This report presents the findings and recommendations of the assessment of energy use and environmental stewardship of Arlington Street Church, Boston, MA. As stewards of the earth it is important that communities of faith understand the contribution of their facilities to environmental conditions. It is also important that they act responsibly to improve their situation, and to prompt similar understanding and action on the part of their congregants.

The information in this report is organized in the following sections...

* **Summary** – Identifies the facility attributes and issues for environmental stewardship

* **Environmental Stewardship Profile** – Shows current use and cost of utilities, with the environmental impacts and potential for change

* **Facility Systems and Conditions** – Covering heating, domestic hot water, cooling, electrical, plumbing, and building envelope systems, with photos illustrating key conditions.

* **Related Environmental Stewardship Action** – Including clean electricity, and actions by congregants.

* **Appendices** – Detailed utilities use data, facility use patterns and materials for use in taking next steps.

SUMMARY

Arlington Street Church, a congregation of approximately 270 members, is located at the corner of Arlington and Boyleston Streets, Boston, Massachusetts. The facility consists of the following structures:

- *Church* – Constructed in 1861, the church building has stone walls, stained glass and other windows, a pitched slate roof, and three sets of double wooden doors providing primary entry to the Sanctuary.
- *Parish House* – The parish house connects to the rear of the Church. It has stone and brick walls, stained glass and single glazed double hung windows, both flat and pitched roofs with built-up and asphalt covering, and three wood doors as primary entry.

The facility is heated by *steam*, which enters in the basement of the parish house. The steam radiators and warm air ductwork distribution systems are of varying age. There are three thermostats to control the heat distribution. *Domestic hot water* is generated by an 48 gallon residential grade gas-fired DHW tank, located in the kitchen and a small electric water heater located in the Parish House bathroom. There is no *central cooling*. Two rooms have through-window/wall *air conditioners*. Electric *service* is through the basement of the church building. It is rated at 600 amps. *Wiring* is of varying age with extensive upgrading in the Sanctuary in 2001. Old wiring is two-wire, with no grounding in areas of the main entry and at the Parish House. *Interior lighting* is of varying age and is a mix of incandescent and fluorescent. There is *entry lighting* at each door, and site lighting around the building. The main *equipment* with electricity demands includes office machines (computers, copy machines, etc) and refrigeration equipment for the kitchen. The primary *water* use is from the sinks in the five rest rooms and in the kitchen. The primary *sewer* use is from toilets and urinals. Most of the plumbing fixtures do not meet contemporary standards for water consumption.

As currently configured and operated the facility paid $33,774 for all utilities in 2002. The cost for the utilities decreased by about 10% from the 2001 costs. As compared to the average facility of its type, Arlington Street Church pays 74% more per square foot for its energy. The pollution generated by this facility is similarly more than average. The key environmental stewardship issues for the facility are...

- **Building** – Improve thermal performance of the building envelope
- **Heating** – Install an energy-efficient heat generation source with contemporary controls for multiple zones; install new means of distribution and heat delivery at points of use. Install an efficient DHW system as part of the new heat generation solution.
- **Cooling** – Replace existing inefficient air conditioners with the best available Energy Star rated air conditioners.
- **Electrical** – An upgrade to energy-efficient lighting is needed. A move to clean electricity by the purchase of 100% green electricity is essential.
- **Plumbing** – An upgrade in sinks and toilets to control water use will not only reduced costs but also improve the aesthetics of the restrooms.

Arlington Street Church

Environmental Stewardship Profile

	2 Years Ago	*1 Year Ago*	*Last Year*	
ELECTRICITY				
	2000	2001	2002	**Total**
kWh Used	87,360	98,760	96,660	**282,780**
Cost	$9,573	$13,033	$11,786	**$34,392**
Cost per kWh	$0.110	$0.132	$0.122	**$0.12**
% change in Use		113.0%	97.9%	
kBtu/year	297,024	335,784	328,644	**961,452**

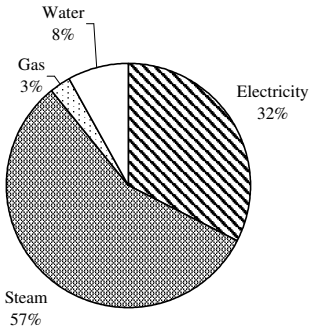
	2 Years Ago	*1 Year Ago*	*Last Year*	
STEAM				
	2000	2001	2002	**Total**
Mlbs Used	1,152	711	752	**2,615**
Cost	$22,223	$20,281	$17,712	**$60,216**
Cost per Mlbs	$19.291	$28.525	$23.553	**$23.03**
% change in Use		61.7%	105.8%	
kBtu/year	1,117,670	689,812	729,590	**2,537,073**

	2 Years Ago	*1 Year Ago*	*Last Year*	
GAS				
	2000	2001	2002	**Total**
therms Used	569	756	748	**2,073**
Cost	$777	$1,331	$957	**$3,065**
Cost per therm	$1.366	$1.761	$1.279	**$1.48**
% change in Use		132.9%	98.9%	
kBtu/year	56,900	75,600	74,800	**207,300**

	2 Years Ago	*1 Year Ago*	*Last Year*	
WATER				
	2000	2001	2002	**Total**
Units Used	262,731	315,936	370,359	**949,026**
Cost	$2,356	$2,784	$3,319	**$8,459**
Cost per Units	$0.009	$0.009	$0.009	**$0.009**
% change in Use		120.3%	117.2%	

	2 Years Prior	*1 Year Prior*	*Last Year*	
	1999	**2000**	**2001**	**Total**
Total Cost	**$34,929**	**$37,429**	**$33,774**	**$106,132**
% change	**-**	***107.2%***	***90.2%***	

Utility Use by Type



Energy Benchmark — How Your Facility Compares

	You	Average	% of Average
Use/SF	44	61	72%
Cost/SF	$1.19	$0.68	174%

Estimate of Your Pollution Production

	CO_2	SO_2	NO_x
Electricity	143,057	899	251
Gas and Steam	1,256,883	1	988
Total	1,399,940	900	1,239

Potential for Pollution Reduction

	CO_2	SO_2	NO_x
Green electricity	***99%***	***100%***	***73%***
Gas & Steam	***<<As much as***	***44%***	***savings>>***
Possible Reduction	(688,979)	(899)	(614)
% reduction	-49%	-100%	-50%

CO2 Carbon Dioxide, a greenhouse gas

SOx Sulfur Oxides, which cause acid rain

NOx Nitrogen Oxide, which causes health problems

Insert CONDITIONS EXCEL SHEET here

FACILITY SYSTEMS AND CONDITIONS

This section presents information on each of the major systems at the facility, the conditions, recommended actions and fundamental reasons for taking these actions.

Heating

Existing Conditions

Heat is generated for the entire facility by *steam*. The steam is provided by Trigen-Boston Energy Corporation with no direct on-site generation. Heating *distribution* is by steam radiators and gravity warm air. There is possible asbestos containing insulation on the steam pipes in areas throughout the building.

Recommendations

It is recommended that the facility investigate the feasibility and associated costs for upgrading the heating system to a high efficiency, on site, gas fired, multi zone hydronic system. The system should be zoned with consideration to the varying demands of the different sections of the facility. This investment will provide greater flexibility of control resulting in increased comfort and long-term savings from both financial and environmental impact perspectives.

Domestic Hot Water

Existing Conditions

Domestic hot water is currently generated by two different type units. There is a *gas fired* freestanding 48-gallon unit located in the kitchen area. This equipment was manufactured by Jet Glass, and installed in 1998. There is also a small *electric* water heater located above the suspended ceiling in the Parish House bathroom. The capacity of this unit is estimated to be 10 gallons.

Recommendations

It is recommended that a high efficiency gas fired on-demand (or in-direct fired stainless steel storage) water heater be installed as part of the upgrade of the heating system. This system upgrade will satisfy the minimal hot water demand of the facility and reduce standing energy losses.

Cooling

Existing Conditions

There is no *central cooling* for the facility. There is a single window air conditioner with a cooling capacity of 24,000 BTUs located at the main office area. There is a second window type air conditioner used to cool the computer server room. This unit was not accessible but discharges into the same interior closet where the main steam pipe is located.

Recommendations

It is recommended that any air conditioners used be upgraded to Energy Star units to reduce electric consumption and the associated environmental impact.

Electrical

Existing Conditions

Electric *service* is provided to the facility via a main service duct that enters the building where at the front left corner of the basement. The date of installation of the service equipment is unknown. The service panels are by General Electric. Service is rated at 600 amps. Facility *wiring* is of varying types and ages including old knob & tube, BX cable, romex, and conduit. There are multiple circuit breaker sub-panels at the front of the basement and kitchen areas. There was reportedly extensive wiring upgrade completed in the main sanctuary area during the

2001 renovations. The *lighting* varies by room, and is a combination of incandescent and fluorescent. The majority of the lighting is not energy efficient. There is a variety of *equipment* in the facility that uses electricity, including office equipment, refrigerators, space heaters, air conditioners, and fans. This equipment varies in age and condition. The majority of the equipment is not energy efficient.

Recommendations

It is recommended that the remainder of old knob & tube wiring be upgraded for improved safety. All inefficient interior incandescent lighting should be upgraded to energy efficient fluorescent lights. Exterior incandescent lights used to illuminate the entry areas and the right parking area should be upgraded to energy efficient with photocell or timer controls.

Recommend upgrading the old refrigeration equipment to new high efficiency Energy Star rated units. The upgrades to energy efficient lighting and appliances will help reduce the overall electrical consumption of the facility and the associated environmental impact.

Plumbing

Existing Conditions

The primary *water* using equipment in the facility includes sinks in the restrooms and the kitchen. The equipment is mostly old and not efficient. The toilets and urinals in the restrooms are the primary generator of *sewer* use. The toilets and urinals are mostly old and are not efficient.

Recommendations

It is recommended that the inefficient toilets and urinals be replaced with fixtures meeting contemporary water consumption guidelines to reduce water and sewer usage. Toilets should use no more than 1.6 gallons per flush and urinals no more than 1 gallon per flush. Installing water

saving on/off aerators or automatic flow controls at the bathroom sinks will also help conserve water. Self-metering faucets using 0.25 gallons per cycle are the preferred option.

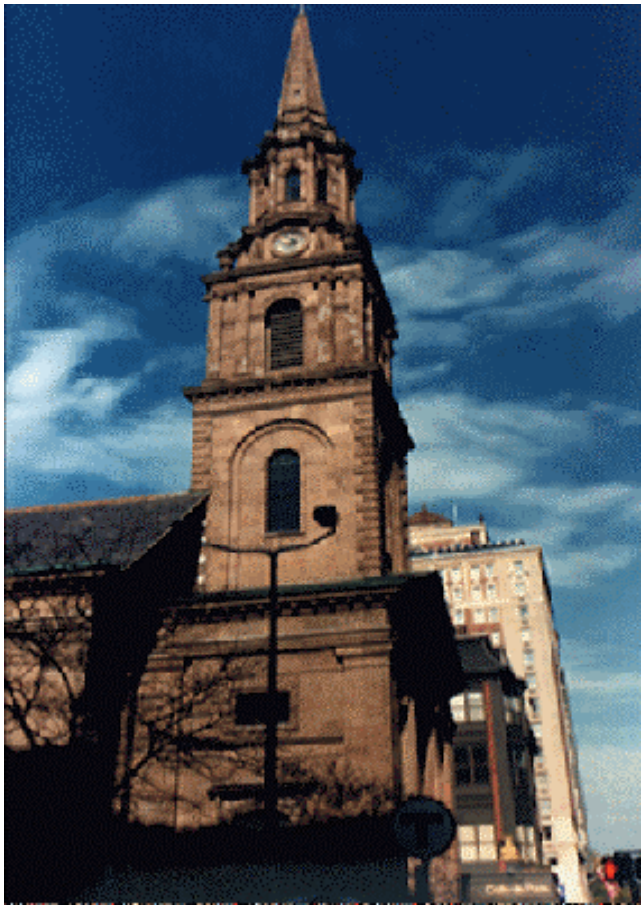
Building Envelope

Existing Conditions

The building *walls* are stone and brick. They are not insulated. There are several *window* types, including double hung and fixed pane units along with the stained glass. They windows do not have storm windows. The date of installation of the non stained glass units is not known. The glazing of the windows is single. The *roof* is comprised of several different ages and types including slate, copper, single ply, built up, and asphalt. The main church building roofing appears to be in good overall serviceable condition. The roofing at the east facing side of the Parish Hall is in poor condition with evidence of chronic leakage into the building. There are no indications of insulation at the roofing thermal barrier. There are several types of *doors*, including single and double solid wood units and wood units with glass.

Recommendations

It is recommended that there be an ongoing maintenance schedule to upkeep the exterior masonry work, which is showing deterioration due to age and exposure. The roof areas of the Parish Hall need replacement. Replace damaged door at Parish Hall roof level. Main entry doors to the church are in poor condition allowing for substantial infiltration of cold air in winter months. These doors need general maintenance including full weather-stripping to improve their performance. All of the non stained glass windows should be upgraded to Energy Star windows. The roof cavities above the ceilings in the Parish House and Sanctuary were not accessible during the building audit. All future roofing projects should include evaluation of the structure and potential for installation of thermal insulation to reduce the rate of heat loss.



#1 Exterior and interior views of the church (from church web site).

#2 Parish Hall roof areas and door. Both need replacement.

#3 Water damage below these roof areas.

#4 Exterior masonry deterioration.

#5 Right side ramp and railing deteriorated and needing rebuilding.

#6 Right side entry to basement level damaged and decayed. Needs rebuilding.

#7 Steam radiator for heat distribution in basement.

#8 Possible asbestos containing material with damage. Evaluate and abate as needed.

#9 Old bath fixtures. Upgrade to water conserving fixtures.