FIXED ELECTRIC RADIANT HEATING FOR CHURCHES
25TH OCTOBER 2015

The following information sheet discusses some points concerning the fixed electric radiant heating of churches. This arises from work by the Sustainability Field Worker for the Anglican Diocese of Auckland in the sustainability assessment of Diocese churches from 2012 to 2015.

GENERAL BACKGROUND

Sustainability for the Anglican Church involves the wise and just use of resources under the "Care of Creation" and "Social Justice" areas of mission. Radiant heating traditionally has not been seen as a particularly sustainable option. However, as the proportion of New Zealand's electricity supply draws increasingly from renewable supplies, electric radiant heating can be viewed as an appropriate option, particularly for churches.

In 2014 New Zealand's electricity supply was made up of 80% renewable generation and the government has set a target of 90% renewable component by 2025. Nevertheless "renewable" does not mean "inexhaustible" as renewable resources rely upon a rate of repletion, as all good fishermen know. In a world of high demand and global climate change we are still required to be good stewards of the resources entrusted to us.

(Ministry of Business Innovation and Employment, Energy in New Zealand 2015 and NZ Energy Strategy 2011-2021)

Mahinerangi Wind Farm by Samuel Mann

There are three broad categories of church that have so far been looked at. The first covers historic, timber churches constructed in the mid to late 1800's and runs through to brick churches constructed in the early 1900's. These all have no insulation.

The second is more modern 1950's to 1970's construction, often concrete block or timber with no insulation.

The last is recent construction from the 1990's to present day, which include some insulation in the walls and ceilings and possibly under the floor. These are often renovations or additions.

The qualities inherent in the building structure can influence the suitability of different types of heating

Radiant heaters

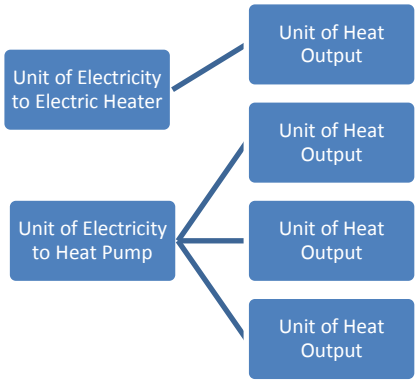
Radiant heaters emit electromagnetic radiation in the Infrared spectrum. Visible light is also a part of this spectrum. This type of radiation (similar to the Sun's) heats the objects and people it falls upon, but does not heat air in a space. There are different types of radiant heaters. The orange glowing bar type heater is an example of a radiant heater that operates in the middle of the infrared spectrum. Heaters that operate in the far infrared part of the spectrum do not glow in operation, nevertheless they still emit radiation that heats objects.

Convector heaters

Convector heaters by contrast operate by raising the temperature of the air in a space. Heat Pumps are an example of a convector heater. Some convector heaters use radiant heat initially to heat fins. Air passing over these fins is then heated and distributed either naturally by warm air rising, or assisted by fans. An example of this is a night store heater. In the case of an oil column heater there is also some radiant heat coming from the appliance along with the convected warm air from the fins.

The relative merits of different types of heaters

All Radiant heaters operate by producing approximately 1 unit of heat output to every unit of electricity input. In other words they are close to 100 % efficient. For this reason Radiant heating is considered to be expensive as compared with say Heat Pumps which can be 300% or higher in efficiency. For every unit of electricity into a Heat Pump you can get 3 or more units of heat output.



However, the search for more efficient and cost effective heating must take into account the nature of the space being heated. For churches this often involves high ceilings and a large volume of air in the space being heated. Most older churches have no wall, ceiling or floor insulation and are very draughty. Therefore heat is lost rapidly through the building envelope. Adding large areas of insulation to older buildings can be expensive and is best undertaken in conjunction with a renovation, such as earthquake strengthening or alteration to the layout or fabric of the building. If the building is old then heritage factors also need to be considered.

For these reasons Radiant heat is very suitable for churches because it heats people even while the air temperature remains colder. There is no attempt to heat the large volume of air. However, once objects and people have been heated, air passing over the surfaces will in turn become heated. As this warm air rises, the heat is mostly lost if the building is uninsulated.

With regard to old timber churches Far infrared heating is recommended by heritage architects as it does not “shock” the building with temperature changes that can occur with medium wave radiant heaters. In an old and dusty environment there is also less fire risk from the lower temperature Far infrared heaters. The casings of the heaters can be painted to aesthetically fit in with the building. For Heat Pumps it can be difficult to hide the exterior units and piping required when installing them in a historic building.

Radiant heater efficiency varies with the design of the heater’s insulation and reflector cone which affect its ability to direct heat to where it is needed. Older radiant heaters are inefficient by modern standards. Radiant heating obeys the “inverse square law” which means that the intensity of the heat radiation felt reduces the further you are from the source of the heat. Therefore in a high ceiling situation heaters may need to be mounted at an intermediate height for them to be effective.

The following is a list of the benefits of Radiant heaters as compared to Convector heaters.

- Radiant heaters come at a comparatively low cost to install
- Comfort is felt almost immediately and comparatively little preheating is required
- There is little or no noise associated with Radiant heaters
- They are suitable for high stud situations and uninsulated buildings
- They have little or no ongoing maintenance costs
- They do have comparatively high running costs so are suitable for intermittent use situations rather than all day operation

Heat Pumps are appropriate for some locations such as small modern churches, offices and day care facilities with lower ceilings, and also for home heating. Their high efficiency output compensates for the relatively high cost to install and maintain the heaters provided they are operated for a long number of hours per day. Another factor in favour of Heat Pumps is that they are less of a load on electricity mains cables and switchboards. In the case of older switchboards this can mean the difference between having to upgrade or not.

Other factors

Ventilation of the space to be heated influences the effectiveness of the heating. For Radiant heating this means reducing cold draughts from doors and windows. For Convector heating in high stud situations the installation of ceiling sweep fans can improve the efficiency of the heating by stopping the heat from accumulating at ceiling level. Fans are also a low cost way to cool the space in summer. Reverse-cycle Heat Pumps have the ability to dehumidify spaces as well as cool them. However using Heat Pumps to cool a space in summer reduces savings made on winter heating.

Lifespan of the heater is another factor to consider when making a heating purchase. Suppliers can be reluctant to provide this information but a rough guide is ten to fifteen years for a Heat Pump in a commercial situation. Radiant heaters, from the experience of churches so far assessed, tend to have a longer lifespan.

Annual maintenance costs need to be factored in to any price comparisons. Heat Pumps for instance require regular servicing over their lifetime.

A flexible switching plan, that allows heating to come on in small groups rather than all at once, is a key point for savings. The use of modern thermostats and electronic controls that reduce the heat output, occupancy sensors and on /off timer functions further enhance savings in use. These economies should not be underestimated as even a small amount of electricity saved over a long number of years adds up.

Gas fired radiant and convector heaters

Gas fired Radiant and Convector heaters are available which also have pros and cons associated with them. In 2013 the Auckland Synod voted for the Anglican Diocese of Auckland to divest funds from companies whose main business is the extraction or production of fossil fuels. This significant call has come in order to mitigate the future burning of fossil fuels and their contribution to the increase of greenhouse gases in the atmosphere and global warming. Installing new gas fired heating would be inconsistent with this mandate.

If you already have gas fired heating some of the pros and cons are as follows. Historically in New Zealand the emission factors for converting kilowatt hours to carbon dioxide equivalent units (a greenhouse gas measurement) have only been slightly poorer for gas than for purchased electricity. As the proportion of renewable electricity grows however, this gap will widen. Gas fired radiant heating provides a good output of heat relative to the size of both its appliances and cost to install. At present Natural gas is less expensive than electricity, but prices may rise if predicted constraints in supply occur from the mid 2020's. As for Heat Pumps, gas can provide relief for an overloaded switchboard. These heaters exhibit a warm glow similar to medium wave electric radiant heaters which is comforting for people. However, unless the heaters are flued, they release toxins and water vapour into the heated space as a by-product of combustion. This must then be expelled through adequate ventilation. For this reason the use of portable, unflued gas heaters is not recommended.

Other types of radiant heaters not discussed in this paper

Low pressure infloor hot water radiators eg. in a concrete floor. This applies to new churches. The hot water could be heated by electricity, gas, heat pumps or solar energy.
Low pressure hot water radiators. These are often seen in schools. They are a very effective form of heating as they produce 60% convective and 40% radiant heat.
Electric wired floor or ceiling heaters.

These alternatives are more suited to spaces that are used for long periods of time and are not suitable for intermittent use, or where a quick heat up time is required.

TABLES SHOWING TYPES OF RADIANT HEATERS IN ANGLICAN CHURCHES

Radiant heaters in use

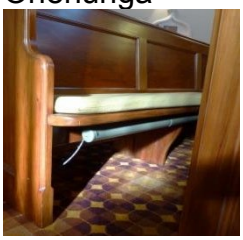
The following tables show the types of Radiant heaters in use at some of the churches assessed by the Sustainability Field Worker for the Auckland Diocese. Radiant heating falls into three categories, based on the wavelength of the heat being emitted.

- Short wave or Near Infrared Radiant heat (IR A)
- Medium wave or Mid Infrared Radiant heat (IR B)
- Long wave or Far Infrared Radiant heat (IR C) (historically called "black heat")

Each has its own pros and cons. These are discussed in the tables below in relation to specific churches assessed. The only shorter wave (in this case Halogen) heaters seen were portable and therefore not included in this table.

Energy Source	Type of Heat	Wavelength	Pros	Cons
Electric	**Radiant – Medium Wave** Technical name Mid Infrared (IR B) St Luke's Mt Albert, Hall and Church  Other Installations St Peter's Pakuranga, Hall and Church St Andrew's Epsom, Hall Papakura Anglican, Christ Church and Hall St Jame's, Orakei	Medium wave - usually Quatrz element Elements glow orange when on Many installed in the 1970's-90's This type of heater is also produced for outdoor applications such as patios	Heat up faster Short preheat period (1 hour or less) Very Good radiant efficiency Not obstructed by air currents or vapour Penetrates clothing and skin more deeply than longer wave Quiet as no moving parts Highly directional so heats people directly Modern units can have separate element switches, dimmer control, motion detectors and timers to improve efficiencies Can have reflector coloured bronze Subjectively, people respond to the warm orange glow of the elements	High heat of elements. Possible fire hazard. Heat can be unpleasant at times to sit under Older elements difficult to replace (however they may be able to be made or sourced to order by an electrician) Highly directional so people can be cold if not in direct line of heat radiation Slimline versions can be less efficient, due to the curve of the reflector, as compared with non slimline models Some heat is lost upwards, by convection and air currents, if the reflector is not insulated. Some modern heaters have ceramic insulation behind the reflector

Energy Source	Type of Heat	Wavelength	Pros	Cons
Electric	**Radiant – Long Wave Older style** Technical name Far Infrared (IR C) St Peter's Church Onehunga, heaters on brackets hung from beams  Other Installations Selwyn Church, Mangere East, Hall St Mark's Church, Remuera	Long wave - Metal encased element Elements do not glow therefore this type of heat is sometimes called **'Black'** heat	Lower surface temperature of element Penetrates clothing and skin less deeply than shorter wavelengths which can be more pleasant over time than shorter wavelengths Quiet as no moving parts Larger arc of heating comfort allows more flexible layout of pews	Slow to heat up Reduced radiant efficiency Some obstruction by air currents or vapour Lots of heat lost upwards due to poor insulation of older units Long time to preheat (3 hours)
Electric	**Radiant – Long Wave Modern style** Technical name Far Infrared (IR C) Old St Mary's, Parnell, Heaters suspended on Wires  Other Installations St Mark's Remuera, Hall (refurbished) St Stephens Chapel, Judges Bay St Luke's, Mt Albert St Andrew's, Epsom	Long wave - Metal encased element, special surface characteristics and good insulation Elements do not glow therefore this type of heat is sometimes called **'Black'** heat Come in High and Low temperature units depending upon mounting height of heaters Lower surface temperatures than Medium wave heaters	Faster to heat up than older style (1 hour minimum) which can give savings in electricity Improved radiant efficiency over old style Lower surface temperature Quiet as no moving parts Penetrates clothing and skin less deeply than Medium wave Large 120˚ wide arc of heat along length of heater allows flexible pew layout	May be visually obtrusive as larger than Medium wave radiant heaters (though frame can be powder coated to any colour for extra cost) Still only 100 % efficient as far as electricity use but design means less heat is lost upwards vs the older style of Long wave heater

Energy Source	Type of Heat	Wavelength	Pros	Cons
Electric	**Radiant Convector** St Peter's Pakuranga, Office  All Saints Church, Howick, nightstore heater 	Medium wave element heats object such as metal fins or bricks for nightstore heaters. Fans or natural convection then move air over these surfaces to heat the air.	Can warm a space more quickly with fan circulation of warm air Good for small meeting rooms Fewer cold spots in the room as not directional heat	Expensive to run as heating a whole room Heat often wasted as it rises quickly, especially if ceiling height is high and uninsulated Nightstore heaters take many hours to warm up (up to 12 hours) Nightstore heaters only economical if electricity is supplied at a lower night rate Can be noisy if the heater has a fan
Electric	**Radiant – low wattage under pew heating** St Peter's, Onehunga  Other Installations Christ Church, Papakura St Luke's, Mt Albert All Saint's, Ponsonby	Medium wave element inside metal tube Or modern Long wave such as "Energoline" from Enersave	Heat conducted through timber pew and convected by air from below Economical provided you can switch on only pews being used Comfortable form of heat Quiet as no moving parts Visually unobtrusive	Localised to pew and person sitting on it Not sufficient heat output to heat a room Take a long time to heat to a comfortable level Limits layout of seating unless flush floor plugs and moveable pews

WHERE TO GO FOR RADIANT HEATING QUOTES AND INFORMATION

All good heating relies upon the correct sizing, spacing and wattage to meet the requirements of the space and this is usually done by a mechanical services engineer or a technical representative associated with the heater supply company at the time of quotation. This person will calculate an approximate heat loss for the space and recommend the amount of heating that will meet the needs of the occupants. Use

competitive quotations to check the amount of heating being proposed for the facility. If necessary, obtain further evidence from a qualified independent engineer.

There are not a large number of specialist Radiant heater suppliers for churches in New Zealand. The following is a list that is known to date and will be added to as more become known. This is not in order of preference.

Medium wave Heaters:

Kelray Heating Limited www.kelrayheating.co.nz

> I-20 to ID-80 models. Have ceramic insulation behind the reflector. Manufactured in NZ by Kelray for Australian and NZ conditions. Sold under various names through distributors but cheaper to go directly to the manufacturer.

Outdoor Concepts www.outdoorconcepts.co.nz

> Infratech normal and slimline models. Manufactured in USA.

Enersave Products www.enersave.co.nz Note: Since end 2012 this company has been in liquidation and trading its way out of receivership. Companies Office status.

> Energoinfra (At this time the Energo range may no longer be available but the company is sourcing a comparable model from Europe), Moël infrared heaters. 2015 update note: they have withdrawn product specs from their current website.

Avon Electric Limited http://www.avonelectric.co.nz/main_prods.htm

> Agents for Frico of Sweden range of infra-red heaters.

Long wave Heaters:

Enersave Products www.enersave.co.nz (see above comment re Enersave Products)

> Energostrip (High Temperature), Energocassette (Low temperature), Energoline (see the above comment re the Energo range of products).

The Heating Company www.theheatingcompany.co.nz

> Radiance Ceiling Heating Panels.

Devi Heating Systems www.devi.co.nz

> Comfortline Ceiling Heaters (High and Low temperature).

Avon Electric Limited http://www.avonelectric.co.nz/main_prods.htm

> Agents for Frico of Sweden range of infra-red heaters.

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