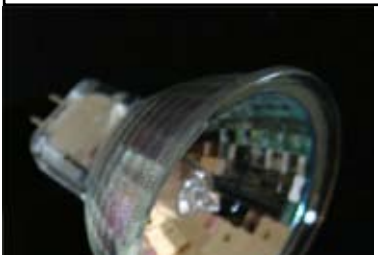
Commission for Mission

JUSTICE & INTERNATIONAL MISSION

Energy Audit Handbook

How to reduce energy use in your church

Second edition



Produced by:
The Justice and International Mission Unit
Synod of Victoria and Tasmania
Uniting Church in Australia
130 Lt Collins St
Melbourne 3000

p + 61 3 9251 5271
f + 61 3 9251 5241
e jim@victas.uca.org.au
w http://victas.uca.org.au/green-church

Everything we have comes from God. What we do with it is an act of discipleship. We have a responsibility to use the Earth's resources in a way that does not jeopardise the integrity of the earth and the enjoyment of it by future generations.

Climate change will touch all of us in some way. The Intergovernmental Panel on Climate Change (IPCC) are now predicting a rise in globally-averaged temperatures of between 2◦C and 6◦C by the end of this century[1]. With these temperature changes, scientists are predicting that we in Australia will experience more extreme weather events such as droughts, floods, and heat waves, further water shortages and more intense bushfires[2]. The most recent IPCC report (the Fourth Assessment Report) stated it is now very likely that most of the observed increase in globally-averaged temperatures in the last 50 years is attributable to human activities[3].

Each year humans burn 1.9 billion tonnes of coal for electricity[4], as well as other fossil fuels (coal, oil and gas). In Australia we are heavily reliant on cheap fossil fuels for our energy supply.

Reducing our demand for energy, using energy more efficiently and increasing the amount of energy we obtain from renewable sources such as wind, sun and hydro are essential to move us towards a more sustainable use of energy.

Reducing your church's energy use will save money, decrease greenhouse gas emissions, help protect our environment and honour our relationship with God's creation.

1 IPCC Fourth Assessment Report http://www.ipcc.ch/
2 Climate Institute http://www.climateinstitute.org.au/images/reports/ipccimplications.pdf
3 IPCC Fourth Assessment Report http://www.ipcc.ch/
4 http://www.umich.edu/~gs265/society/fossilfuels.htm

This handbook has been designed specifically for churches. While each church will have unique considerations, there are some general characteristics that typify a church's energy use. Most churches have a large worship space and/or hall which requires significant energy to heat and cool and often little or no insulation. Churches usually have multiple users so any behaviour change strategies have the additional challenge of needing to be targeted to various groups.

This handbook has four sections:

1. Six Preliminary steps to completing a sucessful audit
Even if you engage a professional auditor you will need to complete these steps.

2. How to conduct a site Inspection
(including a walk through audit checklist)
You can employ someone to do a walkthrough audit, but this gives you an understanding of what they will do.

3. Caluculating how much energy you use
This section helps you calculate how much energy you use in particular areas so you can gain an overview of your energy use.

4. Case studies and further suggestions

Note that the principles discussed in this document can also be used in your own home to save further energy, money and reduce greenhouse gas emissions.

- A 1000 Watt (= 1 kilowatt) electrical appliance will consume 1 kWh of electricity in one hour
- In Victoria, the burning of brown coal to make most of our electricity produces carbon dioxide (CO_2) a Greenhouse Gas (GHG) - 1 kWh produces about 1.4kg of GHG.
- 1000 kWh = 1.4 tonnes (1400 kg) of GHG
- 1 kWh of electricity is equivalent to 3.6 MJ of gas but 3.6 MJ of gas only results in 0.2 kg of GHG. So, natural gas is a much cleaner fuel than standard electricity.
- All electricity retailers offer “Green Power”, which is guaranteed to come from accredited renewable energy sources (such as wind, solar, biomass and hydro). The resulting greenhouse gas emissions from this type of electricity are close to zero.

Photovoltaic (solar) panels Castlemaine Uniting Church

Six preliminary steps to completing a successful audit

1. Get a team together
Appoint an energy 'champion' or a team of champions who are interested in and committed to undertaking the necessary work.

2. Get support
Get the support of your parish council or property committee and some key members of your congregation.

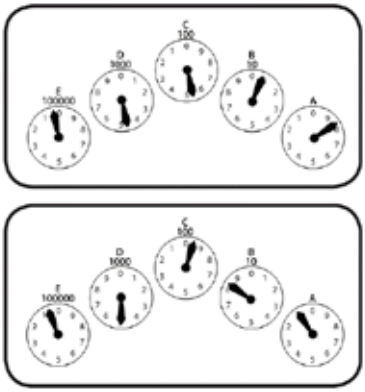
3. Get to know the basics
Learn some terms that will be useful. You will need to become familiar with the following units for gas and electricity consumption.

- *kWh = kilowatt-hour [the measure of electricity consumption]*
- *MJ = Megajoule (million joules) [the measure of gas consumption]*
- *GJ = Gigajoule (billion joules) = 1000 MJ*

4. Get to know your meters
Become familiar with your electricity and gas meters. Where are they located? Have you got easy access? You can measure how much electricity you use in a day, a week, or any other period by reading your meter at the start and finish of the period. If you have a digital meter, just read the numbers off the meter (you may need to press a button to scroll through different readings – the menu on the meter will tell you which numbers relate to which reading eg. peak, off-peak).

To read a meter with a clockface, begin by standing directly in front of the meter. Commence reading from the right hand side, reading the dials in turn – ABCDE. Write down the corresponding figures from right to left as read.

When a dial hand is between two numbers, write down the lower of the two numbers (except when the hand is between 9 and 0 – in this instance write '9'). For example, the reading in the diagram below is 04508 (four thousand five hundred and eight kilowatt-hours).
When a dial hand appears to be exactly on a number as on dial



D in the lower diagram, look at the previous dial (C) to the right. If the hand on dial C hasn't passed '0' the number '5' has not actually been reached on dial D and the reading on this dial is the next lower number (4). The reading is therefore 04981.

There are various types of electricity meters but the method of reading is the same. Usage is obtained by subtracting the previous reading from the present reading. Note that some meters have a 'multiplier' built in so that the kWh usage you calculate must be multiplied by (for example) 40. The multiplier is shown on the meter and on your bill.

Reading gas meters is similar - you read how many cubic meters of gas has been used and then on the bill there are two multipliers 'heating value' and 'pressure factor' which change from bill to bill because, for example, the composition of natural gas is not constant. These two multipliers result in a figure for the Megajoules used.

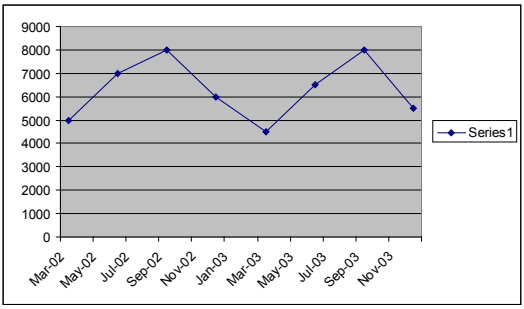
5. Get your bills together

Establish the historical energy use. Gather together the gas and electricity bills for the last two years and record the information in a spreadsheet like the sample given here.

For practice, enter the following billing information into an Excel spreadsheet.

kWh	
Mar-02	5000
Jun-02	7000
Sep-02	8000
Dec-02	6000
Mar-03	4500
Jun-03	6500
Sep-03	8000
Dec-03	5500

Highlight the information. Go to the Insert menu, then chart - choose a line or bar graph.



You can now see the seasonal variations. The next step is to establish why the energy is being used in this way. For example, is there increased heating needs between March and September?

6. Get to know who does what

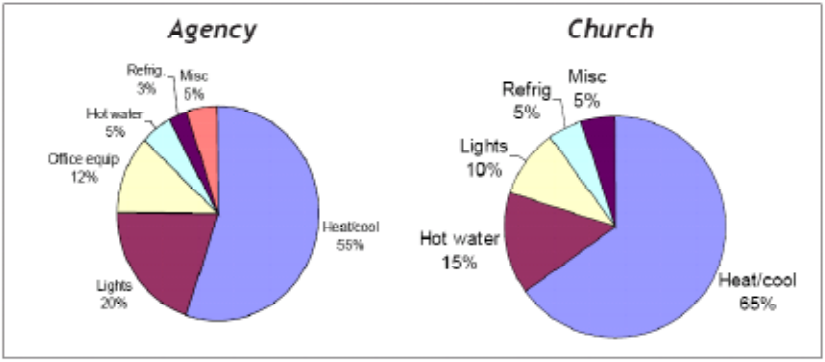
Make a list of the activities undertaken in the buildings and hours of usage. It is easy to overlook things because you are so used to them occurring, so this list is provided below to help start you thinking. If there is a roster book, consult it.

- Activities - Time per week - All year?
- Sunday morning service (no. of services; average no. of people attending)
- Fellowship luncheon
- Youth Group Callisthenics
- Dancing Playgroup
- Daycare Nursing Mother's
- Craft group / Music / choir rehearsals
- Yoga Tai Chi
- Kung Fu Hall hire
- Other church meetings (eg. parties on Saturday night)
- Church office activities
- Using the kitchen for coffee and tea
- Using the kitchen to cook meals

Templestowe Uniting Church Photo: Chris Rowntree

Site Inspection (Audit)

Once you have completed the preliminary steps and established the baseline of energy consumption and identified seasonal patterns, you can start investigating in more detail using the following site audit checklist. You will be able to make reasonable estimates of how much energy you use by noting down the following characteristics of your building and appliances.



The above pie graphs provide a guide as to where energy is used in a typical Uniting Church property. Note that every building and its utilisation is unique and will therefore have its own particular energy-use breakdown.

Heating, hot water and refrigeration are usually the largest energy users. Lighting can also be significant if you have a number of lights on for a long time or high wattage lights like sensor lights.

The bigger potential energy savings can be found in those areas where more energy is being used. However, it may be that it is too expensive or too difficult to make changes to the heating and cooling systems for example. Lots of smaller savings can also add up and for most churches around 15% of their energy can be saved through small changes – see the Case Studies from Bentleigh, St Luke's and Fitzroy Uniting Churches at the end of this handbook.

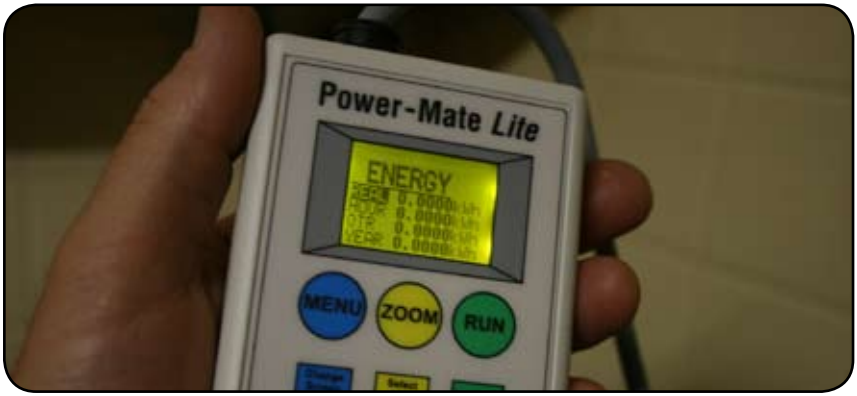
By using the following checklist and identifying and counting all energy using equipment and noting their energy ratings, you can begin to develop a ‘picture’ of your energy use (eg. heating, hot water and lighting).

You can use an energy meter to determine how much energy an appliance uses. If you are not using a meter, estimation will be necessary. As you develop experience over time, you will be able to refine your estimates. This will help you to determine with increasing accuracy where energy is being used.

Things you will need:

- A copy of building(s) plan or make your own sketch of the building(s)
- A thermometer that goes from –20°C to 100°C

As you work through the building, check the items below and where appropriate, mark on your plan any relevant information. This will help determine the action that needs to be taken to reduce your energy use.



Auditing tool - Free hire!

If you want to know how much energy an appliance uses such as a fridge which will fluctuate, contact the Justice and International Mission Unit on (03) 9251 5271. You can borrow up to two ‘Energy Meters’ to help you determine the amount of energy being used by different appliances.

Walk-through Audit Checklist

Passive Building Features

Construction

❑ Stone / double brick ❑ Brick veneer ❑ Weatherboard

Floors

❑ Concrete ❑ Timber ❑ Bare boards

❑ Other covering: type (eg. carpet)

Ceiling height

❑ High ❑ Medium

Building construction, floor type and ceiling height will influence the amount of heat lost from your building. A building with double brick construction, carpet and lower ceiling height will be more energy efficient than a weatherboard church with bare boards and a high ceiling.

Insulation

Wall:	❑ Yes	❑ No	❑ Unknown
Ceiling:	❑ Yes	❑ No	❑ Unknown
Floor:	❑ Yes	❑ No	❑ Unknown

Gaps in insulation?

❑ Yes ❑ No ❑ Unknown

More insulation means less heat loss or gain. Hot air rises so ceiling insulation should be the top priority to maintain heat in winter and a lot of heat is also lost through the floor and walls.

Window Area

North-facing:	❑ Large	❑ Medium	❑ Small
West-facing:	❑ Large	❑ Medium	❑ Small
South-facing:	❑ Large	❑ Medium	❑ Small
East-facing:	❑ Large	❑ Medium	❑ Small

North facing windows receive sunlight all day during the winter months, but should be shaded by appropriate eave overhang, external blinds or shading plants in summer. By planting deciduous plants in front of large North facing windows you can reduce the amount of sun in summer but allow sun through in winter to warm the church. East and west facing windows should have external blinds because in summer they are difficult to shade from morning and afternoon sun respectively. South facing windows receive less sunlight.

❑ Single glazed ❑ Double glazed ❑ Louvred
Double glazing increases the insulation properties of windows (which are a primary area for heat loss and gain).

❑ No gaps present ❑ Gaps present
Seal any gaps around windows to prevent heat loss.

Roof eaves	❑ Present	❑ Not present
External sun blinds	❑ Present	❑ Not present
Curtains	❑ Present	❑ Not present
Blinds	❑ Present	❑ Not present
Pelmets	❑ Present	❑ Not present

Roof eaves, external sun blinds, curtains and pelmets can all help with passive temperature regulation in your church.

Doors
Gaps around door: ❑ Present ❑ Not present

Ceiling
Vents: ❑ Sealed against draughts

Walls
Number of vents ___
❑ Sealed against draughts? ❑ Able to be closed?

Open fireplaces (mark as “OFP1”, etc.)
❑ Yes ❑ No ❑ Chimney sealed off?

Doors and vents allow warm air to escape so seal off gaps and close vents in winter if you can. Open fireplaces can also allow heat to escape when not in use, so see if you can seal off the chimney.

Active Building Features

Heating/Cooling: Mark on your plan as “H1”, “H2”, etc.

Fuel ❑ Natural Gas ❑ Electricity ❑ Other

Type

❑ Room / Space ❑ Ducted ❑ Pew

❑ Bar / Strip / Radiant ❑ Portable

❑ Hydronic (hot water)

❑ Refrigerative / reverse-cycle air conditioner

❑ Evaporative air conditioner

Heater	Energy rating (MJ/hr or kW)	Thermostat?	Temp of thermostat	Usage (hours/ week)
H1		Yes / No		
H2		Yes / No		
H3		Yes / No		
H4		Yes / No		
H5		Yes / No		
Total				

*Heating and cooling are often big energy wasters in churches. Make sure you have the right solution for your church. Generally heating with natural gas produces less greenhouse gas emissions than with electricity, and radiant or bar heaters (used in many churches) can be very energy intensive. For more information see http://www.yourhome.gov.au/renovatorsgui*de/products-heating.html

Zoning

❑ Entire building heated ❑ Areas in use heated

Ceiling fans

❑ Yes (mark as “CF1” etc) ❑ No

If yes, how often are these fans used?

Try to heat or cool only the areas you are using. Ceiling fans can help to recirculate warm air or keep you cool.
With heating (and cooling) being the major energy user, in winter keep the heat in – close doors and heat only those areas being used. In summer keep the heat out - close doors, pull down blinds (especially external blinds). Eliminating drafts helps keep heat in or out of the building – use draft excluders on doors and windows, seal off other gaps and close off vents where practical.

Hot Water
Hot water units will be found (or hidden) in a variety of places including cupboards and in the roof space.

Also check the hot water unit overflow pipe for leaking water. A small quantity leaking is normal, but large quantities may indicate the need for the unit to be serviced.

Sometimes churches have multiple hot water units. Check that you need to have hot water in the toilets for example. Particularly if the hot water takes a long time to come through, fewer people will actually wait to get the hot water.

Cooking / Other Kitchen
Cooktop

❑ Gas ❑ Electric
❑ High ❑ Medium ❑ Low use

Oven

❑ Gas ❑ Electric
❑ High ❑ Medium ❑ Low use

Microwave oven

❑ Yes ❑ No
❑ High ❑ Medium ❑ Low use

Pie warmer

❑ Yes ❑ No
❑ High ❑ Medium ❑ Low use

Toaster Oven / Griller

❑ Yes ❑ No
❑ High ❑ Medium ❑ Low use

Water Cooler

❑ Yes ❑ No
❑ High ❑ Medium ❑ Low use

Dishwasher

❑ Yes ❑ No
❑ High ❑ Medium ❑ Low use

Boiling Water (for hot drinks)

Type: ❑ Jug / Kettle ❑ Urn
❑ Boiling Water Unit - capacity in litres _____
❑ High ❑ Medium ❑ Low use

Brand / model _____
(you can sometimes look up a product's energy use specfifications on the internet or call the company)

Boiling water units for hot drinks are often running 24 hours a day, 7 days a week. Can the hours be reduced? Better yet, can you use a kettle? Consider installing a timer so that the hot water unit is only on when it's needed.

Did you know: For a single cup of coffee a microwave uses less energy than a kettle?It is best to purchase kettles without an element in the bottom so you can just boil the amount of water you need. Alternatively have a thermos to keep water that's heated warm until it is needed again.

Refrigerators / Freezers
Type

Unit	Type	Capacity (litres)	Energy rating and consumption (kWh/year)	Temperature in fridge and freezer section (°C)
F1				
F2				
F3				

Because they are on all the time, refrigerators use a lot of energy. If yours doesn't get used very often, or is very large consider other options – such as a spare fridge that is only turned on when it's needed, or an esky.

Lighting (interior and exterior)

Natural light levels ❑ Yes

Skylights ❑ Yes

Type	Location	Wattage	Number	Ability to separately switch?	Usage (hours/ week)
Tubular fluorescent					
Compact fluorescent					
Mecury vapour					
Halogen					
Incande-scent					

Except for security lighting, areas that are not being used do not need light. Tubular and compact fluorescent lights are more energy efficient than normal (incandescent) globes and low voltage halogen globes. Note that 'low voltage' does not mean low energy use. T5 bulbs or LEDs are both efficient and reduce lower frequency flicker therefore providing a better indoor environment.

When halogen globes are installed, many are used instead of one overhead light; this makes them generally more energy intensive. The need for a transformer to change the voltage from 12V to 240V (often installed in a roof cavity) has been associated with fire risk. The efficiciency of halogen lighting is further reduced because there is a need for holes in the ceiling which usually compromises the effectiveness of the insulation.

1200 mm fluorescent tubes are typically rated 36 Watts and 600 mm tubes are 18 Watts. In addition, 5 to 10 Watts per tube is consumed by 'control' gear in the lighting fixture.

For more information on choosing the best energy efficient lighting system

for your church start here: http://www.renovationplanning.com.au/display_story.php?story_key=0000000358

Other Equipment

Item	Location	No.	Wattage	Hrs used p/wk	Notes
Computer					
Computer server					
Printer					
Photocopier					
Fax					
Overhead projector					
PA System					
Sound system					
Organ					
Alarm system					
Hand dryer					
Other					

The growing use of computers and associated equipment means growing energy consumption, although laptops and LCD screens are more energy efficient. All computers should have their energy saving (Energy Star) feature activated and set to sleep mode when

not active for 5 or 10 minutes. Screen savers use as much energy as if the screen were activated.

Totals Page

To use the table below first work out the totals of all the sections then add the figures in place of the instructions in the Results table

Calculation Table

Section	**Total Energy use per year**	**CO2 Equivalent emissions**	**Cost per year ($)**
Heaters	Total Kw X total hours used per week X 52	Multiply the figure to the left by 1.4	Multiply the energy use per year by 0.151
Hot Water	Total MJ/3.6 X total	If electric multiply the figure to the left by 1.4 If gas multiply the figure to the left by 0.2 If solar multiply the figure to the left by 0.	For electricity multiply the energy use per year by 0.15 For gas multiply the total MJ by 0.752 For solar multiply by 0
Refrigerators/ Freezers	Total kwh per year	Multiply the figure to the left by 1.4	Multiply the energy use per year by 0.15
Lights	Total Watts/ 1000 X total hours used per week X 52	Multiply the figure to the left by 1.4	Multiply the energy use per year by 0.15
Other Equipment	Total Watts/ 1000 X total hours used per week X 52	Multiply the figure to the left by 1.4	Multiply the energy use per year by 0.15

Total for Church	**Add column**	**Add column**	**Add column**

Results Table

Section	**Total Energy (Kwh) use per year**	**CO2 Equivalent emissions**	**Cost per year**
Heaters			$
Hot Water			$
Refrigerators/Freezers			$
Lights			$
Other Equipment			$
Total for Church	Kwh	CO2e	$

Now you can easily show your church where you are using the most energy, wasting the most money and producing the most greenhouse gas emissions.

Case Studies

Case Study 1 – Bentleigh Uniting Church

Bentleigh UC has a worshipping congregation of approximately 100 people as well as at least 10 community groups who use their facilities throughout the week.

An informal energy audit was carried out by analysing the electricity usage accounts for four quarters (22/9/2006 – 26/9/2007). They were then analysed to elicit the most cost-effective ways to reduce emissions whilst not increasing their expenditure on energy.

They found that their biggest energy uses were the electric heaters in the hall, their two boiling water units and their lighting.

The first step was to turn off one of the boiling water units, which resulted in an immediate saving of around $800 per year.

The electric heaters were primarily being used by other community groups to heat the hall which has a very high roof (a large space to heat) and no insulation. They were unable to change over the heating to gas (which would have reduced their greenhouse gas emissions by approximately 3/4) as they didn't have gas connected to the property. They explored solar thermal forms of heating and cooling but at this stage they were too expensive. The first issue to be addressed will be the education of both the congregation and the hall-hirers in energy conservation.

Space-heating and water heating will be addressed in the forthcoming year during a second round of an ongoing energy-management program.

The foyer and halls of the church have many fluorescent lights. Replacing this lighting with T5 fluorescent tubes (these are small highly efficient tubes) will reduce their energy consumption by a small amount. Overall, the congregation is expecting to reduce its energy use in the first year by 40% which will save them $1800.

Leading Environmental Change

The Minister Ji Zhang and the congregation were keen to develop the mission of the church around environmental sustainability. A significant donation was made by one of the members of the congregation in order to install solar photovoltaic panels on the roof of the church. The church council also agreed to apply for funding for the solar array through the (Federal) Department of Heritage, Water and the Arts and the Victorian Department of Primary Industries.

As part of this, an education program has been established and the congregation has looked at ways of reducing their energy usage.

Case Study 2 - St Luke's Uniting Church, Highton

St Luke's commitment to lessening the environmental footprint of their church began in 2007 when they employed the services of an auditor to conduct an energy, water and transport audit of their property. After the audit was received in February 2008 it was made available to all members of the congregation and inspired the improvements that have since been made.

Listed below are some of the changes completed;

1. The floor heating in the Worship Centre was replaced with three gas heaters which significantly reduced the electricity usage.

2. An emphasis was placed on turning off appliances immediately after use.

3. Replacing radiant wall heaters in the hall with two gas space heaters and with split cycle air conditioners in the kitchen and meeting room.

4. Replacing incandescent light bulbs with compact fluorescent bulbs.

5. Removing tubes from security lights (from 2 to 1 fluorescent tube)

6. Disconnecting the hot water service in the toilets.

The congregation at St Luke's have a goal to try and reduce their CO_2 emissions every year by setting a CO_2 reduction target for the

next 12 months. In 2008 they reduced their emissions by 22% and they are aiming for a 10% reduction in 2009.

Leading Environmental Change:

The St Luke's Environmental Group meet regularly to discuss environmental issues, engage with a guest speaker, write letters to politicians and plan activities in the local community (such as tree planting). They have also spread the conservation message through the Pastoral Connections Team and holding four public forums on environmental themes. However, they are not done yet and are investigating solar panels, rain water tanks and other measures to further reduce their electricity and water consumption.

Next Steps

Once you have identified where you are using energy, there are a number of other important factors to consider:

- How much money can you afford to spend?
- Where are you going to get the biggest energy reductions for the amount of money you have?
- What are your constraints?
- What are your opportunities?

The bigger potential energy savings can be found in those areas where more energy is being used ie. heating and cooling. However, sometimes these measures are more costly. Concentrating on behaviour change measures such as switching off lights are cheap and easy, but require education and probably won't on their own deliver large reductions in energy.

Professional Auditing Services

If you want to conduct a more detailed audit than what you find in these pages, the companies below can help you out.

Useful things to know before a professional to do your audit:

There are three generally accepted levels of energy audits that can be conducted of a facility. Level one involves an analysis of the last year or two of electricity bills and a brief visual survey is conducted on a walk-through of the property to identify areas where energy might be saved. This Energy Audit Handbook is designed to help you perform a level one energy audit.

Level two is more detailed, with an additional break down of where energy is used in the building and a report detailing recommendations is produced.

Level three focuses on capital-intensive opportunities and collects detailed data in order to detail potential costs and savings and assist

with decisions that may take considerable capital. Each level is more detailed (and usually expensive) than the last, and levels two and three are usually done by professionals.

Further Steps to Sustainability

You may wish to only tackle this area once you have completed the electricity and gas side of things. Alternatively, if you can share the work around, someone else could undertake this area at the same time as you concentrate on building energy use.

Water Saving

- Consider installing a tank to flush toilets
- Consider installing flow restrictors on taps

Indoor Air Quality

- Consider the use of non-toxic paints such as bio-paints

Church Land use

- **Consider** planting Australian plants local to the area or native species that are drought resistant and provide a haven for birds and wildlife.
- **Consider using a wor**m farm for food scraps to generate fertiliser for the garden.

Sustainable Transport

- Form a recreational walking or cycling group in your church
- Install bike racks close by
- Resist putting in extra car parking spaces

In the Office

- Purchase recycled paper - contact (03) 9251 5279 for a copy of our guide to recycled paper.
- Set up a place for recycling milk cartons, paper etc.

Awareness raising

- Provide a green tips and ideas section in your church notice sheet.

- Have a worship service on Creation - resources at www.seasonofcreation.com

Company name	Phone/Fax	Postal address	Email and Webpage
Arup	(03) 9668 5459 Fax (03) 9663 1546	Level 17, 1 Nicholson St, Melbourne, VIC 3000	Rob.Clinch@arup.com.au www.arup.com
CarbonetiX	(03) 9015 8344 (03) 9783 1111 Fax (03) 9783 9068	PO Box 590, Frankston, Vic., 3199	bruce@carbonetix.com.au www.carbonetix.com.au ; www.schoolenergysavings.com.au
Ecomaster	1300 326 627 03 5428 8526 Fax: 03 5428 8527	PO Box 820 Gisborne 3437	info@ecomaster.com.au www.ecomaster.com.au
EEP Management	(03) 9870 1600 Mobile:0418 58 66 88		gargari@melbpc.org.au
Energy & Thermal Services P/L	(03 9873 2802) Fax (03 9873 2806) Mobile 0408 310 008		loom@alphalink.com.au
Enman Pty Ltd	(03) 9877 2266 Fax: 03 9894 1911	15/79 Mahoneys Road Forest HIll Vic 3131	anwar@enmam.com.au www.enman.com.au
Environmental Services United Group Services	(02) 6245 5851 Fax: (02) 6245 5252 Mobile: 0448 279 531	Level 4, 64 Northbourne Ave Canberra ACT 2600	

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