Our path to NET ZERO

From an ancient gas fired heating system to "green" electrical heating including solar generation.

CHRIST CHURCH NEW MILL

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BACKGROUND

The parish of Christ Church, New Mill, was until 1831 part of the much older parish of Kirkburton, but the present church building was built on land purchased in 1829 for £100, by the Church Commissioners under the "Million Act" of 1818. It was completed in 1830 and consecrated in 1831. At that time, it was a plain, barn like building with no decoration.

The building was restored and extended in 1881. The chancel was formed by converting the north east corner into an organ chamber, and the south east corner into vestries; the building was extended eastwards to form the sanctuary area with the altar now under a stained glass window. New pews, a pulpit, a new font and other decorations were added, and new stained glass windows were installed.

In 1970, the rear balcony in the nave was converted into a Gallery Room - effectively a parish hall to replace the day-school sited across the road from the church, which had been a church school, taken over by the local authority, but closed when a newly built school opened elsewhere in the village. The church had the option to purchase the building, but decided that the cost of its upkeep would be prohibitive, and opted instead to use the church building itself. The Gallery Room had a small kitchen (extending part way up the south balcony), and a small room (opposite the kitchen on the north balcony). There was one toilet, accessed through the kitchen.

The church's hot water heating apparatus had been added in 1855, presumably coke-fired; this was replaced by oil firing sometime around 1960, and this was replaced by a gas boiler around 1980; the hot water pipes system remaining unaltered.

Gas lighting was installed in 1862, replacing candles, and this was replaced by electrical lighting in 1926. The incandescent bulbs were replaced more recently by firstly compact fluorescents, and more latterly LEDs, in fittings that had been installed in the 1970s.

FUTUREPROOFING THE BUILDING

We were aware some years ago that the facilities we could offer in church were substandard for use by the community. In particular, there were no disabled facilities, and the toilet was inadequate, especially when the church was used as a concert venue. As with many churches, we had encouraged local groups to hire the building, particularly for concerts. The acoustic is favourable for vocal and instrumental music, and the building will hold the largest audience in the village, and is one of the largest in the Holme Valley. Apart from hiring the building as a source of income, we feel that to allow the use of the building is part of the mission of the church in the community.

We therefore looked at ways of futureproofing the building so as to ensure its ability to continue to serve the community into the next few decades. We considered:

- Better toilet facilities and disabled access to the church, and to the Gallery Room.
- More comfortable and versatile seating to replace the pews
- Considering climate change, we should aim for net zero by 2030.

Of these, the greatest priority seen around 2020 was to upgrade the toilet and access facilities. Removing the pews and installing movable chairs was considered to be both expensive and of less priority at the moment - but we noted the success of removing pews in Wakefield Cathedral, and in other local churches. We also noted that some changes could be made towards net zero without great expense. The decision at that time was to raise funds and upgrade our access facilities.

NET ZERO PLANS

Christ Church, in common with all churches, is very much aware of the changes in world climate, and the need to take action to try to ameliorate the problems. The plan in early 2023 was to follow the advice to aim for net zero by 2030. This would eventually require the replacement of our gas boiler with some greener form of heating. Coupled with that would be the minimisation of heat losses from the building, so as not to waste energy.

Clearly, replacement of the heating system would incur significant capital expenditure; were there any initial steps we could take immediately to reduce energy wastage?

Heat Losses

The church walls are thick, and largely of stone, so the heat loss by conduction through the walls themselves is small. But they also need a large amount of energy to heat them, which slows down any temperature rise during the heating phase. Conversely, they act as "storage radiators" during cooling. For a building which is heated only at weekends, this is highly inefficient. If heating was needed every day, once the church had reached temperature, energy consumption would decrease, the walls helping to maintain the temperature. Our building is normally heated only at weekends.

Heat loss through the windows is significant. As can be seen from the image on p.3, the stained glass windows are large. There is no double-glazing, and there is some air leakage in places. Given the Grade II listing, any modification to the windows would need to be carefully designed to prevent any damage to their aesthetic appearance. Fitting double glazing - if acceptable to the diocese and other interested historical bodies - would be extremely expensive (possibly up to several thousand pounds per window).

The nave ceiling is timber, of unknown thickness, but probably around 2cm. A simple U-value calculation shows that in winter with a 10 degree temperature difference across the ceiling (e.g. 18°C inside below the ceiling, 8°C in the loft void above the ceiling, the heat flow through the ceiling would be around 35kW. Installing a layer of 200mm rockwool insulation would change this to around 0.8kW.

Noting that in winter it was necessary to switch the heating on around 20 hours before the church was to be used in order for the temperature to become comfortable, a saving of 34kW over 20 hours would be 680kWh. This equates to 0.14 tonnes CO_2 saved (at 0.2kg CO_2 per KWh), which over several weeks becomes a significant saving.

We therefore decided at this point to:

- install loft insulation,
- install three destratification fans on the ceiling (Airius, finished in brown to match the ceiling colour) - to circulate the warm air which accumulates under the ceiling. This circulation both serves to spread the heat around, especially to floor level where it's needed, and also reduces the temperature difference across the ceiling, so reducing the heat loss there.
- install a remote control switch for the boiler, which had previously required switching on manually inside church. This allows the boiler to be switched on from home at a more convenient/suitable time depending on the ambient temperature, using a mobile phone app, and indeed could be set to switch on automatically.

The loft insulation was quoted at £3400 including installation. The fans £5900 + installation, and

Accordingly, plans were drawn up for an extension to the building to accommodate access toilets, a permanent ramp to the entrance, and a lift to the gallery room. This is not the primary subject of this booklet, suffice to describe the outcome.

Appearance in 2020

After the building of the new extension.

Above: external view. *Right: upstairs extension*

Having built the extension, the next phase was to modernise the Gallery Room and its facilities. The kitchen was refitted and extended (by taking over the area formerly occupied by the toilet), the wall separating the small room on the north balcony from the Gallery Room was removed, as that small room was no longer used except for storage. This enlarged the Gallery Room, now L-shaped.

One downside of the alterations to improve the kitchen was that the works were now subject to the most recent building regulations, meaning that the South balcony could no longer be used as a public area, since the only access to it was through the kitchen. A fire in the kitchen would leave occupants of the balcony no exit route. We could at great expense have created a door from the balcony to the upper vestry, but the vestry stairs would have had to be widened, which was not convenient. Since the south balcony was in any case used only very rarely by the public, it was decided to lock it off and use it purely for storage. The north balcony was still available for public use when needed.

We also created a kitchenette in the south-west corner of the downstairs nave, for the serving of refreshments at services and other events.

remote switchgear £233 + installation, the installation to be done by our usual electrician. We submitted a faculty application to make these alterations, which the diocese quickly granted.

Points to be noted in applying for the faculty.

- Work for which a faculty is applied normally needs to be done under the supervision of an appropriate professional acceptable to the diocese - often the inspecting architect. We therefore contacted our inspecting architect for his comments and support, which were submitted to the diocese as one of the supporting documents. As expected, one of the conditions imposed by the faculty was that the work should be done "under the direction of the Parish's inspecting architect".
- Maintaining the aesthetic appearance of the building is important, especially where the building has historic significance. So cable runs need to be carefully planned. We submitted photographs of the relevant areas and indicated on the photographs the positioning of cables, and any trunking needed.
- The fans manufacturers produced a design for us, recommending where the fans should be situated and how many would be needed - i.e. professional designs may carry more weight than a home-grown design produced with good intention but without specialist knowledge.

This work came to a total around £10000, which is not insignificant. In our case, we had recently benefited from a legacy which helped to finance these alterations.

SOLAR PANELS and NEW HEATING SYSTEM

Three factors led us to develop further plans:

- There were very significant energy price rises which threatened our ability to survive financially.
- Our gas boiler, over 40 years old, was basically obsolete. It seemed to be working without problem, with an annual service, but the service engineer had pointed out some years ago that although he could replace the thermocouple annually, other key components could not be replaced in the event of failure.
- Climate change was becoming a more significant issue, which was encouraging us to aim for net zero as soon as possible.

We therefore commissioned a professional energy survey to recommend possible courses of action. The survey produced the following suggestions:

Description of Works	Estimated Capital Expenditure (£)	Forecast Savings (£/yr.)	Simple Payback (years)	Energy Savings (kWh/yr.)	CO_2 Savings (tonne/yr.)
Install a Solar PV Array on the Roof with Battery Storage	£46,570	£4,920	9.5	16,020	3.32
Infrared Heaters	£26,290	£2,550	10.3	57,750	10.38
EV Charger	£8,400	£740	11.4	-12,045	-2.49
Total	£85,110	£9,060	9.4	64,495	11.78

(The totals include some upgrading of lighting to LED, [£3850 estimated] which was done without changing the luminaires - the incandescent and compact fluorescent bulbs/PAR38 floodlights have all been replaced by LED equivalents, at a much lower cost than the estimate.)

Our decision as to what actions we should take was based on the following questions:

- Will the action lead to a reduction in our carbon footprint?, and
- is it affordable (i.e. have we already sufficient funds, or is it suitable for a grant application)?
- if the answers to both the above is "yes", will it be feasible to obtain permission from the diocese/other relevant bodies.

Installation of EV chargers was suggested partly as support for the local community in addition to church users, and as such, the project may have qualified for grant support otherwise not open to religious organisations. Although this may be considered again, it has not yet been implemented, nor have any detailed plans been produced, since all other permissions and grants have been obtained without the need to implement it.

It was clear that installation of solar panels would be environmentally advantageous. There are grants available too, so even though the estimated cost is high, it would probably not be prohibitive. The key (economic) factor here is the payback time, quoted at 9.5 years. This is significantly less than the expected lifetime of solar panels (guaranteed for 15 years, but likely to last for 25 years, meaning that this is economically viable.

Replacement of the gas boiler by electric heaters would enable us to approach net zero, provided that any electricity imported from the grid was "green" electricity (which we are informed is the case - our suppliers indicate that it comes from North Sea wind farms). Furthermore, input from solar panels would offset the energy needed from the grid, although it would be well below the amount needed by electric heaters.

There were at this stage several possibilities to consider for the installation of electrical heating:

- Heat pump - either air source or ground source.
- Replace the gas boiler with an electric boiler, keeping the existing hot water system.
- Install overhead infra-red heaters.
- Install under-pew heaters

Heat pumps were quickly eliminated. The size of the building is large, and the heat losses particularly through the stained glass windows are too large. We were advised that the output from an air source heat pump would be insufficient to counter the heat losses; we would need to install double glazing and possibly further lagging of the stone walls. This would be prohibitively expensive, may possibly be disallowed in a listed building, and altering the insulation could affect the breathing of the fabric of the building, leading to significant problems with condensation, which would at the least need to be investigated carefully. A ground source heat pump would also not be feasible: there is no area of ground close to the building which could be used for a shallow ground source (the building is surrounded by a graveyard). It would be possible theoretically to drill downwards from the inside of the church to reach the water table, providing a vertical ground source pump, but the church (being on a hillside) is some 250 metres above the water table (a very expensive long drill down) and this would involve a massive operation inside the building, possibly affecting its foundations.

We could in principle install a new boiler, which would need to be rated around 80kW. (The current gas boiler was rated when purchased around 100kW, and people remember it always being warm in church then. It has deteriorated over the years , its output measured recently around 70kW, and it now refuses to heat the building to more than around 10 degrees above the external temperature). 70kW electrical power corresponds to a current of 304 amps - but although we already have a 3-phase supply to the building, and therefore a current limit of 300A rather than 100A for a single phase supply, taking into account the other loading, is insufficient. Using water circulation through the existing pipework certainly heats the building, but if electrically heated, would be exorbitantly expensive.

The two other possibilities work on the principle of heating the people rather than the building. This means that in cold weather, we could lose the homely effect of having a warm building to come into, but people will nevertheless be able to sit comfortably in the pews. The power needed would be less (estimated by the heater suppliers at around 40kW, which can be covered by our 3-phase supply), it would need to be switched on only when people are present, and can be zoned so that only the used areas are heated. Even though the cost per kWh of electricity is significantly more than gas, the total electrical energy needed will be much less than the total gas energy used currently per weekend.

We decided to aim to install overhead IR heaters in the nave, spacing them to give coverage of all the seating areas. We looked at various available designs, the overriding considerations being:

- as uniform a coverage of seated areas as possible, and
- as unobtrusive as possible.

We settled on the Etherma EXO DARK range because:

- the shape of the heaters would allow fitting to existing beams and tucking into the existing curvature of the panelling in a relatively unobtrusive manner
- the available colours were black (against the dark wood panelling) and white (against the white/magnolia beams)
- the glow when switched on, although visible, was not glaring.

We found also that we could control the power of these heaters (so that they needn't be operated at full power in Spring/Autumn when only a small amount of heating is needed).

The chancel, however, does not lend itself to the installation of overhead heaters. Although it would be possible to position one on the south chancel wall, it would be clearly visible from the nave, and would heat only the south choirstalls. Any such heater at the north side would have to be attached to the organ case, which would not be aesthetically desirable, but worse, the organ itself would be adversely affected by the close presence of a heater. We decided that the best approach for the chancel would be to install under-pew heaters. (We didn't consider under-pew heaters for the nave because although the pews there are permanent, we would like eventually to replace these by more versatile movable seating, at which point under-pew heaters would not be appropriate). We have no desire to reorder the chancel.

Accordingly, we prepared detailed plans firstly for the installation of solar panels, then on completion of that, the replacement of the heating system. We decided to split this project into these two phases because

- the heaters would potentially be too expensive to run, but solar generation would offset this;

- Both phases are expensive, each in a £35000 ball-park; we would need significant grants;
- Both need successful planning applications from the Diocese (faculties); the solar panels, but not the heating, would need a local authority planning application.

PHASE1 Solar Panel Planning

Local authority (Kirklees) - application 2024/62/93188/W

This is publicly available for consultation at https://www.kirklees.gov.uk/beta/planning-applications/search-for-planning-applications/detail.aspx?id=2024/93188

Our proposal was to install solar panels on the south roof (62 panels, maximum power generation in summer of around 21kW, plus battery storage (23kWh).

We applied for coverage of all the available space on the south roof, which amounted to 62 panels. The building being grade 2 listed meant that its appearance must not be materially altered. Our application pointed out (by including images as supporting documentation) that the south roof is only partially visible from ground level, and only from two angles, one of which is obscured by trees during much of the year and the other is from a small area higher up the hillside. The south roof is not visible in the iconic view of the church as the village is approached from the west. We also emphasised the positive effects that the proposed solar panels would have on climate change - an estimated saving of approx. 10 tonnes CO_2 per annum.

We also sought and obtained the support of our local parish council, and our ward councillors, emphasising to them the community use of the building, and the necessity for proposals such as these for such community use to continue. Also included with the documentation was the statement of significance we had prepared for the diocesan faculty application.

Kirklees Planning department consulted their own Conservation & Design department, who suggested that "the proposals would cause less than substantial harm" and raised a number of points of concern, suggesting alternatives including installing panels on the tower roof instead of the south nave roof, and using heat pumps instead of panels. They also recommended installing fewer panels, limiting to the lower part of the roof which is not visible from ground level because of the parapet. We responded to these comments (the tower roof area is too small to be of economic use; heat pumps as already mentioned, and limiting the area would not allow enough power generation). The consultant pointed out that the proposals "would be required to be balanced against the public benefits, and where applicable against secure the long term viable use of the building" and it was left to the planning committee to decide. They (perhaps rather surprisingly in view of the consultee response, but in line with their Net Zero ideals) decided to grant us permission for the full 62 panels in our original application.

Faculty Application

All faculty applications are made online via https://facultyonline.churchofengland.org/ . There are standard forms to be filled in online, but we have found that the easiest way is to fill in the compulsory data required about the church and the outline statement of the proposals, then prepare separate documents containing the detail of the proposals. A project of this importance will need a statement of significance, and a statement of needs. The statement of significance has sections about the church in general (and once prepared, this part can be re-used in future faculty applications), and a section referring to the particular areas affected by the proposals. The statement of needs is perhaps the most important document - it sets the background to the proposals, stating what is needed, why it is needed, and the details of the proposals to meet the need. It also sets out any alternative solutions that have been considered, and explains why they have been discounted. In this case, it also contains an analysis of the expected benefits in terms of carbon footprint.

Whilst the local authority application is concerned mostly with the external effects of the proposals, the faculty is concerned about the whole building - the diocese is responsible for overseeing all aspects of church buildings. So although the faculty includes a schedule of works which can be in outline, it will need to contain details of anything which would alter the appearance or functioning of the building in any way. In particular, the positioning and concealment of cable runs need to be thought out and sufficiently detailed that the diocese can see exactly what changes will be made to the appearance of the church once the project is finished. The faculty application should also contain an indication of finance (competing quotations received, finance already available, and how any outstanding funds will be raised). We obtained 3 quotations from established companies for the work before deciding which one to accept; it's normal to have competing quotations not only to aid the faculty application, but also grant awarding bodies will take this into account. A copy of the PCC minute authorising the project/application is required also.

The documents submitted online are likely firstly checked by one of the DAC officers (*Diocesan Advisory Committee - the body that checks a faculty application and if/when happy with it, submits the application with its recommendation to the diocesan Chancellor, who is the person who makes the final legal decision and grants the faculty*). If that officer spots any obvious problems (s)he will get back to you, otherwise the documents will be forwarded to the DAC's specialist advisors, who will comment and make appropriate recommendations. The application is normally then considered by the full DAC committee (unless it is considered straightforward enough for the DAC officers alone to decide), and their decision determines whether the application goes to the Chancellor. The DAC/consultants can request further details at any point during the application process, which can delay the final decision, hence the importance of pre-empting any questions and providing well-reasoned and justified detail.

Other considerations relevant to solar panel installation.

- work on the roof, plus the associated wiring will involve some disturbance of the loft space. A bat survey may/will be needed to satisfy the DAC.
- is the roof strong enough to support the extra weight of the panels? The inspecting architect should be able to comment on this, but a structural engineer's report may be needed and certainly will be more authoritative than an architect's.
- Battery safety - where will these be positioned. There are regulations in the UK for solar batteries in domestic properties, but so far not in public buildings. Church insurers will need to be satisfied that batteries are installed so as not to compromise fire safety. Our insurer's rep visited the church to check our provision. Initially we had planned to put the batteries in an available space inside the church on the south balcony, but during the planning, the availability of a more compact battery pack allowed us to install it under the stone stairs in the church porch. This had the advantage of being a compartment bounded by a stone floor, stone ceiling, two stone side walls (the church tower wall), all of which are totally fireproof, leaving us with just two sides to provide fireproof walls - which we manufactured out of cement board, giving us a fire rating better than 60 minute which our insurers specified.
- Local authority Building Control may need to be satisfied of fire safety, but our Building Control Officer commented: "we do not necessarily need to be involved with this work

where utilising a self-certifying installer under a Competent Persons Scheme. See excerpt from Schedule 03 of The Building Regulations 2010 (As Amended) "

- The solar panel equipment may need internet connection (in our case to allow continuous monitoring via a mobile phone app).

There was a further important consideration in our case. We have for some years rented space in our tower for mobile phone radio equipment. The company coordinating this pays us an annual rent, and separately for the electrical power used by the equipment. (We pay the electricity suppliers for the energy as supplied to the building, then we bill the phone company for the energy they use; we have a meter monitoring electricity usage by the tower equipment). This equipment of course operates 24 hours per day, every day, and runs constantly around 5kW. It follows that although our own electricity consumption is limited currently to Sunday services and occasional evenings, the building is consuming energy continuously, so we will be able to use all the solar generated power during most of the year. The batteries will help with this, and only during days of sunshine during the summer months will we be generating more than we can use, and sell that back to the grid. We have noted that the rate we can get for power fed back to the grid is less (as a business, into which category a church falls) than the domestic rate. There are also other options available for either profitable or charitable disposition of excess solar generated power (see Parish Buying for details).

PHASE 2 : Heating system planning

Local authority - were not involved as no changes to the external parts of the building are involved.

We obtained two quotations for the work, which proved to be very similar in both price and suggested hardware and design. We settled for the one recommending heaters we thought would best fit in with the church's layout and furnishings.

Faculty application.

Again, a specification of needs and a specification of significance is required; we submitted documents using the same wording as for the solar panels application except for the sections specific to the heating.

Installation of heaters involves significant work to the internal appearance of the church, particularly the nave. We therefore supplied a separate document "Heating proposal details" (see appendix 1) showing clearly, with annotated images, where the heaters will be placed, what they will look like (by superimposing images from the manufacturer's catalogue on a photograph of the church), and where/how the cabling will be done. This was prepared after site visits and consultation with

- the suppliers of the heaters (who designed the overall system according to our general wishes),
- our usual electricians (we employ a local commercial firm with the necessary qualifications to work in commercial/industrial premises),
- our inspecting architect (we expected the diocese to require this).
- our insurers (to check that we weren't specifying anything likely to impact our insurance)
- (noting the listed status of some of our furnishings) the Georgian Society representative (who had visited and produced a written report as part of Phase 1, but offered comments verbally on our outline proposals).

We also have a couple of technically qualified members of our congregation whose comments were useful in preparing this document. It's important to specify the correct details at this stage - although it is possible to make alterations to a faculty, this will at the very least introduce delays, and create extra work for the diocese. Nevertheless it's also possible that something can be inadvertently discovered later, in which case the necessary amendments to the faculty must be sought through official application - the instructions given in a faculty when granted must be exactly adhered to - it's illegal otherwise and the diocese can require any such work to be reversed. (We had to obtain a faculty amendment in our solar panel application when we changed the location of the batteries).

In our case, the faculty for the heating system was granted without problem (the solar panels faculty raised much more discussion). We successfully applied for a number of grants, and the heaters were installed.

FINANCING

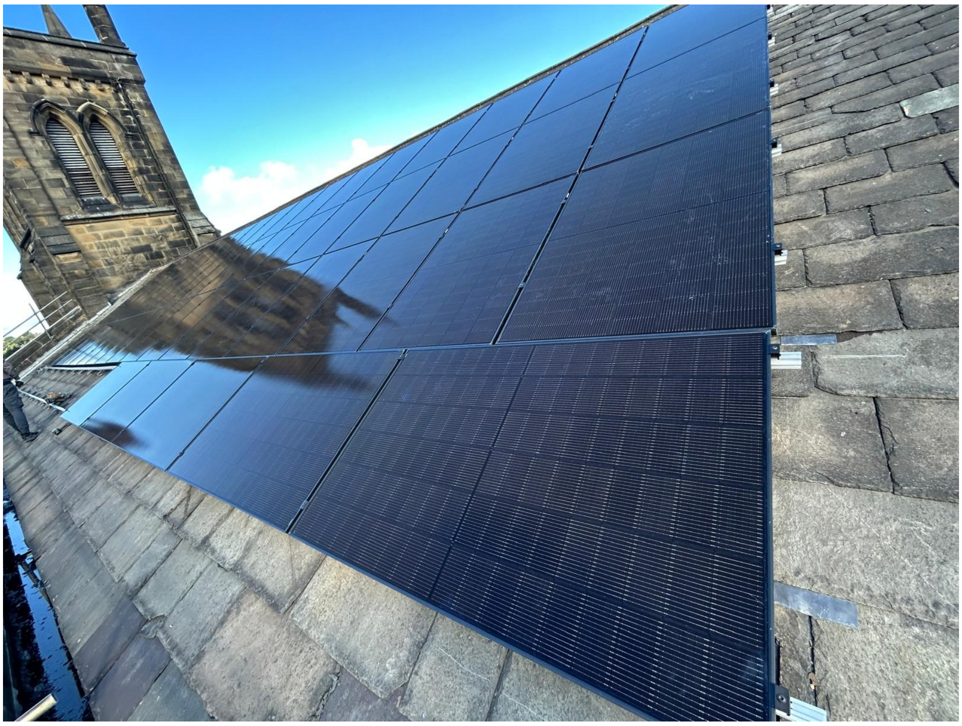
We were in the happy position of having in our congregation a couple of people whose professional work involves obtaining grants (for research work), and who are skilled in matching our needs to grant awarding bodies. Checking and matching is important because filling in application forms can be very time-consuming, and non-matched applications are doomed to failure from the start.

Whilst the Church awards grants for Net Zero projects, there are other bodies that award grants to community-based charities but not (purely) religious groups. Our building is used by the community (concerts - the church is suitable for brass band, orchestra and choral concerts, and is used by local musical societies regularly; the gallery room is hired for private functions, and is used at the moment regularly by local scout groups). Emphasising the community use can increase eligibility for non-religious grants.

Our grants writer advises:

- Prepare a clear budget for the whole of your project from start to finish.
- Prepare a plan to fund the whole project.
- Identify grant opportunities for which there is a good fit with your project. Make sure that churches are eligible, and that your project aligns with the goals of the scheme. Look for local grants with a sustainability focus as well as grants aimed at religious organisation. Look for schemes aimed at churches (or religious organisations)
- Recover your VAT if your church is listed (but note that the Listed Places of Worship scheme is currently being replaced, details not available at the time of writing).
- Engage the community e.g. by a “sponsor a panel” project. This is unlikely to raise a lot of money, but can raise awareness locally
- Don’t apply for grants too early. You need to convey confidence that you will be able to fund the whole project, and some schemes are only open to you when you have raised a large proportion of the funds. Don’t apply unless there is a good fit with the remit of the scheme. Make sure that you can articulate the whole mission of your church (including community engagement), and you can explain the benefits of the scheme (especially in terms of sustainability metrics). Use AI tools to sharpen your case.

Work in progress : Solar Panels



Stages in solar panel installation, showing the mounting brackets attached to the roof trusses. It's clearly impossible to do this without disturbing the slates in some way, but the method used avoids drilling holes through the slates, and ensures that water cannot leak through, it will always run off.

We were advised by the installers that no extra precaution is necessary to prevent birds accessing the space under the panels.

Work in progress : Battery installation

The battery fits in the void under the main stone stairs at the north west corner of the foot of the tower. The wall behind the battery is stone, and therefore fireproof, the wall to the left is also an outer wall (plastered) and also fireproof, as are the stone floor (overlaid with cement board for levelling), and stone stepped ceiling. That leaves the wall to the right, which was originally a timber panel linking with the church porch. We covered this with cement board (extending the coverage behind the inverters, one of which is visible at the bottom right of the image. We also constructed a cement board panel to separate the battery compartment from the rest of this area, so totally enclosing the battery is a fireproof container. This front panel can be easily unscrewed for any access to the battery that might be needed.

We were assured that this enclosure of the battery would not cause any problems with temperature rise - the battery remains cool during charging and discharging, and so far this has proved true.

This arrangement was seen and approved by our insurers, who specified a minimum 60 minute fireproofing. The cement board specification exceeds this.

Evaluation of the completed works

Solar panels installation

View after panels installation from the south. Compare this with the similar view from a little further east printed on the cover page taken a few years ago (that vantage point is no longer available as houses have been built there. The occupants will see a full view of the panels from their upstairs window except when the trees are in full leaf.

Left: View of south roof from the east. Right: looking further up Sude Hill. The picture on the left was taken from the point shown by the arrow. This is the optimum position for viewing the panels - there are buildings to the right, and the house behind the arrow obscures the view from higher up Sude Hill. Our planning application and submission to the Georgian Group emphasised that installing the panels had minimal impact on the view of the building, there being only these positions from which they could be seen.

The solar panels installation was finished and operation started in October 2025. Winter is not the most productive time to test solar panels, but generation has occasionally reached around 17kW. The low position of the sun during winter means that even on a bright sunny day, generation is low, and the parapet will cast a shadow over the lower panels.

One problem we have noted is that several times, particularly on brighter days, the system has stopped, then reset some minutes later. The error code shown indicates that the grid supply is outside the safe limits. On investigation, it seems that the mains supply to the church occasionally spikes above the allowed range (the mains voltage should be 230V with a lower limit of 216V, and an upper limit of 253V). A spike measured at 263V would cause the system to shut down, followed by an attempt to reset. This, whilst being annoying, does not greatly impact performance since it resets after only a few minutes, and it does show that the safety measures are working. We have followed this up with Northern Powergrid who are looking into possible solutions, but it does seem to be a Northern Powergrid problem affecting our system.

Between installation in October 2025 and the beginning of March 2026, Solax's app tells us that our system has generated total earnings of £912, although since the telecoms equipment in our tower represents a "sitting tenant" continuously using around 5kW for which we can charge, this figure may not be a true estimate.

Heaters

Views of the heaters in operation - above looking east, below looking west. As can be seen, there is some residual light emission (despite being called "DARK"), but they do not have the bright orange colour of traditional electric fire elements. Furthermore, the colour appears somewhat brighter on the photographs because of the greater IR sensitivity of the camera than human eyes.

The heater controllers. We still need to construct a cabinet around these which will both conceal the controllers and wiring, and prevent them from misuse.

Detail of heaters compared with a lamp.

Under-pew heaters in the choirstalls. There is a switch next to each heater allowing the seat occupant to control the individual heater, with a master switch for each side of the chancel.

At the time of writing, we have used the full electrical heating system only once; the feedback from both choir and congregation was that although the air temperature was colder than it would have been with the old gas-fired system (around 10C in church that morning) the majority were comfortable sitting in the pews, and we were running the heaters at 80% power, so we could have increased it a little. It is probably worthwhile to switch the heaters on some 30 minutes before (most) people arrive.

We are so far pleased with the system; our treasurer is particularly pleased since it was costing us around £70 to £100 per weekend in gas to heat the church (a rise of temperature of 6 to 10 degrees C would require the heating to be switched on the previous day), but 3 hours of electrical heating would have cost us only around £30 at the full unit rate, probably saving a further £4 from the rather sparse solar generation on the test day.

Looking at this in energy terms, switching the gas heating on for 15 hours to heat the church for one service would consume 70kW x 15 = 1050kWh, compared with 3 hours of 40kW = 120kWh, a very significant energy saving.

However, hindsight would be marvellous, and there are a few alterations to the design which would have been better. We grouped the heaters for switching/control purposes into zones, this grouping saving significant costs in terms of extra control units and cabling. It would probably be better to have the heaters individually switched from the control areas. We zoned the heaters into two groups of three heaters plus seven groups of two heaters, a total of nine controllers. Nine cables therefore are routed from the control units to the nine zones, with the heaters in each zone being paralleled (or "daisy-chained"). Our electricians did include an isolating switch for each heater, but installed that on the beam next to the heater (the isolating switches weren't on our original design, but presumably they were required by wiring regulations). My recommendation now would be to put these isolating switches (20 of them) with the control units, reduce the number of control units (re-zone making six groups of three and one group of two), a saving of two controllers (although the 6kW controllers are more expensive than the 4kW controllers), the downside being that 20 cables would now need to exit the control area, needing more cable, probably needing larger trunking. We have found already that using controllers will be beneficial because we won't need full power when the ambient temperature is higher. However it's likely that we will find that all the heaters can be controlled to a similar power depending on the ambient temperature - making the zoning less significant.

Note that the heaters we ordered also come in a more expensive version that has its own power control, operated by a remote control (similar to a TV remote control). We decided against this - 20 remote controllers would be difficult to manage, and having people moving about church during a service pointing a remote control at a heater would be inappropriate. Much better to position the controls behind the assembled people, close to the wardens' pew.

The Etherma heaters were supplied by ARC Thermal Solutions. Their staff were helpful at all stages, from making the initial design recommendations, through several modifications as our thinking evolved. Although they would have installed the heaters too, they cooperated with our regular local electricians who did the wiring. There was a problem with the heaters as supplied by Etherma, but ARC sorted that and ensured all was working correctly.

Further work needed

There are a few small extras needed to complete the work. The heaters installed cover most of the areas used in church, but there are a few specific areas that are not yet covered. Also, we need to consider frost protection where necessary.

Vestries

In the 1881 reordering of the church, the chancel was made at the east end of the nave by creating an organ chamber on the north side of the easternmost bay, and a two-storey vestry on the south side. The east end of the chancel was simultaneously extended to form the sanctuary/ altar area.

The lower storey vestry is used currently by the choir before and after services, and the upper vestry houses clergy materials and the church safe. Neither of these are currently electrically heated, but the original hot water pipes did ensure that the vestries were warm.

We intend to install a wall-mounted convector heater in the lower vestry. This will both heat the used area and serve as frost protection. We believe at the moment that heat from this heater will permeate to the upper vestry for frost protection; at the moment the upper vestry is not used other than for storage, but a portable heater could be used there.

Altar area

The choirstalls are heated by the under-pew heaters, but there is no heating at the moment for the celebrant and servers in the altar area. The intention is to use portable heaters where required.

Frost protection

The existing hot water pipes will be drained (and the gas supply capped off), but we have a cold water supply to the building - to the kitchen, kitchenette and toilets. The supply (installed many years ago) enters the building under the choir vestry, in its south west corner by the vestry to nave door. The water pipe runs up the vestry wall to the upper vestry (where there is a tap and sink) then through to the nave south gallery, where it runs under the existing hot water pipes, along the south wall, to the kitchen at the south west of the nave. The pipework almost to the kitchen is mostly copper, but the new piping from then on is plastic.

The copper pipe needs frost protection, and we intend to install trace heating cable along its length. That in the vestry will be protected by the convector heater we install there, which will be set to come on if the temperature falls below around 5C. The trace heating cable will also automatically switch on at temperatures below 5C.

The pipes in the toilets are already protected by the convector heaters installed in the new Extension, which we know function well in cold weather. The run of plastic pipe between the kitchen and new Extension goes under the gallery room floor, i.e. above the west nave ceiling, and we think that this area is well protected with no further action needed.

APPENDIX 1. Heating Proposal Details (the document submitted supporting the faculty application.

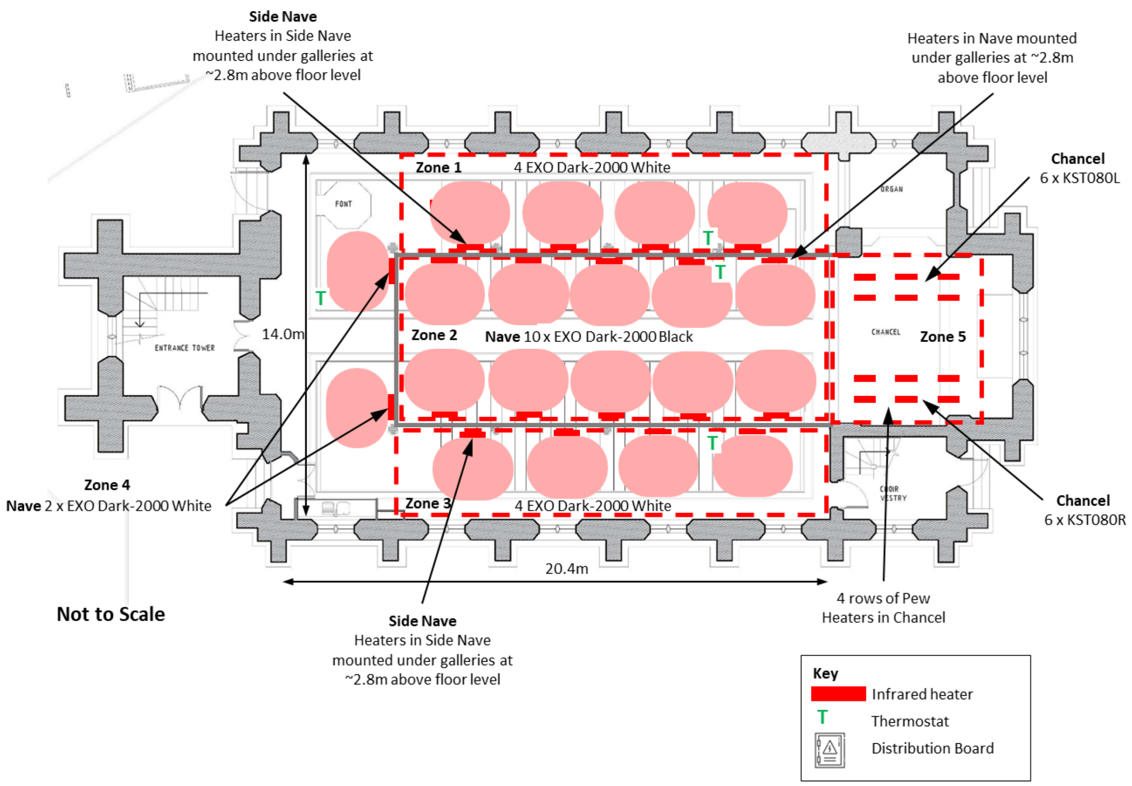
CHRIST CHURCH, NEW MILL : INSTALLATION OF IR HEATERS

Following consultation with ARC and HeatingGlobal, who provided similar quotations, we have decided to take ARC's (who supplied the heaters we installed in the gallery room in 2023) because the appearance of their heaters will more suitably fit the church.

We propose to locate Etherma EXO Dark 2000 heaters as shown in the drawing below, as produced by ARC:

Proposed Infrared Heating Layout – Ground Floor

ARC THERMAL SOLUTIONS



01/04/2025 **ARC Thermal Solutions** • Chesham • Buckinghamshire • HP5 3QW • 01923 889480 • www.arcthermal.co.uk Ref: QU-2621 v4

On each side of the nave, there will be 5 heaters (black finish) mounted in the curved bottom section of the balcony panelling, equally spaced, emitting radiation in cones covering the seating between the line of balcony support pillars and the central aisle. On each side of the nave, there will also be 4 heaters (white finish) mounted on the beams running under the balconies, one in each bay, emitting radiation in cones covering the seating between the line of balcony support pillars and outer walls. In the drawing above, indicates the radiation coverage. There will be two further heaters installed on the west balcony support beam, warming the area at the rear of the nave where there are no pews, as shown. The colours (only white and black available) will best match the surrounding decoration. The mounting positions are shown in the photographs below, of the beam areas, with pictures of the heaters superimposed (scaled and with altered perspective to give an idea of the expected appearance). The heaters are supplied with fixing brackets which will support the heaters approx. 6cm clear of the beam/panelling, allowing suitable ventilation but maximising unobtrusiveness.

We do not propose to install any heaters upstairs on the balconies at the moment. The south balcony is used only for storage and has no public access (for fire regulations). The north balcony is used only infrequently and only then when additional seating is needed for an event attracting a full church – in which case the combination of all the downstairs heaters plus body warmth will generate heat likely to warm the balcony area (or portable heaters could be used).

Photograph of north balcony with picture of heater added showing the typical positioning of the heaters in Zone 2 of ARC's diagram.

Note that these heaters will be black finish to maximise unobtrusiveness.

Photograph as above, but showing the typical positioning of the heaters in Zones 1 and 3 of ARC's diagram.

Note that these heaters will be white finish to most closely match the painting of the beams.

(These heaters are available only in white or black finishes)

Chancel heating

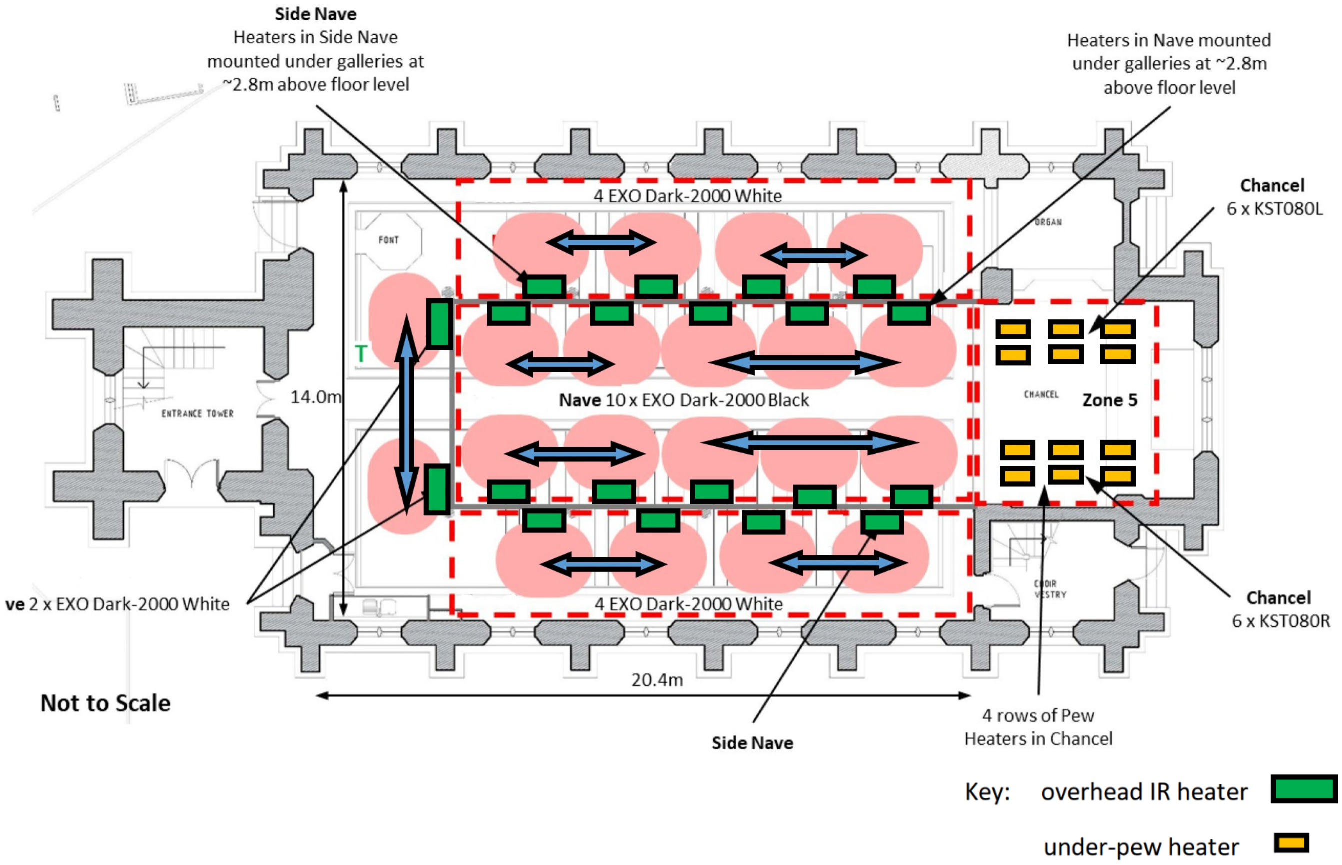
There are no suitable unobtrusive mounting points in the chancel for overhead heaters. It would be possible to install heaters on the south wall, but impractical to position similar heaters on the north side where they would interfere with the organ (there would be significant organ tuning problems if electric heaters were installed near the great soundboard). We propose therefore to install 3 under-pew heaters under each of the choirstalls, as discussed with and advised by ARC, each 320W power.

Heater Control

We initially considered coupling heaters together for switching purposes in zones, each zone switchable remotely via wifi/internet, as quoted by ARC. However on consideration of alternatives, we note that:

- these heaters provide instant heat to the seat occupants, so they could always be switched on site – there is no need for remote control or thermostatic control similar to our current boiler control system.
- seat occupancy varies from week to week; it would make sense to have each heater separately switchable, or switchable in small groups, avoiding heating unoccupied areas – the original zoning proposed by ARC is not ideal.
- heating between May and October often may not require full power – we may be able to make further savings in electricity consumption by incorporating power regulation. In this respect, we note that we would need to avoid regulators (such as phase angle switching) which may generate RF interference which would affect the regular livestreaming of services from Christ Church. We therefore arranged a site visit with ARC, who demonstrated one of the proposed heaters in use with their recommended power regulator, showing that there was no detectable interference with our microphone and streaming setup.
- Individual or small group switching will need a significant amount of cabling, which with a 2kW loading per heater is likely also to need screened conduit to avoid interference.

We therefore propose to switch the 20 heaters using 9 power regulators, grouping them as indicated by the blue arrows in the diagram below (2 x 6kW controllers for the 2 groups of 3 heaters, 7 x 4kW controllers for the 7 groups of 2)



Power requirements

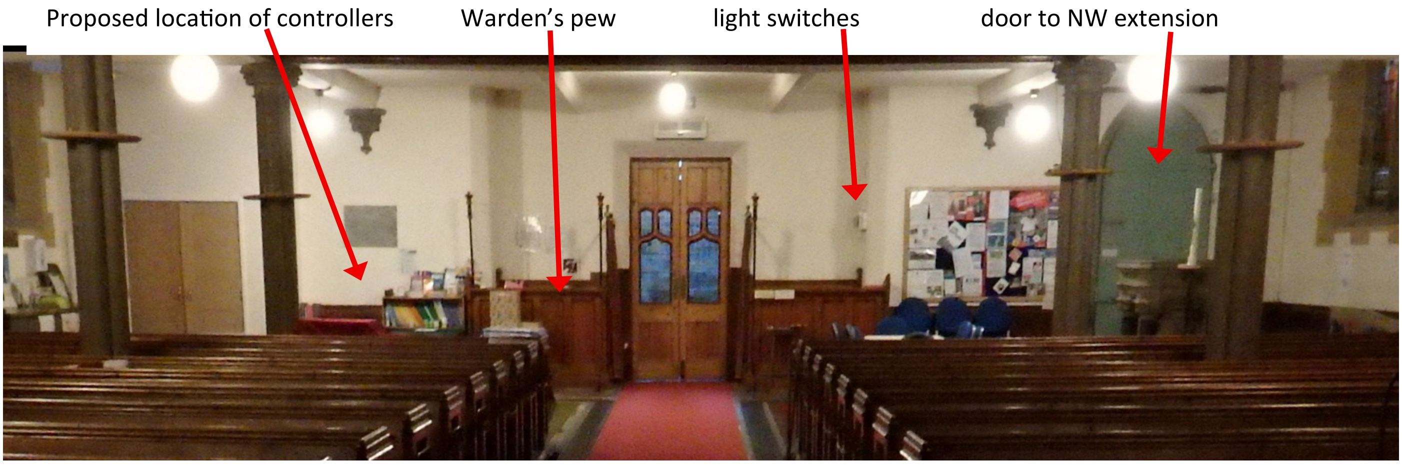
We already have a 3-phase supply to the building (which was installed together with mobile phone relay equipment in the Tower by NET some years ago), and we are advised that this will cope with the proposed heaters when all switched on, together with the existing power usage (lighting, amplification, water heater, Tower NET equipment).

Positioning of controllers

The recommended controllers are each 280mm x 200mm x 80mm (both the 4kW version controlling 2 heaters, and the 6kW version controlling 3 heaters). We considered various alternative positions for these:

- Alongside the existing lighting switches – this is the most obvious position, but there is insufficient wall area to accommodate 9 controllers.
- In the NW extension, which would not be visible from the nave – but this would involve drilling through two church walls, with a significant amount of cabling in the Font area, likely to prove obtrusive.

The optimum location is to use the section of west wall of the nave as shown in the photograph below.



Larger view of proposed location of heating controls

Position of control cabinet (i.e. 9 controllers plus fusebox or equivalent and any necessary switches. The tables, books, bookcase etc will be repositioned elsewhere, so the control cabinet can use all the height between the stone plaque (which commemorates the installation of electric lighting in 1926, and its benefactor) and the wood panelling, and all the width from the photocopier cupboard to the end of the flat section of wall (aligned left).

This location minimises cable lengths and allows trunking to be confined to corners where after painting to match the surroundings, it will be unobtrusive. The location is also conveniently positioned close to the churchwarden's pew giving her easy and unobtrusive access during services/events. We propose to encase the control gear in a suitable cabinet (improving appearance, and preventing unauthorised access to the switches), whose lower and upper faces will allow a ventilation through-draught.

Cabling routes

The under-stairs compartment in the church porch houses the mains inlet to the building, the main fuse-boxes, switchgear and distribution.   We need to run a 3-phase cable from there to the proposed location of the heater controllers.

Our initial thought was to run the cable through an existing cable path from the distribution board up to the bell ringing chamber, around the walls of the chamber, through the existing opening into the nave loft space, across the floor, down through the SW balcony kitchen to the space under the kitchen floor which is approx. 70cm above the back nave ceiling, then down the nave W wall from the nave ceiling to the controllers.   This would avoid the need to drill through the thick original walls of the church.

However after discussion with MJL Electrical, we are assured that a direct route would be much more appropriate and not impractical.   We propose to run the 3-phase cable through the existing trunking in the porch over the main door, continuing it to the east wall of the porch, then via a hole drilled through the masonry to the west wall of the nave, then via the route shown in the picture below to the controllers.   Trunking will be rectangular cross-section, and finished, together with any disturbed plasterwork to match the surrounding paintwork. The cable will be run via trunking A to the controllers cabinet, if possible chased into the plaster work/drilled through the masonry.   The individual cables from the controllers to the heaters all go via trunking B to the beam as shown, and then using similar trunking along beams to respective heaters via the routes shown in the further pictures.   These cables will traverse the (timber) beams where necessary via holes of minimum diameter, in accordance with building recommendations.

Artist impression of appearance of controller cabinet (size approximate) and trunking as proposed, superimposed on a photograph of the west nave wall.

Porch view – 3-phase cable to run through existing trunking pathway immediately above the door, extended to the left wall just above the glass-covered notice-board, then through the wall into the nave.

The mains supply distribution is in the compartment under the stairs behind this door.

Cable routes to the heaters on the south side of the nave

Cable routes to the heaters on the north side of the nave

Finance

Cost of heaters + controllers (ARC quotation) £27,641

Installation cost estimated by MJL: approx. £10,000

We have applied for Demonstrator Church status for our project to reduce our carbon footprint to zero as soon as possible. Work on Stage 1 (faculty 2024-104557 granted 7 July 2025) – the installation of solar panels – starts on 17 August, and the costs of this have already been covered. The present application for replacement heaters is Stage 2 of the project, and the Demonstrator Church application requires both stages to be able to be substantially completed by the end of 2025. The grant provided by success in the Demonstrator church application is expected to cover the outstanding costs.

APPENDIX 2. Analysis of Solar Panel output, 29 Sep. 2025 to 5 Mar 2026

(data from Solax's user app.)