

Energy Audit of Worship Buildings

Why conduct an energy audit? Energy audits serve to identify areas where buildings can improve on efficiency. If you look at energy bills (electric, gas, and water) over time, you can examine trends and identify areas for improvement. Therefore, it is important to collect your energy bills for the prior 12 months so that ECOFaith can create graphs and see improvement over time. However, energy bills do not provide specific solutions to energy waste. To understand how your building can reduce its energy consumption, save your congregation money, and lower its environmental impact, conduct an energy audit using this guide and see where improvements can be made immediately.

Please take an hour or two to walk through the building and complete this audit thoroughly.

- You may need to consult with the facilities manager for some of these answers. It is a good idea if he/she came along with you on the energy audit walk-through.

When you are finished, use the attached “Energy Measurement Tool: Post-Walk-through” to see how the building scored and which actions you should take to improve the energy efficiency of the worship building.

What You’ll Need:

- This tutorial
- Pen
- Tape measure
- Light meter (available from SCE’s tool lending library) phone # (800) 772-4822
- The last 12 months of gas and electricity bills, for input into “Utilities Form.xls”

Walk-Through & Information Gathering

Lighting

1) What types of lights are used? How often are they used?

Type of bulb	Example	How many?	Where are they located?	Mark which are used most frequently (estimated hrs/wk)
Incandescent bulbs				
Compact Fluorescent (CFLS)				
Fluorescent Tube Lighting		Fixtures: Bulbs:		
Halogen				
LEDs				

2) Are the lenses and covers of your lights and light fixtures clean and are they cleaned regularly? Are the lenses and covers of fluorescent lights old, yellowed or broken? Are windows and screens cleaned regularly?

3) How do lights turn on in the building? Be specific as to where each type occurs.

- Manual lightswitches

- Motion sensors

- Dimmers

4) Are you over-lighting? Take the light meter into each room. Take several measurements in each room, and average these measurements for the room. This will give you an idea of whether you are using too many fixtures or bulbs with too many watts to provide the ideal amount of lighting. Please also take into account whether shades are usually left open or closed, as daylighting from the sun is preferred to artificial lighting.

Space (e.g. "Office"): _____	Space: _____
Light Level Reading: _____	Light Level Reading: _____
Space: _____	Space: _____
Light Level Reading: _____	Light Level Reading: _____
Space: _____	Space: _____
Light Level Reading: _____	Light Level Reading: _____
Space: _____	Space: _____
Light Level Reading: _____	Light Level Reading: _____

5) If you have fluorescent lights, check the ends of the fluorescent tubes. Are they blackened?

6) Locate your exit signs: what kind of light bulbs do they use? How many exit signs are there and where are they located?

Type of Bulb	Example	How Many?	Where are they located?
Incandescent (clear glass bulbs with a filament inside bulb)			
Fluorescent/CFL (1 or 2 narrow, U-shaped tubular frosted lamps)			
LED (String of small glowing red or green bulbs arranged in a circle, or softer light than CFL or incandescent)			

7) What colors are the walls and flooring of the spaces inside the worship building?

HVAC (Heating, Ventilation, and Air Conditioning)

- 8) Does the building have a furnace and/or individual heaters?
- If so, where are they located?
 - Is the main heater natural gas or electric?
 - What temperatures are the units set to in the wintertime?

- How old is the unit? (Estimate if possible.) If age is unknown, write down the model # from the unit here, as well as the brand. You can look up the approximate age of the unit from this number as well as the AFUE (annual fuel utilization efficiency) online.
 - Are activities held in rooms that can be separately heated?
- 9) Does the building have a central air conditioner or individual air conditioners?
- If so, where?
 - How old is/are the units?
 - What temperatures are the A/Cs set to in the summertime?
 - Are activities held in rooms that can be separately cooled?
- 10) Is there a programmable thermostat for heating and cooling?
- If so, is the programmable thermostat set?
 - What temperature is it set to?
 - Who is responsible for the thermostat?
- 11) How often does an HVAC specialist perform maintenance for the furnace and/or air conditioning?
- 12) How often are air filters replaced? Is there a maintenance schedule for their replacement?
- 13) How often are condenser and evaporator coils cleaned? How often are fans/blowers for HVAC cleaned? HVAC fans and blowers can be mounted to an exterior wall in a ventilation unit or above the ceiling (plenum fan), or used as part of a ducted system (duct fan).

A dirty HVAC blower:



14) Are the ducts and pipes coming off of the furnace/AC properly sealed? (If you can see a gap or feel air flow coming off of any of the pipes, they are not properly sealed.)

15) Are your furnace, water heater, and hot water pipes insulated? (They are insulated if there is some sort of wrapping around them).

- What temperature is your water heater set to?
- Is your water heater natural gas or electric?
- What is the brand and model number of your water heater?

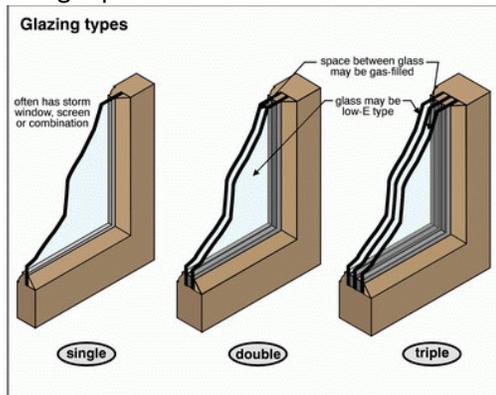
Weatherization/Insulation (Building Envelope)

16) Check each window, door, skylight, baseboard and electric outlets for the following for air leaks:

- Doors and windows – if they are broken or if you can rattle them, see daylight, see visible warping, or feel air flow, you have a leak!
- For baseboards and electrical outlets - simply feel for air flow.
- Note any obvious air leaks such as mail slots, or doors that are often propped open, etc.
- Note if weather stripping on doors is absent, damaged or insufficient.
- On outside, inspect all areas where two different building materials meet, including all exterior corners, or areas where foundation and bottom of siding meet.

Note here where air leaks occur:

Note here whether the windows are single-paned or double-paned and where they are located, if single-paned. Note the number of windows in the building.



Source: MBMCarpentry.com

Note here how curtains and blinds are used (left open during the day/night, always open/always closed, etc.).

- 17) In attic or crawl spaces check for air leaks to the outside and around any ductwork or piping. Also check for the absence, dampness or health/age of insulation. Are attic vents blocked by insulation?

Other Important Areas

- 18) Do you turn off your office equipment or other plug-in items when you leave the building?

- 19) Do you plug your equipment into power strips?

- 20) Are computers and other office equipment (i.e., copiers) set to auto-off and/or hibernate modes, when not in use? Are computer screens left on when not in use?

- 21) Does your building have a refrigerator? If not, skip to question 23. If so, check the back.

- Are the fridge and freezer condenser and evaporator coils clean from dirt or dust?
 - What is the brand, model number, and serial number of your refrigerator (usually found on the inside of the door or on the top shelf)?
- 22) Check door gaskets of your refrigerator.
- Is there condensation around doorframes?
 - Take a piece of paper and slide into door crack when open. Close the door and try to slide out the paper. Is it easily removed?
- 23) In restrooms and kitchens, check for obvious leaks and under the sink to see if you detect any leaks and note where this occurs.
- 24) In your restroom, are your sinks and toilets visibly old (15+ years)?

Energy Measurement Tool: Post Walk-Through

Please go through your answers to the energy audit with the post walkthrough guide to identify possibilities for action. For each item below, check the box on the left if the action is relevant and feasible and answer the accompanying questions. Be as specific as possible about noting opportunities for energy efficiency projects (where, when possible, feasibility).

Lighting:

Question 1: What types of lights are used? How often are they used?

If you have mostly incandescent bulbs, these are the least energy-efficient bulbs on the market.

- Bulbs with high usage should be high priority for changing to CFLs or LEDs.

Where will you change them? When?

- Old fluorescent lighting fixtures or lamps (T12) should be replaced and/or upgraded to Low-Wattage T8 or T5 if possible. For more information, see Fluorescent Lighting section in:

http://www.energystar.gov/index.cfm?c=sb_guidebook.sb_guidebook_lighting.

Where? When?

Question 2: Are the lenses and covers of your lights and light fixtures clean and are they cleaned regularly? Are the lenses and covers of fluorescent lights old, yellowed or broken? Are windows and screens cleaned regularly?

- If your answer was that they are not clean, the light fixtures need to be cleaned, and cleaning light fixtures should be added to the building's regular maintenance activities. The dust that collects reflects light away from the area it is supposed to light, resulting in wasted electricity usage. Where do they need to be cleaned?

- Light covers may need to be upgraded if they are yellowed and broken. Where?

- Windows and screens should also be cleaned to allow more daylighting to enter the building. This task can also be added to the building's regular maintenance activities. Where do they need to be cleaned, and who should clean them?

Question 3: How do lights turn on in the building? Be specific as to where each type occurs.

- a. Manual lightswitches
- b. Motion sensors

c. Dimmers

If your answer is manual lightswitches, consider installing motion sensor detectors in areas such as kitchens, bathrooms, and hallways, and outside areas. Dimmers can be installed in offices and sanctuary space to reduce electricity needs. This will result in lighting only when people are present, reducing consumption of electricity.

Where? When would it be possible to implement this action?

Install signs to remind people to turn off the lights when they exit the room.

Where? When?

Question 4: Are you over-lighting? Take the light meter into each room. Take several measurements in each room, and average these measurements for the room. This will give you an idea of whether you are using too many fixtures or bulbs with too many watts to provide the ideal amount of lighting. Please also take into account whether shades are usually left open or closed, as daylighting from the sun is preferred to artificial lighting.

Based on recommended illumination levels from the IES (Illuminating Engineering Society), see how this facility compares with the recommended levels.

	Light Level	Light Power Density
• Eating Area	20 FC	0.6 W/SF
• Food Preparation	75 FC	1.5 W/SF
• Conference Rooms (Sanctuary space)	35 FC	0.9 W/SF
• Hallways/Lobbies	20 FC	0.7 W/SF
• Offices		
• Private w/o task lighting	50 FC	1.2 W/SF
• Open w/ task lighting	35 FC	0.8 W/SF
• Computer Work	30 FC	0.7 W/SF
• Rest Rooms	20 FC	0.7 W/SF

Task lighting is individually controlled lighting in office spaces (such as desk lamps), whereas no task lighting would be use of overhead lights that light the entire room.

An FC is a foot-candle and is a unit of illuminance or light density used in the lighting industry.

Light Power Density is measured in watts per square foot.

If you discover that you are over-lighting in certain areas, consider:

Removing certain unnecessary light fixtures/unscrewing every other bulb within a fixture

Where?

Replacing dead light bulbs with lower wattage (CFLs are preferable to incandescent!)

Where?

- Increase the amount of daylighting by opening shades when possible
Where? Who is responsible?

Question 5: If you have fluorescent lights, check the ends of the fluorescent tubes. Are they blackened?

If your answer was yes, your lights are most likely degraded and are only running at 60% efficiency, resulting in a lot of lost electricity.

- Replace fluorescent lamps before they fail completely, and consider fixture replacement with T-8 electronic ballasts (check with SCE for rebates).
Where?

Question 6: If you have exit signs, what kind of lightbulbs do they use? How many exit signs are there and where are they located?

- a. Incandescent
- b. Fluorescent
- c. LED

- If your answer was incandescent, replace existing fixtures with compact fluorescents or LED lighting. These fixtures run for 8,700 hours per year, and on average incandescent bulbs need to be replaced five times per year. LEDs are more expensive upfront but need to be replaced less than one time per year. There are rebates available from SCE to offset the cost of purchasing LED exit signs (please see the 12_Rebate_Information for how to access these).
Where?

Question 7: What colors are the walls and flooring of the spaces inside the worship building?

- If your answer includes dark colors, consider repainting in a lighter color that better reflects light throughout the room, which results in less lighting needed for the room, which reduces electricity costs.
Where?

HVAC:

Question 8: Does the building have a furnace and/or individual heaters? If so, where is it located? What temperatures are the units set to in the wintertime? How old is the unit? (estimate if possible) If age is unknown, write down the brand and the model # from the unit. You can look up the approximate age of the unit from this number as well as the AFUE (annual fuel utilization efficiency) online.

You can Google the brand and model unit of your furnace to check out the approximate age and AFUE rating. Current Energy Star AFUE ratings are 85 and 90%. (For more information, see: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=FU)

Units that are more than 15 to 20 years old and with a low AFUE should be considered for early replacement for a unit with a higher efficiency rating (i.e. Energy Star). Old units are already likely to be running inefficiently, and will most likely fail when you need them the most.

If space heaters are present, running a typical space heater for an hour uses 70% more energy than a furnace.

Educate occupants to use space heaters less often or at lower temperatures if it is necessary to use one at all.

If possible, hold activities in rooms that can be separately heated so that the entire building does not have to be heated for a small event.

Question 9: Does the building have a central air conditioner or individual air conditioners? If so, where? How old is/are the units? What temperatures are the A/Cs set to in the summertime?

AC units that are more than 15 to 20 years old should be considered for early replacement for a unit with a higher efficiency rating (i.e., Energy Star). Old units are already likely to be running inefficiently, and will most likely fail when you need them the most.

Raise the temperature from 73° F in the summer to 78° F to maximize energy savings while still ensuring comfort.

- If possible, hold activities in rooms that can be separately cooled so that the entire building does not have to be cooled for a small event.

Question 10: Is there a programmable thermostat for heating and cooling? If so, is the programmable thermostat set? What temperature is it set to? Who is responsible for the thermostat?

- If there is a programmable thermostat, make sure that it is programmed correctly. Often, units are not reset when power outages occur, have never been programmed at all, or are not changed during Daylight Savings Time. Time when the program turns on to when occupants arrive in the building, and vice versa for when occupants leave. In the summer, increase the thermostat from 78° F to 85° F when building is unoccupied and in the winter, decrease thermostat temperature from 68° F to 55° F when the building is unoccupied.
- If there no programmable thermostat, consider installing one. The cost ranges from \$40 to \$200, with a short payback period in terms of energy saved. If this is not feasible, consider lowering the heating in the winter to 68° F to save on energy use.

Question 11: How often does an HVAC specialist perform maintenance for the furnace and/or air conditioning?

Recommended HVAC maintenance for furnaces is once per year. SCE says that it is not unusual for a heating system to lose 2% in efficiency for each year that it is not serviced. In addition, tuning up an A/C system can save up to 17% of cooling energy. These savings would be realized during the first year after servicing.

- To find a licensed contractor to have HVAC maintenance, go to <http://www.phccweb.org>

Question 12: How often are air filters replaced? Is there a maintenance schedule for their replacement?

Air filters for high occupancy buildings should be checked and replaced (if necessary) once per month; at the very least, change air filters every three months. Dirty filters slow down airflow and waste energy, and also may induce problems for the system, requiring expensive maintenance.

- Ensure that there is a schedule for maintenance and that someone specific is responsible for making it happen.

Question 13: How often are condenser and evaporator coils cleaned? How often are fans/blowers for HVAC cleaned? HVAC fans and blowers can be mounted to an exterior wall in a ventilation unit or above the ceiling (plenum fan), or used as part of a ducted system (duct fan).

If your coils are dirty, this restricts air flow so that your system will work harder and will thus be less efficient.

Coils should be cleaned often so that they do not accumulate dust. Add this activity to the building's maintenance plan.

Question 14: Are the ducts and pipes coming off of the furnace and/or AC properly sealed? (If you can see a gap or feel air flow coming off of any of the pipes, they are not properly sealed.)

Hire an HVAC specialist to help to seal the leaky ducts; this should be part of the yearly maintenance for the furnace.

Question 15: Are your furnace, water heater, and hot water pipes insulated? (They are insulated if there is some sort of wrapping around them). What temperature is your water heater set to? What is the brand and model number of your water heater?

If any of these are not insulated and they are hot to the touch, purchase relatively inexpensive hot water heater or furnace insulation blankets, as well as pipe wrap for hot water pipes. There are available rebates for insulating through Southern California Gas Company (socialgas.com/rebates). If your water heater is electric, you can install the blanket yourself, but if your unit is gas, please consult a professional.

Set the water temperature: the water heater should be set no higher than 120° F. (Usually, dishwashers require 140°F, but they usually preheat water to this temperature unless the preheat function has been turned off, in which case turn it back on and turn the water heater down!)

If your water heater is due for replacement, consider replacing it with a new tankless or gas-condensing water heater that meets current Energy Star specifications.

Weatherization:

Question 16: Check each window, door, skylight, baseboard and electric outlet for the following for air leaks:

- a. **Doors and windows – if they are broken or if you can rattle them, see daylight, see visible warping, or feel air flow you have a leak!**

- b. For baseboards and electrical outlets - simply feel for air flow.
- c. Note any obvious air leaks such as mail slots, or doors that are often propped open, etc.
- d. Note if weather stripping on doors is absent, damaged or insufficient.
- e. On outside, inspect all areas where two different building materials meet, including all exterior corners, or areas where foundation and bottom of siding meet.

Note where air leaks occur.

Note whether the windows are single-paned or double-paned and where they are located, if single-paned.

Note how curtains and blinds are used (left open during the day/night, always open/always closed, etc.).

If you encounter any air leaks there are several ways to plug them. For leaks around window perimeters, ducts, vents, etc. you should seal them on both sides with caulking (preferably silicone, polyurethane expanding foam or water-based foam sealant).

Caulk air leaks; list where: _____

For leaks around doors and window openings, you should install weather stripping most suited to your location – the weather stripping you choose should allow the window or door to open and close freely while sealing effectively when closed. It should fit snugly against both surfaces.

For leaks on the outside of the building seal them with the appropriate material (Butyl rubber caulking is the most durable, not recommended for indoor application).

For single-paned windows, when replacement becomes necessary, consider double-paned windows. Windows can be expensive to install if new ones are not needed, so most likely you should wait until you are replacing windows. Replacing windows can save a significant amount of energy, however, so it should still be a priority goal even if it is not currently feasible.

One behavior change that can help to save energy is to keep curtains and blinds closed at night during the winter, keeping warmth in the building. In the summer, keep curtains and blinds closed during the day to keep heat from getting into the building. To implement this action, you may need to educate office/maintenance staff and/or post signs.

Question 17: In attic or crawl spaces check for air leaks to outside and around any ductwork or piping. Also check for the absence, dampness or health/age of insulation. Are attic vents blocked by insulation?

If you encounter air leaks around ductwork, you should seal them with silicone caulk.

- If you find air leaks to the outside, use polyurethane expanding foam to seal.

- If insulation is absent or present but is visibly worn or old, consider replacing with new cellulose or fiberglass insulation.

- If insulation is present but inefficient, considering adding in additional blow-in cellulose insulation or upgrade current insulation to a higher rated insulation.

- If present insulation is damp, you should remove it in order to find the nearby leaks, seal with caulk, and reinstall new cellulose or fiberglass insulation.

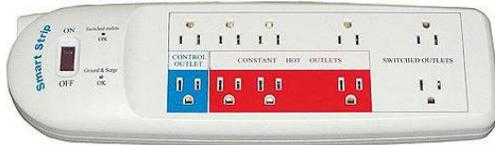
- If attic vents are blocked by insulation, remove that portion of insulation to ensure proper airflow.

Other Important Areas:

Question 18: Do you turn off your office equipment or other plug-in items when you leave the building? Do you plug your equipment into power strips? Are computers and other office equipment (i.e., copiers) set to auto-off and/or hibernate modes, when not in use? Are computer screens left on when not in use?

If you leave your electronics on (even in power save mode) they are often still drawing power from your outlets. This is called phantom load. To reduce your phantom load, turn off equipment and appliances that do not need to be on, and install signs near office equipment reminding others to turn off equipment when they are finished with them.

Purchase smart power strips that reduce the standard phantom loads used by electronics.



To test the standard or phantom load of any of your appliances or electronics, consider renting/borrowing a Kill-a-Watt from the CEC (email commrel@cecmail.org with subject line: Kill a Watt asking to borrow it) or the Southern California Edison tool-lending library (visit: <http://www.sce.com/b-sb/energy-centers/agtac/tour-agtac/tool-lending-library.htm> or call (800) 772-4822 to borrow). They are also available for purchase at Amazon.com or Home Depot for approximate \$20 each.

Work with office staff to set office equipment to auto-off and/or hibernate modes when not in use (use Google to find information relevant to your specific brand and model number of copier, computer, printer, fax machine, etc.)

Make signs to put on computer monitors reminding office staff to turn monitors off when not in use.

Question 19: Check the back of your refrigerator. Are the fridge and freezer condenser and evaporator coils clean from dirt or dust? What is the brand, model number, and serial number of your refrigerator (usually found on the inside of the door or on the top shelf)?

If your refrigerator coils are dirty, it is working harder than needed and thus inefficiently. Clean coils regularly. Assign someone this responsibility.

Use the following tool to determine the age of your refrigerator:
<http://www.appliance411.com/service/date-code.php>. Consider upgrading to a more energy efficient

model, if possible, which can save anywhere from 2-4 times the energy costs of the refrigerator depending on the age of the refrigerator. It is recommended that you consider replacing your fridge before it breaks, especially if it is over ten years old, and to replace it with a new Energy Star fridge (rebates and free removal services available).

Question 20: Check door gaskets of your refrigerator. Is there condensation around doorframes? Take a piece of paper and slide into door crack when open. Close the door and try to slide out the paper. Is it easily removed?

If there is condensation around your refrigerator door gaskets or if the paper slide out easy during your test, your door gaskets are worn and your fridge is functioning inefficiently. Replacing door gaskets is not easy. It is recommended that you consider replacing your fridge with a new Energy Star model (rebates and free removal services available).

Question 21: In restrooms and kitchens, check for obvious leaks and under the sink to see if you detect any leaks and note where this occurs.

Leaky faucets waste more water than you think! Go to <http://www.awwa.org/awwa/waterwiser/dripcalc.cfm> to get an idea of just how much wasted water you are paying for. If your faucet or showerhead is leaking, you may be able to tighten the gasket around the fixture for a quick fix. If this doesn't work, you may have to call a plumbing professional to fix this leak. Note the locations of the leaks you'll fix:

Question 22: In your restroom, are your sinks and toilets visibly old (15+ years)?

Older faucets and toilets have much higher flow rates than those sold under today's standards.

To decrease the flow of faucets, you can install a very inexpensive faucet aerator.

For toilets, consider installing low-flow or dual-flush toilets in their place.

If you are financially limited or leasing your space, there are several options for self-installable dual-flush toilet retrofit kits such as the [Flush Choice Dual-Flush Toilet Retrofit](#) (\$59.95) which is a universal retrofit designed to fit most 2-piece toilets, and installs in 30 minutes; or the [Simple Flush from Brondell](#) (\$79), which is also very easy to install and can save you up to \$100 per year in water bills.

Other potential actions not covered by the energy audit that you may wish to implement:

- Install solar panels for high-electricity consuming congregations/campuses, once energy efficiency projects are complete.

- Set up a carpool board or a system so that members can carpool to weekly service and other events, in order to reduce gasoline used.

- Replace conventional incandescent holiday lights with new LED versions.

- Replace a patch of lawn or parking lot with a community garden. Educate gardeners about organic and water-saving gardening methods.

- For every trash can, make sure there is a recycling bin, preferably larger than the trash can. Post signs educating congregants on what can be recycled.

Discussion with Other Green Team Members:

Are any of these items applicable to your home (not just the worship building)? Can you think of ways you can increase the energy efficiency of your home?

What are ways that you can share the knowledge of what actions can be taken?

Some suggestions are a quick skit in front of the congregation; conducting an “energy efficiency workshop”; posting signs in the worship building to let people know what the faith community is doing to increase energy efficiency. Please see the Educational Action Item List for more ideas.

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