Energy Plan Assessment: Level II

St. Paul's Episcopal Church

August 2019

Energility your energy solution

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ENERGY AUDIT EXECUTIVE SUMMARY

We recommend St. Paul's Episcopal Church implement the projects, or Energy Conservation Measures (ECM), shown below. In doing so, the organization will realize:

1. A 59% reduction in energy use.
2. A total energy cost reduction of 56% or $15,365 per year.
3. A reduction in greenhouse gas emissions of 90.2 tons per year.
4. The annual energy and maintenance savings of $16,574 is the equivalent to 13 annual pledges of $1,200 each.

The cost to implement the projects is $191,525 and when electric and natural gas utility rebates of $38,355 are included, the simple payback is 9.2 years. Utility rebates are subject to pre-approval. Implementation costs include 4% for project management. Individual ECM results are shown below and the interaction of the results is accounted for as noted in the analysis.

Table 1. St. Paul's Episcopal Church Recommended ECM Summary

ECM No.	Title	Total Project Cost	Project Cost (incl. Rebates)	Annual Cost Savings					Simple Payback (yrs)
				Electric Demand	Electric Energy	Natural Gas	O&M[1]	Total	
C-1	Retrocommission mechanical systems	$10,136	$8,124	$0	$164	$1,522	$0	$1,686	4.8
C-2	Improve space temperature controls	$11,775	$9,991	$0	$0	$1,428	$0	$1,428	7.0
H-1	Upgrade the existing heating systems by installing new high efficiency boilers	$56,297	$54,491	$0	$0	$1,446	$800	$2,246	24.3
L-1	Upgrade lighting systems to LED technology	$47,516	$46,260	$926	$1,841	$0	$238	$3,005	15.4
S-1	Improve electric generation by adding a solar PV array	$62,561	$31,280	$423	$1,931	$0	$0	$2,355	13.3
O-1	Improve operations with best practices	$3,240	$3,024	$80	$759	$4,843	$171	$5,853	0.5
	Total	**$191,525**	**$153,170**	**$1,429**	**$4,696**	**$9,240**	**$1,209**	**$16,574**	**9.2**

The recommended next step:

- Operational recommendations (immediate actionable savings)
- Engage Energility as your Project Manager to implement the cost effective ECMs

Table 2. Financing Options

Financing Options	Total Project Cost[2]	Annual Payments	Annual Cash Flow
Property Assessed Clean Energy (PACE), Ohio Energy Loan Fund, or Private Equity Firms	$210,678	$20,989	($4,930)

[1] Operations & Maintenance

[2] Total cost of the project over 15-years with 5.5% interest and 10% administrative costs by lending entity; varies by institution and level of guarantee

Benchmarking

The normalized energy use for St. Paul's Episcopal Church was benchmarked against energy use of similar houses of worship using Energy Stewards. Energy Stewards interfaces with the US EPA ENERGY STAR Portfolio Manager® online tool. The tool uses building characteristics like building size, hours of use factors, and correction factors for weather to provide a percentile ranking, or Energy Performance Index (EPI). Electric energy in kWh and natural gas energy in Ccf were converted into a common energy value of British thermal units (Btu)[3] to identify the energy use on a per square foot basis, or Energy Utilization Index (EUI). St. Paul's Episcopal Church is compared to other houses of worship having similar characteristics. A cost per square foot was identified by using the normalized energy use and the current electric and natural gas rates. St. Paul's Episcopal Church energy rates were applied to the similar houses of worship EUI to obtain a comparison of cost, or Energy Cost Index (ECI).

An EPI of 50 is the median and 75 is defined as high performance. St. Paul's Episcopal Church has an EPI of 30. The church is releasing 148.4 metric tons of CO_2 which is better than 30% of other Houses of Worship.

Table 3. Energy Performance Metrics

Site Benchmark	St. Paul's Episcopal Church Normal Year	Median House of Worship Building	ENERGY STAR® House of Worship Building	St. Paul's Episcopal Church with ECM Implementation
EPI	30	50	75	82
EUI	74.8	63.1	45.6	33.7
ECI	$1.13	$0.95	$0.69	$0.51

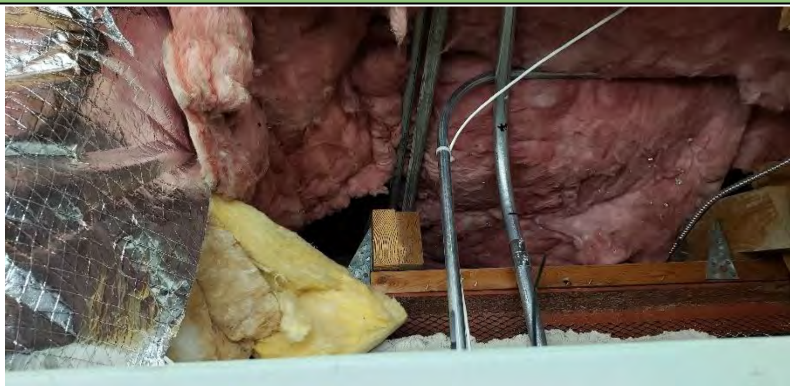
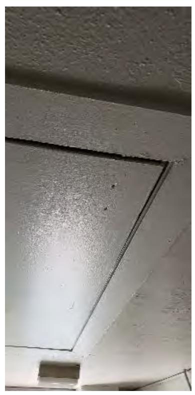
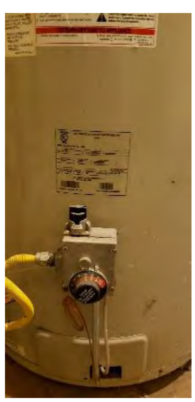
Operational Recommendations

These recommendations are best practices in building operations for St. Paul's Episcopal Church. The existing staff and the building operations and maintenance budget can be used to repair and maintain existing building systems while at the same time minimizing or eliminating energy waste will benefit the organization, the building, and the occupants. The implementation costs and benefit calculations are intended to be within 10%.

[3] each kWh equals 3,412 Btu and each Ccf equals 102,700 Btu

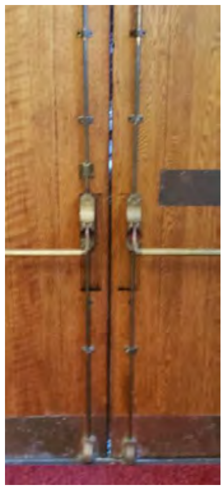
Table 4. Low Cost and No Cost Recommendations

Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
1. Engage Energility to deliver competitively bid natural gas energy supply agreements. We reviewed the terms and conditions of your current natural gas supplier contract. In a review of the existing natural gas markets, your current natural gas commodity supplier, Volunteer, is providing a rate ($0.6085 per Ccf) which is more than market prices and tariff rates at $0.43 per Ccf. We recommend getting a competitive bid for your next supply agreement.	$0	$2,548
2. Track energy use through Energy Stewards. Use the Energy Stewards site to track energy use and post results for congregational feedback. Input energy bills monthly to identify unusual usage patterns. Actively use the Action Table function of Energy Stewards to continually improve the building operation and track the future performance of actions. See sample Action Table: http://www.energystewards.net/ohipl/action_table. Tracking energy performance can result in up to 5% of energy reduction by identifying and eliminating wasteful patterns. Establish and work with the Green Team to understand which of the Ohio Interfaith Power and Light Programs shown in Appendix A fit within the Green Team's goals.	$120	$844
3. Turn off boiler during warm weather months. Based on our observations of the boiler being on and cycling, the system could be shutdown for the season and lower energy consumption, energy costs, and reduce run hours on the equipment which may extend the life of the system (boiler, pumps, and controls). We calculated energy savings based on reducing idle losses of 2% for 5 months per year.	$0	$515
4. Repair attic insulation in mechanical room of upstairs preschool. The attic insulation is currently adding unnecessary heating and cooling loads to the upstairs preschool area. The reduction of these energy gains/ losses is calculated at 5% of the space loads. The cost to make this repair is estimated at 2 hours of maintenance tech time.	$120	$485

Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
 Figure 1. Attic Insulation  Figure 2. Missing Attic Hatch Seal		
5. Use the lowest possible functional setpoint for domestic hot water systems. Domestic hot water temperatures were measured at 135°F. Gradually reduce these until the temperature at the point of use is 110-115°F. Allow at least 24 hours between adjustments to ensure the system has been used enough for the change to be noticed. The kitchen has a booster heater for sanitizing reusable products and does not require this high temperature water.  Figure 3. Storage Hot Water Tank Setting	$50	$344

Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
6. Establish an HVAC preventive maintenance contract. The agreement should provide support for the site staff in conducting preventive maintenance of HVAC Systems. Preventive maintenance done correctly will keep the heat transfer surfaces free from debris which maintains the equipment efficiency. The identification of simple and correctable problems happens sooner than reacting to equipment failures. Equipment life can be extended beyond the expectations of useful equipment life cycles. All of these lower operating costs and maximize investments. Improve air filtration. A 1" air filter that has a minimum efficiency reporting value (MERV) of 11 or greater should be used (a MERV rating of 8 is standard). Consider filtration requirements, space use, and energy use impact. We calculated an additional savings of up to 5% of your heating and cooling energy could be reduced by improving the filtration from the existing standard efficiency filtration. Confirm the preventive maintenance agreement for **RTUs** includes at minimum: • Inspections of the primary electrical connections for the rooftop units, fan power variable air volume boxes, and exhaust fans annually • Inspect evaporator coils and change filters in the air handling units quarterly • Confirm condensate pan is draining • Clean condensing coils semi-annually • Confirm proper operation of rooftop unit cooling compressors annually, including refrigerant charge, oil level, and pressures • Inspect compressor motors annually including comparing motor current draw to specification • Confirm proper operation controls and heat exchanger in rooftop units annually • Grease fan shaft bearings annually • Inspect fan motors quarterly, including comparing motor current draw to specification • Replace belts on fan motors annually with notched belts • Confirm proper operation of the fan motor controls and control sequence quarterly, including calibrate if outside of specification • Confirm proper operation of the economizer dampers and control sequence semi-annually, including calibrate if outside of specification • Confirm proper operation of zone temperature sensors quarterly, including calibrate if outside of specification Confirm the preventive maintenance agreement for **boilers** includes at minimum: • Inspect combustion fan motors annually including comparing motor current draw to specification • Inspect and clean burner assembly annually • Confirm proper operation of heating controls annually • Conduct combustion testing annually and confirm settings are within specification • Inspect water side at least every two years	Custom	$282

Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
• Inspect and calibrate safeties annually including pressure relief valves Confirm the preventive maintenance agreement for **split systems** includes at minimum: • Inspections of the primary electrical connections for the split systems annually • Inspect evaporator coils and change filters in the air handling units quarterly • Confirm condensate pan is draining • Clean condensing coils semi-annually • Confirm proper operation of compressors annually • Inspect compressor motors annually including comparing motor current draw to specification •Confirm proper operation of heating controls annually • Inspect fan motors annually, including comparing motor current draw to specification • Confirm proper operation of the economizer dampers and control sequence semi-annually, including calibrate if outside of specification • Confirm proper operation of zone temperature sensors quarterly, including calibrate if outside of specification		
7. Engage Energility to deliver competitively bid electric energy supply agreements. We reviewed the terms and conditions of your current electric supplier contract. In a review of the existing electricity markets, your current electric commodity supplier, FirstEnergy Solutions Corps, is providing a rate ($0.0533 per kWh) which is more than market prices and tariff rates at $0.0505 per kWh. We recommend getting a competitive bid for your next supply agreement.	$0	$245
8. Install occupancy sensor switch lighting controls in non-sanctuary areas. We recommend installing motion sensor switch lighting control to replace typical wall toggle switches in non-sanctuary areas. The optimal control cycle will be to turn the lighting system in these spaces off after 10 minutes of inactivity. This will avoid unnecessary cycling of equipment and maximize cost savings. The sensor switches should have manual control capability to enable the occupants leaving the space to turn them off immediately which will further maximize cost savings. These spaces will account for 50% of the lighting load once ECM L-1 is implemented. The lighting system burn hours are expected to decrease by 20% on average and is reasonable for these types of spaces as we observed higher rates with the data loggers. Lower lighting system burn hours would extend equipment life and reduce future maintenance costs by $1 per luminaire annually or based on historical maintenance costs that were reviewed. The lighting controls will reduce energy costs, lower maintenance costs, and increase the environmental performance of the lighting system.	$1,500	$226

Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
9. Replace failed and missing weatherstripping on exterior doors. The calculation is based on the heat loss from wind speed for an aggregate of 20' of door crack across the exterior doors. Some doors have small sections which are damaged or depressed and some doors it is missing completely. The cost is estimated at 5 doors for $75 per door installed cost.  **Figure 4. Missing Weatherstripping**	$375	$173
10. Update time clock calibration for daylight savings time eliminating burn hours during daylight time periods. The electronic astronomic time switch will use an astronomic program combined with independent programs to provide a sunset on/ timed off or sunset on/ sunrise off program. The time switch should be capable of 7-days of programming and controlling up to 2 circuits. The project cost is estimated based on use of time clocks for lighting in 3 areas (parking, landscape, and wall sconces). This will eliminate mechanical time clock drift or seasonal time change adjustments. Energy savings is calculated based on eliminating 1 hour per day of exterior lighting. Lower lighting system burn hours would extend equipment life and reduce future maintenance costs by $1 per luminaire annually or based on historical maintenance costs that were reviewed. The lighting controls will reduce energy costs, lower maintenance costs, and increase the environmental performance of the lighting system.	$975	$135

<table>
<tr><th>Recommended Action</th><th>Estimated Implementation Costs</th><th>Implementation Annual Benefits</th></tr>
<tr><td>
Figure 5. Existing Time Clock</td><td></td><td></td></tr>
<tr><td>11. Insulate exposed domestic hot water system piping.

These sections should be insulated with at least 1" of elastomeric or fiberglass pipe insulation to reduce heat loss. The heat loss eliminated is calculated by estimating total exposed piping with the above temperature and pipe characteristics (20' in sanctuary mechanical room). An estimated installed cost to repair is $5 per linear foot of insulation.

A best practice is to have an insulation professional install a custom made "saddle" to wrap both the pipe and valve area with removable straps so future repairs can take place when the insulation saddle is first removed and reinstalled afterwards. This is a higher cost but maximizes the benefits and eliminates the need for future insulation repairs following routine maintenance and repairs.

The office area mechanical room storage hot water tank piping is well insulated.


Figure 6. Uninsulated Piping</td><td>$100</td><td>$56</td></tr>
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Recommended Action	Estimated Implementation Costs	Implementation Annual Benefits
 **Figure 7. Well Insulated Piping**		

The benefit of the best practices listed below is directly correlated to the amount of action taken, which includes lowering future budget requirements, lowering environmental impact, and increasing overall building performance.

- Purchase ENERGY STAR® equivalent computers, monitors, printers at end of useful life.
- Use low flow aerators on restroom and kitchen sinks to lower domestic hot water load
- Install notched belts on fan system(s)
- Insulate exposed copper refrigerant piping on split cooling system(s)

Energy Audit Methods

Standard energy audit techniques were used while conducting this Level II Energy Audit. Specifically, the audit was conducted in accordance with the guidance of American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Publication RP-669, SP-56 Procedures for Commercial Building Energy Audits.

The energy audit fieldwork was completed in July 2019. Various parameters were measured and/or assessed throughout the audit including measuring building temperatures, assessing equipment efficiencies, identifying lighting use patterns, and reviewing other operational characteristics. We used data logging equipment to project energy savings from various energy conservation or energy efficiency measures. Additionally, we used spot measurements combined with the actual readings from the gas and electric meters which are used to calculate projected energy savings results after correcting for weather variations. Engineering analysis is then used to determine final energy and operational savings based on a building energy profile which is corrected for weather and occupancy variations.

All data collected only represent what was observed during the field study. Actual building operating conditions may vary throughout regular operation.

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ENERGY USE SUMMARY

Electric Use

Electric demand is the peak instantaneous power use over the billing period. Energy use is total electrical use over the billing period. Demand and electric use have separate billing rates. A graph of historical electric energy use and demand for the building from July 2017 to June 2019 is shown in Figure 8. Electric use for the most recent twelve months was 74,200 kilowatt hours (kWh), a summer peak of 27 kW, a winter peak of 28 kW and resulting in a cost of $14,628. The electric load profile is consistent year round.

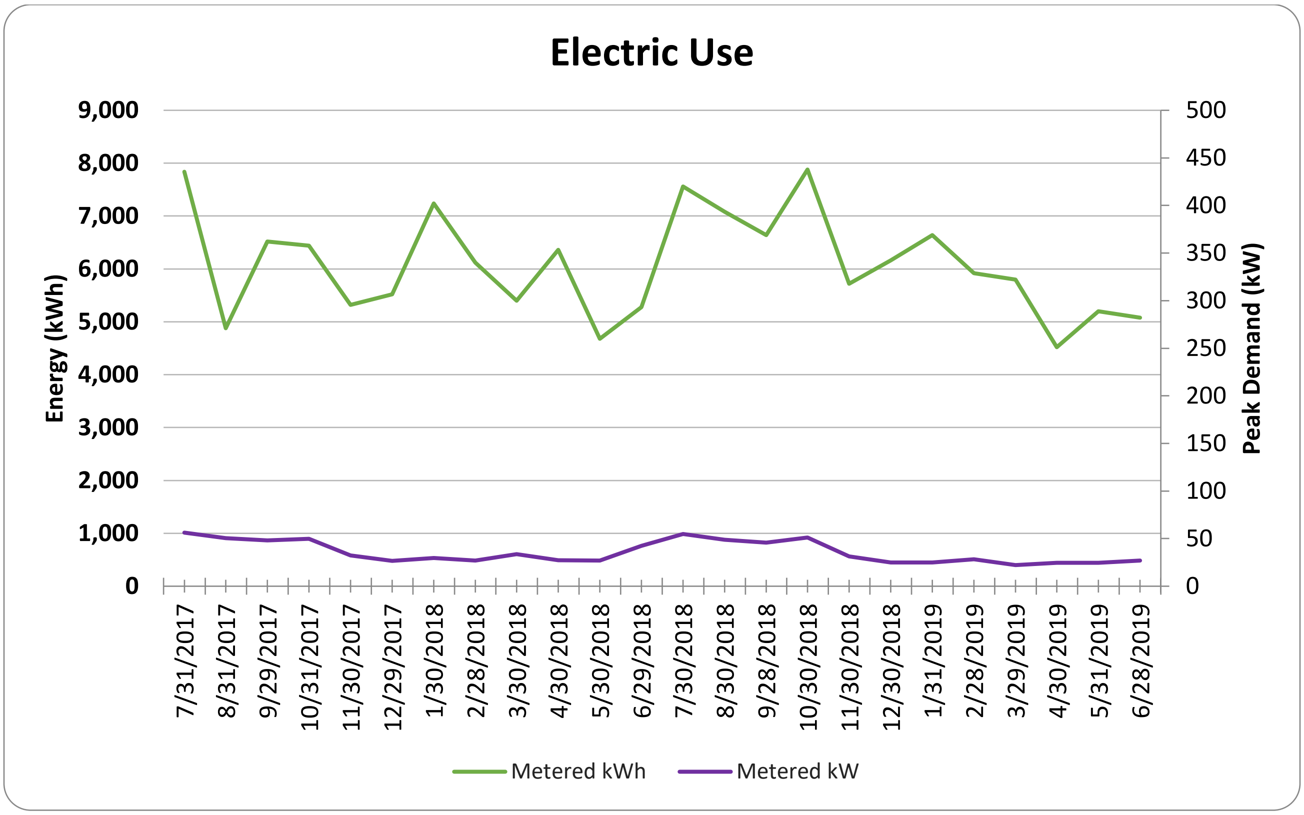

Figure 8. Electric Use

Natural Gas Use

A graph of historical natural gas use for the building from June 2017 to May 2019 is shown in Figure 9. For the recent 12 months, natural gas use was 14,277 Ccf at a cost of $12,829. The energy use peaks during the winter and has a consistent baseload year round. Some of this constant load is from the domestic hot water tanks, but most is coming from boiler and commercial range oven pilot lights. One boiler (under office area) was observed in idle mode during summer months.

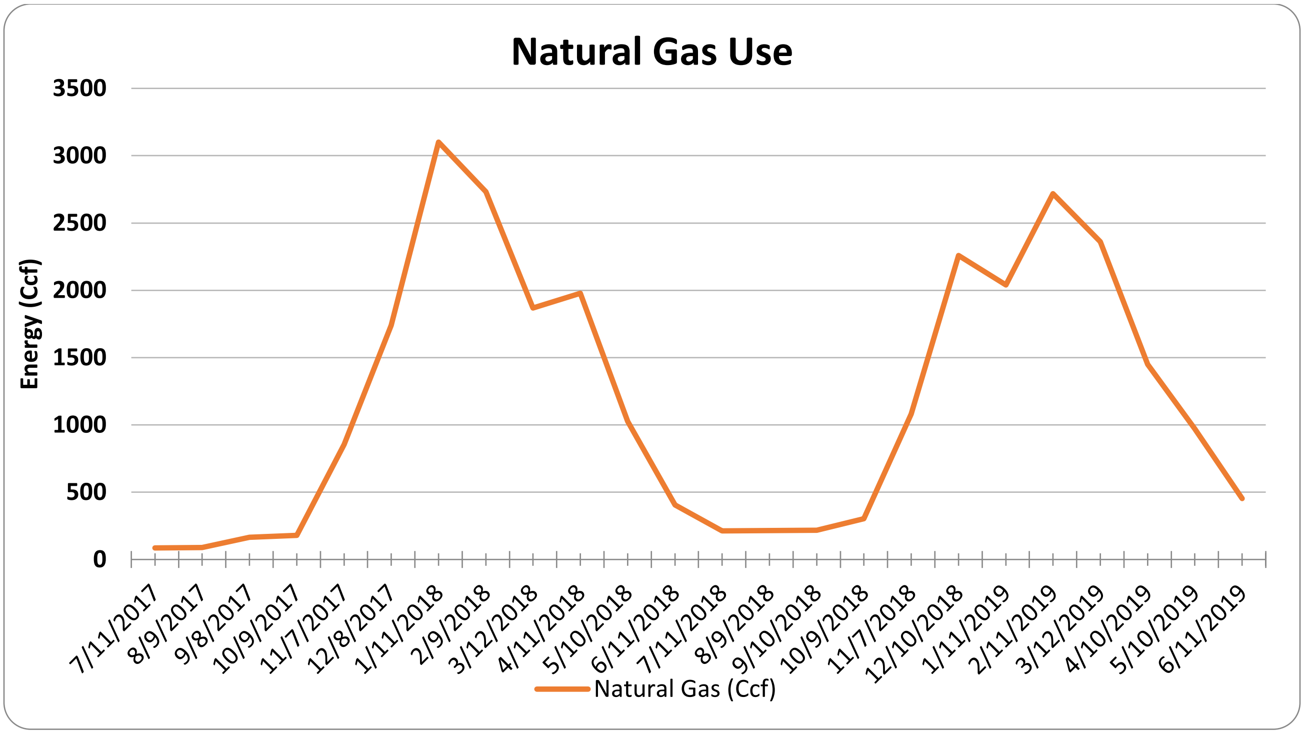

Figure 9. Natural Gas Use

Energy Performance Summary

Using our technical expertise, the building's energy fuel source data was compared with actual average daily outdoor temperatures to develop the analysis summarized below. Energy Explorer software, developed at the University of Dayton, is used for this analysis. This detailed regression analysis (see Appendix B) establishes an energy signature for how the building consumes energy.

Table 5. Energy Signature Description

	Electric Energy Use	**Description**	**Baseload[4]**	**Weather Dependent**
Cooling Load	n/a	n/a	n/a	No
	Natural Gas Energy Use	**Description**	**Baseload[5]**	**Weather Dependent**
Heating Load[6]	1.9 Ccf/Day/°F	Additional natural gas energy used when the average daily temperature is lower than 66°F	8.9 Ccf/Day	Yes

Energy Use Profile

Energy use for a normal year for the St. Paul's Episcopal Church building was then developed using Typical Meteorological Year (TMY) weather data for Toledo, Ohio. Version 3 of the data (TMY3) representing typical weather years based on actual data from 1981 to 2010 was used. The equations defined above were applied to the TMY3 hourly temperature data to arrive at normal year energy use patterns as shown below. The electric use shown below is actual for the past 12 months because the use is not weather dependent.

[4] The electric baseload is composed of energy for the building lighting, ventilation, and plug load.
[5] The gas baseload is composed of energy use for the building domestic storage hot water system and commercial kitchen equipment.
[6] The natural gas heating load is composed of the energy use for the building natural gas fired boilers.

Table 6. Energy Use Profile

Normal Year Energy Use			
Month	**Natural Gas (Ccf)**	**Electric (kWh)**	**Cost**
January	2,629	6,640	$3,671
February	2,356	5,920	$3,284
March	1,803	5,800	$2,764
April	1,067	4,520	$1,850
May	578	5,200	$1,545
June	266	5,080	$1,241
July	275	7,560	$1,737
August	275	7,080	$1,643
September	419	6,640	$1,685
October	1,201	7,880	$2,633
November	1,748	5,720	$2,699
December	2,619	6,160	$3,568
Total	**15,236**	**74,200**	**$28,319**

Energy Costs

The energy costs used to calculate ECM savings are based on current rate structures and the avoidable costs. See Table 7 for electric and natural gas costs.

Table 7. Electric and Natural Gas Costs

Billing Parameter	**Electric Rate**	**Natural Gas Rate**
Blended Rate[7]	$0.1971/kWh	$0.8986/Ccf
Fixed costs[8]	$31.91/mo	$116.20/mo
Energy or Generation rate[9]	$0.0533/kWh	$0.6085/Ccf
Transmission and Distribution rate[10]	$0.0200/kWh	$0.1924/Ccf
Avoided Peak Demand[11]	$12.60/kW	--
Avoided Energy[12]	$0.0733/kWh	$0.8009/Ccf

[7] The blended rate is simply the sum of the last 12 months of use and divide by the last 12 months of consumption.
[8] Fixed costs are charges on the bill regardless of consumption.
[9] The energy rate is the cost of the commodity which is supplied through a retail supplier. If no supplier is selected, then a supplier is selected by the utility based on a public auction.
[10] The transmission distribution rate is the costs for maintaining the transmission and distribution grid and network to get to the facility. These costs are billed by the utility regardless of supplier choice.
[11] Peak demand is the highest rate of electric use (usually over a 15 or 30 minute) period during the billing period. It represents the cost of the capital equipment to supply the power.
[12] Avoided costs are the portions of the total rate which can be avoided by consuming less energy.

Building Energy End Use

Energy use at the St. Paul's Episcopal Church building is further broken down by how it is used at the end use of each fuel source in the table below. When end use application is less than 10% of the total energy, then it may be excluded unless reasonable accurate data is available. See Appendix C for more detailed descriptions of the mechanical and lighting systems.

Table 8. End Use Breakdown

End Use	Input Energy		Combined Energy Use	
	kWh[13]	Ccf[14]	kBtu	
Heating	13,016	11,998	1,276,653	70%
Other Baseload Systems	1,683	3,237	338,233	19%
Lighting (Interior)	18,756	0	63,996	4%
Lighting (Exterior)	17,734	0	60,510	3%
Cooling	15,050	0	51,354	3%
Ventilation	7,961	0	27,165	1%
Total	**74,200**	**15,236**	**1,817,911**	
per sf	**3.05**	**0.63**	**74.80**	

ENERGY CONSERVATION MEASURES

All ECMs for St. Paul's Episcopal Church are calculated using industry accepted engineering methods including accounting for interactive effects as noted in the analysis. Projected implementation costs are based on experiential pricing from similar past projects or industry accepted estimating technique. The following is a list of all ECMs considered.

C-1 Retrocommission mechanical systems

The existing heating and cooling systems are referenced in Appendix C Mechanical Systems report. These systems are inefficient because the we observed there is no control to avoid simultaneous heating and cooling. The building's consistent electrical energy load indicates some heating system operation is overlapping with cooling of spaces. Analysis shows the current building heating and cooling balance points are 65°F and 71°F (see Figures B1 and B2). Adding self contained radiator valves (see Figure 10) will lower the heating balance point and improve space temperature control.

We recommend retrocommissioning (RCx) of the existing equipment to better control the heating and cooling systems. A "tune-up" for each system will bring the equipment back into design

[13] any equipment estimated <1,000 kWh annually may not be included in the breakdown
[14] any equipment estimated <100 Ccf annually may not be included in the breakdown

operating specifications. At a minimum, the following components of those systems must be checked for functionality and condition and then cleaned and repaired to return to proper operating condition (note definitions listed below each component):

1. Ductwork, internal insulation, dampers (mixed air and outside air), and operators
    - functional dampers
    - functional operators
    - ductwork air leaks and insulation damage repaired

2. Temperature and humidity, controls and sensors
    - sensors need to be calibrated or replaced so they are operating within the design operating parameters

3. Interior evaporator and heating coils
    - coils are cleaned and free from debris
    - design air flow achieved through the coils
    - MERV 11 pleated air filter installed (some systems are currently using these but it is not consistent across all units)

4. Heating and cooling control valves and adjacent pipe insulation
    - new filtration
    - no leaking pipes
    - sealed elastomeric or fiberglass pipe insulation for all exposed piping to
    - match existing
    - operable control valves

5. Fan motors, sheaves, belts, and wiring
    - a properly aligned motor and sheave with a notched belt
    - motor is operating within the design power input

The expected result of the retrocommissioning is a heating/cooling load factor that is 15%[15] less than the existing load factors. The energy savings is calculated as the product of the difference between the existing and proposed heating/cooling load factors and the design heating/cooling degree days. The retrocommissioning of the existing equipment will reduce energy costs, lower maintenance costs, improve space comfort to occupants, and increase the environmental performance of the systems.

The new system analysis includes labor and materials to meet the above recommendations including 30 self contained radiator valves. We observed at least 22 finned tube or old steam radiators and

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[15] The California Commissioning Collaborative estimates energy related savings from recommissioning existing buildings at $0.11-0.72 per sq.ft. and industry estimates routinely observe 5-15% of energy savings from retrocommissioning activities specified above http://www.cacx.org/resources/documents/CA_Commissioning_Guide_Existing.pdf

anticipate that some of the longer finned tube sections may be able to be zoned in smaller sections. This will need confirmed at the time of implementation. The cost includes a 4% management fee for professional oversight of the project including developing design bid specifications and project management. Utility rebates are calculated based on currently available program details and require pre-approval before selecting equipment and installation. Future avoided annual energy and maintenance costs are quantified in the economic analysis. Energy costs are calculated based on the current avoided costs for both gas and electric.

Table 9. Retrocommission Mechanical Systems ECM Savings

Location	Existing Heating Load Factor (Ccf/ °F/ Day)	Post RCx Heating Load Factor (Ccf/ °F/ Day)	Load Factor Reduction (%)	Heating Degree Days[16]	Energy Savings (Ccf)
Heating systems	1.86	1.58	15%	6,812	1,901
Location	**Existing Cooling Load Factor (kWh/ °F/ Day)**	**Post RCx Cooling Load Factor (kWh/ °F/ Day)**	**Load Factor Reduction (%)**	**Cooling Degree Days[17]**	**Energy Savings (kWh)**
Cooling systems	12.69	12.06	5%	3,526	2,237

Energy Savings (Ccf) = (Existing Heating Load Factor - Post RCx Heating Load Factor) x Design Heating °F-dy

Energy Savings (kWh) = (Existing Cooling Load Factor - Post RCx Cooling Load Factor) x Design Cooling °F-dy

Table 10. Retrocommission Mechanical Systems ECM Budget

ECM	Item	Units	Unit Cost	Extended Cost
Retrocommission mechanical systems	Labor	0.5	$9,556	$4,778
	Materials	0.5	$9,556	$4,778
	Misc (2%)			$191
Project management (4% of total)				$390

Table 11. Retrocommission Mechanical Systems ECM Project Cost Results

Project Cost	Electric Rebate	Gas Rebate	Net Project Cost	Annual Electric Demand Savings	Annual Electric Energy Savings	Annual Natural Gas Energy Savings	Annual Maintenance and Other Savings	Net Annual Project Benefits	Equipment Life (yrs)	Simple Payback (yrs)
$10,136	($112)	($1,901)	$8,124	$0	$164	$1,522	$0	$1,686	5	4.8

[16] Heating degree days based on system balance point of 66°F

[17] Cooling degree days based on system balance point of 71°F

Figure 10. Self Contained Radiator Valves

C-2 Improve space temperature controls

The existing heating and cooling systems are referenced in Appendix C Mechanical Systems report. This system is inefficient because observed space conditions showed variations of night time temperatures of less than 5°F when the spaces were unoccupied.

We recommend connecting the split systems zones to wireless programmable thermostats and using optimized temperature settings. This control uses a "night setback" control strategy where temperature set points are adjusted during unoccupied time periods - down in the winter and up in the summer - which reduces heating and cooling loads during long unoccupied periods. The zone start and stop time can be optimized based on actual outdoor and interior space conditions, a desired occupied temperature set point, and a targeted occupancy time. The normal zone schedules will be entered to control space temperatures when occupied. Improved space temperature control will reduce energy costs, lower maintenance costs, improve space comfort to occupants, and increase the environmental performance of the heating and cooling systems. This ECM will provide better space temperature control during occupied time periods. The wireless thermostat will have wireless capability to allow the unit programming to be altered remotely from its physical location or anywhere with internet access for a special event or atypical schedule occurrence (i.e., longer office hours). After the event, the unit will return to its normal schedule which will eliminate energy waste from conditioning spaces for long periods of unoccupied time which can typically occur when controls are placed in override conditions. The analysis calculates energy savings based on 55°F unoccupied setback, existing setback temperature, and a recovery period of one-hour per day (i.e., a time in which the system will need to operate to "get up to temperature") to maintain a conservative energy savings estimate. The calculation includes a Load Factor for heating which represents the outside air infiltration, envelope thermal, internal loads, and solar loads on the systems.

The installation cost analysis includes 16 wireless programmable thermostats programmed to these specifications. The integration will require connecting heating zones to the thermostats for the cooling units in the zone. The cost includes a 4% management fee for professional oversight of the installation including developing design bid specifications, project management, and commissioning. Utility rebates are calculated based on currently available program details and require pre-approval before selecting equipment and installation. Future avoided annual energy and maintenance costs are quantified in the economic analysis. We calculated for maintenance savings. Energy costs are calculated based on the current avoided costs for both gas.

Table 12. Improve Space Temperature Controls ECM Savings

Time Period	Heating Load Factor (Ccf/ °F/ Day)	Recommended Setting (°F)	Current Set Point (°F)	Heating Days	Weekly Hours	Days/ Week	Energy Savings (Ccf)
Unoccupied	1.86	55	65	150	94	0	1,561
Occupied	1.86	70	72	150	74	7	223

Energy Savings (Ccf)[18] = [Heating Load Factor x (Current Set Point - Recommended Setting) °F x [(Weekly Unoccupied hr -1 hr of Recovery/Day) / 168] x Heating Days

Table 13. Improve Space Temperature Controls ECM Budget

ECM	Item	Units	Unit Cost	Extended Cost
Improve space temperature controls	Labor	32	$125	$4,000
	Equipment	16	$350	$5,600
	Commissioning	2	$750	$1,500
	Misc (2%)			$222
Project management (4% of total)				$453

Table 14. Improve Space Temperature Controls ECM Project Cost Results

Project Cost	Electric Rebate	Gas Rebate	Net Project Cost	Annual Electric Demand Savings	Annual Electric Energy Savings	Annual Natural Gas Energy Savings	Annual Maintenance and Other Savings	Net Annual Project Benefits	Equipment Life (yrs)	Simple Payback (yrs)
$11,775	$0	($1,784)	$9,991	$0	$0	$1,428	$0	$1,428	7	7.0

H-1 Upgrade the existing heating systems by installing new high efficiency boilers

The existing heating system is referenced in Appendix C Mechanical systems report. This system is inefficient because both boilers are operating independently and are in an idle condition during much of the year.

[18] Savings for occupied hours setpoint changes are calculated the same but without the allowance for recovery

We recommend replacing the existing boilers with high efficiency condensing boilers which have an Annual Fuel Utilization Efficiency (AFUE) of greater than 95%. The recommended heating capacity of 800 kBtu/h should properly size the new equipment and meet peaking system heating requirements. The system may be able to be connected into one contiguous loop. Piping in the center of the building will need further investigation. In the kitchen and central spaces which previously were outside walls there are radiators which may be able to be connected to one another, insulated, and provide a union for the two systems. This will need to be confirmed during the project implementation prior to ordering equipment. A minimum of four modular boilers will be installed and provide continued heating capacity should one boiler be down. The system will operate with a reset schedule for lowering the supply water temperature when outside conditions are warmer. This will lower energy consumption and reduce idle operation. The modular condensing boilers will reduce energy costs, lower maintenance costs, and increase the environmental performance of the heating system. If the systems cannot be joined then the two systems can be retrofitted with a pair of module for each system (200-250 kBtu/h each). The same sequences can be used to reset water temperature based on outside air conditions.

The installation cost analysis includes a system installed to these specifications. The project cost includes the additional design and engineering to confirm joining the systems is feasible. In past projects of similar scope, the budget has been $60-65/ kBtu/h of system capacity. The cost includes a 4% management fee for professional oversight of the installation including developing design bid specifications, project management, and commissioning. Utility rebates are calculated based on currently available program details and require pre-approval before selecting equipment and installation. Future avoided annual energy and maintenance costs are quantified in the economic analysis. A single HVAC tech trip of 8 hours (at $125 per hour) could be avoided by a new system installed and under warranty. Energy costs are calculated based on the current avoided costs for gas.

Table 15. Install New High Efficiency Boilers ECM Savings

Heating and Cooling System	Input Heating Design Capacity (kBtu/h)	Existing Combustion eff	Annual Radiation Loss	Standing Pilot Loss (cu. ft./h)	Proposed AFUE	Annual Operating Hrs	Annual Heating Load (Ccf)
HWB-1	630	76.0%	4.0%	0.75	95.0%	5,057	5,478
HWB-2	750	82.4%	2.0%	0.75	95.0%	5,057	6,521

Energy Savings (Ccf) = Annual Heating Load x (1- (Existing AFUE / Proposed AFUE))

Table 16. Install New High Efficiency Boilers ECM Budget

ECM	Item	Units	Unit Cost	Extended Cost
Upgrade the existing heating systems by installing new high efficiency boilers	Labor	800	$31.63	$25,300
	Equipment	800	$31.63	$25,300
	Engineering and design	1	$2,520	$2,520
	Misc (2%)			$1,012
Project management (4% of total)				$2,165

Table 17. Install New High Efficiency Boilers ECM Budget

Project Cost	Electric Rebate	Gas Rebate	Net Project Cost	Annual Electric Demand Savings	Annual Electric Energy Savings	Annual Natural Gas Energy Savings	Annual Maintenance and Other Savings	Net Annual Project Benefits	Equipment Life (yrs)	Simple Payback (yrs)
$56,297	$0	($1,806)	$54,491	$0	$0	$1,446	$800	$2,246	25	24.3

L-1 Upgrade lighting systems to LED technology

The existing lighting system is referenced in Appendix C Lighting Systems report. This system is inefficient because legacy luminaire and lamps permeate the interior and exterior property. New light emitting diode (LED) technology in the marketplace has the potential to increase the efficacy of the existing systems while lowering the cost to do the same task.

We recommend lighting upgrades to LED technology as specified below. The LED lighting recommendations will reduce energy costs, lower maintenance costs, improve space comfort to occupants, and increase the environmental performance of the lighting system.

Regardless of manufacturer, the LED lamps, exit signs, and kits should have an ENERGY STAR® or Design Lights Consortium (DLC) listing indicating they meet or exceed industry standards for their designed application based on current lumen efficacy (lumens per Watt), color quality, even light distribution, and rated product life expectancy. The new LED lighting will reduce lighting power consumption while improving the illumination of the spaces through better light quality. LED technology will deliver a high lumen maintenance, or the ability to maintain its output over the life of the product, which ensures that the high quality of light is sustained. Their instant illumination feature require no warmup time, even when cycled off and immediately back on when controls are installed. The new LED technology when combined with LED dimmers, occupancy sensors, vacancy sensors and/or photocells are value added devices supplementing continued energy savings and cost savings.

The installation cost analysis includes a system installed to these specifications. The cost includes a 4% management fee for professional oversight of the installation including developing design bid specifications, project management, and commissioning. Utility rebates are calculated based on currently available program details and require pre-approval before selecting equipment and installation. The byproduct of removing wasted heat generated by inefficient lighting technologies will reduce the cooling load and increase the heating load. Future avoided annual energy and maintenance costs are quantified in the economic analysis. LED products contain no toxic materials, are 100% recyclable, and are more durable than existing lighting products as they can withstand most harsh conditions (although they may have shorter expected life at extremely high temperatures). The calculated maintenance savings is based on $1 per luminaire of avoided future costs or the history of past maintenance costs which could be avoided in the future with long expected life of quality LED products. Energy costs are calculated based on the current avoided cost of electric.

The replacement equipment should meet these specifications:

- 15 Watt 4’ T8 LED tube which does not use the existing luminaire ballast and delivers over 100 lumens per Watt, exceeds 80 on color rendering index (CRI), 3500K on color correlated temperature (CCT) scale and meets Underwriters Laboratory (UL) and DLC listings.

- 18 Watt 4’ T8 LED tube which does not use the existing luminaire ballast and delivers over 100 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and DLC listings.

- 13 Watt 3’ T8 LED tube which does not use the existing luminaire ballast and delivers over 100 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and DLC listings.

- 5 Watt LED Candelabra lamp with an E26 or equivalent base which delivers over 80 lumens per watt, exceeds 80 on CRI, 2700K on CCT scale and meets UL and ENERGY STAR® listings.

- 9 Watt LED A-type lamp with an E26 medium base which delivers over 85 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and ENERGY STAR® listings.

- 19 Watt LED R-30 lamp with E26 medium base which delivers over 70 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and ENERGY STAR® listings.

- 18 Watt LED kit for an 8" existing luminaire which delivers over 75 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and DLC listings.

- 20 Watt LED surface mount decorative luminaire which delivers over 79 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and Energy Star rated listings.

- 48 Watt 2'x4’ LED Luminaire which delivers over 110 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and DLC listings.

- 78 Watt LED high bay luminaire which delivers over 80 lumens per Watt, exceeds 80 on CRI, 3500K on CCT scale and meets UL and DLC listings. Listing

- 40 Watt LED wall pack luminaire which delivers over 90 lumens per Watt, exceeds 70 on CRI, 4000K on CCT scale and meets UL and DLC listings. Listing

- 80 Watt LED wall pack luminaire which delivers over 110 lumens per Watt, exceeds 70 on CRI, 4000K on CCT scale and meets UL and DLC listings. Listing

- 78 Watt LED pole arm mounted luminaire which delivers over 120 lumens per watt, exceeds 70 on CRI, 4000K on CCT scale and meets UL and DLC listings.

- 150 Watt LED pole arm mounted luminaire which delivers over 110 lumens per watt, exceeds 70 on CRI, 4000K on CCT scale and meets UL and DLC listings.

- 50 Watt LED flood luminaire which delivers over 100 lumens per Watt, exceeds 70 on CRI, 4000K on CCT scale and meets UL and DLC listings.

- LED exit signs should have input power demand of 3 Watts or less per illuminated side, a power factor not less than 0.7, and minimum 5 year warranty. Luminaire should meet all applicable National Fire Protection Association (NFPA), Occupational Health and Safety Administration (OSHA), and meets UL listings.

Table 18. Upgrade Lighting Systems to LED Technology ECM Savings

Location	Existing Equipment	Proposed Lighting System	Luminaire Quantity	Proposed Luminaire Watts	Diversity Factor	Energy Saved (kWh)
St. Paul's Exit Signs	Exit, 2L 15W Incandescent	New Exit Sign	21	3	1.0	2,182
Parking Lot	Low Bay, 1L 400W Metal Halide	New LED Pole Shoebox 150W	4	150	1.0	5,081
Outside	Shoebox, 1L 150W Hi Pressure Sodium	New LED Pole Shoebox 78W	2	78	1.0	473
Outside	Drum, 1L 100W Incandescent	New LED Surface Mount 20W	1	20	1.0	241
Outside	Shoebox, 1L 350W Metal Halide	New LED Pole Shoebox 78W	2	78	1.0	2,843
Outside	Drum, 1L 100W Incandescent	New LED Surface Mount 20W	3	20	1.0	1,051
Outside	Shoebox, 1L 400W Metal Halide	New LED Pole Shoebox 150W	1	150	1.0	1,270
Christian Formation	Socket, 1L 75W A' Lamp Incandescent	New LED Surface Mount 20W	5	20	0.1	106
Christian Formation	Chandelier, 6L 6W LED 'A' Lamp	no change				
Christian Formation	Track head, 1L 9W LED R20	no change				
Christian Formation	Globe, 2L 12W CFL 'A' Lamp	Retrofit, LED lamp only, A-19 9W (2 lamps)	1	18	0.8	17
Christian Formation	Industrial Pendant, 4L 12W CFL 'A' Lamp	Retrofit, LED lamp only, A-19 9W (4 lamps)	2	36	0.3	23
Upper Pre-School	Flanged, 1L 75W A' Lamp Incandescent	Retrofit, LED lamp only, A-19 9W (1 lamp)	2	9	1.0	508
Lower Preschool Mech Rm	Socket, 1L 65W PAR	Retrofit, LED lamp only, A-19 9W (1 lamp)	4	9	0.1	86

Location	Existing Equipment	Proposed Lighting System	Luminaire Quantity	Proposed Luminaire Watts	Diversity Factor	Energy Saved (kWh)
Lower Preschool Stairwell	Wall Sconce, 1L 9W LED 'A' Lamp	no change				
Library	Chandelier, 8L 12W CFL 'A' Lamp	Retrofit, LED lamp only, Candelabra E26 Base, 5W (8 Lamps)	2	5	0.3	175
Library	Socket, 1L 100W A' Lamp Incandescent	Retrofit, LED lamp only, A-19 9W (1 lamp)	4	9	0.3	350
Sanctuary	Chandelier, 12L 9.5W LED 'A' Lamp	no change				
Sanctuary	Recessed Can, 1L 65W PAR	Retrofit, LED 8" Recessed Can Kit 18W	14	18	0.3	633
Sanctuary	Recessed Can, 1L 45W R20	Retrofit, LED 8" Recessed Can Kit 18W	2	18	0.3	52
Sanctuary	Shoebox Flood, 1L 75W CFL Pin Base	New LED Indoor/Outdoor Flood Light 50W	1	75	1.0	-
Sanctuary	Globe, 2L 12W CFL 'A' Lamp	Retrofit, LED lamp only, A-19 9W (2 lamps)	1	18	0.3	6
Sacristy Hall	Socket, 4L 12W CFL 'A' Lamp	Retrofit, LED lamp only, A-19 9W (4 lamps)	1	36	0.1	5
Sacristy Basement	Socket, 1L 22W CFL 'A' Lamp	Retrofit, LED lamp only, A-19 9W (1 lamp)	7	9	0.1	35
Guild Room	Recessed Can, 1L 65W PAR	Retrofit, LED lamp only, PAR38 flood 19W	14	19	0.1	248
Outside	Wall Sconce, 1L 25W A' Lamp Incandescent	Retrofit, LED lamp only, A-19 9W (1 lamp)	4	9	1.0	280
Outside	Wall Sconce, 1L 18W LED R20	Retrofit, LED lamp only, A-19 9W (1 lamp)	2	9	1.0	79
Outside	Wall Sconce, 1L 100W A' Lamp Incandescent	Retrofit, LED lamp only, A-19 9W (1 lamp)	1	9	1.0	399
Outside	Wall Sconce, 1L 29W A' Lamp Incandescent	Retrofit, LED lamp only, A-19 9W (1 lamp)	2	9	1.0	175
Outside	Highbay, 2L 300W CFL Pin Base	New LED Wallpack 40W	1	55	1.0	2,387
Outside	Lowbay, 2L 65W PAR	Retrofit, LED lamp only, PAR38 flood 19W	1	19	1.0	486
Outside	Lowbay, 1L 350W CFL Pin Base	New LED Wallpack 80W	1	80	1.0	1,183
Outside	Wall Sconce, 1L 9W LED 'A' Lamp	no change				
Christian Formation	Wrap, 2L 40W T12	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	8	36	0.3	431
Christian Formation	Strip, 1L 25W T5	Retrofit, T8 LED 3' tube lamps 13W (1 lamp)	1	13	0.3	15
Christian Formation	Wrap, 4L 32W T8	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	1	36	0.3	101
Gym	Wrap, 4L 32W T8	New LED Circular High Bay 78W	6	78	0.8	1,087
Upper Pre-School	Modular, 4L 32W T12	New LED 2'x4' Flat Panel 48W	26	48	0.8	7,444
Upper Pre-School	Wrap, 2L 32W T12	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	2	36	0.1	26
Lower Preschool	Modular, 4L 40W T12	New LED 2'x4' Flat Panel 48W	12	48	0.1	628

Location	Existing Equipment	Proposed Lighting System	Luminaire Quantity	Proposed Luminaire Watts	Diversity Factor	Energy Saved (kWh)
Lower Preschool	Wrap, 4L 34W T12	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	8	36	0.1	371
Office Area Hallway & Rms on Flr.	Modular, 4L 34W T12	New LED 2'x4' Flat Panel 48W	19	48	0.8	5,944
Office Area Hallway & Rms on Flr.	Modular, 3L 34W T12	New LED 2'x4' Flat Panel 48W	1	48	0.8	200
Library	Direct/ Indirect, 1L 40W T12	Retrofit, T8 LED 4' tube lamps 15W (1 lamp)	10	15	0.3	298
Library	Wrap, 4L 32W T8	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	1	36	0.3	101
Library	Wrap, 2L 32W T8	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	1	36	0.3	33
Kitchen	Modular, 3L 34W T12	New LED 2'x4' Flat Panel 48W	6	48	1.0	1,600
Skyroom	Modular, 4L 40W T12	New LED 2'x4' Flat Panel 48W	3	48	0.3	392
Sanctuary Rm	Wall Bracket, 2L 25W T5	Retrofit, T8 LED 4' tube lamps 15W (2 lamps)	3	30	0.1	16
Pantry	Wrap, 2L 32W T8	Retrofit, T8 LED 4' tube lamps 18W (2 lamps)	6	36	0.8	596
Pantry	Modular, 3L 25W T5	New LED 2'x4' Flat Panel 48W	1	48	0.3	33
Pantry	Modular, 3L 32W T8	New LED 2'x4' Flat Panel 48W	1	48	0.8	166
					Total	**25,123**

Energy Savings (kWh) = [Existing System Wattage - Recommended System Wattage] x Burn Hr / 1,000

Table 19. Upgrade Lighting Systems to LED Technology ECM Budget

ECM	Item	Units	Unit Cost	Extended Cost
Upgrade lighting systems to LED technology	Labor	1	$21,779	$21,779
	Interior/Exterior Equipment	1	$21,779	$21,779
	Lift rental	1	$500	$500
	Commissioning	1	$750	$750
	Misc (2%)			$881
Project management (4% of total)				$1,828

Table 20. Upgrade Lighting Systems to LED Technology ECM Project Cost Results

Project Cost	Electric Rebate	Gas Rebate	Net Project Cost	Annual Electric Demand Savings	Annual Electric Energy Savings	Annual Natural Gas Energy Savings	Annual Maintenance and Other Savings	Net Annual Project Benefits	Equipment Life (yrs)	Simple Payback (yrs)
$47,516	($9,854)	$0	$37,661	$1,490	$2,921	$0	$238	$4,649	14.5	8.1

S-1 Improve electric generation by adding a solar PV array

We recommend installing a photovoltaic (PV) array on the roof space. Angled roof spaces are a good candidate for a PV array. Typically, less roof penetrations are required to flush mount angled solar. Calculations show that a 22.4 kW PV array will reduce energy costs, lower maintenance costs, and increase the environmental performance of the whole building (see Figure 11 below and the full analysis in Appendix E Solar PV Array Analysis).

Based on a review of related literature[19], the peak demand for the building will be shifted to later in the day during the summer and will amount to 25% of the installed capacity for the six months of the cooling season. There is no impact on demand in the winter because the monthly peak will occur early in the morning.

Nonprofit organizations can use a special purpose entity (SPE) to take advantage of a 30% investment tax credit[20] (ITC) and MACRS depreciation for solar installations, potentially adding additional tax benefits of approximately 20% of project cost in the first five to seven years. PV units have a standard 25-year warranty period which guarantee production output over the life of the equipment. An annual maintenance agreement is included in the project cost to clean, maintain, and ensure generation output sustained during the warranty period. Cost of power from the system as is calculated at $0.0622 kWh and would be negotiated as part of the power purchase agreement between the SPE and the electric company.

Table 21. Add a Solar PV Array ECM Savings

PV Array Capacity (kW)	Monthly Peak Demand Reduction (kW)	Total Annual Energy Production (kWh)	Total Energy Reduction (Normal Year)	Total Energy Reduction (after implement all ECMs)
22.4	5.6	26,350	36%	66%

Table 22. Add a Solar PV Array ECM Budget

ECM	Item	Units	Unit Cost	Extended Cost
Improve electric generation by adding a solar PV array	Labor	22.4	$1,040	$23,296
	Equipment	22.4	$1,560	$34,944
	Commissioning	1	$750	$750
	Misc (2%)			$1,165
Project management (4% of total)				$2,406

Table 23. Add a Solar PV Array ECM Project Cost Results

Project Cost	Federal Tax Credit	Gas Rebate	Net Project Cost	Annual Electric Demand Savings	Annual Electric Energy Savings	Annual Natural Gas	Annual Maintenance and Other Savings	Net Annual Project Benefits	Equipment Life (yrs)	Simple Payback (yrs)

[19] http://www.nrel.gov/docs/fy16osti/64793.pdf

[20] http://www.seia.org/research-resources/solar-investment-tax-credit-itc-101

						Energy Savings				
$62,561	($31,280)	$0	$31,280	$423	$1,931	$0	$0	$2,355	25	13.3

Figure 11. Solar PV Array Layout

Additional ECMs Reviewed

The following ECMs were reviewed, analyzed, and need further study to confirm initial estimates or are deemed not cost effective on the merits of energy savings alone.

1. Upgrade the existing cooling systems by installing new VRF systems. We recommend replacing the existing equipment with Variable Refrigerant Flow (VRF) split systems when the individual systems begin to have repair issues or fail. The energy costs alone do not justify the replacement as the cost savings exceeds the life of the equipment. The VRF systems at the proposed SEER of 17.0 and variable speed compressor motor control. The variable speed compressor control will more closely match the cooling needs for each space. The recommended cooling capacity of each system should meet peaking system cooling requirements. This will need to be confirmed during the project implementation prior to ordering equipment. The new VRF systems will reduce energy costs, lower maintenance costs, increase the environmental performance and improve space comfort for occupants. The VRF units should be able to be connected to the wireless programmable thermostats recommended elsewhere in the report. These types of units are currently eligible for an electric utility rebate which is calculated based on system capacity per ton of cooling.

APPENDIX A. OHIO INTERFAITH POWER AND LIGHT (Ohio IPL) PROGRAMS FOR CONSIDERATION

Energy Stewardship - Ohio IPL's **Energy Stewards** program connects the faith community with available technical and financial resources to implement energy conservation, energy efficiency and renewable energy programs. http://www.ohipl.org/programs/stewards/

Cool Congregations - Cool Congregations is a stewardship program designed to help congregations engage their members in caring for Creation by reducing their individual greenhouse gas emissions. National Interfaith Power and Light offers both Certification and a prize money Challenge to exemplary Cool Congregations.
http://www.ohipl.org/programs/cool-congregations/

Green Teams - A Green Team can be called many different things, but basically it a group of individuals within a congregation who are committed to environmental responsibility and creation care.
http://www.ohipl.org/programs/going-green-starting-kit/

Earth Stewards Directory - This is an online clearinghouse of environmental stewardship activities and resources for Ohio faith communities. Ohio IPL's Earth Stewards Directory, a clearinghouse of resources, is designed to be a "trusted source"!
http://www.ohipl.org/earth-stewards-directory/

Faith Climate Action Week – This week, previously known as the Preach-In, will encompass seven days in April surrounding Earth Day. The theme is "Act on Climate" and will focus on how we can take action to protect our climate laws, and encourage our senators to share their climate action plans. https://ohipl.org/programs/faith-climate-action-week/

Climate Conversations - We believe faith communities are settings where we can discuss climate change in ways that encourage the sharing of values, concerns, and hopes. We can explore together our shared connections and responsibility.
http://www.ohipl.org/climate-conversations/

Public Engagement - Many voices promote renewable energy and energy efficiency policy, but the faith community speaks uniquely with a moral authority that draws from religious values to be good stewards of creation and ensures the earth's blessings to the poor, the vulnerable, and all succeeding generations.
http://www.ohipl.org/public-engagement/

E-Newsletter Signup - Join the growing network of people of faith coming together to respond to climate change. Receive updates and information from Ohio IPL!
http://www.ohipl.org/about-us/e-newsletter-archive/

APPENDIX B. ENERGY SIGNATURES

Actual electric and natural gas use data is compared with corresponding average daily outdoor temperatures to develop the regression analyses summarized below. Energy Explorer software, developed at the University of Dayton, is used for this analysis. The detailed regression analyses for the building are shown below. The key regression statistic indicator, R-squared, is ideally greater than 0.75. This key indicator has a reasonable confidence when greater than 0.75 (1.0 meaning the equation exactly predicts energy use) in each case. This is an acceptable value determining how accurately the equations predict the actual electric energy use for each building. The Baseline is the energy used every day regardless of heating and cooling loads. The balance points are the temperature at which heating or cooling begins. The heating (or cooling factor) is the heat loss (or gain) factor multiplied by the difference between the average daily temperature and the balance point. For example, in this case, the natural gas balance point is 66°F. There is an additional 1.9 Ccf per day per degree difference between the average daily temperature and 66°F. This is the outside air temperature when the heating systems begins to turn on.

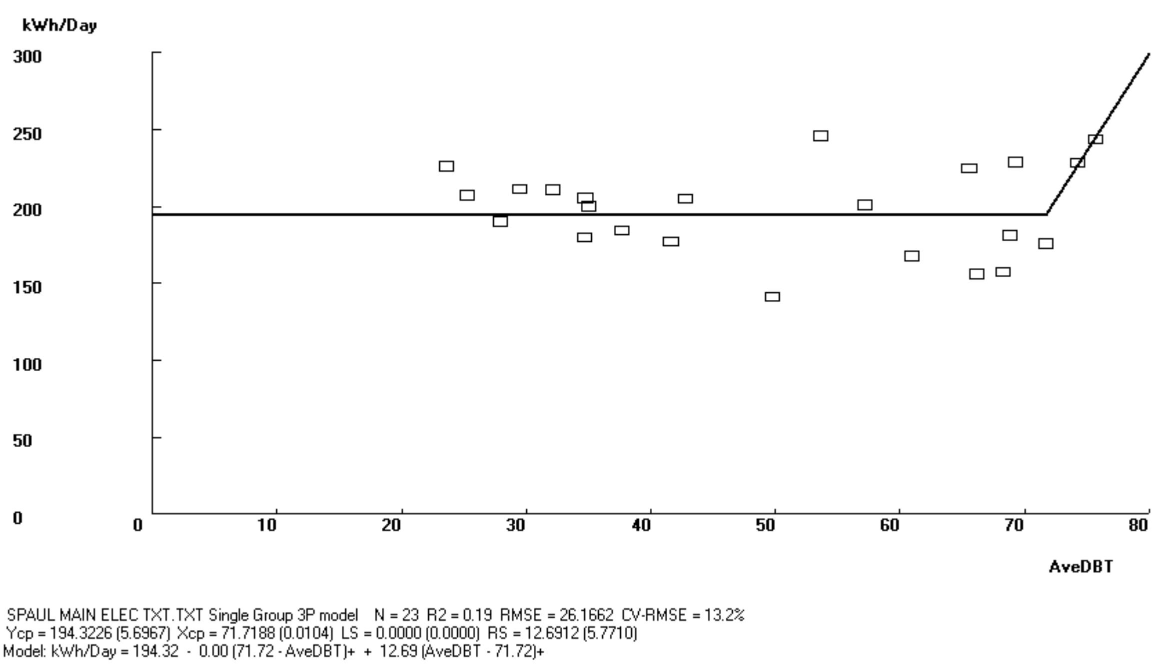
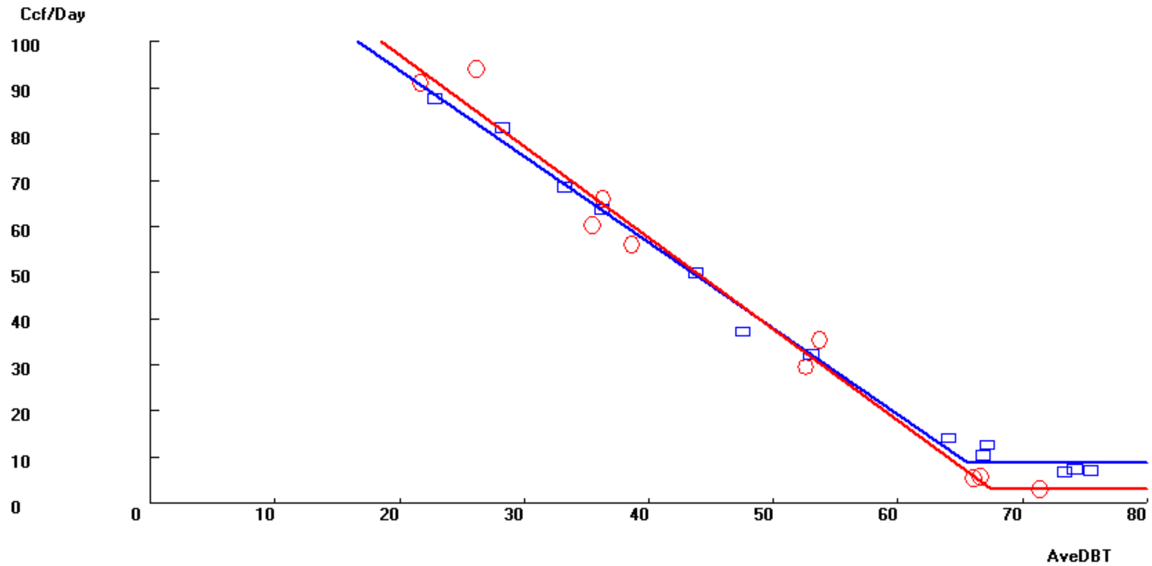


Figure B1. Electric Energy Signature



SPAUL MAIN GAS TXT.TXT 6/11/18-6/11/19 3P model N = 13 R2 = 0.99 RMSE = 2.5480 CV-RMSE = 6.9%
Ycp = 8.8733 (0.9838) Xcp = 65.5954 (0.0105) LS = -1.8583 (0.0454) RS = 0.0000 (0.0000)
Model: Ccf/Day = 8.87 - -1.86 (65.60 - AveDBT)+ + 0.00 (AveDBT - 65.60)+

SPAUL MAIN GAS TXT.TXT Before 6/11/18 3P model N = 10 R2 = 0.98 RMSE = 4.8182 CV-RMSE = 10.8%
Ycp = 3.1082 (2.4909) Xcp = 67.4525 (0.0100) LS = -1.9809 (0.0938) RS = 0.0000 (0.0000)
Model: Ccf/Day = 3.11 - -1.98 (67.45 - AveDBT)+ + 0.00 (AveDBT - 67.45)+

Figure B2. Natural Gas Signature

APPENDIX C. BUILDING USE DESCRIPTIONS

Architectural Systems Report

The 24,305 square foot House of Worship building has an irregular shape and is constructed with masonry block walls on wood frame with a finished interior surface. The windows are a mix of single pane wood and steel framed in most of the building. The preschool has double pane vinyl windows. The majority of the doors are solid wood core door to the exterior. There are multiple doors with glass panels - aluminum, metal, and wood framed. The roof construction is mostly pitched and wood framed with either asphalt shingle or copper tile materials. A small section in the center of the structure has a roof surface that is built up with 2-3" of polystyrene insulation board and rubber membrane or copper tile over a wood deck. The building elevations have different window to wall ratios with an average of 15%. The building was originally built in 1837. Individual systems have been modeled and analyzed according to their specific operating hours.

ECMs to improve the architectural systems are made in the technical sections of the report.

Table C1. Existing Architecture Characteristics

Building Type	Year Built	Gross Building Area	Overall Shape of the Building	Building Operating Hours
House of Worship	1837	24,305	irregularly shaped	3,848

Lighting Systems Report

The system components are shown below. There are primarily linear fluorescent lamps in troffer, parabolic and wrap type luminaires for area lighting within the office space, hallways, classrooms (upper/lower preschool), kitchen, pantry and gymnasium. The chandeliers in the sanctuary and entryway have been upgraded to light emitting diodes (LED). Recessed can lights with parabolic aluminized reflectors (PAR) in the sanctuary use halogen and incandescent lamps. Incandescent, compact fluorescent (CFL), and high intensity discharge (HID) lamps make up the remainder of the lighting system on the interior and exterior. Interior lighting controls are controlled by switches. Restrooms use motion sensors to control the lights. Exterior lighting is attached to photocells and timers.

Lighting levels and room occupancy was logged for a period of one week. The results of this logging are shown below. Office and sanctuary spaces indicate that 23-29% of the time lighting systems are on in unoccupied spaces. Data loggers were left at St. Paul’s in the office, preschool and sanctuary to collect information related to the lighting systems. These devices revealed that in the office area the lights were turned off 65% percent of the time when that space was unoccupied. Twenty-nine percent of the time when the space was unoccupied the lights were left on.

The preschool lights were turned off 92% percent of the time when that space was unoccupied and in the sanctuary lights were shown to be turned off 70% percent of the time when that space was unoccupied, while 23% percent of the time when that area was unoccupied the lights remained on.

ECMs to improve the lighting systems are made in the technical sections of the report.

Table C2. Existing Lighting Systems

Room/ Location Name	Existing Equipment	Controls	Quantity	Existing Luminaire Watts	Calculated Burn Hrs
St. Paul's Exit Signs	Exit, 2L 15W Incandescent	Continuous	21	30	3,848
Parking Lot	Low Bay, 1L 400W Metal Halide	Time Clock	4	440	4,380
Outside	Shoebox, 1L 150W Hi Pressure Sodium	Time Clock	2	132	4,380
Outside	Drum, 1L 100W Incandescent	Time Clock	1	75	4,380
Outside	Shoebox, 1L 350W Metal Halide	Time Clock	2	403	4,380
Outside	Drum, 1L 100W Incandescent	Time Clock	3	100	4,380
Outside	Shoebox, 1L 400W Metal Halide	Time Clock	1	440	4,380
Christian Formation	Socket, 1L 75W A' Lamp Incandescent	Switch	5	75	3,848
Christian Formation	Chandelier, 6L 6W LED 'A' Lamp	Motion Sensor	1	36	3,848
Christian Formation	Track head, 1L 9W LED R20	Switch	6	9	3,848
Christian Formation	Globe, 2L 12W CFL 'A' Lamp	Switch	1	24	3,848
Christian Formation	Industrial Pendant, 4L 12W CFL 'A' Lamp	Switch	2	48	3,848
Upper Pre-School	Flanged, 1L 75W A' Lamp Incandescent	Switch	2	75	3,848
Lower Preschool Mech Rm	Socket, 1L 65W PAR	Switch	4	65	3,848
Lower Preschool Stairwell	Wall Sconce, 1L 9W LED 'A' Lamp	Switch	1	9	3,848
Library	Chandelier, 8L 12W CFL 'A' Lamp	Switch	2	96	3,848
Library	Socket, 1L 100W A' Lamp Incandescent	Switch	4	100	3,848
Sanctuary	Chandelier, 12L 9.5W LED 'A' Lamp	Switch	6	114	3,848
Sanctuary	Recessed Can, 1L 65W PAR	Switch	14	65	3,848
Sanctuary	Recessed Can, 1L 45W R20	Switch	2	45	3,848
Sanctuary	Shoebox Flood, 1L 75W CFL Pin Base	Switch	1	75	3,848
Sanctuary	Globe, 2L 12W CFL 'A' Lamp	Switch	1	24	3,848
Sacristy Hall	Socket, 4L 12W CFL 'A' Lamp	Switch	1	48	3,848
Sacristy Basement	Socket, 1L 22W CFL 'A' Lamp	Switch	7	22	3,848
Guild Room	Recessed Can, 1L 65W PAR	Switch	14	65	3,848
Outside	Wall Sconce, 1L 25W A' Lamp Incandescent	Time Clock	4	25	4,380
Outside	Wall Sconce, 1L 18W LED R20	Time Clock	2	18	4,380
Outside	Wall Sconce, 1L 100W A' Lamp Incandescent	Time Clock	1	100	4,380

Room/ Location Name	Existing Equipment	Controls	Quantity	Existing Luminaire Watts	Calculated Burn Hrs
Outside	Wall Sconce, 1L 29W A' Lamp Incandescent	Time Clock	2	29	4,380
Outside	Highbay, 2L 300W CFL Pin Base	Photocell	1	600	4,380
Outside	Lowbay, 2L 65W PAR	Photocell	1	130	4,380
Outside	Lowbay, 1L 350W CFL Pin Base	Photocell	1	350	4,380
Outside	Wall Sconce, 1L 9W LED 'A' Lamp	Time Clock	2	9	4,380
Christian Formation	Wrap, 2L 40W T12	Switch	8	92	3,848
Christian Formation	Strip, 1L 25W T5	Switch	1	29	3,848
Christian Formation	Wrap, 4L 32W T8	Switch	1	141	3,848
Gym	Wrap, 4L 32W T8	Switch	6	141	3,848
Upper Pre-School	Modular, 4L 32W T12	Switch	26	147	3,848
Upper Pre-School	Wrap, 2L 32W T12	Motion Sensor	2	70	3,848
Lower Preschool	Modular, 4L 40W T12	Switch	12	184	3,848
Lower Preschool	Wrap, 4L 34W T12	Switch	8	156	3,848
Office Area Hallway & Rms on Flr.	Modular, 4L 34W T12	Switch	19	156	3,848
Office Area Hallway & Rms on Flr.	Modular, 3L 34W T12	Switch	1	117	3,848
Library	Direct/ Indirect, 1L 40W T12	Switch	10	46	3,848
Library	Wrap, 4L 32W T8	Switch	1	141	3,848
Library	Wrap, 2L 32W T8	Switch	1	70	3,848
Kitchen	Modular, 3L 34W T12	Motion Sensor	6	117	3,848
Skyroom	Modular, 4L 40W T12	Switch	3	184	3,848
Sanctuary Rm	Wall Bracket, 2L 25W T5	Motion Sensor	3	44	3,848
Pantry	Wrap, 2L 32W T8	Motion Sensor	6	70	3,848
Pantry	Modular, 3L 25W T5	Switch	1	83	3,848
Pantry	Modular, 3L 32W T8	Switch	1	106	3,848

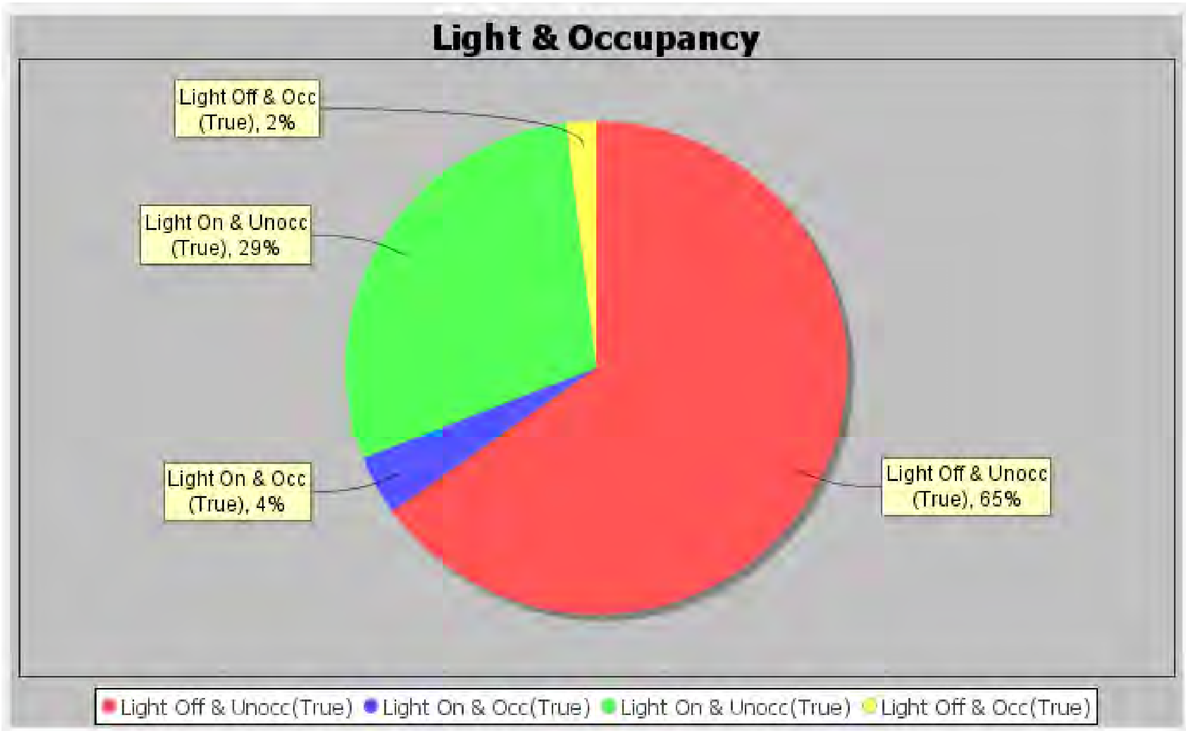


Figure C1. Office Lighting Profile

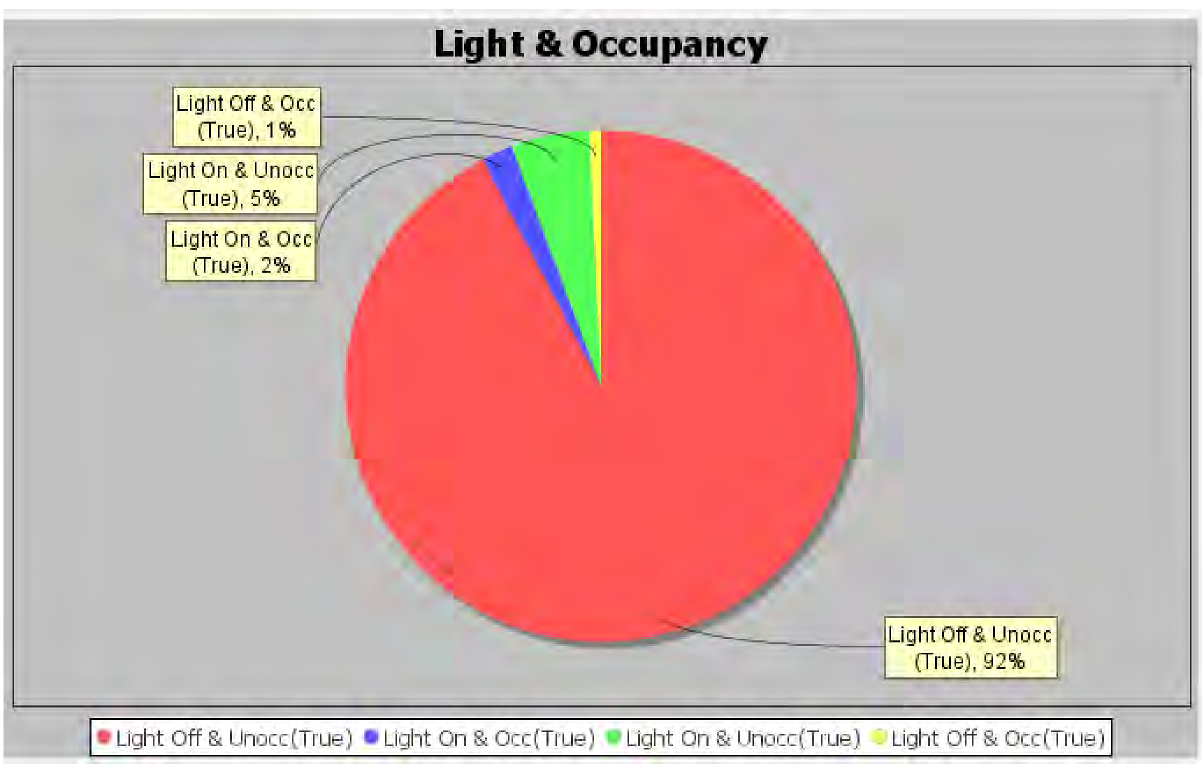


Figure C2. Preschool Lighting Profile

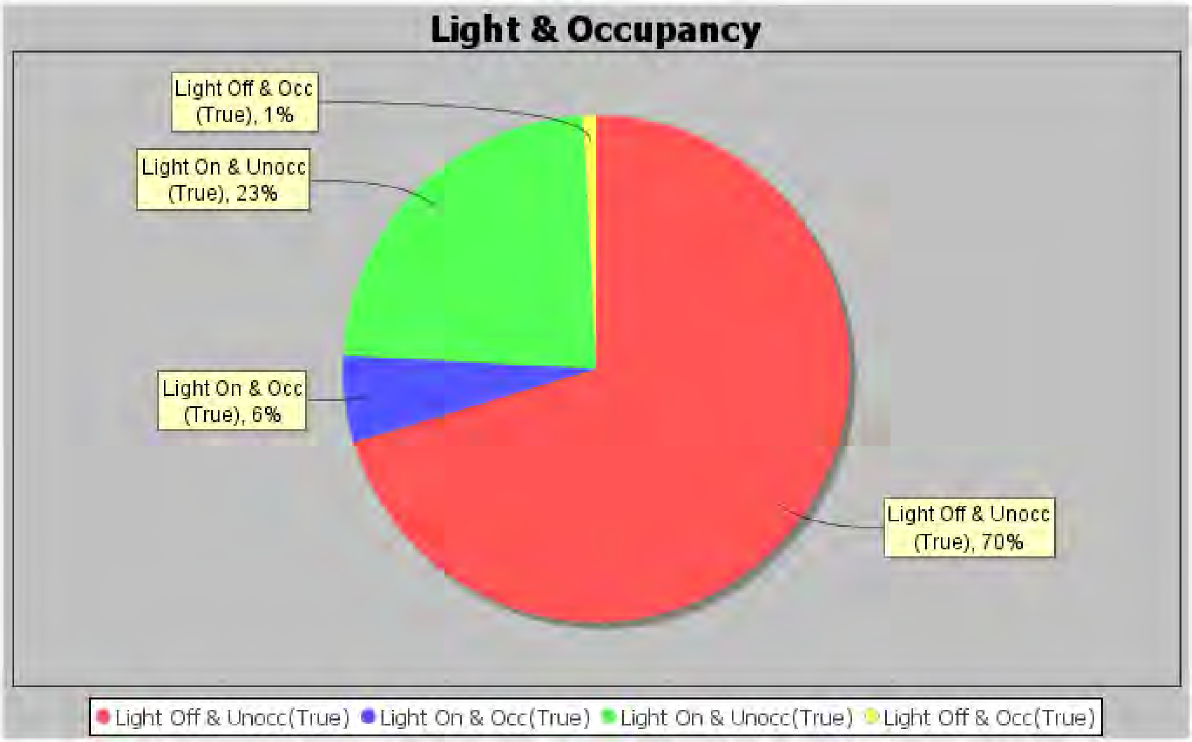


Figure C3. Sanctuary Lighting Profile

Mechanical Systems Report

HVAC System and Controls

The system components are shown below. There are numerous direct expansion (DX) cooling units controlled with electronic thermostats. A few areas have window cooling only units, the food pantry and kitchen spaces have a ductless minisplit cooling unit. The 12 cooling systems are mounted on the roof (rooftop units and DX split systems). There is some exposed duct work on the roof which serves the sanctuary (it was measured to be at 130°F during a static time period). There are two separate boiler loops where each has a set of zones and distribution pumps along with finned tube radiators and steam radiators. The boilers are turned on during the fall time when weather dictates the need for heating. During the heating season the boilers cycle on. The office area boiler was observed on during field study. The office boiler uses a Honeywell outside air limit controller to keep the system off when outside air temperature rises above a set point. The commercial kitchen has a make up air and kitchen exhaust fans. All cooling systems are controlled by electronic thermostats.

Temperature was logged for a period of one week. The results of this logging are shown below. The temperature settings show a narrow band of movement indicating that the temperature changes are minimal or no temperature setback control is being performed.

ECMs to improve the HVAC systems are made in the technical sections of the report.

Table C3. Existing Heating Systems

Name	Terminal Unit	Space Served/Zone Designation	Manufacturer and Model #	Heating Type	Heating Capacity (kBtu/hr)	Heating eff	Cooling Capacity (kBtu/hr)	System EER/ SEER	Supply Fan Motor Size (hp)	System Age (yrs)
AHU-1	Packaged split unit	Preschool Upstairs	Trane TWE120D3R3AA/TTA120F3HRAA	-	-	-	120	11.4	1.00	5
-	Radiator/ finned tube	Preschool Upstairs	160 linear feet	Hot Water	160.00	-	-	-	-	20+
CU-1	Split system	Sanctuary	York H2RA060S06A	-	-	-	60	10.0	0.25	20+
CU-2	Split system	Sanctuary	York H2RA060S06A	-	-	-	60	10.0	0.25	20+
-	Radiator/ finned tube	Sanctuary	45 linear feet	Hot Water	45.00	-	-	-	-	20+
CU-3	Split system	Library	York H1RD030S06G	-	-	-	30	10.0	0.13	20+
-	Radiator/ finned tube	Library	5 linear feet	Hot Water	5.00	-	-	-	-	20+
BCU-3	Split system	Guild Room	Luxaire N1AHB1206G/ cond n/a (36 kBtu/h)	Electric	35.17	100%	36	10.0	0.13	20+
-	Radiator/ finned tube	Guild Room	15 linear feet	Hot Water	15.00		-	-	-	20+
BCU-4	Split system	Gym	Luxaire N1AH2006G/ York H1RA060S25G	Electric	58.62	100%	60	10.0	0.25	20+
CU-4	Split system	Gym	York GCGD60S21S2B	-	-	-	60	10.0	0.25	20+
-	Radiator/ finned tube	Gym	20 linear feet	Hot Water	20.00	-	-	-	-	20+
BCU-1	Split system	Meeting Room	Luxaire N1AHB0806G/ York H1RD024S60G	Electric	23.45	100%	24	10.0	0.13	20+
-	Radiator/ finned tube	Meeting Room	20 linear feet	Hot Water	20.00	-	-	-	-	20+
BCU-2	Split system	Music Dir and Choir Rm	Luxaire N1AHC1606G/ York H1RA042S25G	Electric	46.89	100%	42	10.0	0.25	20+
-	Radiator/ finned tube	Music Dir and Choir Rm	75 linear feet	Hot Water	75.00	-	-	-	-	20+
BCU-5	Split system	Office	Luxaire AE36CX2D/ cond n/a (36 kBtu/h)	-	-	-	36	13.0	0.13	<1
-	Radiator/ finned tube	Office	40 linear feet	Hot Water	40.00	-	-	-	-	20+
MS-1	Split system	Kitchen	LG LSN242CE/ York AY012MA321A (TBD)	-	-	-	23	13.0	0.13	10
-	Radiator/ finned tube	Kitchen	10 linear feet	Hot Water	10.00	-	-	-	-	20+
MS-2	Split system	Pantry	Mitsubishi PCA-A36KA6/ PUZ-A36NHA6	Electric	36.00	10.4 HSPF	36	14.4	0.13	4
AC-4	Window DX	Christian Formation	GE AQV05LAM2	-	-	-	5	10.0	-	20+
-	Radiator/ finned tube	Christian Formation	15 linear feet	Hot Water	15.00	-	-	-	-	20+
AC-3	Window DX	Preschool (basement)	Frigidaire FFRS1022R1	-	-	-	10	10.0	-	5
AC-2	Window DX	Preschool (basement)	Frigidaire FFRS1022R1	-	-	-	10	10.0	-	5
-	Radiator/ finned tube	Preschool (basement)	125 linear feet	Hot Water	125.00	-	-	-	-	20+
AC-1	Window DX	Sacristy	GE AQV05LAM2	-	-	-	5	10.0	-	20+
-	Radiator/ finned tube	Sacristy	5 linear feet	Hot Water	5.00	-	-	-	-	20+
EF-1	Exhaust Fan	Restrooms	Jenn-Air 80CRQT	-	-	-	-	-	-	20+
MAU-1	Make Up Air	Kitchen	Captiveaire A1-D.250-G10	Natural Gas	180.00	81%	-	-	1.00	4
KEF-1	Exhaust Fan	Kitchen	Captiiveaire NCA16HPFA	-	-	-	-	-	1.50	4

Table C4. Existing Central Heating Systems

Name	Manufacturer/ Model Number	Space(s)/ Equipment Served	Type	Draft	Media	Burner Control	Fuel Source	Heating Capacity (kBtu/hr)	Equipment eff	Equipment Age
HWB-1	Crane 40W10NR	Hallways (1st and 2nd Flr), 1st Floor Classrooms, Offices, and Basement	Sectional	Natural Draft	Hot Water	On-Off	Natural Gas	630	76%	20+
HWB-2	Multi Temp Hydro Therm MR-750C	Sanctuary, Gym, Guild Room, Sacristy, and Lobby	Sectional	Natural Draft	Hot Water	Modulating	Natural Gas	750	82%	20+

Table C5. Existing Pumps

Heating System Equipment Name	Pump Service	Manufacturer/Model Number	Equipment Served	Pump Motor Size (hp)	Pump Type	# Months Used
HWB-1	Basement	B&G n/a	zone	0.17	inline	7
HWB-1	2nd Floor Hall	B&G PL-30	zone	0.08	inline	7
HWB-1	1st Floor Hall	B&G PL-30	zone	0.08	inline	7
HWB-1	1st Floor Class	B&G PL-30	zone	0.08	inline	7
HWB-2	Sanctuary	B&G PL-75	zone	0.17	inline	7
HWB-2	Gym	B&G PL-75	zone	0.30	inline	7
HWB-2	Guild Room	B&G PL-30	zone	0.08	inline	7
HWB-2	Sacristy/ Lobby	B&G NRF-22	zone	0.10	inline	7

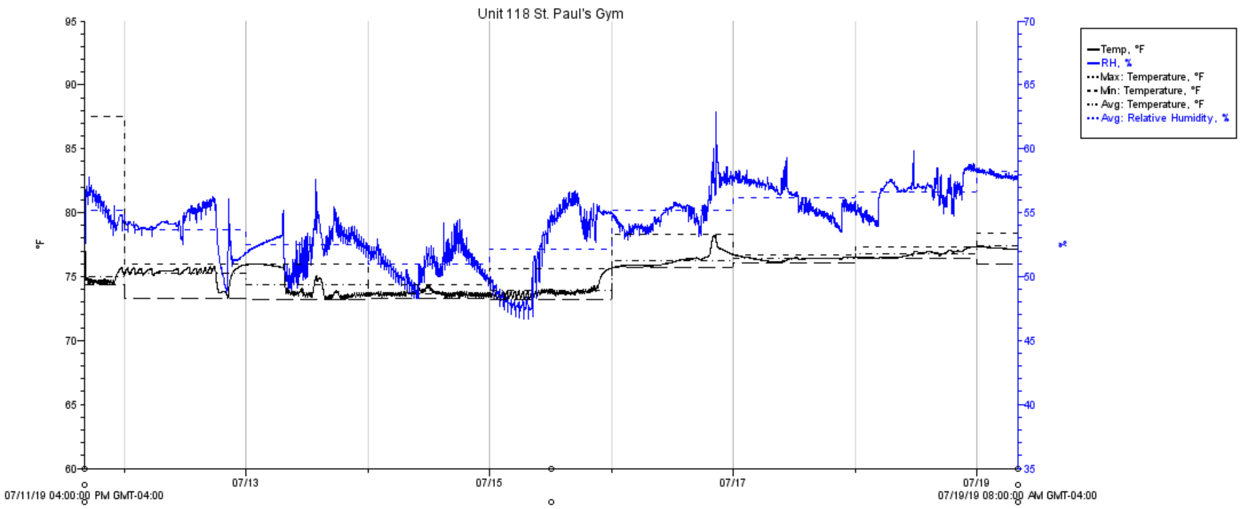


Figure C4. Gym Temperature Profile

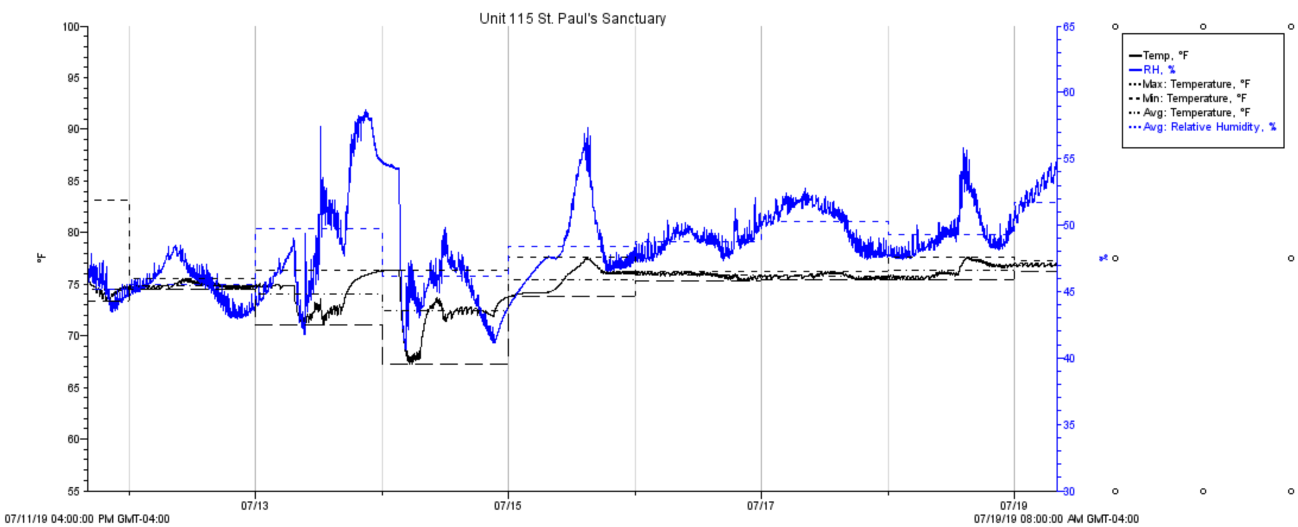


Figure C5. Sanctuary Temperature Profile

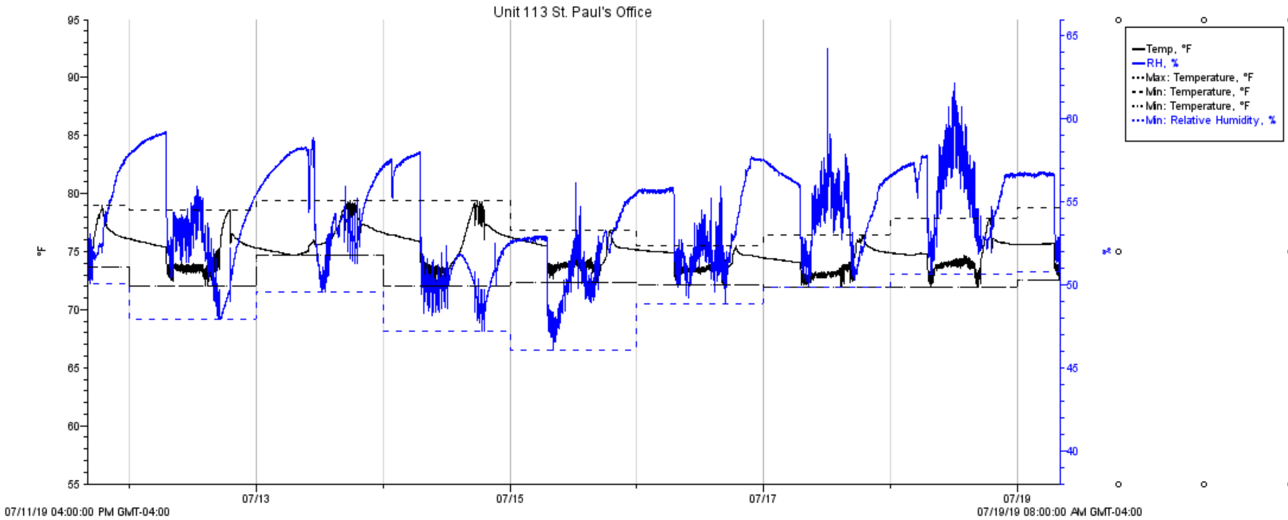


Figure C6. Office Temperature Profile

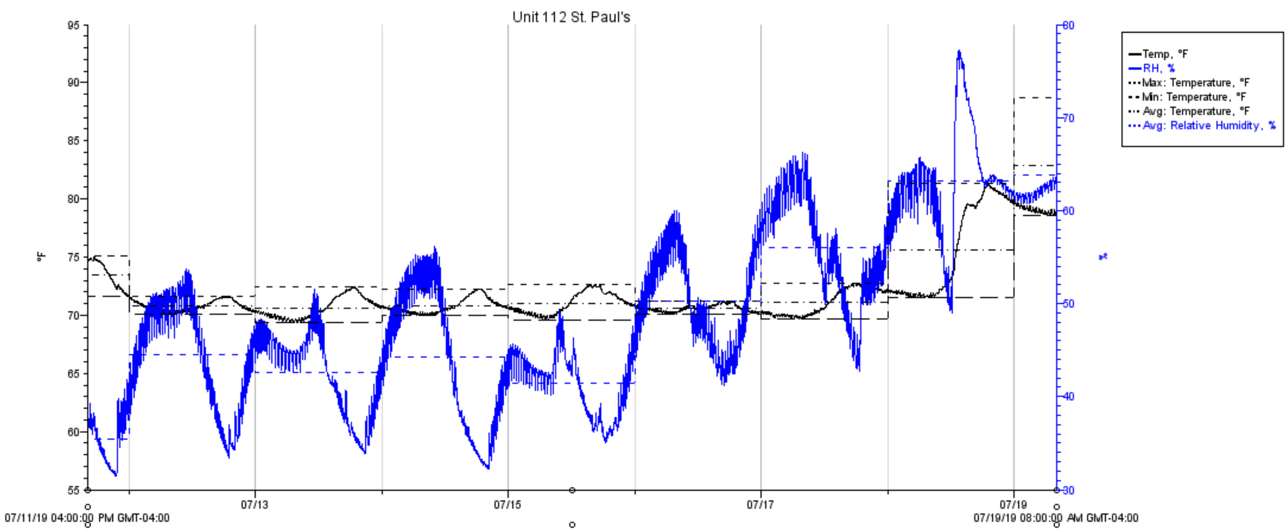


Figure C7. Preschool Temperature Profile

Other Mechanical Systems

Domestic Hot Water

The system components are shown below. There are two separate storage hot water tank systems each located in the basement in different areas. Both units have the manual setpoint turned up to be at or near the "very hot" settings. This setting may be used to increase water temperature for sanitization or to add heat so that long stretches of uninsulated pipe will receive hot water more promptly at the end use lavatory.

ECMs to improve the domestic hot water system are made in the technical sections of the report.

Table C6. Existing Domestic Hot Water System

Location	Manufacturer/ Model Number	End Use Application	Type	Storage Tank Capacity (gal)	Fuel	Rated Input (kBtu/hr)	Equipment Effectiveness/ Efficiency	Temp Set Point (°F)
Basement (sanctuary)	Richmond 5V30-6	restrooms and kitchen	Storage tank	30	Natural Gas	32.0	60%	140
Basement (office)	AO Smith FCG 75 270	restrooms and kitchen	Storage tank	74	Natural Gas	75.1	60%	130

Plug Loads

The system components are shown below. There is commercial grade plug load kitchen equipment in the kitchen. The kitchen is used regularly for programs and events. The eight-burner range and dual oven gas pilot light manual switch was off, which is a best practice. All equipment observed was in good condition. The pantry refrigerator and freezer temperatures recorded are what we would expect from commercial grade appliances like these. The refrigeration systems are rejecting heat into the occupied space which adds to the cooling load. Laundry appliances are onsite but is only used sporadically. The office spaces have typical office equipment and classrooms have minimal plug-in appliances.

ECMs to improve the plug load system are made in the technical sections of the report.

Table C7. Existing Plug Loads

Location	Existing Equipment	Quantity	Diversity
Kitchen	Coffee Maker	1	High
Upper Pre-School	Mini Refrigerators without glass door	1	High
Pantry	Refrigerator/Freezer (Combo), 47"	1	High
Office Area Hallway & Rms on Flr.	(Monitor) Electric Information Displays	3	Low
Library	(Monitor) Electric Information Displays	1	Low
Skyroom	(Monitor) Electric Information Displays	1	Low
Upper Pre-School	Televisions	2	Low
Sanctuary	Ceiling Fan	2	Low
Lower Preschool	Dehumidifier	1	Medium
Sanctuary Rm	Restroom Exhaust Fan	3	Low
Office Area Hallway & Rms on Flr.	Computer Monitors (Average 22" in.)	4	Low
Office Area Hallway & Rms on Flr.	Desktop Computers	3	Low
Christian Formation	Fans	1	Low
Office Area Hallway & Rms on Flr.	Multifunction Devices (Printer/fax/copier/scan)	1	High
Office Area Hallway & Rms on Flr.	Paper Shredders	1	Low
Office Area Hallway & Rms on Flr.	Small Printers (desktop)	1	Low
Pantry	Small Printers (desktop)	1	Medium
Sacristy Basement	Washing Machine	1	Medium
Lower Preschool	Water Coolers	1	Low
Kitchen	Microwave oven: commercial	1	Medium
Kitchen	Commercial Side -by-Side Refrigerator	1	Medium
Kitchen	Dual Oven Bottom/Top	1	Low

Location	Existing Equipment	Quantity	Diversity
Kitchen	2 oven, 8 burners on/oven on	1	Medium
Sacristy Basement	Dryer (Nat. Gas) 7.3 Cu ft	1	Low

APPENDIX D. DUDLEY HOUSE AND RECTORY

The church owns two residential structures: Dudley House and Rectory.

They are paying a comparable rate for electric ($0.0533/kWh) and natural gas energy ($0.6085/Ccf). When securing future procurement, consider contracts that include the loads for each of these structures.

Recommended actions:

- (Dudley House and Rectory) Upgrade all lighting from compact fluorescent lamp (CFL) and incandescent bulbs to LED 9W A19 (non-vanity) or 5W G25 (vanity).

- (Dudley House and Rectory) Replace the thermostat in each residential space with a wireless programmable unit which matches the recommendation (XXX-insert ECM reference). Add each to the church network to monitor energy use.

- (Dudley House and Rectory) Replace the storage hot water tanks with equivalent sized units which are ENERGY STAR® rated. The tanks should meet the following criteria:

    1. Energy Factor ≥ 0.67,
    2. First Hour Rating ≥ 67 gallons per hour,
    3. Warranty Warranty ≥ 6 years on system, and
    4. ANSI Z21.10.1/CSA 4.1 Safety requirements

- (Dudley House and Rectory) Continue to upgrade windows to double pane glass with a vinyl frame to replace single pane units.

- (Dudley House) Repair the vinyl siding on the Dudley House. On the rear elevation, the vinyl siding has begun to de-laminate from the surface and should be repaired to eliminate air and moisture infiltration.

- (Dudley House) Replace the outdoor condenser. The furnace is high efficiency and is in good condition, but the outdoor condenser which is used for cooling appears to be past its useful service life. It can be replaced with a high efficiency unit (above 15.0 SEER) to reduce energy costs when the unit begins to have equipment functionality or maintenance issues.

- (Rectory) Upgrade the boiler to a high efficiency unit to reduce energy costs when the unit begins to have equipment functionality or maintenance issues. The system should be able to have a combustion efficiency exceeding 94% and should be evaluated for proper size at the time of replacement.

APPENDIX E. SOLAR PV ARRAY ANALYSIS

Energility your energy solution — **Annual Production Report** produced by Energility LLC- jeff@energility.com

Design 1 St. Paul's Episcopal Church Solar Assessment, 310 Elizabeth St, Maumee, OH 43537

Report

Project Name	St. Paul's Episcopal Church Solar Assessment
Project Address	310 Elizabeth St, Maumee, OH 43537
Prepared By	Energility LLC- jeff@energility.com info@energility.com

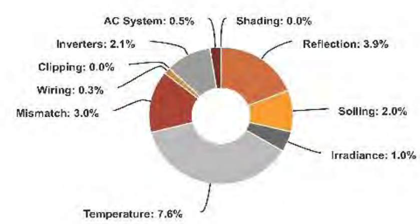
System Metrics

Design	Design 1
Module DC Nameplate	22.4 kW
Inverter AC Nameplate	24.1 kW Load Ratio: 0.93
Annual Production	26.35 MWh
Performance Ratio	81.2%
kWh/kWp	1,176.5
Weather Dataset	TMY, 10km Grid (41.55,-83.65), NREL (prospector)
Simulator Version	89a860c2c8-a2e0356b3d-9756436255-07060ca97f

Project Location

Monthly Production

Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,417.0	
	POA Irradiance	1,448.7	2.2%
	Shaded Irradiance	1,448.6	0.0%
	Irradiance after Reflection	1,392.7	-3.9%
	Irradiance after Soiling	1,364.8	-2.0%
	Total Collector Irradiance	**1,364.8**	**0.0%**
Energy (kWh)	Nameplate	30,588.6	
	Output at Irradiance Levels	30,285.7	-1.0%
	Output at Cell Temperature Derate	27,973.6	-7.6%
	Output After Mismatch	27,139.3	-3.0%
	Optimal DC Output	27,053.8	-0.3%
	Constrained DC Output	27,053.7	0.0%
	Inverter Output	26,485.8	-2.1%
	Energy to Grid	**26,353.3**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		12.5 °C
	Avg. Operating Cell Temp		27.4 °C
Simulation Metrics			
		Operating Hours	4638
		Solved Hours	4638

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km Grid (41.55,-83.65), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Characterization
TSM-PD14 320 (May16) (Trina Solar)	Spec Sheet Characterization, PAN

Component Characterizations

Device	Characterization
Sunny Tripower 24000TL-US (SMA)	Modified CEC

 1/2 July 19, 2019

Annual Production Report produced by Energility LLC- jeff@energility.com

Components

Component	Name	Count
Inverters	Sunny Tripower 24000TL-US (SMA)	1 (24.1 kW)
Strings	10 AWG (Copper)	4 (824.9 ft)
Module	Trina Solar, TSM-PD14 320 (May16) (320W)	70 (22.4 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	5-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Landscape (Horizontal)	10°	247.704°	1.0 ft	1x1	39	36	11.5 kW
Field Segment 2	Flush Mount	Landscape (Horizontal)	10°	247.704°	1.0 ft	1x1	28	28	8.96 kW
Field Segment 3	Flush Mount	Landscape (Horizontal)	10°	247.704°	1.0 ft	1x1	6	6	1.92 kW

Detailed Layout

APPENDIX F. ODSA SUMMARY

ODSA Summary Table

Table F1. ODSA Summary

ECM #	ECM Description	ECM Price	Rebates	Electricity Savings		Annual Gas Savings		Total Utility Savings				% of Total Utility Spend	Annual O&M Savings	Total Savings	Simple Pay-back w/ Rebate & O&M	Simple Pay-back w/ Rebate & w/o O&M	Simple Pay-back w/o Rebate & O&M
				$	kWh	$	mmBTU	$	mmBTU	% Energy Saved	Tons CO2						
C-1	Retrocommission mechanical systems	$10,136	$2,013	$164	2,237	$1,522	195	$1,686	203	11%	12	11%	$0	$1,686	4.8	4.8	6.0
C-2	Improve space temperature controls	$11,775	$1,784	$0	-	$1,428	183	$1,428	183	10%	10	10%	$0	$1,428	7.0	7.0	8.2
H-1	Upgrade the existing heating systems by installing new high efficiency boilers	$56,297	$1,806	$0	-	$1,446	185	$1,446	185	10%	10	10%	$800	$2,246	24.3	37.7	38.9
L-1	Upgrade lighting systems to LED technology	$47,516	$1,256	$2,767	25,123	$0	-	$2,767	86	5%	18	5%	$238	$3,005	15.4	16.7	17.2
S-1	Improve electric generation by adding a solar PV array	$62,561	$31,280	$2,355	26,350	$0	-	$2,355	90	5%	19	5%	$0	$2,355	13.3	13.3	26.6
O-1	Improve operations with best practices	$3,240	$216	$839	7,019	$4,843	294	$5,682	318	18%	21	18%	$171	$5,853	0.5	0.5	0.6
	Total	**$191,525**	**$38,355**	**$6,125**	**60,729**	**$9,240**	**858**	**$15,365**	**1,065**		**88**	**59%**	**$1,209**	**$16,574**	**9.2**	**10.0**	**12.5**

Ohio | **Development Services Agency**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Lydia L. Mihalik, Director

Date: August 14, 2019

Office of Community Assistance

Engineer or Architect Certification of ASHRAE Level II Energy Audit (or equivalent) and other Applicable Technical Requirements of the Energy Efficiency Program for Manufacturers and Non-Manufacturers (EEPM/EEPNM) Audit Report

ENGINEER OR ARCHITECT CERTIFICATION: I, Craig A. Foster, duly licensed to practice engineering or architecture in the State of Ohio, do hereby certify that the ASHRAE Level II Energy Audit (or its equivalent as agreed by the Office of Community Assistance) provided for the St. Paul's Episcopal Church involved a total of 24,305 square feet (Sq. ft.) of building space. The total square footage of building space audited, energy efficiency audit process, baseline energy consumptions, projected energy savings calculations, and other applicable technical information provided for this project's ASHRAE Level II Energy Audit, or its equivalent, under the Energy Efficiency Program for Manufacturers or Non-Manufactures (EEPN/EEPNM) submitted to Ohio Development Services Agency, Office of Community Assistance were duly reviewed and approved by me.

Engineer or Architect Signature: Craig A. Foster

Print Name: Craig A. Foster Ohio Engineer License # E-50749, or Ohio Architect License # ____________________

Contact Address: 243 W. Schreyer Place, Columbus, OH

Telephone Number: 614-940-6274 Email: craig@energility.com

Affiliated Company, if any: Energility, LLC

Affiliated Company Address: 4041 N. High Street, Suite 100A

Affiliated Company Telephone Number/Fax: 614-754-8468 Fax 614-386-1169

Affiliated Company Website: www.energility.com

Note: (Must affix Engineer or Architect's seal, signature and date for this Certification to be considered valid).

(Rev. June 2016/AS/MA)

STATE OF OHIO ★ CRAIG A. FOSTER E-50749 REGISTERED PROFESSIONAL ENGINEER ★

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