Energy Workbook for Religious Buildings

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This is a reformatted version of a resource produced for the 2000-2001 project Outreach to Canadian Churches, called "Creating a Climate for Change".

It was sponsored by the former coalition, now part of KAIROS, called the Taskforce on the Churches & Corporate Responsibility (TCCR), through the InterChurch Committee on Ecology (ICCE), with additional funding support from the Government of Canada Climate Change Action Fund (CCAF) and the Baptist Convention of Ontario and Quebec.

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In the Ecology section under Energy Efficiency

KAIROS – Canadian Ecumenical Justice Initiatives
Ecological Justice Program, November 2004

ENERGY WORKBOOK FOR RELIGIOUS BUILDINGS

Preliminary Assessment[i]

An initial walk through assessment will help to identify energy losses that can be often be corrected by maintenance or operational actions. You will be amazed at how much can be done at little or no cost.

Checklist

Important: Please read carefully through the detailed descriptions (see page 4) related to the assessment as they will provide your church with the technical descriptions, samples, and information needed to complete the forms, as well as hints and options for increasing energy savings.

1. Basic Information			
1.1.	Collect anything relevant to energy use within the church for future reference.		☐
1.2.	Does the church have an energy policy?	Yes	No
1.3.	Has the church established energy reduction targets? If Yes, What are they?_____	Yes	No
1.4.	Record information about the building on Worksheet 1 - “Building Characteristics”		☐
1.5.	Record information about the building usage/occupancy on Worksheet 2 - “Weekly Occupancy”		☐
1.6.	Does the church regularly track its energy consumption?	Yes	No
1.7.	Record information from monthly utility bills for the past year or for a typical 12-month period on Worksheet 3 - “Energy Consumption Record”		☐
1.8.	Calculate the Energy Consumption per square meter		☐
2. Building Envelope (Insulation, Sealing and Vapour Barrier)			
2.1.	Is weather-stripping in good condition?	Yes	No
2.2.	Are cracks well sealed around windows, doors, wall sidings, block foundations?	Yes	No
2.3.	Is the building well insulated? Areas that are poorly insulated or uninsulated are:_____ _____	Yes	No
3. Equipment			
3.1.	Is equipment shut down when not in use?	Yes	No
4. Greenspace			
4.1.	Are deciduous or broad leaf trees or shrubs planted strategically around the building to reduce heating and cooling demands?	Yes	No

4.2 SOLUTIONS • Plant coniferous varieties in the North and North-west of the structure and deciduous in the South and South-west of the structure.			
5. HVAC (Heating, Ventilation and Air-conditioning)			
5.1.	Temperature settings during occupied hours – Summer and Winter		°C
5.2.	Temperature settings during unoccupied hours.		°C
5.3.	Are building temperatures set back during non-use periods?	Yes	No
5.4.	Is the boiler operating efficiently?	Yes	No
5.5.	Is the furnace filter clean?	Yes	No
5.6.	Does the area need to be this hot in winter?	Yes	No
5.7.	In summer does the air-conditioner need to be set so low? What type of air-conditioning is used? (window, central, packaged)_____	Yes	No
6. Lighting			
6.1.	Record lighting information on Worksheet 4 “Lighting Information”		
6.2.	Are lights turned off when space is unoccupied?	Yes	No
6.3.	Are lights turned off in areas where daylight is available?	Yes	No
6.4.	Are you using efficient types of lighting?	Yes	No
6.5.	Is the light level appropriate for the purpose of the area?	Yes	No
6.6.	Are you making the most of available natural light?	Yes	No
7. Refrigerators			
7.1.	Have all unnecessary refrigerators and freezers been unplugged?	Yes	No
7.2.	Are all water coolers unplugged?	Yes	No
7.3.	Are the freezer coils cleaned twice a year?	Yes	No
7.4.	Is the refrigerator at least 3 inches from the wall?	Yes	No
7.5.	Is the refrigerator door well sealed when shut?	Yes	No
8. Waste			
8.1.	Do you have a scrap paper box?	Yes	No
8.2.	Are both sides of paper used for photocopying or as notes?	Yes	No
8.3.	Are organic wastes composted or used as a biomass fuel source?	Yes	No
8.4.	Are materials recycled whenever possible?	Yes	No
9. Water			
9.1.	Are all faucets, toilets and water pipes regularly checked for drips and leaks?	Yes	No
9.2.	Are all water drips and leaks fixed?	Yes	No
9.3.	Do you have ultra-low flow toilets in place?	Yes	No
9.4.	Are the hot water tank and pipes insulated?	Yes	No
9.5.	Is the hot water tank set between 40-45°C (110-120°F)?	Yes	No
9.6.	Do you avoid watering the gardens and lawn in the heat of the day?	Yes	No

Detailed Descriptions

Helpful Hint: Many churches will find it beneficial for the committee responsible for caring for the building and grounds and the committee concerned with social justice and environmental ministries to work together with the pastor, custodial staff and volunteers. We recommend that each congregation assemble an energy management team responsible for tracking energy use, formulating and coordinating an energy conservation program, documenting savings achieved, and educating the congregation about energy efficiency at church and at home.

1. Basic Information

1.1. Relevant Materials may include thermostat operation manual, energy bills, minutes for property committee meetings, energy policy, blue prints, etc.

1.2. An Energy Policy will help to establish energy efficiency as a priority in the church. It is helpful for reminding the congregation about energy management work and encouraging everyone to become involved.

1.3. Reduction Targets can be used to help prioritize actions that will meet the church's goals. Having a reduction target is an essential first step to reducing energy consumption. Choose a target, which is challenging, but obtainable.

1.4. Record building and occupancy information. *Use blue prints of the church for floor plans (if available) otherwise make basic sketches.* If floor area is in square feet use conversion chart to obtain square meters. Age - Make note of the age of renovations if they affect the exterior building envelope, otherwise use the age of the main building structure. *Optional: Climate information such as heating degree days, cooling degree days, etc. can be obtained from Environment Canada. This information would be useful if you want to compare your data to religious buildings in other cities. Solar radiation, wind speed and direction data should be recorded if available to you.*

1.5. Occupancy - If church building usage/occupancy varies greatly during the summer season, use an additional table to show the weekly occupancy during that time period. Record the average weekly occupancy during the regular and Summer seasons with a break down by day, hours, purpose, room and number of occupants.

1.6. By monitoring your energy consumption it will help point the way to potential cost-effective energy-saving measures. If you have set a reduction target it is important to record this information to verify whether you've met the goal.

1.7. If your church uses other energy sources, not listed in the "Energy Consumption Record", record these in the additional columns with the type, unit, monthly consumption and cost. Calculate the actual energy consumption in MegaJoules (MJ) using: Oil = 38.68 MJ/L, Natural Gas = 37.2 MJ/m^3, Electricity = 3.6 MJ/KWh

1.8. Calculate the total energy consumption per square meter of gross floor area. Use the gross floor area in square meters from Worksheet 1. Use the total of all sources of energy consumption (MJ) from Worksheet 3. This will give you an overall idea of how efficient your church building is for energy consumption and can be compared with other churches/buildings in your area.

1.9. SOLUTIONS:

- Develop an energy policy for your church
- Ask utility company for 'green power'
- Increase use of renewable energy (Biomass, solar, waste fuels, and wind)

2. Building Envelope (Insulation, Sealing and Vapour Barrier)

2.1. Examine weather-stripping. If it easily pulls away from the wall or is broken this is an indication that it should be replaced.

2.2. Cracks in the foundation, wall structure, gaps between bricks, etc can be a significant source of heat loss as well as incoming drafts, by fixing these it will make the building more comfortable as well as reduce the overall energy consumption.

2.3. Note the rating of the insulation if available. A rating of R20 would indicate a well-insulated space. Are there specific areas, which are poorly insulated or uninsulated? i.e. Basement, Attic, Sanctuary walls, etc. Basements and attics in particular are often a significant source of heat loss.

2.4. SOLUTIONS:

- Repoint brick or stone work to minimize drafts
- Caulk and weather strip the inside and outside of all doors and windows
- Close shades at night in winter and during day in the summer
- Add insulation where needed (particularly in attics and basements)
- Install storm windows or upgrade windows to dual or triple pane glass
- Use reflective film on windows to block out solar heat and direct sun glare
- Rent or lease space in your building (does not directly reduce energy use, but allows for a better use of resources)

3. Equipment

3.1. Energy saving features, and good habits of shutting down equipment when not in use will help to reduce energy consumption.

3.2. SOLUTIONS:

- Auto shut off
- Use energy saving features (EnerStar feature on computer)
- Purchase high energy-efficient equipment

4. Greenspace

4.1. Planting trees and shrubs in strategic locations can help to minimize heating and cooling demands this is done by providing shade in summer months, and in the winter allowing light in while breaking the wind.

4.2. SOLUTIONS:

- Plant coniferous varieties to the North and North-west of the structure and deciduous in the South and South-west of the structure.

5. HVAC (Heating, Ventilation and Air-conditioning)

5.1. By knowing your setback temperatures, you can look at whether the church is making the most efficient use of heating and cooling systems.

5.2. Consider the length of time require to return to operating conditions from the setback temperatures.

5.3. Maintaining optimal occupied temperatures during non-use times is both demanding on your system and a significant factor for heating and cooling costs

5.4. Talk to maintenance and your boiler inspector to determine whether your boiler is operating at its optimum. If it is not operating at its best, find out what changes could be made to improve its efficiency and, taking long-term energy costs and savings into consideration whether or not it is worth investing in a more efficient model.

5.5. A clean furnace filter will help to keep your furnace operating efficiently and reduce energy demand.
5.6. Consider the purpose of each area in making this decision. What are most people saying about the temperature? Note: Temperature is different from an area being drafty, often the thermostat can be lowered in winter once cold drafts are sealed.
5.7. In summer it can often get too cold in a building because of air-conditioning. Consider the purpose of each area some you may wish to have cooler than others. Are most people comfortable?
5.8. SOLUTIONS:
- Install an energy-efficient furnace or boiler, which is adequate for the size and operation of the building.
- Inspect and tune-up furnace or boilers each fall
- Change furnace filters every other month during heating season
- Install a 7-day Programmable setback thermostat
- Set back thermostat, when facility is not in use to 12°C (55°F) in winter
- Set air conditioning thermostat to 25°C (80°F) in summer, when facility is not in use
- Install in-floor heating coils in large meeting areas
- Keep air grills, registers and space heaters clear

6. Lighting

6.1. Record the Location, Type of light, Wattage of bulb, # of bulbs, Hours used / year, Cost of Bulb, Life expectancy of Bulb and any comment. This information can be used to calculate payback periods and help to determine the feasibility of replacing with more efficient bulbs
6.2. Lights left on during unoccupied periods are often half of the energy demand for lights during use time.
6.3. Natural light is higher quality than manufactured lighting. Making the most of available light can reduce energy and heating costs.
6.4. Consider the amount of light you get from the type of bulb being used and compare to other possible alternatives.
6.5. Different purposes require different light levels and light quality.
6.6. Natural light can be used to reduce lighting and heating costs.
6.7. Notes:
- Motion sensors work well in small areas with irregular occupancy patterns.
- Timer switches can be used in areas such as washrooms, where the use is infrequent and lights (and fans) tend to be forgotten.
- LED lamps offer the same function in exit signs at a fraction of the energy cost (10-15%) and have a life expectancy of 25 years.[ii]

6.8. SOLUTIONS:
- Use the most appropriate design and maintenance (number, position, and type)
- Use high-efficiency lighting (i.e. replace incandescent lighting with CFL bulbs)
- Use natural light whenever possible
- Install dimmers
- Use computerized controls (timers, motion and light level sensors)
- Replace bulbs with a lower watt bulb for over lit areas or remove some fixtures.
- Use LED lamps in exit signs.

- Use task lighting for specific jobs rather than overhead lighting
- Use silver or aluminum reflectors in fixtures (reflectors maximize light output as they direct the light down and reduce glare by minimizing reflected light off of walls.)

7. Refrigeration

7.1 The efficiency of refrigerators correlates closely with age. Prior to federal standards created since the late 1980s, refrigerators were relatively inefficient. **The newest models use about half the energy of those made about 15 years ago**. For estimating the efficiency of your current unit, use the following guidelines:
Low: Units more than 10 years old
Medium: Units less than 10 years old but made before 1993
High: Units made in 1993 or later
A refrigerator which is unnecessary still requires the same energy as one, which is being used.

7.2 Consider storing cool water in an available refrigerator. Water coolers are often inefficient and not well used.

7.3 Built up ice can reduce available space and efficiency of freezers

7.4 Allow a space between the back of the refrigerator and the wall prevents coils from heating up and allows the fridge to run more efficiently

7.5 If a dollar bill can easily slip out from a closed door than the door is not sealing properly

7.6 SOLUTIONS

- Consolidate contents and unplug unnecessary refrigerators and freezers
- Move the refrigerator 3 inches from wall
- Unplug all water coolers
- Clean the freezer coils twice per year
- Replace seal on refrigerator door
- Make sure refrigerator is level (door may not seal properly if not)

8. Waste

8.1. A scrap paper box reduces energy costs for manufacturing. It also indicates an effort to conserve resources.

8.2. New products consume energy. By using both sides we can cut in half the cost of producing new materials, transporting, packaging, and reduce our cost of supplies.

8.3. Organic materials can be used as a source of energy or to minimize the use of fertilizers. In the landfill organic material is compressed and will produce methane gas as it biodegrades, since there is little or no oxygen available. Methane is one of the primary greenhouse gases.

8.4. If a product can not be reused, recycling will help to minimize the energy costs of extracting new resources from mining, logging, etc.

8.5. NOTES:

- Both the production of materials and their disposal consumes energy

8.6. SOLUTIONS:

- Use both sides of paper (photocopying, notes, etc.)
- Compost organic wastes or if available in your municipality your organic waste may be collected for use as a biomass fuel source (reduces organics in waste stream)
- Recycle materials whenever possible

9. Water

9.1. Regularly checking for leaking faucets or dripping taps will allow you to spot potentially more serious problems before they happen.

9.2. Ongoing drips and leaks is a source of regular energy consumption that can be easily fixed.

9.3. Pumping water into a building requires energy as well as the treatment of water.

9.4. Insulation or even a blanket can be wrapped around the hot water tank. This will help to reduce the heat loss, which occurs

9.5. It requires less energy to maintain a lower temperature on a hot water heater.

9.6. Much of the water is lost to evaporation, as well as the potential to burn plants from the intensity of the sun.

9.7. SOLUTIONS:

- Insulate hot water tank and hot pipes
- Turn hot water tank down to 40-45°C (110-120°F)
- Install a timer on electric hot water tanks
- Install tankless hot water tanks
- Fix all leaking faucets and toilets
- Replace conventional toilet with ultra-low flow one
- Avoid watering gardens and lawn in the heat of the day

Initial Energy Retrofits

Correct the obvious energy waste found in your walkthrough survey immediately. Appreciable savings can be realized from such simple, minimal or no-cost steps as lowering the thermostat settings, and turning off lights and fans in unoccupied areas. You can eliminate many energy wasting practices and inefficiencies by changing operational and maintenance procedures requiring little capital investment.

If, after you've evaluated the findings in your own assessment, a more detailed analysis of your energy consumption seems necessary, then you can contract a professional energy-management specialist to conduct an energy assessment and assist you to identify potential improvements. Your assessment information will provide the important preliminary data required for an in-depth analysis.[iii]

Factors

Conversion Factors:

1ft2 = 0.09295 m2
1 m^2 = 10.764 ft^2
1 kWh = 1000 Watt-hours (Wh)

Energy Factors:

38.68 MJ/L - Oil
37.2 MJ/m^3 - Natural Gas
3.6 MJ/KWh – Electricity

Definitions:

Billed Demand: The maximum power draw (kW or Kva) for the month after adjustments.

Building Envelope: The shell of the building (exterior walls, windows and doors and roof.)

Cooling Degree-Day: The amount of cooling energy required. It is measured by the difference between the mean temperature for the day and the base temperature of 18 C, where the mean temperature is above 18 C.

Colour Rendering Index (CRI) – is the ability to distinguish between different colours and how close the colour viewed under a particular light source is to that colour under natural light. i.e. Incandescent lighting has the lowest colour distortion, but provides the least amount of light (brightness) per kilowatt.

Demand: The instantaneous power requirement of a building, or the rate at which electricity can be supplied to the building.

Efficiency: Output/Input x 100%

Heating Degree-Day: The amount of heating energy required. It is measured by the difference between the mean temperature for the day and the base temperature of 18 C, where the mean temperature is below 18 C.

Lumens - Is a standard measure of the brightness of light.

Table: Colour Quality vs. Lumens/Watt[iv]

Light Source	CRI	Color	Lumens/Watt
Incandescent lamps	97	Excellent	10-18
Fluorescent, full spectrum 7500	94	Excellent	40-90
Fluorescent, cool white deluxe	87	Excellent	40-90
Compact fluorescent	82	Excellent	40-90
Fluorescent, warm white deluxe	73	Good	40-90
Metal halide (400 W clear)	65	Good	60-90
High pressure sodium (250 W)	65	Good	60-120
Fluorescent, cool white	62	Good	40-90
Fluorescent, warm white	52	Fair	40-90
Mercury	43	Poor	20-50
High pressure sodium (400 W)	32	Poor	60-120
Mercury vapour (clear)	22	Poor	20-50
Low pressure sodium	-	Undefined	90-200

Worksheet 1 “Building Characteristics”

Church: _____ Address:_____
Prepared By: _____ Date: _____

Building Physical Data

Age: No. of floors:
Total Floor area (Square Meters): Net Floor area air conditioned (Square Meters):

Construction Type:

Walls:
Exposure (N, E, S, W) Type(stone, brick, etc.)

Roof:
Type: Flat_____ Colour: Light_____
Pitched____ Dark_____

Window Glazing:
Exposure (N, E, S, W) Type (single, double, insulating, reflective, etc.) % Glass/Exterior wall area

Doors:
Exposure (N, E, S, W) Type

Levels of insulation on all exterior walls and roof

Draw or attach basic floor plans, which shows the location and sizes of all rooms, doors, windows and basic layout.

Worksheet 2 “Weekly Occupancy”

Occupancy Season:

Day	Hours	Purpose	Room	# of Occupants	Notes

Occupancy Season:

Day	Hours	Purpose	Room	# of Occupants	Notes

Worksheet 3 “Energy Consumption Record”

Church: _____ Reporting Period:_____

Prepared By: _____ Date: _____

	Oil			Natural Gas			Electricity Consumption			Electricity Demand				
Meter No.														
Meter Location														
	L	**$**	**MJ**	**m^3**	**$**	**MJ**	**KWh**	**$**	**MJ**	**KW**	**$**			
January														
February														
March														
April														
May														
June														
July														
August														
September														
October														
November														
December														
Total														

Note: Adjust amount to reflect the average consumption over the # of days in that month, since reading dates vary.

Total Energy Consumed/Gross Floor Area (MJ/m^2) _____

Worksheet 4 “Lighting Record”

Location	Type of light	Wattage of bulb	# of bulbs	Hrs used / year	Cost of Bulb ($)	Life of Bulb (Y)	Comment

[i] Energy Stewardship Action Checklist www.webofcreation.org/stewardship/checklist.html
[ii] Dollars to Sense: Spot the Energy Savings Opportunities – Guidebook – NRCan/OEE
[iii] Pembina Institute's Eco-Efficient Communities Initiative www.climatechangesolutions.com
[iv] Dollars to Sense: Spot the Energy Savings Opportunities – Guidebook – NRCan/OEE