Bio-methane is created from anaerobic digestion of waste. A note of caution; some providers say they offer green gas, but actually they are simply paying to offset standard gas.
- Hydrogen (see below) can also be blended with natural gas (up to 20%) without any changes needed to pipelines or equipment, which will also be beneficial in carbon terms.

Looking ahead, the 'Zero Carbon Britain' report suggests that part of the future of heat is synthetically created methane, created from water and CO_2, using 'spare' 100% renewable electricity when electricity supply to the grid is greater than demand.

Electricity

- Standard, grid electricity: Gradually becoming a cleaner energy source as oil and coal fired power stations are making up less of the mix in our grid electricity, and renewables are growing. However, switching to renewables (below) is one of the easiest steps a church can take to cut its carbon footprint.
- **'Green'** electricity purchased from renewable sources : Moving to purchasing 100% renewable electricity combined with electric heating is one of the most effective things a church can do to cut its net carbon footprint.
- Electricity generated onsite through solar PV : Some churches are suitable for installing solar panels on-site. Combined with electric heating, this cuts somewhat the net and gross carbon footprint of the church. However, use needs to be matched to generation: the financial benefit of the panels to the church comes from having free daytime electricity, so they are generally best for churches with a high and regular daytime usage.
- Other renewables such as wind turbines or small-scale hydro can also sometimes be used to generate electricity on site.
- Note: On site energy generation from solar, wind and hydro can be combined with battery storage, so that the electricity is 'time shifted" from the time in the day it is generated to the time it is needed. However, batteries are still relatively expensive, and until costs drop further a good business case can rarely be made.

Biomass

Biomass works by burning wood pellets or logs in a boiler, to heat hot water which then circulates around radiators as it would from any other type of boiler. There is quite a lot of concern around wood burning and the potential air quality impacts; there will some areas where this technology will not be allowed by the Clean Air Act.

If biomass is being considered you need to ensure that the fuel source and delivery is zero carbon (for example, a waste product from a local saw mill) and the replenishment of the harvested source needs to be known. Biomass has a role to play mainly with rural churches which want to move away from oil and which do not have a connection to the gas grid or three phase electricity.

Heat pumps

Heat pumps act like a fridge in reverse, taking heat from the outside the building and using a heat exchanger and a pump to move the heat inside the building. They are – in effect – an efficient, low-carbon form of electric heating.

Heat pumps are generally air-source or ground-source, occasionally water-source. They can attach to radiators or underfloor heating, or (less efficiently) simply heat the air like an air conditioner in reverse.

They produce warm water at a lower temperature than a conventional boiler, and so are best for regularly used budlings which need steady heat. With a very draughty buildings, with high heat loss, they may not be sufficient.

'Hybrid boilers' are coming on to the market which combine a gas boiler with an air source heat pump; the heat pump is sufficient on most days of the year, with the gas boiler acting as a back up on cold winter days.

Case Study: St Mary the Virgin Ashford, Ground source heat pump

Right: Air Source Heat Pump

Hydrogen

Hydrogen is a potential fuel of the future, and is currently being studied as a low carbon approach to heating. (See section 4 on 'the future of heat'.)

There are different options here; hydrogen can either be created by extracting it from methane or natural gas (a process which creates CO_2, and therefore requires carbon capture), or it can be created by splitting water into hydrogen and oxygen. The hydrogen can either be used in a specific building by using a fuel cell to create heat and electricity or there could be a nation-wide programme to switch the gas grid over to hydrogen and converting boilers.

In preparation for the latter possibility, it is now possible to buy 'hydrogen-ready' boilers which are simple to convert.

Coal/coke

Decreasingly common.

Solar thermal

Unlike solar PV panels (mentioned earlier) which generate electricity from sunshine, solar thermal panels generate hot water from sunshine. They can be used to supply hot water to a church or to run underfloor heating.

However, it is very rare than this is effective in a church setting, since the panels rarely produce enough output, and because the heating is needed throughout winter when it is the least sunny.

Few churches need a high output of hot water, and point-of-use electric water heaters are generally recommended.

3d Different heat emitters

There are a wide range of heat emitters, which release the heat into the church.

Churches can use conventional 'wet' radiators, electric radiators, trench heaters, pew heaters, panel heaters (including modern far-infra-red radiant panel heaters), portable heaters, chandelier heaters, underfloor heating (either electric or 'wet'), air blowers, and 'curtain heaters' over doors.

The variety of heating approaches, energy sources and heat emitters points to why churches need to seek good advice, early on, in any heating project.

Many churches use a *combination* of these emitters, sometimes powered by different energy sources, to get the heat solution they need.

For example:

- a church might use electric pew heaters for its normal Sunday services, when numbers are lower, but keep the gas boiler and radiators for the larger Christmas services, weddings and funerals.
- a church could use far-infra-red radiant panel heaters in specific areas of the church when they are needed for choir practice, prayer group, or a PCC meeting, and then run the main church heating only on a Sunday.

A system can be updated by changing the energy source without the expense of changing all the emitters. For example, a gas or oil boiler could, in the future, be changed for an electric boiler or a hydrogen boiler and use the same radiators.

Energy source / emitter	Oil boiler	Gas boiler	Electricity	Heat pumps	Biomass boiler
'Wet' radiators (water filled)	✓	✓	* Can be converted or run from electric boiler	✓ but at a lower temperature	✓
Oil filled electric radiators			✓		
Electric radiators			✓		
Trench heaters	✓	✓	✓	✓	✓
Pew heater	✓ 'wet'	✓ 'wet'	✓ electric	✓ 'wet'	✓ 'wet'
Panel heaters	✓ 'wet'	✓ 'wet'	✓ electric	✓ 'wet'	✓ 'wet'
Portable heaters			✓		
Chandelier heaters					
Underfloor heating	✓ 'wet'	✓ 'wet'	✓ electric	✓ wet'	✓ 'wet'
Air blowers (including curtain heaters)	✓	✓	✓	✓ 'air to air'	✓

Above: There is a wide variety of energy sources and heat emitters available. Many churches use a combination.

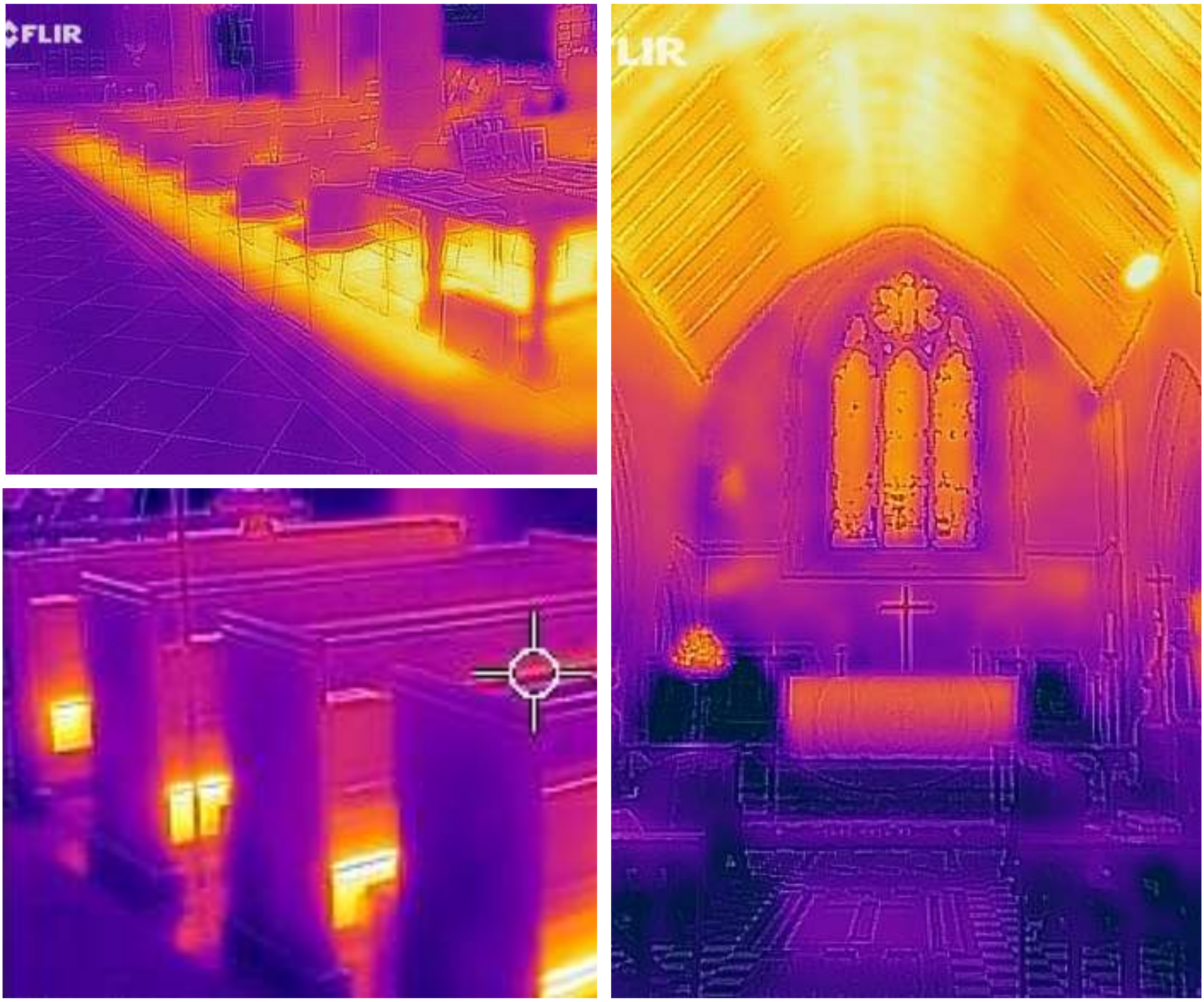
3e Different approaches achieve different outcomes

As we saw in Section 1, these different heating approaches, combined with the different heat sources and different emitters, achieve different outcomes.

(See the diagram in Section 1 for more detail)

Each church will need to consider what they want to achieve, based on their own circumstances, having taken good advice.

The next sections help you look forward and consider the Future of Heat (Section 4) and then assess your current start point with a Heating Checklist (Section 5).



Above: Thermal imaging photographs can help illustrate how different heating approaches achieve different outcomes. Underfloor heating (top left) and pew heating (bottom left) direct heat where it is needed most. Underfloor heating is a major intervention and more suitable for churches in regular use. Pew heating is lower in cost and more responsive; it is typically suitable for churches used for only a few hours per week. The photo on the right shows one of the disadvantages of space heating. Hot air rises, so the heating system must be run for a long time until all the space warms and the church users can benefit. This uses energy and increases the carbon fooprint. Space heating is more suitable for regularly used churches.