Updating Lighting in Small Churches

By Peter Humphrey, July 2011

A Winston Churchill 2010 Travel Fellowship.
Updating Lighting in Small Churches

This project is to support the Church Wardens and Parochial Church Councils of small churches who are faced with the job of updating their church lighting. It was made possible by a grant from the Winston Churchill Memorial Trust through the award of a 2010 Travel Fellowship.

The thought that there may be a need for some practical advice to church wardens on lighting arose from a reordering project at my village church. With the help of an enthusiastic young electrician, new power supplies and my internal and external lighting design were installed and tested for around £14,000, far less than the quotes received. Having partly retired I had studied lighting design out of personal interest but claim no professional status. Following the reordering in 2009, the church entered the Country Life Magazine’s, “The Best Village Church for Village Life” competition and won the first prize of £10,000. There were many positive aspects of the reordering and I believe the improved lighting helped.

The fellowship enabled me to travel to two of the major manufacturers of lamps (electric light bulbs), Philips and Osram, and four leading European manufacturers of luminaires (light fittings) Erco GmbH, Artemide SpA, Targetti SpA and iGuzzini, SpA. It also included visits to churches, small and large, to look for examples of lighting that may be helpful. This document is a summary of these experiences together with information on light and the equipment that facilitates lighting.

Large churches were more accessible in general than small churches. The lighting examples from larger churches can in most instances be adapted to smaller places of worship.

Introduction

For many years there had been a sort of stability in the lighting world. The ‘Edison screw’ may have caused a few problems in the UK but the conventional 40/60/10 watt lamps and functional fluorescent tubes were the staple. (Terminology can cause confusion. In the industry and among lighting specialists, the electric light bulb is called a ‘lamp’ and the fittings that the lamps go into are called ‘luminaires’ or light fittings or light fixtures.)

There have been clever developments over the years in technologies for gas discharge lamps, including: fluorescents, mercury vapour, sodium and metal halide, and in tungsten filament, halogen and others described later. What has thrown the industry into a maze of complexity though, is a combination of shrinking electronics and growing energy costs.
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Then about 20 years ago manufacturers found that they could use electronic chips to produce light. The gradual improvement in the light output, particularly over the last ten years, has made these chips, called ‘light emitting diodes’ (LEDs), an additional low energy and efficient light source. Now LEDs are everywhere. (examples in fig, 4 & 5)

As you continue through this report you may notice that there are some generalisations. There are several and founded only on an attempt to keep things relatively simple.

The pictures below show what is happening to many churches. Lighting alone will not stop this happening but it can make a contribution by using light to bring churches to life, enhancing architectural features, highlighting beautiful artefacts and inspiring people.

Notwithstanding the great advances in technology and choice, it is not all about the lamps and fixtures. It is also about the use of light.

About Light (That is, artificial light from electric lamps.)

Artificial light from electric light sources is a complicated subject. In an effort to make things clear the most important characteristics are described below.

Quantity

The amount or volume of light from a lamp/bulb is specified in 'lumens'. In simple terms, a lumen is a unit of light specified by a particular standard measurement. (A more in-depth description can be looked up on the internet).

Energy

The energy consumed is specified in watts and therefore how many lumens you get out of a lamp per watt of energy is a measure of the efficiency of a lamp/bulb or lumens per watt (lm/w). For example, a conventional 60 watt lamp/bulb produces about 700 to 750 lumens.
Colour

There are two categories of colour associated with lamps/bulbs. (Not coloured lamps). The first involves the colour of light emitted from the light source and the second is the ability of light to reflect colour. These are outlined below:

**Colour (1)** The colour of the light produced by a lamp is characterised by reference to the colour of a heated body. Think of a poker in a fire; the hotter the temperature the whiter the light (white hot). It is specified as the Colour Temperature. 3500\(^{\circ}\) Kelvin is a ‘cool white’ (cool being the colour description not the temperature). 2500\(^{\circ}\) K is a warmer white even though it is a lower colour temp.

**Colour Temperature Kelvins**
- ‘Warm white’ ≤ 3,000 K
- ‘Cool White’ 3,500 K
- ‘Cold White’ 4,000 K
- ‘Daylight’ ≥ 5,000 K

Different manufacturers may use different descriptions but you get the idea. Osram demonstrated in their showroom in Munich, 14 different tones of white light using various lamps.

**Colour (2)** The second is the ability of light to reflect colour as you would see it in clear daylight. Specified by the Colour Rendering Index or Rendering Ability (CRI or Ra), a CRI/Ra of 100 is a highly accurate reflection of colour whereas one of under 80 is quite poor. You could regard this characteristic as the quality of light. The CRI/Ra is not usually shown on the lamp packaging but is often in the lamp manufacturer’s catalogue or their website specifications.

**Inverse Squared Law**

Light fades with distance at a rate of the distance squared. Distances between 1, 2, 3 and 4 are equal. Light at 1=1 at 2=1/2 at 3=1/4 at 4=1/16 Light fades quickly.

**Intensity**

The GLS lamp shape illuminates in a global sense. Spotlights use reflectors to direct the light into a beam. In a beam the important characteristic is the intensity of the beam in a certain direction which is specified in candela (cd). A 35 watt halogen down light, with a beam angle of 30 degrees has a luminous intensity of 1300cd whereas the same lamp with a 10 degree beam angle has an intensity 7000 cd.

**Reflection/ Absorption**

Light is reflected, absorbed or diffused depending on the surfaces it contacts. Light hard surfaces will reflect light more so than dark rough surfaces. You would need more light from an uplighter reflecting from a dark surface/ceiling than you would from a light coloured surface/ceiling to achieve the same level of illumination.

**Shadow**

With light you have shadows. Shadow is very important and great for effects but a nuisance in the wrong place. It is not easy to specify but easy to recognise and we’ll have more about this later.

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![Fig 8. ERCO is a major manufacturer of luminaires. This is their factory in Germany. A subtle reminder of this law is the line thickness of the letters of the ERCO name adjusted to mimic the inverse square law.](image1)

![Fig 9. From the Targetti Lighting Gallery near Florence in their Lighting Academy. The shadow is formed by a light projecting on a tiny metal ballerina.](image2)

![Fig 10. Glare](image3)

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About Electricity

It needs careful handling, sometimes expert or at least professional, but worth thinking about in the context of lamps. High and low voltage are relative terms. The normal household voltage is 240 volts and 'low voltage' lamps are usually 12 volts or less. There are also higher voltages in some of the electronics associated with particular fixtures.

Electrical power in watts is the product of the current flow in amps and the electrical potential in volts. Watts=Volts x Amps

To go from a high voltage, say 240v, to a lower voltage, say 12v, you need a transformer. As you can see below in Figure 11, with low voltage systems it is not just a lamp.

240v in [TRANSFORMER] out 12v.

Fig 11. Transformer and electronic management for a 23 watt LED Light Fixture.

About Lamps

The conventional 60 watt GLS lamp provides about 700 lumens of light at about 12 l/w with the life of about 1,000 hours. As most people are familiar with this lamp and have a notion of how much light it provides, you could refer to this as a benchmark. Although the quality of light is very good these are inefficient devices with most of the energy being consumed as heat and only about 15% of the energy producing light.

The poor energy efficiency is the reason that tungsten filament lamps are being withdrawn by Government regulation.

Halogen Lamps

Halogens are a form of tungsten incandescent lamp with many notable differences from the conventional tungsten GLS. The Halogen (a class of chemicals, often iodine) used with inert gas allows the vaporised tungsten to redeposit on the filament. This cycle takes place at higher temperatures and requires a quartz envelope instead of glass. As quartz is stronger than glass the temperature can be further increased which improves efficiency and gives a light output of about 30 lumens/watt.

A combination of 'point' light from the filament and the even spread of frequencies in the visible light spectrum gives the light from halogens exceptional brilliance. This quality makes them very popular with jewellers and those with glassware displays.

The redeposit of the tungsten is not consistent on the filament, which will eventually fail, but does result in about twice the life when compared with conventional tungsten lamps. Halogen lamps are much smaller and are more flexible for integration into fixtures. They come in a huge range of different forms and there are some important considerations.

1. From the 1st October, 2010 Building Regulations require that lamps should have an efficiency of 45 l/w to 55 l/w depending on applications. Churches, however, are generally exempt from the new requirements. For certain applications halogen lamps/bulbs have some advantages over more energy efficient lamps. They have very good colour rendition, and their compact nature allows them to be used in smaller fixtures than otherwise could be the case.

2. Prices for halogen lamps/bulbs vary considerably but they have been in volume production for a long time and cost considerably less than equivalents LEDs. The low utilisation of lighting in Churches makes them practical for a number of applications.
3. Low voltage halogens (12v) have a thicker filament which can double the life compared to the 240v versions. (Low voltage means higher current). As mentioned earlier a transformer will be required and this can provide difficulties with installation and the transformer is another source of failures.

4. The small size and having the surface of the lamp closer to the filament means that halogen lamps get much hotter than conventional incandescent. High temperature is required for their operation and can pose burn and fire hazards. Great care needs to be taken with installations in churches.

5. Halogen lamps can be dimmed in the same way as conventional lamps.

6. There are halogen replacements for the conventional 60 watt GLS lamp. A 42/45 watt halogen GLS shape equivalent (Fig 12) would save about 30% in energy and provide about the same lumen output with a high quality CRI/Ra.

![Fig 12. Halogen capsule in a conventional GLS envelope](image1)

7. Although more efficient than conventional tungsten incandescent, they are not in the same league as Fluorescents/CFLs or LEDs which are described later.

### Fluorescents

Another lamp that is very familiar is the fluorescent tube. Again, most people are aware of the type of light that these transmit. Over the years, they have suffered from flicker and a delay in start up, often buzzing noises, and they produce a flat, cold light which is hardly attractive. Now many of these problems have been overcome with electronic ballasts, advanced phosphors, and improved materials. The range of light quality has been improved and they have high energy efficiency. Modern fluorescent tubes are capable of producing well over 100 lumens per watt. The other major advantage is their long life approaching 20,000 hours. Although they are produced in a wide variety of lengths and widths, it is often difficult to find the space for attractive installations.

Surprisingly, fluorescent tubes have been used to great artistic effect by artists such as Dan Flavin as shown below in the photo of *Santa Maria Annunciata in Chiesa Rosa* in Milan.

![Fig 13. Santa Maria Annuciata in Chiesa Rossa in Milan with lighting by Dan Flavin](image2)

As mentioned in the introduction, technology has now allowed the tubes to be shrunk, curled, twisted and integrated with their electronics to produce a lamp known as a compact fluorescent (CFL).

![Fig 14. Another form of compact fluorescent](image3)

### Gas Discharge Lamps

Gas discharge lamps are a family of lamps that produce light by causing an electrical discharge through ionised gas. Gas discharge lamps have been researched and developed over many years. They are the most efficient way to generate artificial light and offer a longer life. The manufacture however is more complicated than the tungsten filament and they require electronics, generally known as ‘gear’, to generate the proper current flow through the gas.

When visible light is generated by a coating on the inside of the lamp’s glass surface, they are known as fluorescents perhaps the best known form of gas discharge lamp.
Compact Fluorescents (CFLs)

The CFL has the advantages of the fluorescent tube: long life and high light output. Its compact nature allows it to have either bayonet cap fitting (BC), which twists and locks, and Edison screw in fitting (ES).

It is therefore easy to replace the conventional GLS lamp with an energy efficient lamp such as a CFL. The CFL however, does have a short delay before it reaches full light output. Apart from the most expensive versions, they will not work with dimming controls. The colour rendition quality has also been improved but again, with the exception of the most expensive, the colour rendition is not as good as the GLS or halogen lamps and they generally have a CRI in the 80s.

CFLs are an area where some care needs to be taken. Following is a list of the key things of which to be aware:

1) They are energy efficient, have a long life and relatively low cost. The environmental agencies, the energy utilities and the lamp manufacturers are promoting these lamps. As a result of these promotions, you can buy a good quality CFL, equivalent to a 60 watt GLS for low cost, often for under a pound. There are lower quality imports also available at low cost. It is probable that as the market transitions from GLS lamps, promotions/subsidies will become scarce as CFLs are sold at a price that reflects their true cost. If you currently have a heavy reliance on CFLs, future costs may be considerably higher than at present.

2) Quality, as just mentioned, can be highly variable. Some cheap imports have high variability in all aspects of the lamp’s specification. In general there are fewer risks when you buy from the large and reputable manufacturers such as Philips, Osram or GE.

3) The light output of CFLs is often specified in equivalent terms to its nearest GLS equivalent. An 11 watt CFL may be marketed as a 60 watt GLS replacement. There are many occasions when a replacement CFL’s lighting effect is disappointing.

The cause is often an issue with the quality of light (CRI/Ra) but can also be a function of the lamp shape or the fixture (luminaire) in which it is installed. Sometimes it is simply because the lamp has not yet reached its full light output. For these reasons it can be perceived as being rather dim and in this light objects do not reflect high contrast. Light generated from the surface of a lamp will be ‘flatter’ than light from a filament or ‘point’ source, but can reduce the effect of shadowing.

Some of these “dim” problems can be overcome by using a higher rated CFL replacing a 60 watt GLS with a CFL rated at 75 watts GLS replacement.

4) The CRI/Ra issue is trickier and is the area where most care should be taken. The ability to reflect colours truly is a function of the number and amplitude of the various frequencies of which light is made. CFLs often do not contain the full range of frequencies or consistent amplitude of frequencies that make up visible light. This means that colour rendition is not faithful to or appears not to provide sufficient contrast to give proper colour resolution.

This probably does not matter if they are used in functional areas but they would not reflect or enhance the appearance of stained glass windows, tapestries or other decorative features where colour is a key element.

Fig 15. CFL replacement for halogen down lighter.

5) The other issue to be considered is that of energy efficiency and cost benefits. A factor in the choice of all lamps, and not just CFLs, is the day to day usage of church lighting. Many claims for efficiency, long life bulbs, and cost recovery are based of models of usage with which church lighting does not conform. Many small churches may only have the lights on for just a few hours a week. Therefore, the costs of replacement lamps are difficult to recover when the lighting is on only occasionally.

6) Dimming can vary the lighting effect, save energy and extend lamp life. It is difficult to dim CFLs and only expensive versions are capable of being dimmed. Even then they do not dim into the warmer spectrum of light colour in the same way as tungsten lamps.

7) CFLs contain a very small amount of mercury. They should be disposed of in accordance with the Waste of Electrical and Electronic Equipment (WEEE) legislation, as with other electrical products. Take them to a good local electrical wholesaler for disposal.
Metal Halide

Metal Halide is another type of gas discharge lamp. It is one of the lamps that produces light by sending an electrical discharge through a metal vapour such as mercury, sodium or in this case a vapour that contains elements of metal halide salts. These metals have high vapour pressures which increase the efficiency of the visible spectrum emission.

These types of high pressure discharge lamps are among the most efficient producers of light giving over 100 lumens/watt. Metal halide lamps can be manufactured to have a neutral white light which can be important where normal colour appearance is important. Like fluorescent lamps metal halides require electronic components to start and maintain their arcs. It takes time to establish the arc to full intensity and there is difficulty in re-striking the arc if switched on and off and back on too quickly.

There are also a large range of metal halide lamps from those used to light big open spaces from car parks to stadiums, down to miniature lamps for commercial and domestic use. Some of these could be sensibly used to project light in churches. Size and heat also need to be considered carefully.

Although they have good colour rendition properties, metal halides can emit light frequencies invisible to the eye in the ultra violet range which can cause fading of colours in textiles and dyed materials. UV blocking filters can reduce the UV output.

There are other types of discharge lamps that can have specific use, for example High Pressure Sodium but we can leave these for further discussions and particular applications.

Light Emitting Diodes (LEDs)

Light emitting diodes are the newest member of the general lighting family and perhaps worth some explanation as to what they are and how they compare.

LEDs are a chip of semiconducting material. When a voltage is applied to the material electrons release energy in the form of light. The voltage is usually between 3volts and 12volts and therefore LEDs may need a particular power supply which may also convert standard AC voltage to DC. Some of the LED lamps used for direct replacement may have the necessary electronics integrated.

An individual LED is very small from about 1mm square. Usually a lens is combined to shape and magnify its light output. As the light output is relatively low several LEDs are often combined to form a single lamp. High temperatures can damage LEDs. Cooling fins and heat sinks are designed to maintain good operating temperatures. While having many advantages over other light sources they are relatively more expensive and need more complex current and heat management.

The efficiency of LEDs has improved rapidly, over ten years or so; they have gone from 20 l/w to over 40 l/w for production devices. Lab and special products achieve even higher efficiencies. However as the current through the device increases the heat goes up faster than the increase in light and the technical solutions for this tend to be expensive.

The array of benefits that LEDs provide and future promise, has created enormous competitive pressure among manufacturers of the LED chip sets and between the luminaire manufacturers. The industry does not yet have agreed standards for all aspects of the lamp/luminaire specification and this leads to difficulties with spec comparisons.

There are also over optimistic claims by manufacturers based on other than real world testing. After all no one tests their product for 50,000 hrs; it would be out of date by the time they had finished. Manufacturers rely on lab tests, sampling and modelling. Efficiencies for the LED chip only are sometimes quoted for devices held at low temperature in a lab. In a lighting application, operating at higher temperature and with circuit losses, efficiencies are much lower. Like other lighting devices, LED performance is temperature dependent.

Most manufacturers’ published ratings of LEDs are for an operating temperature of 25°C.
LED White Light

There are two primary ways of producing high intensity white-light using LEDs. One is to use individual LEDs that emit three primary colours—red, green, and blue—and then mix all the colors to produce white light. The other is to use phosphor material to convert monochromatic light from a blue or UV to broad-spectrum white light, much in the same way a fluorescent light bulb work.

Organic Light-Emitting Diodes (OLEDs)

If the emitting layer material of the LED is an organic compound (organic not biological), it is known as an organic light emitting diode (OLED). Today these are found in some flat panel applications and are expensive and probably not appropriate for general use in churches.

Advantages

1. **Efficiency**: LEDs are being produced with increasing lm/watt and are improving at about 20% every two years. Their efficiency is not affected by shape and size, unlike fluorescent light bulbs or tubes. The challenge is to get the energy which is in light form out of the semiconductor. Various technologies are being used to do this albeit at higher cost.

2. **Lifetime**: LEDs can have a relatively long useful life. Some may reach as much as 35,000 to 50,000 hours (many, many years in a typical Church application) and time to complete failure may be longer.

3. **Colour**: LEDs can emit light of an intended colour without the use of the colour filters that traditional lighting methods require. This is more efficient and can lower initial costs.

4. **Size**: LEDs can be very small and are easily populated onto printed circuit boards.

5. **On/Off time**: LEDs light up very quickly. LEDs are ideal for use in applications that are subject to frequent on-off cycling, unlike fluorescent lamps that burn out more quickly when cycled frequently, or metal halide lamps that require time before restarting.

6. **Dimming**: LEDs can be easily dimmed.

7. **Gradual failure**: LEDs mostly fail by dimming over time, rather than the abrupt burn-out of incandescent bulbs.

8. **Robust**: LEDs, being solid state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs which are fragile.

9. **Environmental**: LEDs do not contain mercury, unlike fluorescent lamps. In contrast to most light sources, LEDs radiate very little Ultra Violet or Infra Red light.

Disadvantages

1. **Some fluorescents** and metal halide lamps are more efficient.

2. **High initial price**: LEDs are currently more expensive, on an initial capital cost basis, than most comparable conventional lighting technologies. The additional expense partially stems from the relatively low lumen output, the circuitry and power supplies needed, the lenses, reflectors and luminaire engineering to optimise light output. They are more difficult to justify on payback given the low utilisation of church lighting.

3. **Temperature**: LED performance largely depends on the ambient temperature of the operating environment. Adequate heat-sinking is required to maintain long life.

4. **Light quality**: CRI is not the best, however, CRI of common fluorescent lamps is often inferior to what is now available in state-of-art white LEDs.
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Fig 21. LED lighting arrays, not in a church but in a cafe in Central Station, Milan could send you dotty.

Fig 22. You get reflections too!

Fig 23. High power LED lamp with GU5.3 fitting and aluminium heat sink, intended to replace low voltage halogen reflector lamps.

LED Summary

It is not currently economical to produce high levels of lighting from LEDs. As a result, current LED replacement lamps offer either low levels of light at a moderate cost usually with a poor CRI, or moderate levels of light at a high cost and a better CRI although not as good as halogen and others. In contrast to other lighting technologies, LED light tends to be directional. This is a disadvantage for most general lighting applications, but can be an advantage for spot or flood lighting.

One configuration of LEDs is in a string or rope of lights. The small cross section and the flexibility allows them to be strung around or along architectural features such as the top of a column capital to uplight the architecture.

As of 2011, many LED lamps are available as 1) replacements for the ordinary household incandescent or compact fluorescent light bulbs, ranging from low power bulbs from 5 up to 40 watts; 2) through conventional replacement bulbs for 60 incandescent bulbs (typically requiring about 7 watts of power); and 3) a few lamps are now becoming available to replace higher wattage bulbs, e.g., giving light to about 100 watts of incandescent light equivalent to using a 13-watt LED, albeit at extra initial cost.

LED lamps are declining in cost, however, these lamps are slightly more power efficient than the compact fluorescent bulbs and offer extraordinary life spans of 30,000 or more hours (although this lifetime is highly dependent on operating temperature). An LED light can be expected to last many years under normal use, therefore even longer in churches, and may be a good choice for hard to reach or difficult to maintain fixtures. The lamps maintain output light intensity very well over their life-times. The aim is to typically drop less than 10% after 6000 or more hours of operation, and, in the worst case, drop less than 15%. They are also mercury free, unlike fluorescent lamps. LED lamps are also available with a variety of colour characteristics. With the savings in energy and maintenance costs, these lamps are becoming more attractive and as a result the manufacturers will be able to maintain an LED price premium.

About Light Fixtures/Luminaires

The light source needs to be connected to the electricity by means of a lamp holder. There is a wide array of connector types from the Bayonet Connector (BC) and Edison Screw (ES) which come in different sizes (27/14) to more and more specialist connectors, GU10, G5, GU 5.3, ... A full list can be found on the internet but is too long for here.

Fig 24. Lamps with different connectors.

To get the light organized, the lamp and its connecting lamp holder need to be engineered into a luminarie which directs, (the dimples on the reflectors are designed carefully to spread or direct the light to where you want it), diffuses, filters, and transforms the light from the source.
The luminaire is engineered with all the items for protecting the lamp, managing the heat generated and perhaps screening to reduce glare. For gas discharge lamps the luminaire will also contain the ‘gear’ for managing the electronics and maintaining electrical safety.

Putting all this around a lamp means that some of the light will not get used. A luminaire that is 70% efficient will reduce the light from say an 800 lumen lamp to 560 lumens. LED luminaires can be very efficient due to the small size and flat surface of an LED array.

One other item relating to the safety of the luminaire is its protection from foreign matter. It is covered by an international standard and rating system. This is known as the International Protection Code or more descriptively the “Ingress Protection Code”

The IP code has two numbers IP XX. The first number (0-6) refers to the protection against the ingress of solids (including fingers). The second number (0-8) relates to the protection from liquids.

A typical domestic table lamp may be IP 22 or IP 20. That is one you cannot get your fingers into but gives little or no protection from liquids. The higher the number the better the protection, up to IP68.

Example- IP68

The ‘6’ in this example represents the level of ingress by solids. A ‘6’ means no ingress of dust and complete protection against contact.

The ‘8’ in this example represents the level of ingress by liquids. An ‘8’ means safe for immersion in water beyond 1metre.

ABOUT LIGHTING DESIGN

Now that we have discussed the various types of lamps/bulbs, we are now going to look at some of the practical areas of lighting design.

This can range from deciding which lamps to replace to reconsidering the lighting for a complete church building, internal and external, or a remodeling or an extension. There are a number of ways to go about things.

Changing Lamps

You may need to change lamps because you cannot buy replacements for the lamps you have been using. It could also be that it is a response to encouragement from the Church authorities to reduce energy use or it may be that the congregation are not seeing as well as they used to and want help in reading their hymn books. (A 60 year old may need up to 15 times more light than a 10 year old to read as effectively, according to Philips). It is something you can probably do yourselves with some thought. If it is other than a direct replacement and you have to get into the wiring, it must be done by a qualified electrician.

An electrician may know a lot about wiring and lamps but may have a very limited knowledge about lighting design. The electrician will probably know what is easiest or most practical for the wiring but sometimes this has very little to do with the effect or use of light.

If the lighting design has been thought through then make sure the electrician does what you want.

If it is just changing lamps, an easy option is to put in something that will work in the same lamp holder. For example, a compatible bayonet cap compact fluorescent (CFL) replacement for a tungsten GLS 60 watt will work and save energy but there may be other concerns. Often the use of CFLs may result in a flat light that cannot practically be dimmed, that does not produce the full volume of light immediately, or a lamp that has a distinctive appearance that may not suit the luminaire or shade to which it is fitted.

You also need to consider if you have chosen the best CFL replacement in terms of light output, colour temperature, shape, and ‘effectivity’ with the luminaire or shade. ‘Effectivity’ refers to how much and where the light from the lamp is distributed from the luminaire/shade. Does it have a reflector and will the shade cut off more or less of the light than the old lamp?

The industry is launching LED lamps that can be a direct replacement for conventional GLS lamps. All the same issues apply to their selection as the CFLs plus they are at a much higher cost.
2. **Employ an independent lighting designer**

who is independent of a specific manufacturer. There are many good lighting designers about and some specialize in church lighting. They can be costly and may be inclined to be more ambitious for the project than is necessary or affordable.

(Some independent designers are more independent than others. They may have associations with, or favour certain manufacturers).

![Fig 26. Vaulted ceiling of San Satyr, Milan.](image)

The lighting of this vaulted ceiling, Fig 26, is from custom designed fixtures to provide precisely balanced and even light across the curved surface. The fixtures were designed by Artemide, an Italian company, specifically for San Satyr. I discussed this installation with the engineer who designed the fixtures who was an optical engineer. The effect is wonderful, but the costs must have been extensive.

3. **Employ a manufacturer’s lighting design.**

Many of the large and better manufacturers of luminaires (such as the companies I visited), and lamps, (Philips, Osram, GE) will create a lighting design to a brief. It will of course generally be designed around their products. Again, expect them to try and talk up the scope and the cost of the project.

![Fig 28. Basilica and Museum dell’Opera, Florence. Another example of a simple uplighter.](image)

Stand alone fixtures like that shown in Fig. 28 may not be very attractive in their own right, but they are flexible and there is no need for rewiring. Just don’t trip over the wire!

![Fig 29. And this is what it illuminates.](image)

4. **Do it yourself.** You know your church better than anyone else. Priests come and go and clearly they should have an input, but if the design is to stand the test of time, say 20-30 years, personal predilections may compromise good design.

**Use of Lighting**

The issue is about the use of light; functional, decorative, dramatic, inspirational, revitalizing. It is not about the lighting fixtures although due consideration needs to be given to energy use, accessibility, and maintenance. How do you want the church and its contents to look and feel? Knowledge of the church, the fabric, the congregation, the history and traditions are all part of the design for the lighting.
Fig 30 Philips promotion at a lighting exhibition. Not the sort of advertising that you may associate with a lighting company but it shows that the emphasis is on the results of good lighting.

The information in this paper may not be detailed or comprehensive enough for those involved to feel confident about designing a lighting scheme themselves. It should, however, allow you to be a more knowledgeable customer and have an informed debate, if you do pay for assistance. (There is vast information on the web, from manufacturers and others which should help).

If you do attempt to create a design yourselves, manufactures will still provide excellent advice and assistance if you enquire about their products even though you may not use them for everything.

Churches And Examples Of Certain Fixtures.

Below are some examples of light fittings and how they have been used in churches.

Internal Lighting.

It illuminates the fresco beautifully however it is very difficult to fit fixtures in the space available and to achieve a uniform spread of light (linear light). Without knowing when this was done it is probable that there are light fittings available that would do away with the dark intervals if preferred. Such coving is probably not available in many small English churches.

Fig 31. Cove lighting illuminates and can provide a comfortable level of ambient light.

Fig 32. Bringing the light to the subject.

A small halogen light fixture placed on the left hand side of the base is not projecting light a great distance but creates both illumination and shadow.

Fig 33. Mounting Fixtures.

The more ornate a church, the greater the options for mounting fixtures. Here, the top of the column provides space for a metal halide projector for general lighting, a halogen uplighter picking out the pilaster, and a flood light illuminating the vaulting.
This fixture (Fig 34) may not have much charm but it has the advantages of bringing the light to the subject(s). It focuses on a number of features in one area and all with just one electrical connection.

In ground lights are great for showing the architectural features of columns and arches... and are spooky too! They also show what happens when you don't look after the roof. Any up lighting in the reveals of windows and the base of columns is generally attractive, and also effective for external lighting.

This is not a small church but an example of attractive ceiling hung lighting. Churches are not only about the structure and memorials, but we also need people to see and be seen.
Fig 40. CFLs fitted to an iron chandelier in Southwark Cathedral. This time, strangely, it looks attractive.

Fig 41. Shilling for the meter.

When it comes to costs many Italian churches (and maybe others) use coin operated lights to illuminate chapels or special paintings. Good for conservation as well as fundraising!

Fig 42. A message in light, above the Uffizi Gallery in Florence, reminds me to say that, notwithstanding all of the above, nothing replaces the candle either for its symbolic or aesthetic value. (See examples below.)
External Lighting

External lighting may be controversial, particularly in rural locations where background lighting is minimal. Fortunately there is a wide choice of fixtures that can provide good illumination at low levels of light. The use of “dark sky” hoods or sharply focussed illumination can help to minimise light pollution.

As a rule of thumb, in a dark environment a little light goes a long way. There are many churches that are hidden by developments or the long term growth of trees and shrubs. Illuminating the church can make the church more visible. It usually makes what is normally the best looking building in the area look stunning. For those with a doubt about the beauty or effectiveness of illumination with low light levels, it is quite easy to fix a simple inexpensive flood or spot light on a good length of electrical cable and carry out some trial and error experiments. It usually wins over the doubters.

External lighting is often run for more hours than normal internal lighting and makes a better case for energy efficient solutions. A 70 watt metal halide lamp will provide more than enough light to illuminate an entire frontage an LED equivalent flood although it will be more expensive, will last longer and be more robust. The use of a timer can manage the number of hours the lights are on.

This is not your typical small church but shows how dramatic night illumination can be. This church is on one of the hills overlooking Florence.
Another church that lets you know it is there but the colours might owe something to Philips presence in town.

This church looked as though it was too venerable to be touched but with a little lateral thinking they developed a water feature which was illuminated at night as well as the church.

**Regulations**

Wiring and lighting of buildings is controlled by building regulations. An electrician or lighting specialist will understand well the essence of these regulations.

For those with a technical interest, the guide below provides detailed guidance for installing, among other things, lighting in new and existing non-domestic buildings to help comply with building regulations.

**Non-domestic Building Services Compliance Guide: 2010 Edition**

The Building Regulations were updated for the “Conservation of fuel and power” effective 1st October, 2010 under Part L of Building Regulations.

Certain buildings are exempt or subject to special conditions from energy efficiency requirements. These included listed buildings, historic buildings and places of worship.

Even so, the intent should be to improve the energy efficiency as far as is reasonably practical and to use the highest lumens/watt lamps consistent with the lighting effect that is trying to be achieved. This is something that the Church authorities would agree with. This also means that lighting can be chosen that best suits the genuine needs of the church from heritage, traditional, archaeological, aesthetic or ecclesiastical perspectives. **Remember that the low utilisation of artificial lighting in most churches makes energy saving a very marginal improvement.**

**SUMMARY**

There are over 13,000 small churches in the UK many of them listed. While lighting alone will not save some of them being made redundant, good lighting can make the building, its features, architecture, memorials and artifacts more noticeable, welcoming and even inspiring.

All churches may share certain characteristics but in their details and contents they are different. It would be difficult to summarise or provide a template that would suit your church but there is one very important area that is key. It is to use light to achieve the effect that you want.

There is a growing choice of light sources and fittings, many with the advantage of lower running costs through efficiency savings. It should be possible to select the right lighting for your church giving due regard to the needs of the congregation, the church and the available budget.

The choices available do make things more complicated but manufacturers of lamps, fittings and any number of websites offer considerable advice and support. It is hoped that in a modest way this report may also help.
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If you think I may be able to help with your church please do not hesitate to contact me. If you have any suggestions or comments on church lighting, again please do not hesitate to contact me on:

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Appendix.

These are the links to the regulatory documents for those who would like to get into the detail.


Basically, it says a way of showing compliance with the requirement would be to provide at a reasonable number of locations, where lighting can be expected to have most use, fixed lighting that only take lamps having a luminous efficacy greater than 55 lumens per watt. (Strictly you should take into account the power consumed in any transformer or power supply.)

External lighting should have a lamp capacity of not greater than 100 watts per lamp or light fitting and use sensors to ensure they are off when not required.

The building regulations however exempt certain places from having to comply with these requirements as shown below.

This is a link to the online document for existing non-domestic buildings

http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfpappartl/bcconsfpappartlappdoc/bcconsfpappartl2bappdoc

This is the link to the online document for new non-domestic buildings.

http://www.planningportal.gov.uk/england/professionals/buildingregs/technicalguidance/bcconsfpappartl/bcconsfpappartlappdoc/bcconsfpappartl2aappdoc

As specified in Approved Document L2B 2010 Edition for conservation of fuel and power in existing buildings other than dwellings, these are pertinent extracts taken from the online version.

GENERAL GUIDANCE

Buildings exempt from the energy efficiency requirements

3.5.................Regulations 9 of the Regulations, however, grants an exemption from compliance with the energy efficiency requirements to certain classes of buildings:

a. buildings which are:

i. listed in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990;

ii. in a conservation area designated in accordance with section 69 of that Act; or

iii, included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979, where compliance with the energy efficiency requirements would unacceptably alter their character or appearance.

Special considerations

3.6 Special considerations apply to certain classes of non-exempt building. These building types are:

a. historic buildings and buildings used primarily or solely as places of worship; the considerations that apply to such existing buildings are given in paragraphs 3.9 to 3.14.

Historic and traditional buildings which may have an exemption

3.7 As mentioned above in paragraph 3.5, the following classes of buildings have an exemption from the energy efficiency requirements where compliance would unacceptably alter the character or appearance of the buildings:

a. listed buildings;

b. buildings in conservation areas; and

c. scheduled ancient monuments.

Historic and traditional buildings where special considerations may apply

3.8 There are three further classes of buildings where special considerations in making reasonable provision for the conversation of fuel or power may apply:

a. buildings which are of architectural and historical interest and which are referred to as a material consideration in a local authority’s development plan or local development framework;

b. buildings which are of architectural and historical interest within national parks, areas of outstanding natural beauty, registered historic parks and gardens, registered battlefields, the curtilages of scheduled ancient monuments and world heritage sites;

3.9 When undertaking work on or in connection with a building that falls within one of the classes listed above, the aim should be to improve energy efficiency as far as is reasonably practical. The work should not prejudice the character of the host building or increase the risk of long-term deterioration of the building fabric or fittings.

3.10 The guidance given by English Heritage should be taken into account in determining appropriate energy performance standards for building work in historic buildings.
3.11 In general, new extensions to historic or traditional buildings should comply with the standards of energy efficiency as set out in this Approved Document. The only exception would be where there is a particular need to match the external appearance or character of the extension to that of the host building.

**Places of Worship**

3.14 For the purposes of the energy efficiency requirements, places of worship are taken to mean those buildings or parts of a building that are used for formal public worship, including adjoining spaces whose function is directly linked to that use. Such parts of buildings of this type often have traditional, religious or cultural constraints that mean that compliance with the energy efficiency requirements would not be possible. Other parts of the building that are designed to be used separately, such as offices, catering facilities, day centres and meeting halls are not exempt.

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