MASSACHUSETTS
Interfaith Power & Light

ENVIRONMENTAL STEWARDSHIP ASSESSMENT

First Church in Sterling

Sterling, Massachusetts

March 2023

This *Environmental Stewardship Assessment* is based upon information provided by the congregation, observations of the visible and apparent conditions of the property and the components evaluated on the date of assessment. Care has been taken in the performance of this assessment. This report is made only in the best exercise of our ability and judgment. However, Massachusetts Interfaith Power & Light (and or its representatives) makes no representations regarding latent or concealed defects that may exist, and no warranty or guarantee is expressed or implied. Conclusions in this report are based on systems attributes, estimates of the age and normal working life of various items of equipment and appliances. Predictions of life expectancy and the balance of useful life are necessarily based on industry and/or statistical comparisons and observed conditions. It is essential to understand that actual and future conditions can alter the useful life of any item. The previous use/misuse, irregularity of servicing, faulty manufacture, unfavorable conditions, acts of God and unforeseen circumstances make it impossible to state precisely when each item will require replacement and/or what the actual savings in use and cost will be. The Member herein should be aware that certain components with the above referenced property may function consistent with their purpose at the time of the assessment, but due to their nature are subject to deterioration without notice. Unless otherwise noted, all building components are assumed to have met the building code requirements in force at the time of construction. Conclusions reached in this report assume responsible ownership and competent management of the property. Information provided to us by others is believed to be reliable. However we assume no responsibility for the accuracy of such information.

This *Environmental Stewardship Assessment* is based on a site visit to First Church in Sterling on Feb 9, 2023, by Jim Nail and Bill Schroeder for Massachusetts Interfaith Power & Light (MassIPL). The report provides a summary of conditions and "To Do" summary, followed by findings that will help guide you as you make the recommended improvements, it can easily be shared with other members of your congregation, in print or electronic format.

Also review the ***Everyday Environmental Stewardship Briefs*** and ***Success Stories*** which may be included and are available at the MassIPL web site.

http://www.massipl.org/everyday-environmental-stewardship
https://www.massipl.org/congregation-success-stories

These provide detailed guidance on the actions possible at your HOW, and at all the places we occupy as we live, work, study, and play.

Remember also that the observations for this House of Worship apply as well
to the houses in which we live, work, learn and play.
Be active in caring for them all.

If We Don't, Who Will?

SUMMARY

This summarizes the energy use, environmental and financial impact, and the rating of First Church in Sterling for its environmental stewardship.

Energy Use Intensity: Below Average (good)

Energy use intensity (EUI) measures the amount of energy used annually per square foot of building space. It is a standard measure used in the energy efficiency field. The Energy Information Administration reports that the average House Of Worship (HOW) in the northeast has an EUI of 54.9. Being "average" as a HOW is not a good rating for environmental stewardship. Your HOW is 44.8 indicating your building envelope is pretty good, especially considering the age of the building.

Carbon Emissions: Above Average

Different types of energy emit different amounts of carbon, with heating oil emitting the most. Gas and the fuels used to generate electricity also emit carbon so reducing all energy use is important. The Next Generation Roadmap for MA Climate Policy legislation calls for Massachusetts to reduce carbon dioxide emissions by 50% by 2030 and be net zero by 2050 (versus a 1990 baseline), in line with scientists' recommendations to avoid the worst effects of climate change. Because your HOW is above average, there is potential to decrease your carbon footprint in two areas this report examines: Behavior and Heating/Cooling/Hot Water.

Financial impact: Below Average (good)

First Church in Sterling spent about $17,000 in 2021 for all its energy use, approximately 3.5% of its overall budget. MassIPL sees a range of 2% - 20% -- wouldn't you like to be closer to the 2%? Green grows two ways – one of which you take to the bank! By implementing the recommendations in this report you can reduce this cost and reinvest the savings in additional energy efficiency measures caring for creation, which is a key element of your mission. MassIPL sees savings in a range of 10% for the "low-hanging fruit" to over 50% for the major work. All actions have continuing benefits, for decades or more.

Your 24 Questions Score **6 YES; 4 Yes & No; 14 NO**

The following page presents the answers to the **24 Questions** on environmental stewardship at your HOW. A perfect score would be answering all 24 questions YES. Currently First Church can only answer 6 questions YES. However these NO answers reveal the most important opportunities to decrease energy use, save money and improve your environmental stewardship.

Question	Answer	Comments
BEHAVIOR		
Do you track your Utility Use and Cost (UU&C) monthly?	Yes and No	
Have you created energy awareness among staff and members?	Yes	
Do you have an environmental stewardship team? A designated "energy manager"?	No	
Do thermostat settings match times of use?	No	
Do you have a plan to cut your carbon emissions 50% by 2030?	No	
Do you have a budget line for Energy Efficiency investments?	No	
ELECTRICITY		
Do you make best use of natural and artificial light?	Yes	
Do all your fixtures have LED bulbs?	Yes	
Do you have occupancy sensing switches in all appropriate spaces?	No	
Are all your refrigerators and freezers efficient and used efficiently?	Yes	
Are all other office equipment and appliances Energy Star top-rated?	No	
Have you evaluated your HOW for solar panels?	No	

Question	Answer	Comments
BUILDING ENVELOPE		
Are your walls, ceilings, floors insulated to current standards?	No	
Have you sealed areas of air infiltration?	Yes and No	
Do you have high efficiency windows? Interior storms? Sun screens?	No	
Are all doors well-insulated and tight fitting?	Yes and No	
Do windows and doors have effective weatherstripping?	No	
HEATING COOLING WATER		
Do heating and cooling zones match use patterns?	Yes	
Do controls and distribution optimize energy efficiency of HVAC equipment?	No	
Are heat/AC/hot water pipes and ducts insulated?	Yes and No	
Is your air conditioning SEER 14+?	No	
Have you evaluated your HOW for heat pumps?	No	
Is your hot water heater 95%+ efficient?	No	
Do you have water-efficient faucets and toilets?	Yes	

www.massipl.org	YES	6
	NO	14
	YES & NO	4

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To Dos

Given that your energy use is below average already, there are a few small steps you can take now, both to save some money in the upcoming heating season and to prepare for the heating system replacements that will be your major project to move toward Net Zero:

- Establish an operational procedure to ensure that thermostats are set to the correct time, programmed correctly to times spaces are occupied, and updated as schedules for church activities change. We recommend this is a responsibility of an energy manager (page 17).
- As you plan other building maintenance projects in this capital campaign, evaluate if there is a possibility to include energy efficiency components in the scope of work, specifically:
    - Painting: consider removing the trim board at the bottom of the siding to expose where the foundation and wall framing meet to enable air sealing
    - Siding: if you remove current siding to replace it with a new material, consider adding exterior insulation.
- Upgrade thermostats to a single model (for ease of programming) and, ideally, internet accessibility (page 17)
- Consider moving all food into the smaller GE fridge in the kitchen and either shutting off the large commercial unit or turning the temperature up (page 24).
- Weatherstrip the Sanctuary windows, preferably with brass spring weatherstripping (page 32)
- Inspect door weatherstripping, especially the Sanctuary, Choir Room, and kitchen door (page 34).
- Consider purchasing and installing interior storm windows for a number of rooms and the Parish Hall (page 34).
- Plan to replace the 40-gallon hot water heater with small point-of-use models in the basement bathrooms in a few years (page 45).
- Evaluate the scope of work to replace the rooftop units with heat pumps. If relatively easy, and cost effective, prioritize this over the boiler replacement.

Net Zero Plan

In the 2021 Next Generation Roadmap for Massachusetts Climate Policy law, the Commonwealth sets goals to decrease carbon emissions 50% by 2030 (compared to a 1990 baseline) and be net zero carbon emissions by 2050. As these goals relate to buildings, the general approach is to decrease the building energy use as much as possible then switch to electric heating and cooling, either air source or ground source heat pumps.

It would be challenging to find data to calculate your 1990 energy consumption and carbon emissions so MassIPL recommends you use the energy consumption documented in this report as your baseline.

In order to make progress toward the 2030 goal, your major action will be to replace your aging HVAC equipment, ideally with heat pumps.

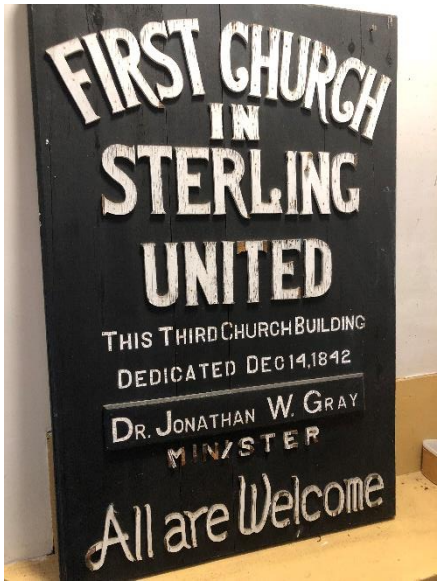
- Hire a mechanical engineer to conduct a "heat load" analysis of the building and develop specifications for replacement equipment (page 44).
- Evaluate whether to replace the oil boilers or the rooftop units first. The oil boilers are by far the majority of your carbon emissions but upgrading the rooftop units (which are not currently heat pumps, they are air conditioning units with electric resistance heating) to heat pumps may be easier. Since heat pumps are 2.5 times as efficient as electric resistance heat, this would reduce your electricity use substantially in the winter, while in summer the will likely use almost half of the electricity for air conditioning as the rooftop units.
- Consider phasing the oil boiler replacement if it can't be done in one project. Areas such as the basement, the Preschool room, and the series of rooms from the Choir Room to Kinder Watch might be converted to heat pumps and taken off the boiler as first steps (pages 43 – 44).
- Begin research on installing solar panels. Each municipal electric company has its own policies and vary in their willingness to let customers install solar. You likely have enough roof space to install a solar array large enough to produce significantly more electricity than you currently use and which would likely provide most of the electricity needed by heat pumps. The combination of heat pumps and solar would go a long way to eliminating your carbon footprint.

Google satellite view

Street Level View from SE corner

Street Level View from NE corner

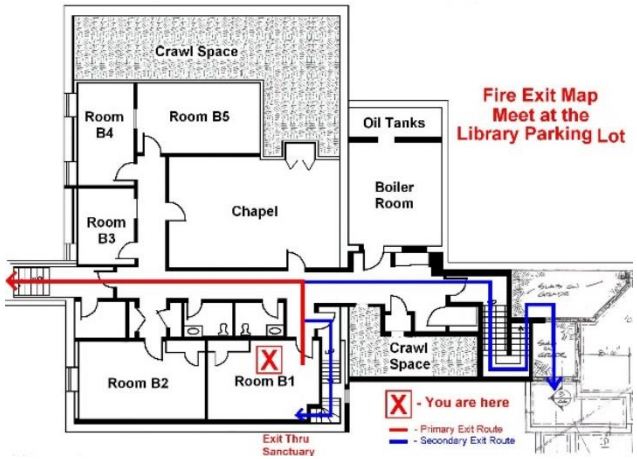
Sign: Now



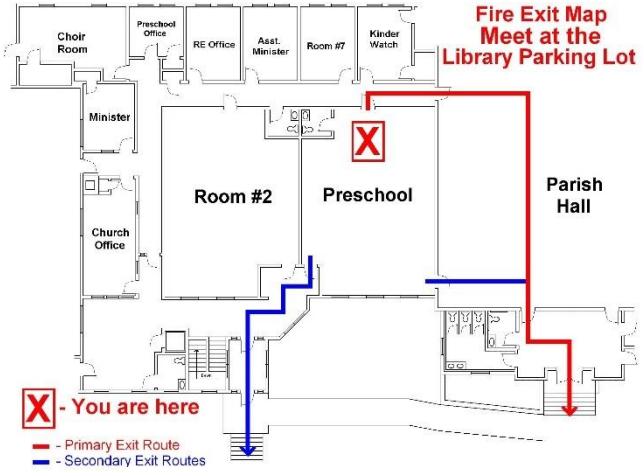
Sign: Then

Southwest-facing Sanctuary Wall

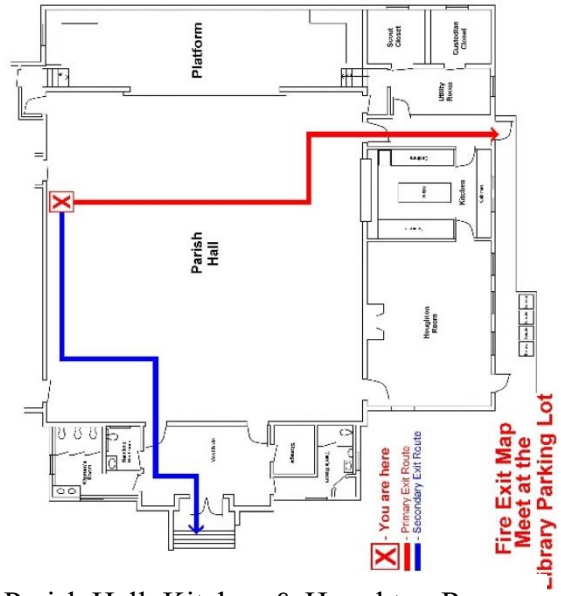
Sanctuary windows: Main floor and basement



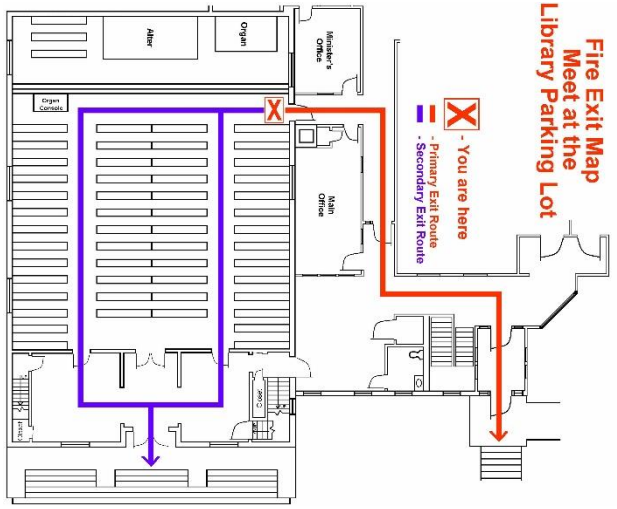
Basement Level



Preschool and Office Level



Parish Hall, Kitchen & Houghton Room



Sanctuary and Office Level

DETAILED FINDINGS

BEHAVIOR

We generally take energy for granted. If we do think about energy, it is usually when we get a big bill! But cost is the result of how we use energy, and **use** reflects our behavior. Behavior is volitional. We can change it and thus lower the cost (in $s and environmental impact) of our energy use. Follow the low cost/no cost ways to reduce energy use in this section and you may save up to 15%.

Do you track your utility use and cost (UU&C) monthly? Yes and No

You have begun, now be sure to update the UU&C spreadsheet monthly and review it regularly to identify unusual patterns that can indicate attention is needed. Using the MassIPL *Utility Use & Cost* spreadsheet for all utilities is an effective way to know the impacts and cost (in $s and pollution) of one's behavior, as a congregation or an individual. For more information, see MassIPL's *EES Brief* on *UU&C.*

Though we usually just focus on the financial cost for utilities, it is imperative that we are also aware of the environmental and health impacts. The spreadsheet calculates the carbon footprint of your HOW as a first step in your environmental stewardship journey. This can be translated to a financial impact with a concept called the "social cost of carbon", an estimate of the costs of the damage from extreme weather such as major storms, droughts, floods, etc. that climate change makes more damaging. The federal government uses a social cost of carbon of $50 per ton.

The summary of Utility Use and Cost information for First Church in Sterling is below. The volume and cost of utility use is fertile grounds for improved environmental stewardship. There are savings to be achieved (in the 10% range) simply by using *PowerOptions* to "bulk-buy" oil; see information in Appendix C. Financial savings and reduction in environmental impact are generally available through buying electricity from a community solar project. However, you have a municipal electric company and the opportunity for buying electricity from a community solar project is probably limited. Also, your electric company has a high percentage of its electricity from renewable and low-carbon sources which is very good.

SUMMARY OF UTILITY USE & COST

First Church in Sterling - Church Bldgs

18,551 *square feet*

		ELECTRICITY		Cooling	Heating	OIL		PROPANE		WATER & SEWER	
YEAR	**TOTAL**	$s	KWH	**Degree Days**	**Degree Days**	$s	GALLONS	$s	GALLONS	$s	VOLUME
2021	**$17,372**	$5,240	31,961	1,300	4,584	$11,297	5,156.7	$373	61.9	$462	54,300
CO 2 lbs	*123,455*		*7,159*				*115,510*		*786*		
% of prior year	*503%*		*112%*				*636%*		*#DIV/0!*		
kBTU per SF	**44.8**	$0.28	2			$0.61	0	$0.02	0	$0.02	2.9
% prior year	**278.6%**	112.4%	112.3%	89.3%	96.2%	718.7%	636.4%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2022	**$23,073**	$5,400	30,145	1,372	4,775	$16,653	4,808.8	$521	83.6	$499	0
CO 2 lbs	*115,531*		*6,752*				*107,717*		*1,062*		
% of prior year	*94%*		*94%*				*93%*		*135%*		
kBTU per SF	**42.0**										
% prior year	**132.8%**	103.1%	94.3%	105.5%	104.2%	147.4%	93.3%	139.7%	135.1%	108.0%	0.0%

Use Patterns

Use for heating should vary in direct relation to heating *Degree Days*. The % change by the congregation at the end of the year should be about the same as *Degree Days*. If the use % is higher, it indicates increasing inefficiency by the congregation. Monthly tracking and comparison with the same month in prior years (adjusting for Degree Days) is also an important indicator in understanding your HOW use patterns.

To learn more about how to use the Utility Cost & Use spreadsheet to lower your energy costs, read the MassIPL's *Everyday Environmental Stewardship Brief* on *UU&C*.

Evaluation

The data for your electricity and oil use was limited to 2021 and 2022. It would be good to continue tracking this over a longer time period to see what variations there may be.

The electricity use in 2021 was about 32,000 kWh and in 2022 was about 30,000 kWh. The difference is probably not significant. A convenient thing about electricity is that the bills are rendered monthly, so you can see seasonal variations, and you can compare the same month in different years. If you monitor them monthly you may discover an unusually high use which can be corrected, for example space heaters left on unnecessarily in winter, or air conditioners in the summer when rooms aren't being used.

Your oil use was about 5200 gallons in 2021 and 4800 gallons in 2022, despite the fact that 2022 was about 4 percent colder than 2021, in heating degree days. Oil use is tricky to monitor precisely because of the irregular deliveries, and the question of whether the tank was filled each time. Some churches make it a practice to fill the tank at the end of December each year, so they have a good number for the actual annual consumption. You could start doing that and get a better handle on your annual oil use.

Your total carbon emission in 2021 was 62 tons. Ninety-four percent of that was from burning heating oil. Converting some, or all, of your heating to heat pumps would greatly reduce your carbon emission. We did a special calculation for the carbon footprint of your municipal electricity. Based on our correspondence with the Sterling Municipal Light Department, we estimated the carbon content of your electricity as being only 40 percent of the ISO-New England grid values. Good for Sterling! Using the $50/ton social cost of carbon, your carbon footprint of 62 tons amounts to $3,100 annually.

Have you created energy awareness among staff and members? **Yes**

Nothing can change if nobody is paying attention. A life of faithful behavior needs help, which of course is one of the reasons we gather as religious communities, to talk, share and worship. Energy awareness prompts faithful behavior. Start with the HOW by including carbon footprint and energy use reports at meetings of the governing body as well as the annual report to the congregation. Then recognize that the actions discussed in this report can also be done at home, business and school, all the places we go in our lives.

Include discussion of energy at least twice a year in staff meetings: in the spring at the switch from the heating season to the spring/summer cooling season and in the fall at the beginning of the heating season. Remind staff to be aware of closing doors between zones, how to adjust thermostats temporarily when necessary without affecting the programmed times, and encourage them to report cases where rooms seem warmer than necessary. Review staff schedule and schedule of outside groups using the space to be sure the thermostat programming is kept in synch with building usage.

Evaluation

You said that you have created energy awareness and that's good. We heard evidence of that in our conversation with your staff. However, it's always good to have some reminders, and a deliberate program to keep the attention up. Here are a few suggestions:

First, discuss with your staff the winter and summer temperature settings and ask them to give energy saving settings a try. For winter, the US Department of Energy recommends 68 degrees and reports that for every 1 degree lower setting for 8 hours you can save 1% of the energy cost. While we didn't check the summer setting, it is likely it is between 72 – 74 degrees. The Energy Department recommends 78 degrees. Of course, the staff's comfort, health, and productivity are most important so if these temperatures don't work for them, be open to adjusting them. Let them know that by trying these different temperatures, they are helping ensure the budget is spent on your programs and mission!

Similarly, overnight temperatures should be 7 – 10 degrees lower in the winter and higher in the summer and be scheduled to return to occupied temperatures 2 – 3 hours before people come to the house of worship. On extremely hot or cold days, the space may not reach the desired temperature until slightly later, so ask them to be patient rather than adjusting the thermostat.

Also ask them to be proactive and inform you of schedule changes in their hours or programs so thermostat settings can be adjusted accordingly.

Do you have an environmental stewardship team? A designated "energy manager"? **No**

Awareness moves to action when responsibility is clear. Just as a HOW has committees for finance, social justice, and other ministries so should it have an *environmental stewardship* team. Simply put, the team consists of a group of people who share concern for Creation Care and environmental justice who serve to identify, plan, and execute environmental stewardship activities. They support each other and convey the stewardship actions to the congregation.

The *energy manager* for your HOW should do several things: update the Utility Use & Cost sheet every month, look for unusual spikes in energy use and, if found, investigate the cause; share findings with committees including the environmental stewardship/green team, finance, property, and the lay leadership; update the Space Use sheet at least twice a year (October and March) and use the information to update programmable thermostat settings. Finally, the energy manager should ensure that energy-using equipment (especially boilers, furnaces, and air conditioners) receive regular routine maintenance to operate as efficiently as possible. The energy manager could be any member of the congregation with an interest in saving energy. Now that you have started the UU&C spreadsheet, it only takes a few minutes each month to update it.

Evaluation

You told us you have a Climate Action Committee with about fifteen people involved, which is divided into teams with different activities and excellent coordination with other related groups that manage different aspects of the congregation's operations. And that Phil Holman is leading the team focused on facilities and operation, with a goal to reduce energy use and carbon emissions. At the site visit we met Janet Madison, Paul Jones, Tony Castagna, and Carl Fawcett. It was clear from our conversation that this group has a good understanding of the building equipment and operation, and has done a number of things over the years to improve the efficiency. You have an excellent team working on the issues.

We were also impressed with the discipline you have applied over the years to the capital needs of the building and regularly raising funds to keep the building and its systems in good condition. We rarely see such a well-planned and managed process. Congratulations! By conducting this assessment, you have taken the first step to consider energy efficiency opportunities in any projects you undertake. In a later section we will suggest a task that could be done in conjunction with painting the building. We also briefly discussed that you are considering new siding, likely vinyl. While vinyl would likely go right over the existing siding should you decide to install new materials you should consider adding a layer of exterior insulation under the new siding.

That said, we do think you should designate an energy manager to be responsible for the items listed above in the job description. It doesn't need to be a lot of work, but it's important that it be done regularly or else you will miss some opportunities to reduce energy use. And the activities of the energy manager remind everyone else about their impact on the total energy use.

Do thermostat settings match time of use? No

One of the benefits of living in a computer age is that thermostats can be programmed and controlled from a distance. A programmable thermostat "remembers" what humans often forget. But all of this relies on knowing the schedule when rooms are typically used, matching thermostat settings to that schedule, and periodically checking to make sure settings are still appropriate and the thermostat's clock is correct. *Programmable thermostats* automatically adjust to the desired temperature for the desired time period. The multiple time settings (typically 4 settings per day) permit scheduling of space conditioning (heat or cool) when and only when needed. With *Wi-Fi* based thermostats, this check can be done remotely, via a *SmartPhone*. This also enables resetting thermostats whenever a significant change to the use of the building occurs, such as a community group beginning/stopping holding meetings, adding a new service, changing times when the office is open, unexpected use or cancellations and so on. *Programmable thermostats* with an ***adaptive recovery*** element anticipate how long it will take to reach the desired temperature and start the system in just the right lead time. See MassIPL's *EES Brief* on *Thermostats*.

The *Space Use* table in Appendix B presents the church's current pattern of use and is the starting point for ensuring temperature settings match use time. MassIPL recommends updating this form at least twice per year: in the fall as activity typically increases after the summer, and in May or June when the summer schedule is known. Another time to consider an update is in January when a new year may bring new activity patterns. This then guides checking the thermostat settings which should be changed at least twice a year: in mid- to late- October as the weather cools and the heating season begins and in late April or early May as the days warm and heating is no longer necessary. If your house of worship has air conditioning, you can adjust the setting for it at the same time.

Evaluation

You have at least ten thermostats located in different rooms around the building, most of which were not set to the correct time. The clocks in thermostats are typically not very accurate and either gain or lose time over weeks or months. If not adjusted periodically and the time is incorrect, any temperature variation which is programmed will not occur at the desired time and thus will not have the comfort and money-saving effects desired.

We recommend you create an operational process for regularly adjusting and updating thermostat programming (some suggestions are in the paragraphs above) and designate someone to execute the process (see the discussion of the energy manager above.

The thermostats also are different models and styles, which makes programming difficult, see photos B1-B4. We recommend you install all new thermostats of the same model and make them Wi-Fi enabled if you can find a model compatible with the current thermostat wires. With Wi-Fi and an appropriate smart phone app, one person can program and monitor them remotely. This should save you money by reducing the amount of unnecessary heating and cooling. The MassSave store periodically has deeply discounted models on sale at their online store: https://www.poweredbyefi.org/masssave/march-thermostat-sale.html Their March 2023 sale had some models at $100 off.

Do you have a plan to cut your carbon emissions 50% by 2030? No

The Utility Use & Cost spreadsheet calculates your carbon footprint – that is, the amount of carbon your HOW is responsible for adding to the atmosphere. As noted above, Massachusetts has set a goal to reduce carbon emissions by 50% by 2030 and we should all do our part to contribute to meeting this goal. Many houses of worship MassIPL has worked with have successfully met this goal. The first step is to implement the recommendations in this report, beginning with the "low-hanging fruit" actions that require minimal cost and effort. Then plan to implement actions that require more time, effort, and budget, ultimately converting as much of your heating system to heat pumps as possible when your current system reaches the end of its useful life.

In addition to reducing the energy you use, you can reduce your carbon footprint by buying carbon offsets or committing to 100% Green Electricity. Although Green Electricity and carbon offsets may add money to your energy budget it will be less than the amount you save by taking energy-saving actions and so is an affordable way to further lower your environmental impact. Appendix D provides information on two ways to buy "green" electricity: MassEnergy Consumer Alliance's program (which offers electricity from New England wind, solar and other renewable energy sources) and Energy Sage's Community Solar Marketplace which helps you find nearby solar farms that you can subscribe to.

Evaluation

Carbon emissions in 2021 was 62 tons. As mentioned above nearly all your emissions are from burning oil for heating. The only direct way to lower your emissions by 50 percent or more is to convert some or all of your heating to heat pumps. Since your heating equipment is nearing or past the end of its expected life, the timing is right to begin planning this change which is the core of our Net Zero Plan for First Church.

***Have you created a budget line for energy efficiency investments?* No**

In considering costs (especially for capital actions), recognize that "return" on such investments for the community-of-faith is measured by the standards of the kingdom of God, not the kingdom of Wall Street. The decisions being made speak to the care we are called to give to the earth, as stewards of God's creation. The age of the building—with portions dating back to 1842—conveys the appropriate time horizon.

At MassIPL we find that often congregations have difficulty finding the money to fund even modest energy efficiency improvements, and so we suggest this "reinvesting the dividends" approach. An *energy efficiency budget* starts by adding a line to the congregation's overall budget for *energy efficiency*. Fund it the first year with a modest amount to pay for some small projects. In subsequent years, the projected savings from line items (electricity, gas, oil, propane, water/sewer) as a result of energy efficiency actions are shown in this line, with the savings invested in additional energy efficiency actions. For example, if programmable thermostats are installed replacing manual thermostats with a savings estimate of 10%, and last year's gas bill was $10,000, then the next budget would show $9,000 for gas and $1,000 for energy efficiency. The $1,000 can then be used in the coming year for other actions, such as the HOW's share of LED bulbs after the electric company rebates. If no actions are taken in the year, the funds are set aside in an *Energy Efficiency Reserve Account* for use in future years. In the sample Efficiency Budget at Appendix E, the percent of the Efficiency line increases over 4 years from 14% to 41%. Setting aside these savings for future investment is a huge help in paying for moderate-cost items (such as the portion of LED upgrades not utility rebate) and also for major work, such as paying a loan for heating system upgrades or replacement. See the MassIPL EES brief *Establish An Energy Efficiency Budget Line*.

An immediate step to start saving is to enroll in a program for **bulk purchase** of oil and use the savings to fund the energy efficiency budget. Bulk purchase of oil at lower cost (and please buy the bio-fuel for better environmental stewardship) is available via: Heating Oil Service | Green Energy Consumers Alliance Information is available at Appendix D.

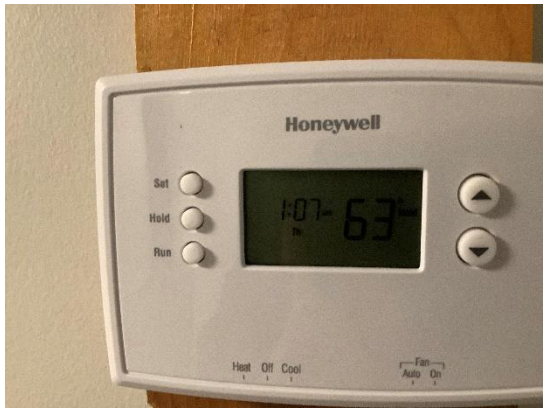
Another way to fund the energy efficiency budget is to adopt your own internal fee on carbon. A fee like this is meant to internalize the cost that carbon pollution and the effects of climate change inflict on others and society at large. Many corporations use this approach, putting a price on carbon ranging from $15 to $50 per ton. One approach would be to follow Canada's example: they started at $10 per ton of carbon in 2018, increasing by $10 per ton until the price reaches $50 per ton in 2022. Use the funds raised by this mechanism to implement the recommendations in this ESA and establish a reserve fund to save for large projects in the future. See the MassIPL Everyday Environmental Stewardship Brief *Establish An Efficiency Budget Line*.

Evaluation
If you do nothing you can expect your energy costs to increase at least at the rate of inflation. For convenience, let's use a 3% annual inflation rate (in the hope that inflation soon returns to this nominal level we saw for many years!). Thus, the $23,000 spent in 2022 can be expected to be $23,690 in 2023, $24,401 in 2024, etc. Budget for that amount and when you reduce energy use and cost, put the savings into your Energy Efficiency Reserve.

The bulk-buying option is a quick way to begin to fund additional efficiency actions. The regular tracking of savings will hopefully show significant $s

BEHAVIOR Photos

B1: Tstat 1 – Parish Hall



B2: Tstat 2 - Basement

B3: Tstat 6 – Room 2

B4: Tstat 7 – Preschool Office

ELECTRICITY

Electricity is costly and is a significant cause of environmental pollution. Lighting, office and kitchen equipment, and air conditioning (if used) are key uses of electricity where upgrades in equipment and adoption of more efficient use practices typically are possible.

The First Church team reported that electricity service at the church is 200 amps, three phase power. The building has grounded wiring, and we did not see evidence of knob-and-tube (ungrounded) wiring.

Do you make the best use of natural and artificial light? Yes

Lighting is likely to be one of the largest users of electricity in your HOW. Depending on the orientation of the building to the sun and the location of rooms, daylight may be sufficient. When there is sufficient daylight, avoid turning on lights. When lights are used, the level should be appropriate for the activity. For example, offices, classrooms, and music rooms need sufficient light so people can read without straining their eyes. Areas such as hallways or entries need lower levels of light, but are often over lit. If an area seems too bright, try removing a bulb or two from a fixture or switch bulbs to a lower wattage. You can often reduce electricity use 20% or more in these areas by this simple, no-cost action.

Evaluation

The sanctuary has large windows and good solar exposure. On sunny days they probably provide most of the light you need. See Photo E1. Try to avoid turning on all the lights in the sanctuary unless they are really needed.

Other rooms may also have reasonably good sunlight. Encourage people not to turn on the lights automatically when they enter a room but check to see if natural light is sufficient.

Do all your fixtures have LED bulbs? Yes

The benefits of efficient lighting are well known. Updating lights is easy and has an immediate impact on your electricity use. LED bulbs are superior to both incandescent and fluorescent lighting in both lower electricity use (50>85%) and longer life (10>50,000± hours). The longer life also means the time and cost to change bulbs is significantly reduced, an important consideration in hard-to-access locations, such as sanctuaries and other big/high rooms. For more information, see MassIPL's EES Brief on *LEDs*.

Fluorescent tube lighting is common, especially in classrooms, hallways and large, open rooms. If your fluorescent tubes and/or fixtures are "old" (3+ years), they are candidates for upgrades to LED that can lower their use and cost 40% or more. A related benefit of LED tubes is better brightness. This often means fewer bulbs are needed to achieve desired lighting levels, such as only 2 tubes in a 3 tube fixture. Another benefit is the ability to dim the fixtures, with the proper dimming switch installed.

In the past 10 years, LED lights have become the industry standard and, as a result, the MassSave program is phasing out the incentives it has historically offered for this upgrade, perhaps as early as June 2023.

Evaluation
Nearly all of your lighting has been converted to LEDs, and that is excellent. Well done!

There may be a few residual places where LED conversions can still be done. One place to be checked is candle-type bulbs in chandeliers. There are a number of attractive LED options now. And there may be a few fluorescent tubes or fixtures in classrooms or hallways that can profitably be changed.

Do you have sensing switches in all appropriate spaces? **No**

Some spaces are well served by having ***occupancy/vacancy*** sensing switches for lighting control. Restrooms are the prime candidates, with storage rooms and meeting rooms additional places to consider. These spaces have multiple users, with highly variable use patterns. Having a motion sensor switch (typically at the entry) that is also calibrated to typical use time means the use pattern (aka *behavior*) is monitored by technical equipment that ensures efficient on/off of electricity for lighting.

Evaluation
There are multiple opportunities for occupancy sensing switches. One of the best places is restrooms. See photo E2 for a restroom which would benefit from one. They are inexpensive and easy to install by a handy person. Meeting rooms and offices are good candidates for motion sensors, also. We suggest you take an inventory of places that could benefit from them and install them over a period of time.

When you deploy occupancy sensors widely, you create energy saving awareness. People know you are serious about it.

We suggest all outdoor lights have daylight sensors installed, so they won't be accidentally left on in the daytime. In addition, we suggest motion sensors so lights go on when needed, either when a member or visitor is approaching the building or to deter intruders.

Are all your refrigerators and freezers efficient and efficiently used? **Yes**

Refrigerators and freezers run 24 x 7 so continuously consume electricity but have become far more energy efficient in the past 20 years. A new Energy Star rated refrigerator uses up to 35% less electricity than a 15-year-old model; an easy way to check the efficiency of your current appliance is to use the Energy Star Flip Your Fridge Calculator https://www.energystar.gov/products/appliances/refrigerators/flip-your-fridge Many houses of worship accept donations of refrigerators from members who buy new ones at their home. Before you accept the next donation, check its age and if it is old, politely thank the member but suggest they recycle it! And if there are times when these appliances are not used, turn them off and unplug them.

Evaluation

You originally answered "Yes and No" however in our research we found that all these appliances are Energy Star qualified. In the kitchen there is a large commercial refrigerator, a GE residential model, and a standing freezer; all look relatively new and are Energy Star rated. That's good. See Photos E3-E7. However, they are not all efficiently used as the large commercial unit had relatively little food in it. Consider if you can move this to the smaller GE fridge and either shut this off when not needed or turn the temperature higher (we have heard that many commercial refrigerators can be damaged by turning them off so speak to your service company to get their advice on this specific model).

Often in churches we find small, underutilized refrigerators scattered around the building. We didn't notice any here. But if you have any you should consider if they are really needed. They all consume electricity 24/7.

Are all your appliances and equipment Energy Star top rated? **No**

Equipment using electricity is found in offices, kitchens, music rooms, and other locations. Computers, printers, copiers, space heaters, dishwashers, humidifiers and dehumidifiers are the most typical sort of such equipment. The ***Energy Star*** program is well known and an excellent guide to finding the most energy efficient equipment to replace older products. But don't just buy any Energy Star product – look for ***Energy Star*** Top Rated. Use the ***Energy Star*** web site to get the best! This ensures both lower electricity use, but likely also longer life for the equipment. Go to

http://www.energystar.gov/certified-products/certified products?c=products.pr_find_es_products

The governing body should adopt a resolution that all new equipment purchased in categories that the Energy Star Program covers should be top-rated, and then apply this policy in all new purchases. For more information, see MassIPL's *EES Brief* on *Appliances*.

Evaluation
You mentioned there are humidity problems in a number of the rooms. There is a dehumidifier in use in the music room. (See photo E8.) There may be others elsewhere; basements are particularly prone to high humidity. In the HVAC section we suggest installing a central dehumidifier in the basement as part of the impending HVAC replacement/upgrade. These appliances also use electricity 24/7 and sometimes a lot. They should all be Energy Star rated.

A good option for controlling humidity for sheet music is to place the music in tight plastic bins, with dehumidification pellets. Archives (especially if very valuable and/or of historic character) may be sensibly placed with a specialty organization (a document conservation center, for example).

The kitchen also has a traditional electric range and a commercial propane range. It was mentioned that the commercial range is rarely used. Over time, consider removing the commercial range if it is no longer needed and replace the electric range with an induction model.

Have you evaluated your HOW for solar panels? **No**

Solar energy produces no carbon emissions. In the past few years the costs to install solar systems have come down dramatically. The cost of a system for a typical HOW is usually in the range of $75,000 - $100,000. The electricity savings plus state incentives will often pay the cost back in under 10 years, and the systems will continue to produce electricity for at least another 10 - 15 years. The HOW also has the benefit of a very visible expression of environmental stewardship, often better than the best welcoming sign.

As costs have come down, purchasing the panels has become the best financial option. Borrow from savings or endowment, then repay it through the electricity savings and the state SMART solar incentive payments. If your HOW doesn't have cash available, consider a loan from a denominational loan program such as the UCC Cornerstone Fund Ecoloan, the Episcopal Diocese of Massachusetts Green Loan, the Unitarian Universalist Association Building Loan, or the Episcopal Church Building Fund (which

loans to other denominations). Check if your denomination has a building loan program. A third option is third-party financing programs such as leases or Power Purchase Agreements. In this model, a third party financing firm owns the system and your HOW does not have to pay any money upfront. The monthly payments are at a fixed rate, generally 10% -15% less expensive than paying the electric company for the same amount of electricity. For more information, see MassIPL's EES Brief on *Solar Financing*.

The federal Inflation Reduction Act, IRA, which was passed in late 2022 provides a Direct Pay option for non-profit organizations so that they can take advantage of a 30% rebate on solar PV installations. This is a real game changer for Houses of Worship.

MassIPL has helped 50 HOWs install solar in the last 10 years. MassIPL has 3 partners for solar panels:

- 621 Energy (http://www.621energy.com/) has been MIPL's solar partner for 2 years and offers a power purchase agreement to make solar affordable for HOWs. Contact Bob Clarke clarker@621energy.com
- Resonant Energy (http://www.resonant.energy/) offers a range of programs to help HOWs install solar, including its Interfaith Community Solar program. Contact Leonard Schloer leonard@resonant.energy
- Energy Sage (www.energysage.com/mipl) is an online site where you post the HOW's address and some information about its energy use, then multiple solar companies will evaluate and provide proposals.

When you install solar panels using one of these partners, they make a donation to support MassIPL. MassIPL can assist you in this process.

If your house of worship is not a good candidate for solar panels or otherwise is not able to install them, you can still use solar energy by purchasing your electricity for a community solar farm. Here, a large array of panels are installed and the electricity generated by them is sold to individuals or organizations. MassIPL has two partners for community solar:

- Energy Sage (www.energysage.com/mipl) When you reach the site after clicking on this link, click the Community Solar tab at the top of the page, then enter your zip code on the next page and then review the community solar projects available in your area.

- Hampshire Power (https://hampshirepower.com/community-solar/) Scroll to the bottom of the page, fill out the form, and upload a copy of a recent electric bill and they will send you a proposal for solar electricity from one of the community solar projects they represent.

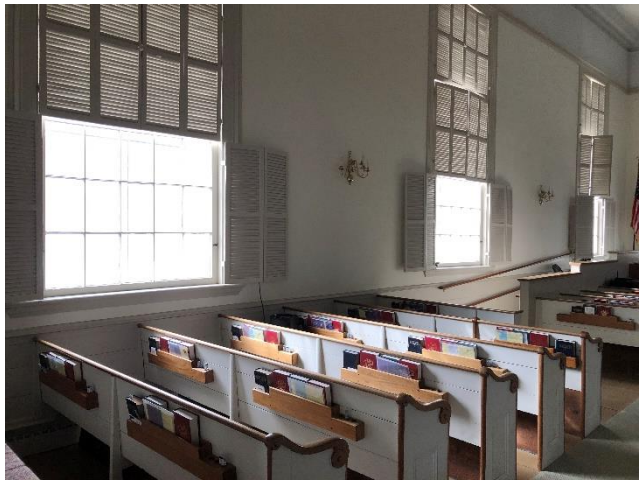
Evaluation

You have an excellent location for solar panels. The sanctuary has a large southwest facing roof, and the parish hall has a large flat roof. Panels installed on the sanctuary roof would be visible from the street. Since the sanctuary is a historic building they might be objectionable to the town historic commission or members of the congregation. Panels installed on the flat roof would be hard to see from the street. Our quick estimate is that you have room for a system that could produce as much as 50,000 kilowatt hours of electricity annually. You could get a more detailed feasibility assessment from our solar partners. Note that the roofing material should be less than 10 years old because the panels will be in place for 20 or more years and having to remove and reinstall them to replace roofing would add to the cost of that project.

We understand the Sterling Municipal Light Department has a limit on the amount of solar panels which can be installed annually in a behind-the-meter configuration. You might need to wait to get permission. Also, the retail rate you pay SMLD for electricity is relatively low – 17.9 cents per kWh in 2022. Your payback time on an investment in solar panels would be longer than average in Massachusetts, approximately 11 years. But solar panels last about 30 years so it is still a good long term investment. And, as you convert from oil to heat pumps, your electricity use will increase considerably.

We recommend you consider installing solar panels.

ELECTRICITY Photos



E1: Sanctuary windows in daylight

E2: Restroom candidate for occupancy sensor

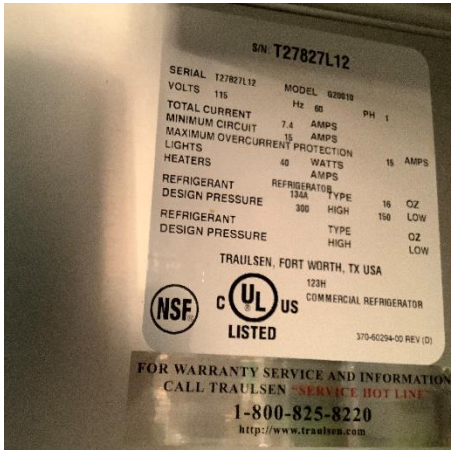
E3: GE fridge in kitchen

E4: GE Fridge label

E5: Atosa Freezer

E6: Traulsen commercial refrigerator. Given how little is in here, could this be moved to the GE fridge and this one either turned off or the temperature turned up?

ELECTRICITY Photos (cont)



E7 – Label with model and specs for Traulsen commercial refrigerator.

E8 – Dehumidifier in Choir Room

BUILDING ENVELOPE

"Building envelope" is a term energy efficiency professionals use to refer to the role walls, windows, insulation, and other physical characteristics play in determining energy use, cost, and carbon footprint. A "tight" envelope prevents the air warmed in the winter or cooled in the summer from leaking out of the building and a well-insulated envelope prevents heat from being transmitted through the walls and roof.

The building consists of three sections of different ages: the church itself dating to the 1850's, the Parish Hall likely dating to the 1950's or 1960's, and the connecting section which houses the offices and was built in the 1990's. In addition, the basement under the church was renovated in the 1990's and the kitchen was updated in the 2000's.

One issue the First Church team raised was management of water: a hill rises behind the church which results in significant water directed toward the building. The church has taken several actions that have reduced this to some degree and the team described the presence of a French drain. Even so, water remains a problem. MassIPL does not have expertise in water management, but we do know water is the biggest enemy of building materials and indoor air quality so we encourage the team to prioritize this issue. We recently viewed a webinar by the Western Massachusetts Episcopal Diocese in which a church described similar problems and hired Dr. Energy Saver/Fogarty Home Services and said they were very happy with the project and the company https://www.drenergysaver.com/energy-audit-contractors/massachusetts.html. We passed on this information as a potential source of a knowledgeable contractor who can provide expert assistance.

Are your walls, ceiling, floors insulated to current standards? **No**

Building materials will conduct heat out and cold in at wintertime, and the opposite in summer. Well-insulated space retains its desired temperature and takes a shorter time to achieve this temperature. The exterior portions of a building (side, top, bottom) are the key areas for insulation. Buildings with pitched roofs and little-used attics are best served by having the floor of the attic insulated, as it is the "exterior" of the occupied space. Similarly the ceiling of a little-used basement is the "exterior" of the occupied space. Older buildings, especially 19th/early 20th century with stone walls, present particular challenges for wall insulation. The Energy Star web site has good information on insulation:

http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_seal_insulate

Evaluation

Not surprisingly given the age of these buildings, insulation is not up to current standards, which have advanced significantly since the year 2000. Infrared photos of the Sanctuary show the striped pattern in the walls revealing the outline of the studs (yellow) with the purple of the cavity in between showing little insulation (See Photos BE1 and 2). The Sanctuary attic has 10 – 12 inches of insulation (see Photo BE3), providing an insulation value of R-30 – R-36; current standards are R-49 and it should be possible to add another 5 – 8 inches on cellulose insulation to achieve this level. The recessed lights have caps on them, but they are a cardboard product (treated with fire retardant, see Photo BE4); if additional insulation is added, ask the contractor to replace them with a mineral wool cap and seal them to the ceiling. As part of this project, also ask the contractor to make sure that penetrations for wiring, etc. are air sealed.

We also noted areas of the basement where insulation could be improved (the 1990's when this renovation was done was relatively early in the process of incorporating energy performance into building codes). In particular, we noted a gap in the insulation between the wall and foundation in Room B4 (see Photo BE5) and infrared photos of Rooms B4 and B2 show significant heat loss (see Photos BE6 and 7). Given the experience the church has with water around the foundation, these areas are challenging to insulate and it is possible the gap was intentionally created to prevent the insulation from getting wet and potentially growing mold. Discussing this with the water management expert and an insulation contractor may result in newer materials and techniques to achieve both better energy performance and water management.

The First Church team noted that the roof above the Houghton Room (and possibly the entire Parish Hall) has 6 inches of rigid foam insulation plus insulation in the attic (we did not inspect these). If this is the case, this area could be at the R-49 insulation level, contributing to the below average energy consumption (EUI) noted earlier.

It appears that the Sterling Municipal Light Department has a partnership with the Center for EcoTechnology to provide more detailed technical audits https://nextzero.org/sterling/energy-audits/ . It is also affiliated with the NextZero initiative of the Massachusetts Municipal Wholesale Electric companies which posts a list of contractors who work in this program: https://nextzero.org/wp-content/uploads/NextZero-Contractor-List-2022.pdf A good next step would be to connect with this program and share this report with them to ask for detailed proposals for insulation and air sealing work.

Have you sealed areas of air infiltration? **Yes** and **No**

Just as open doors between zones are a cause of inefficiency, areas of air infiltration (aka "holes") cause inefficiency. The most common areas of infiltration are doors or windows that have gaps around the edges, places where pipes or electric wires enter the building, electric sockets and switches that are on outside walls, and along the sill plate (where the top of the foundation meets the framing of the walls). It is rather amazing how these small areas can add up to a large hole. The EPA estimates they

can add up to as much space as if you left a window wide open! Sealing these areas can be a project for a work day with simple materials you can buy at any hardware store or home center: door and window weather stripping kits, socket and outlet insulation, caulk, cans of spray foam. An additional benefit is that sealing these areas can also keep out mice and insects.

Evaluation
As noted above, air sealing is an important part of an insulation project. We noticed that the door to the Sanctuary attic was well-fitted so minimizes the ability of warm air to continue rising into the attic. Because the Parish Hall does not have a basement, there is little opportunity for air to infiltrate at the base of the walls.

The basement under the Sanctuary may experience air infiltration, though there is little access so it would be challenging to access from the interior. The area where the foundation meets the building framing (called the sill plate and rim joist) is a common place for air infiltration to occur. There may be an opportunity to apply caulk or spray foam from the exterior, especially if the trim board at the base of the siding can be removed and reinstalled (see Photo BE8); this task could be included as part of painting the church if that project proceeds. An additional benefit of this would be reducing pathways for mice and insects to enter the building.

Do windows and doors have effective weatherstripping? No

Doors and windows that don't fit their frames well leave gaps that can allow a significant amount of air leakage – letting that heated or cooled air escape and requiring energy to heat or cool more air to replace it. Weatherstripping doors is an easy DIY project with many different types of products to suit the specific needs of different doors and windows. The *This Old House* web site has excellent information and videos about weatherstripping: https://www.thisoldhouse.com/doors/21112231/how-to-weatherstrip-a-door

Evaluation
The most problematic windows – and also the most challenging – are the Sanctuary windows, which are double-hung with sash weights (See Photo BE9). As is common with old windows, the sashes are loose in the framing and the best material to use is brass spring weatherstripping; as is shown in this video, it is easy to install with basic tools and skills: https://www.youtube.com/watch?v=usKALTZ8MkM; *This Old House* has another video showing other products and approaches https://www.youtube.com/watch?v=PYOhxK0yauE. In addition, these windows have wall cavities that hold the sash weights that allow air infiltration and should you ever replace these windows, you would remove the weights and insulate the cavity before installing the new window. But as a historic feature, replacing these windows may not be possible.

Do you have high efficiency windows? Interior storms? Sun screens? **No**

High efficiency windows (sometimes referred to as *thermopane*) serve to provide additional insulation. Some are *fixed* while others are *operable*. Operable windows with cranks can shut tightly but may need weatherstripping if they are old. Older windows (typically single pane) that slide up-and-down typically have counterweights, with a cord or chain moving over a wheel at the top, with the counterweight in a void on the side of the window. This void needs to be filled with insulation when the window is upgraded to thermopane and a vinyl track installed for up-and-down movement.

In general, windows are considered to have the lowest return (measured in either financial terms or carbon reduction) of common energy efficiency projects as long as the windows are in acceptable condition. If the window frame is in good condition, you may be able to reduce the cost by replacing just the sashes with new thermopane sashes. However, if the frames have deteriorated there is likely significant air infiltration that loses more energy than the window itself. In this case, full replacement (taking the window and framing out to the rough framing and installing the window unit) is a necessary investment. In this case consider triple pane windows: the incremental cost to go from double pane to triple pane is a relatively minor part of the overall cost but results in double or more insulation value.

Interior storms also called *window inserts* add another layer of physical protection to block drafts and create an additional barrier to heat loss. Interior "storm" windows serve to make the single-pane windows similar to *thermopane* glazing, reducing heat loss in winter and heat gain in summer. This also improves occupant comfort. Stained glass windows are almost always single pane and allow significant air infiltration around the leading and sections that may be operable. Constructing interior "storms" can be a congregation workday activity or purchased to fit the window. There are a number of companies that make window inserts which cost $100 - $150 for a typical size window. One noteworthy provider is Skylarc Innovations' Windowtherm panels www.skylarcinnovations.com which has been tested to increase window insulation value by R-2. For more information, see MassIPL's *EES Brief* on *Interior Storms.*

In the summer, consider window inserts that use a film that blocks the sun's heat from entering the building. Similarly, for windows that have screens, consider installing *sun screens* that block up to 80% of the heat from sun exposure, keeping the room cooler without the use of air conditioning. For both window inserts and sun screens, rooms that face south and west – especially frequently-used rooms like offices – are the best candidates. Install them in early June or when people using them room notice that the sun heats the room to an uncomfortable temperature. Remove them and replace the regular screens in early September.

Evaluation
Most windows are single pane in wood frames which typically have a low insulation value of R-1. Most windows (with the exception of the Sanctuary) have exterior storms which raise the insulation value to R-2 (see Photo BE10). However, the frames are in good condition with no obvious problems that require replacements. Over time, you may want to upgrade to double- or triple pane windows.

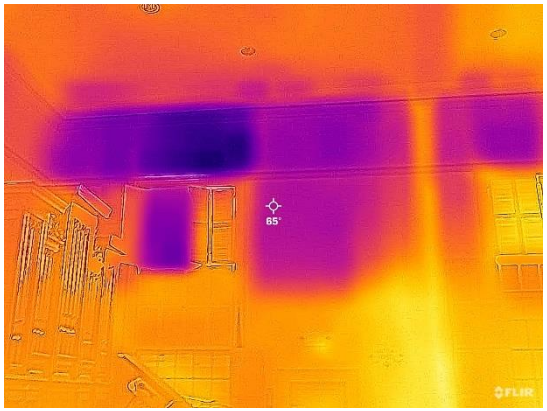
A "low-hanging fruit" step is to install interior "storm" windows to upgrade thermal performance. The best candidates for these are the windows in rooms along the rear of the building, eg, Choir Room, Preschool Office, RE Office, Assistant Minister office. Room #7, and Kinder Watch. Also, while we weren't able to make a close inspection of the windows in the Parish Hall, they are excellent candidates for interior storms and likely can be left in place year-round as those windows are likely not opened (see Photo BE11). Windows that are operable, and opened in spring, summer and fall can have interior "storm" windows installed, then removed when the natural air change is desired.

Are doors well insulated and tight fitting? Yes and No

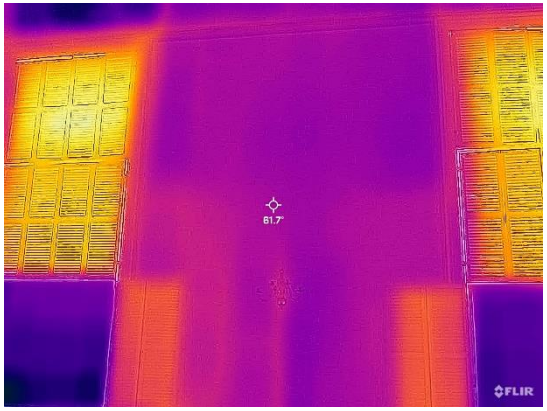
Like windows, door replacements are expensive. But an old wooden door will likely have an insulation value as low as R-2 less while a new door may have an R-5 or more, over twice the insulation value. In addition, new doors are more intentionally designed to reduce the air leakage around them. If door show signs of age and wear – being out-of-square, large gaps between the edge of the door and the jambs or sills – a replacement is worthwhile, not only for energy savings but improved security. Most doors are "pre-hung", i.e., it comes as a unit with the framing, jambs, and sills; these units are designed together to minimize air infiltration. However, if the framing is sound, you may be able to save money by just purchasing the door "slab", i.e., the door itself, and having a carpenter or handyman hang the door in the existing frame and adding appropriate weatherstripping.

Evaluation
Most doors are reasonably well-fitted. The Sanctuary door was replaced a few years ago and the weatherstripping is good, though there are some small gaps at the top and bottom of line where the two doors meet (see Photo BE12). The Stoughton Room and kitchen doors appear to be tight (see Photos BE 13 – 14). The most problematic door is the Choir Room (see Photo BE 15): the presence of spider webs indicates significant air infiltration since spiders hope this air movement will blow insects into their webs. This should be an easy project for a handyman or even a member who is reasonably handy with basic tools.

BUILDING ENVELOPE
Photos

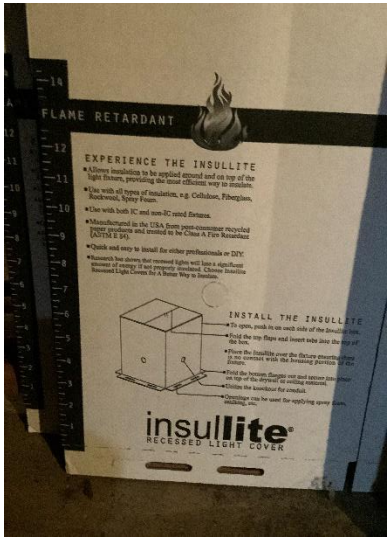


BE1 — Infrared photos of the Sanctuary walls show dark areas of missing insulation…



BE2 — …and little insulation in cavities between studs.

BE3 — The Sanctuary attic has about 10 – 12 inches of blown insulation; more could be added.

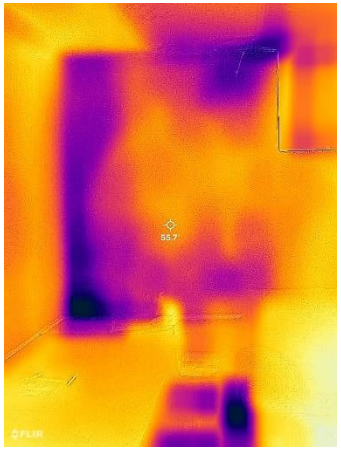


BE4 — Recessed lights in the Sanctuary ceiling are covered by these caps in the attic.

BE5 — Infrared photo of wall in Room B4 shows heat loss despite insulation.

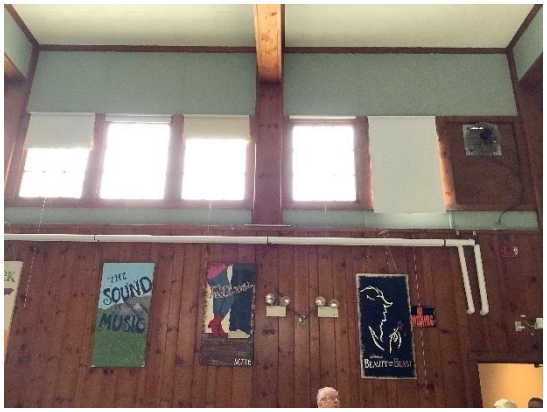
BE6 — A gap was left between the foundation wall and the insulation, seen through a hatch in the wall in B4.

BUILDING ENVELOPE
Photos (cont.)



BE7 – Infrared photo of wall in Room B2 shows missing insulation.

BE9 – Sanctuary windows are double hung with sash weights. Weather-stripping can cut down of air infiltration.



BE11 – Interior storms on these windows in the Parish Hall would add further insulation value.

BE8 – Air sealing where the foundation meets the framing is important. Consider removing the trim board at the bottom of the siding then applying caulk, spray roam or a fluid-applied flashing.

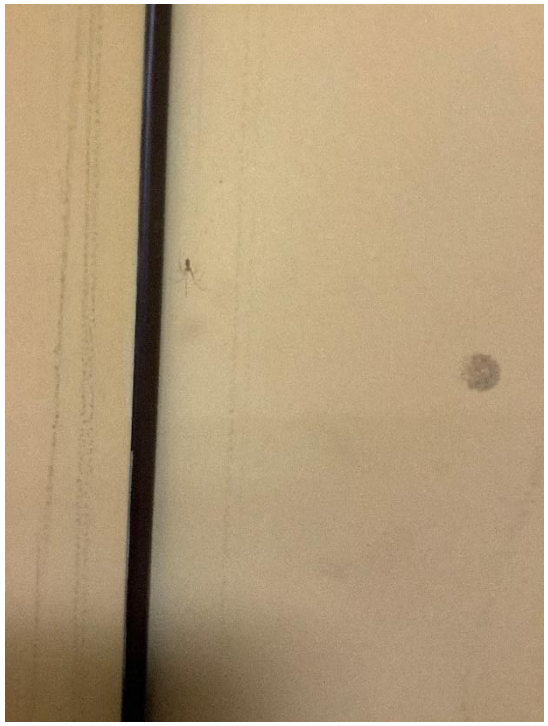
BE10 – Exterior storm windows like these on Houghton improves energy performance of single pane windows.

BE12 – The church doors are relatively new and tight fitting, though there are small gaps at the top and bottom where light and air enter; try to fill these gaps.

BUILDING ENVELOPE
Photos (cont.)

BE13 – The Stoughton Room door fits tightly in the frame.

BE14 – The door outside the kitchen also is pretty tight, though some of the weatherstripping is slightly worn.



BE 15 – The Choir Room door has significant air infiltration, indicated by the presence of spider webs along the edge of the door.

HEATING, COOLING AND WATER

Heating (and if used cooling) is the biggest user of energy at your HOW, accounting for as much as 60% of your total energy use. Thus, it is both the largest contributor to climate change and a significant expense. In looking at this equipment, three areas are evaluated:

- *Generation* (the equipment that heats or cools air or water)
- *Distribution* (the system that takes the heated air or water to the spaces where it is needed)
- *Controls* (mechanisms that control generation and distribution).

Each of these offers opportunities to decrease your energy use and carbon footprint. When it comes time to replace generation equipment, you should prioritize energy efficiency and lowest carbon emissions in choosing new equipment. That will likely mean upgrading to *heat pumps.* The MassSave program is prioritizing heat pumps as a replacement for fossil fuel-fired equipment and the Baker Administration's 2050 Decarbonization Roadmap says this:

- "...in order to achieve Net Zero, the use of gas for building heat must start to decline in the near term."
- "...electrification and efficiency strategies rely on infrequent opportunities to change out heating, ventilation, and air conditioning (HVAC) equipment, such as equipment end-of-life or major renovation. Leveraging these opportunities early is essential for keeping costs low."

Heating and cooling equipment typically last between 15 - 30 years and so it is likely every piece of equipment operating today will be replaced at least once between now and 2050. If your equipment is more than halfway through its useful life, you should begin educating yourself about new technologies, begin planning for its replacement, and setting aside money to pay for it. In addition, MassIPL believes it is likely there will be new programs and incentives developed in the next few years to encourage Commonwealth residents to replace fossil fuel fired equipment. Learning and planning now will mean you will be in a good position to take advantage of new programs as soon as they are available.

Though often taken for granted, water use can be significant and costly. This is especially true if the HOW is the location for a pre-school program and/or if it hosts a variety of other users (AA, AlAnon, choral groups, other congregations, and so on). In these instances, use of sinks and toilets draws considerable water. It also increases the demand of water supplies, a matter of increasing concern.

General Observations

First Church has a mix of heating equipment, with the main equipment being oil-fired boilers (see Photos H1 -3) that serves radiators as well as two Hydro-Air units (see Photos H4-6). The offices are served by two roof-top units (which we did not inspect closely though Photo H7 of the owners manual provides make and model information) which appear to offer cooling and use electric resistance for heating. All of this equipment is believed to have been installed in the 1990's and so should be considered

at or past its useful life and candidates for replacement in the next couple of years. The Houghton room recently had a Mitsubishi heat pump installed (see Photo H8) The table below identifies each thermostat in the building, the equipment it controls, and the areas served:

Thermostat	Location	Associated Equipment	Rooms/areas served	Condition
1	Parish Hall	Boiler	Parish Hall, Houghton Room	Incorrect time: 1:07 am
2	Basement, near room B2	HydroAir in closet next to stairway	Rooms B1 - 4, Chapel	Incorrect time: 1:07 am
3	Sanctuary	HydroAir unit in main boiler room	Sanctuary	Incorrect time: 1:00 am
4	Office	Trane roof top unit #1	Office	Incorrect time: 12.47 am
5	Entry	Boiler	Entry	Incorrect time: 2:26 pm vs 1:30 pm actual time
6	Room 2	Trane roof top unit #2	Room 2	Not programmable
7	Preschool office	Boiler	Preschool office, RE Office, Asst. Minister, Kinder Watch	Not programmable
8	Music Room	Boiler	Music Room	Correct time
9	Pre-school Room	Boiler	Preschool Room	Incorrect time: 4:10 am
10	Houghton Room	Mitsubishi heat pump	Houghton Room	New

Do heating/cooling zones that match use patterns? **Yes**

The best efficiency for an existing heating and cooling system is achieved when zones cooling allows for heating or cooling areas of the building consistent with how they are used. The use patterns of HOWs are highly variable, even for buildings that

otherwise are essentially identical. Often, only the offices or a meeting room are being used, but many heating systems we see heat up much larger areas. If the current zones of a HOW do not match use patterns, money and energy are being wasted.

There are two ways to think of zones: 1) the physical areas served by a single thermostat, and 2) the usage patterns that determine which rooms require heat at particular times. Ideally, these should align so that only the spaces being used are heated or cooled. But often as building usage changes, heating systems are replaced, additions built, etc. and zones may be designed for the convenience of the installer or low cost to the congregation.

Updating zones can be more or less complicated (ergo expensive) depending on the type of heating or cooling generation and distribution equipment. Typically, it is easier with hydronic heating and more challenging with either steam or forced air systems.

Evaluation
The *Space Use* table in Appendix B presents First Church's current pattern of use and the zones associated with them.

While you originally answered "no" to this question, we have changed this to a "yes" because the 10 thermostats are located and serve areas that are reasonably close to the use patterns of the building. Plus, with the installation of the heat pump for the Houghton Room, you have fixed the largest mismatch, ie, Houghton and the Parish Hall being on a single zone.

The other area where there is a mismatch is the basement area where one thermostat located in a stairway controls the entire space; the stairway location is likely colder than the rooms and due to this location may not accurately reflect when the rooms reach the desired temperature. When you plan replacement equipment, plan for room-by-room controls. If you upgrade to a heat pump system, while you have the option of installing a central heat pump using the existing ducts, consider installing mini-splits in each room. Also consider a central dehumidification system. While this adds some energy use, it will enable easier and more effective management of humidity levels in the basement, improving indoor air quality and may even prevent damage to building materials from moisture and mold growth.

Do controls and distribution optimize energy efficiency of HVAC equipment? No

Even if generation equipment is highly efficient, energy can be wasted if controls don't match heating and cooling to the actual need. The most familiar control is the ***thermostat***. (See the discussion on thermostats in the Behavior section.) Hydronic heating systems should also have an ***outdoor reset control***. It adjusts the water temperature based on how cold it is outside. For example, in deep winter it would set the boiler to heat water as high as 180° but in fall and spring only to 110°>140°. Thus the amount of fuel used to reach a desired comfort level matches need. Next consider replacing existing pumps with ***variable speed pumps***

which vary the volume of heated water sent to the use locations. If heated water is returning at a temperature not much lower than it was sent out, the speed of delivery can be reduced so that the heat is transferred in the use spaces. Again, this reduces fuel use, and therefore cost. Similarly, for forced air systems, variable frequency drives adjust fan speeds to deliver the right amount of heat to rooms. An ***energy management system*** (*EMS*) is a computerized system that centrally manages all thermostats, logging in remotely to change settings rather than setting each individually on site. These systems also provide detailed information about energy use in the building to help manage use and cost even more closely. If your existing HVAC equipment is less than 10 years old, modest investments in these kinds of controls and distribution equipment can improve efficiency today while you plan for conversion to heat pumps in the future when the current equipment reaches the end of its useful life.

Evaluation
As mentioned above, it would be beneficial to install more modern thermostats that have wireless access, if the current thermostat wires can accommodate them. Otherwise, when replacing equipment talk to the HVAC contractor about thermostat controls that provide these features.

The Tekmar 268 controller (see Photo H9) has an outdoor reset feature, as well as sequencing the individual boilers. At your annual service call, ensure that the technician checks that the controller is programmed correctly.

Are heating/cooling/hot water pipes and ducts sealed and insulated? Yes and No

Getting space conditioning (water, steam, air) to the use location is the first delivery consideration. Uninsulated pipes and poorly-sealed ducts lose 10 - 30%of the heat or cooling before reaching the use space. Improving insulation and reducing air leakage in ducts is often a simple, inexpensive project that members and other volunteers can do on a work day if the ducts and pipes are readily accessible.. Such work days are also good learning experiences, reducing anxiety about doing such work, thus increasing the probability that those involved will "go and do likewise" in other needed locations, such as their own homes. MassIPL can help organize this kind of event. Sometimes ducts are inaccessible behind doors or under floors. In that case, consider contracting with an Aeroseal dealer; the Aeroseal process injects a fine mist of a sealant into the ducts under pressure, causing the sealant to find and plug any leaks. You can find an Aeroseal dealer here: https://directory.aeroseal.com/

Once at the location, delivery should match space type and use. For example, in-floor forced air vents in large/high worship spaces are very inefficient, blowing warm or cooled air to the ceiling, rather than distributing at the level of people. (7± foot maximum) Similarly exposed steam radiators in classrooms (especially nursery and pre-school) risk burning occupants if they are touched. There are now ***"high-efficiency" radiators*** that can be wall-mounted, including in classrooms. Even better for classrooms (especially where kids crawl on the floor) and in large and/or high spaces (such as meeting halls and sanctuaries) is ***in-floor radiant***. This can be installed over existing flooring, or if accessible from below, beneath the current flooring. Use of in-

floor radiant is beneficial in classrooms and worship spaces because heat will be uniform throughout the space, delivered where the kids or people are. The heat "pools" slowly, staying at the base of the space rather than going upwards to the ceiling. This system can be zoned within large spaces so that for small gatherings, the participants can be clustered at the heated area, which is beneficial in both energy efficiency and community formation.

Evaluation
The pipes in the boiler room are well insulated, though we were not able to inspect them in other locations. Nor were we able to inspect the duct insulation. Given the age of the system, they are likely not up to current standards but being difficult to access it may be impractical to add insulation. Ducts also lose up to 30% of their air through joints that aren't sealed properly. Should you decided to stay with a ducted system for the basement, consider having them tested for leakage and, if the leakage rate is high, sealed using the Aeroseal process https://aeroseal.com/

Is your air conditioning SEER 14+ efficient? No

If you have air conditioning (AC), it can be a significant use of electricity in summer. Thus, it is essential to have highly efficient equipment that is properly sized for the space. Given most HOWs are old, AC tends to be localized, often through-window. Some equipment is of the "gift-horse" type, given to the HOW when it was no longer useful to a member. This is a situation that lends itself to the installation of a *mini-split* heat pump system: an outdoor compressor feeds refrigerant to a small delivery device in the room or rooms without the need to run expensive duct work. The most common of these delivery devices hang on the wall, but they can also sit on the floor or be installed in the ceiling.

However, if you already have a central air conditioning system and have ductwork, you may be able to convert to a ducted heat pump system. MassSave is offering significant incentives to convert air conditioning-only systems to heat pumps. For more information, see MassIPL's *Everyday Environmental Stewardship* brief on heat pumps.

Evaluation
While you indicated you don't have cooling, the rooftop units do have that capability. According to an owner's manual we found via Google (see Photo H10), this model number has a SEER rating of 10, which is in line with the belief that these units date to the 1990's.

Have you evaluated your HOW for heat pumps? **No**

In order to achieve net zero carbon emission by 2050, we must transition away from fossil-fuel fired heating equipment to the maximum practical extent. Any time an existing fossil fuel heating system reaches the end of its useful life, it should be replaced by equipment that doesn't emit carbon. Heating equipment typically has a useful life of 15 – 20 years so unless you have replaced equipment in the last couple of years, you will likely replace equipment in your HOW by 2030.

The leading technology today is a *heat pump*. A heat pump may sound like an exotic new technology, but is already widely used in Europe and Asia, and increasingly in the US. Simply put, a heat pump moves heat from one place to another. In fact, a refrigerator is a type of heat pump that cools food by taking the heat from the inside and blowing it outside-- you feel the heat coming out from under the refrigerator when it is working. Air conditioners work by a similar principle, using an electrically-driven compressor to cool occupied spaces while blowing hot air outside. So, by reversing the process, occupied spaces can be heated. The equipment for doing both heating and cooling is called a ***heat pump***. Because New England winters are cold, install a *cold climate heat pump* which will remain efficient down to zero degrees Fahrenheit or lower. Because heat pumps operate on electricity, their carbon footprint will decrease as more wind and solar power is added to the electric grid; if you can install solar panels, your heat pumps may have zero carbon emissions. See MassIPL's *EES Brief* on *Heat Pumps*.

Upgrading to heat pumps will be more complicated than replacing an existing gas or oil furnace or boiler with similar equipment, so it is important to begin planning 2 – 3 years before the old equipment is at the end of its life. MassIPL always recommends working with a mechanical engineer on a major heating/cooling system project and it is especially important for conversion to heat pumps. Depending on the configuration of your current HVAC equipment, it may be possible to phase replacements, for example, converting offices or classrooms before converting the sanctuary or large gathering spaces. Because converting heating and cooling to heat pumps is such a high priority for the state, the MassSave program offers generous incentives that will help finance this project.

Heat pumps come in two main versions: air source and ground source (aka, geothermal). Geothermal is attractive because the ground temperature is constant throughout the year and thus the system operates at a higher level of efficiency. However, it is up to twice as expensive to install because you must drill wells or excavate a large field to install piping. Air source heat pumps are able to extract heat from the air, with *cold climate* heat pumps able to extract heat even when temperatures hit zero degrees or lower – thermodynamically speaking, there is heat in the air as long as temperatures are above absolute zero: -459 degrees F.

Evaluation

As noted earlier, with equipment nearing 30 years of age, it is time to plan for replacements. Given that you have not mentioned issues with repairing the current equipment you can spend the time carefully planning this project. But we recommend target

installing a new system within 5 years. Given that your oil boilers account for over 90% of your carbon emissions, retiring the boilers is the priority. The Sanctuary and Parish Hall may be challenging to heat with heat pumps but the rest of the building should be reasonably straightforward. It may be possible to phase the project to focus on areas such as the basement, the preschool room and the string of rooms from the Choir Room to the Kinder Watch.

All that said, an easier, lower cost first step might be to replace the rooftop units. The current units are not heat pumps, but air conditioning units with electric resistance heating. Heat pumps have a coefficient of performance for heating of 2.5 (meaning they are 2.5 times as efficient and electric resistance) and in summer a SEER rating of 18 or higher compared to the SEER 10 of the current units, thus will use almost half the electricity as the rooftop units. The spaces they serve aren't large and so a smaller heat pump unit might be adequate. In our experience, residential scale equipment is lower cost than commercial scale equipment, there is more competition among manufacturers, and they are easier to service.

We strongly recommend hiring a mechanical engineer to evaluate the building and your needs to then design the system specifications (see note below). They would be able to provide a more definitive answer to the question about replacing the rooftop units with heat pumps as part of their scope of work. MassIPL members have worked with these two firms:

Norian Siani Engineering Incorporated
43 Bradford Street, 3rd Floor
Concord, MA 01742-2972
781 398 2250 x-117 fax 781 398 2280
www.ns-engineering.com/
Matt Bean
mattb@ns-engineering.com

Elevated Design
Quincy, MA
724-561-6329
www.elevateddesign.boston
Mark Schow
mark.schow@elevateddesign.boston

Is your domestic hot water heater 95%+ efficient? **No**

Standard domestic hot water ("DHW") vertical tanks are not very efficient (65±%) and little hot water is typically used in an HOW: virtually no HOW's have showers or clothes washers and use is typically limited to sinks and dishwashers. And because there are long periods of time when none might be used, there is some "standby loss", i.e., after being heated the water cools off while waiting for a faucet to open and must be reheated to maintain temperature. Modern tank hot water heaters have significant insulation to limit this loss.

Similar to heating systems, the Commonwealth is encouraging us to move away from fossil fuels for heating water and installing a ***hybrid heat pump hot water heater***. Like the heat pumps discussed above for space heating, a heat pump hot water heater uses electricity, but uses it 3 times as efficiently as an electric resistance tank. While heat pump water heaters are more expensive, their lower operating costs (and incentives from the MassSave program) can pay back the investment in under 2 years.

If you are not able to switch to a heat pump water heater and currently have a gas hot water heater, switch to an on-demand DHW system which heats water only when the tap is turned on, eliminating the waste of heated water in a tank cooling because no one is using it. This cuts energy use by 30 - 40%. On-demand DHW systems save more money because they typically last 20 years, compared to tanks which often need to be replaced in about 10 years. If you have an electric resistance hot water tank, on-demand is likely not a practical alternative.

Whatever type of hot water system you have, make sure it is no bigger than needed: 40 gallons is more than enough to serve sinks and dishwashers. If it is located far away from where hot water is used, try to move it closer when the time comes to replace your current water heater. Finally, be sure the temperature is set to no more than 120˚, both for energy saving and to prevent scalding. When used in dishwashers (whether residential or commercial), the DHW from the source (typically at the 110° level) is heated to an even higher temperature by the dishwasher. For more information, see MassIPL's *Everyday Environmental Stewardship* brief on *Domestic Hot Water*.

Evaluation

First Church has a mix of water heating appliances; a 40-gallon electric tank (see Photo H11, 12), a propane-fired on-demand heater in the kitchen (Photos 13 – 14), and point-of-use water heaters ranging from 2.5 – 2.7 gallons in bathrooms (Photos 15 – 18).

The 40-gallon heater is 8 years old, near the expected life of 10 years. It serves the two bathrooms downstairs and when it comes time to replace it First Church should consider installing point of use tanks in those bathrooms rather than another large tank.

Do you have water-efficient faucets and toilets? Yes

Water is another scarce resource that is often taken for granted but should be part of your environmental stewardship. There is also an energy connection: it takes considerable amounts of energy to pump the water, treat it, send it to you, then treat the wastewater. Reducing water use also reduces this energy. Many faucet aerators are 2.2 gallons per minute (gpm) when 0.5 gpm is sufficient for restrooms, 1.5 gpm for kitchens; faucet aerators are inexpensive and easy to install.

Modern toilets use 1.6 gallons per flush (gpf) or less while toilets older than 1992 use 4 or 5 gpf). Dual flush toilets save even more water, with .8 gpf for flushing liquids and only using the higher 1.6 gpf for solids. Given the higher gpf needed to flush defecation, and that the ratio of urination to defection of about 6:1, it means that for 6 out of 7 flushes more water is used than needed. Dual-flush converters can be installed in any a.6 gpf toilet, are less than $20, and are easy to install. If your house of worship hosts a pre-school program, the savings can be quite significant. Each involves an environmental stewardship practice readily followed.

These are easy projects that members and volunteers can do on a work day – and can also be done at work, homes, schools, day care centers and so on. When replacing fixtures, look for the *Water Sense* logo, the water equivalent of the *Energy Star* label. (See https://www.epa.gov/watersense for more information.)

Evaluation

You noted that "most" of your faucets and toilets are efficient. With the Village Green Preschool, the bathrooms likely get a lot of use, so water efficiency is an important component of First Church's environmental stewardship. Make note of any that need upgrading and incorporate them into your upcoming capital campaign.

Special Notes on Heating

Given that heating equipment (generation, distribution, controls) can be costly, a **studied process** to determine the equipment to be used is sensible. Key factors include operating cost, life expectancy of equipment, ease of operation, care and maintenance, and improved comfort in spaces when in use. And since the lowest carbon and least cost energy is that which isn't used, prior to planning for the heating equipment it is wise to invest in tightening the building envelope so you can install smaller, less expensive heating equipment.

For proper design of a heating system, it is important to hire a **mechanical engineer** (ME) to plan and design the new system, especially if it includes new generation, distribution, and controls. The ME will provide system specifications that will be used

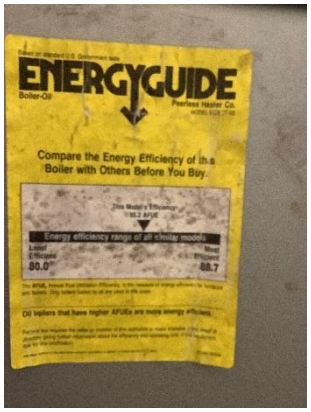
to obtain competitive bids from contractors. The cost of hiring this professional is a small investment relative to the total cost of the heating system and will ensure you get the right equipment for your needs.

This is especially true for heat pumps. Because of their different operating characteristics, a conversion to heat pumps requires more careful planning to match the equipment to the building's needs. And while heat pumps are not new, HVAC contractors by and large have much more experience with gas and oil burning equipment and are still climbing the learning curve with heat pumps. For example, if a contractor tells you that heat pumps don't work below about 30 degrees, you'll know they have not kept up with the development of a new generation of equipment called cold climate heat pumps which work even in below zero temperatures. MassIPL has several HVAC contractors we believe are highly knowledgeable and will look to expand our list in the coming years.

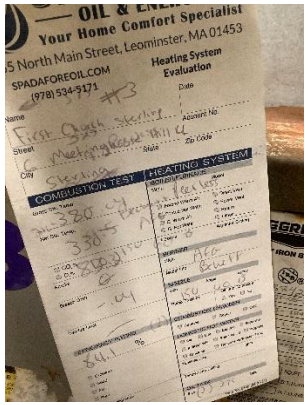
A practical action is to have a good equipment ***maintenance contract*** with a prepared and knowledgeable service company. Most HVAC companies offer an annual service contract, priced based on the equipment you have. They usually include an annual cleaning and tune-up for boilers, or twice-per-year service for furnaces and air conditioning equipment. Just as a well-tuned car gets more miles per gallon, well-maintained heating and cooling equipment uses less energy and lasts longer. Not having a maintenance contractor is like not having a doctor.

HVAC Photos

H1 — Three oil-fired boilers provide the bulk of heat to the building.



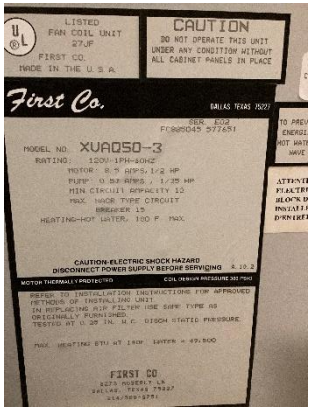
H2 — The boiler's Energy Guide label indicates 85.2% efficiency, good for this type of equipment.



H-3 – A recent service measured actual efficiency as 84.1%, indicating the boilers are in good condition for their age.

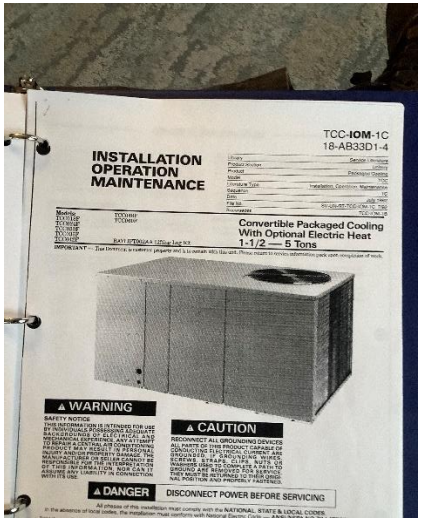
H4 — This hydro-air unit runs hot water from the boiler through an air handler to blow warm air into the Sanctuary.

H5 — This hydro-air unit serves the basement



H6 — Model and specifications of the hydro-air unit in Photo H-4.

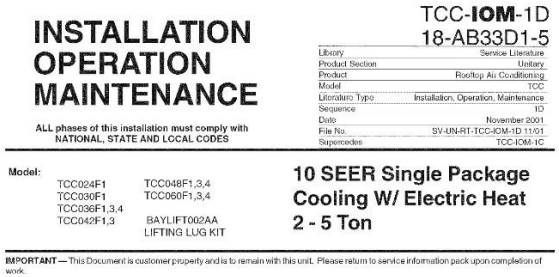
HVAC Photos (Cont)



H7 — One of these rooftop units serves the offices, another serves Room 2.

H8 – The new Mitsubishi heat pump that serves the Houghton Room.

H9 This Tekmar controller provides outdoor reset and boiler sequencing capabilities.



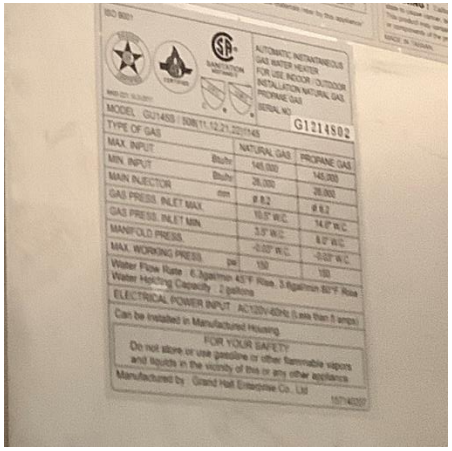
H10 Found on the Web, this manual appears to be for the same rooftop units at First Church and indicates 10 SEER, low by today's standards.

H11 This electric 40-gallon hot water heater dates to 2015, as indicated in the label in Photo H-2

H12 – Label for electric hot water heater showing the manufacturing date of 2015.

HVAC Photos (Cont)

H13 – This propane-fired on-demand hot water heater serves the kitchen



H-14 – Model and specs for the kitchen on-demand water heater

H- 15 Point of use water heater

H-16 Point of use water heater

H-17 Point of use water heater

H-18 Point of use water heater

Appendices

Appendix A — Utility Use & Cost 2021>2022

SUMMARY OF UTILITY USE & COST

First Church in Sterling - Church Bldgs

Insert Sq Ft here: **18,551** *square feet*

YEAR	TOTAL	ELECTRICITY $s	ELECTRICITY KWH	Cooling egree Da	GAS $s	GAS THERMS	Heating egree Da	OIL $s	OIL GALLONS	PROPANE $s	PROPANE GALLONS	WATER & SEWER $s	WATER & SEWER VOLUME
2021	**$17,372**	$5,240	31,961	1,300	$0	0	4,584	$11,297	5,156.7	$373	61.9	$462	54,300
CO₂ lbs	*123,455*		*7,159*			*0*			*115,510*		*786*		
% of prior yea	*50.0%*		*112%*			*#DIV/0!*			*6.96%*		*#DIV/0!*		
kBTU per SF	**44.8**	$0.28	2		$0.00	0		$0.61	0	$0.02	0	$0.02	2.9
% prior year	**278.6%**	112.4%	112.3%	89.3%	#DIV/0!	#DIV/0!	96.2%	718.7%	636.4%	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2022	**$23,073**	$5,400	30,145	1,372	$0	0	4,775	$16,653	4,808.8	$521	83.6	$499	0
CO₂ lbs	*115,531*		*6,752*			*0*			*#####*		*1,062*		
% of prior yea	*94%*		*94%*			*#DIV/0!*			*93%*		*135%*		
kBTU per SF	**42.0**												
% prior year	**132.8%**	103.1%	94.3%	105.5%	#DIV/0!	#DIV/0!	104.2%	147.4%	93.3%	139.7%	135.1%	108.0%	0.0%
CO_2 lbs 2022	**115,531**	**6,752**			**0**				**107,717**	**1,062**			
kBTU per SF for 2022	**42.0**	**The US Energy Information Administration calculates that the average house of worship in cold/very cold climate zones uses 54.2 kBTU per square foot per year. Is your house of worship better or worse than average?**											
would need	**9.4**	20 mpg cars			CO_2 LBs >	11.7	lbs/therm		22.4	lbs/gallo	12.7	lbs/gallon	
en off the road (12,000 miles/year) all year													
	OR										DD Balance point temp		60°
about	**139**	NE trees			www.MassIPL.org							Degree D.	*Boston*
to offset this Carbon Footpint													

OIL USE

First Church in Sterling - Church Bldgs

Provider Iarrington Oil **Serves>** First Church

Account # 3712

Year	Start Date	$S	% $s of prior year	Gallons	$/gallon	% gallons of prior	Heating Degree Days	% of prior year
2021	January	$2,048.45	#DIV/0!	1,055.9	$1.94	######	981	106.3%
	February	$2,015.47	#DIV/0!	1,038.9	$1.94	######	922	105.3%
	March	$1,678.88	#DIV/0!	865.4	$1.94	######	649	103.3%
	April	$846.81	#DIV/0!	436.5	$1.94	######	350	70.3%
	May		#DIV/0!	0.0	#DIV/0!	######	132	76.3%
	June		#DIV/0!	0.0	#DIV/0!	######	3	
	July		#DIV/0!	0.0	#DIV/0!	######	4	
	August	$451.36	#DIV/0!	177.7	$2.54	######	0	
	September		#DIV/0!	0.0	#DIV/0!	######	14	
	October		#DIV/0!	0.0	#DIV/0!	######	162	59.3%
	November	$1,522.27	#DIV/0!	565.9	$2.69	######	591	123.6%
	December	$2,734.12	173.9%	1,016.4	$2.69	######	776	91.2%
		$11,297.34	718.7%	5,156.7	$2.19	######	4,584	96.2%
2022	January	$3,523.36	172.0%	1,309.8	$2.69	######	1,167	119.0%
	February	$2,489.06	123.5%	925.3	$2.69	89.07%	845	91.6%
	March	$2,313.40	137.8%	860.0	$2.69	99.38%	673	103.7%
	April	$1,378.24	162.8%	318.3	$4.33	72.92%	376	107.4%
	May	$1,868.88	#DIV/0!	312.0	$5.99	######	100	75.8%
	June		#DIV/0!	0.0	#DIV/0!	######	8	
	July		#DIV/0!	0.0	#DIV/0!	######	0	
	August		0.0%	0.0	#DIV/0!	0.00%	0	
	September		#DIV/0!	0.0	#DIV/0!	######	46	
	October	$1,474.54	#DIV/0!	314.4	$4.69	######	250	154.3%
	November	$2,158.00	141.8%	460.0	$4.69	81.29%	478	80.9%
	December	$1,448.00	53.0%	309.0	$4.69	30.40%	832	107.2%
		$16,653.47	147.4%	4,808.8	$3.46	93.25%	4,775	104.2%

ELECTRICITY USE

First Church in Sterling - Church Bldgs

Provider Sterling Municipal

Meter # **Rate** **Serves>** First Church

Account # 2606001

Year	Bill Month	$s	% of prior year $s	kWh	$/kWh	% of prior year kWh	Cooling Degree Days	% of prior year DD
2021	January	$362.93	71.0%	2,456	$0.148	76.6%	0	#DIV/0!
	February	$496.93	81.3%	3,049	$0.163	79.0%	0	#DIV/0!
	March	$356.85	81.5%	2,026	$0.176	79.5%	2	#DIV/0!
	April	$347.40	121.5%	2,000	$0.174	122.3%	3	#DIV/0!
	May	$275.03	116.0%	1,571	$0.175	113.1%	102	120.00%
	June	$425.02	149.8%	2,791	$0.152	164.4%	331	114.53%
	July	$524.10	115.0%	3,048	$0.172	110.3%	282	57.09%
	August	$524.20	92.2%	3,048	$0.172	87.9%	406	102.01%
	September	$590.98	164.2%	3,780	$0.156	166.1%	141	85.45%
	October	$489.08	195.2%	3,117	$0.157	209.1%	33	194.12%
	November	$402.88	141.4%	2,400	$0.168	131.9%	0	0.00%
	December	$444.42	118.0%	2,675	$0.166	115.6%	0	0.00%
		$5,239.82	112.4%	31,961	$0.164	112.3%	1,300	89.35%
2022	January	$408.67	112.6%	2,681	$0.152	109.2%	0	#DIV/0!
	February	$528.28	106.3%	3,166	$0.167	103.8%	0	#DIV/0!
	March	$449.45	125.9%	2,494	$0.180	123.1%	0	0.00%
	April	$443.56	127.7%	2,429	$0.183	121.5%	0	0.00%
	May	$356.82	129.7%	1,888	$0.189	120.2%	138	135.29%
	June	$474.76	111.7%	2,755	$0.172	98.7%	193	58.31%
	July	$520.63	99.3%	2,898	$0.180	95.1%	441	156.38%
	August	$643.49	122.8%	3,647	$0.176	119.7%	459	113.05%
	September	$612.86	103.7%	3,327	$0.184	88.0%	116	82.27%
	October	$505.68	103.4%	2,559	$0.198	82.1%	9	27.27%
	November	$455.70	113.1%	2,301	$0.198	95.9%	16	#DIV/0!
	December		0.0%		#DIV/0!	0.0%	0	#DIV/0!
		$5,399.90	103.1%	30,145	$0.179	94.3%	1,372	105.54%

PROPANE USE

First Church in Sterling - Church Bldgs

	Provider			Serves>	FIRST CHURCH			
	Account #							
Year	Start Date	$S	% $s of prior year	Gallons	$/gallon	% gallons of prior	Heating Degree Days	% of prior year DD
2021	January	$177.77	#DIV/0!	30.0	$5.93	######	981	106.3%
	February		#DIV/0!		#DIV/0!	######	922	105.3%
	March		#DIV/0!		#DIV/0!	######	649	103.3%
	April		#DIV/0!		#DIV/0!	######	350	70.3%
	May	$96.48	#DIV/0!	15.2	$6.35	######	132	76.3%
	June		#DIV/0!		#DIV/0!	######	3	
	July		#DIV/0!		#DIV/0!	######	4	
	August		#DIV/0!		#DIV/0!	######	0	
	September		#DIV/0!		#DIV/0!	######	14	
	October	$98.56	#DIV/0!	16.7	$5.90	######	162	59.3%
	November		#DIV/0!		#DIV/0!	######	591	123.6%
	December		#DIV/0!		#DIV/0!	######	776	91.2%
		$372.81	#DIV/0!	61.9	$6.02	######	4,584	96.2%
2022	January	$179.27	100.8%	29.0	$6.18	96.7%	1,167	119.0%
	February		#DIV/0!		#DIV/0!	######	845	91.6%
	March		#DIV/0!		#DIV/0!	######	673	103.7%
	April		#DIV/0!		#DIV/0!	######	376	107.4%
	May		0.0%		#DIV/0!	0.0%	100	75.8%
	June	$224.58	#DIV/0!	36.0	$6.24	######	8	
	July		#DIV/0!		#DIV/0!	######	0	
	August		#DIV/0!		#DIV/0!	######	0	
	September		#DIV/0!		#DIV/0!	######	46	
	October	$116.88	118.6%	18.6	$6.28	111.4%	250	154.3%
	November		#DIV/0!		#DIV/0!	######	478	80.9%
	December		#DIV/0!		#DIV/0!	######	832	107.2%
		$520.73	139.7%	83.6	$6.23	135.1%	4,775	104.2%

WATER & SEWER USE

First Church in Sterling - Church Bldgs

	Provider	iterling DPW		Serves>	irst Church	
	Meter #					
	Account #					
Year	Bill Date	$s	% $s of prior year	Units	$/unit	% of prior year volume
2021	January	$ 81.25	#DIV/0!	5300	$0.02	#DIV/0!
	February		#DIV/0!		#DIV/0!	#DIV/0!
	March		#DIV/0!		#DIV/0!	#DIV/0!
	April	$ 149.62	#DIV/0!	23900	$0.01	#DIV/0!
	May		#DIV/0!		#DIV/0!	#DIV/0!
	June		#DIV/0!		#DIV/0!	#DIV/0!
	July	$ 149.62	#DIV/0!	22900	$0.01	#DIV/0!
	August		#DIV/0!		#DIV/0!	#DIV/0!
	September		#DIV/0!		#DIV/0!	#DIV/0!
	October	$ 81.25	#DIV/0!	2200	$0.04	#DIV/0!
	November		#DIV/0!		#DIV/0!	#DIV/0!
	December		#DIV/0!		#DIV/0!	#DIV/0!
		$461.74	#DIV/0!	54,300.0	$0.01	#DIV/0!
2022	January	$ 121.24	149.22%	17300	$0.01	326.42%
	February		#DIV/0!		#DIV/0!	#DIV/0!
	March		#DIV/0!		#DIV/0!	#DIV/0!
	April	$ 122.96	82.18%	17700	$0.01	74.06%
	May		#DIV/0!		#DIV/0!	#DIV/0!
	June		#DIV/0!		#DIV/0!	#DIV/0!
	July	$ 142.31	95.11%	22200	$0.01	96.94%
	August		#DIV/0!		#DIV/0!	#DIV/0!
	September		#DIV/0!		#DIV/0!	#DIV/0!
	October	$ 112.21	138.10%	15200	$0.01	690.91%
	November		#DIV/0!		#DIV/0!	#DIV/0!
	December		#DIV/0!		#DIV/0!	#DIV/0!
		$498.72	108.01%	72,400.0	$0.01	133.33%

Appendix B — Space Use

First Church in Sterling, Sterling, MA — ***Space Use by Day of Week***

SPACE	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	NOTES
Name	**Sanctuary**							
Morning	9am>noon						10am>noon	Saturday - random wedding or funeral ~20 /year
Afternoon								
Evening								
Name	**Freeman Hall**							
Morning	9am>noon						10am>noon	Saturday - random wedding or funeral ~20 /year
Afternoon								
Evening								
Name	**Sanctuary Foyer**							
Morning	9am>noon						10am>noon	Saturday - random wedding or funeral ~20 /year
Afternoon	noon>2pm							
Evening								
Name	**Main Hall and Foyer**							
Morning	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon	
Afternoon	noon>6pm	noon>6pm	noon>6pm	noon>6pm	noon>6pm	noon>6pm	noon>6pm	
Evening	7pm>10pm	7pm>10pm	7pm>10pm	7pm>10pm	7pm>10pm	7pm>10pm	7pm>10pm	

Name	**Office, Main**							
Morning	9am> noon	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon		
Afternoon		noon>4pm	noon>4pm	noon>4pm	noon>4pm	noon>4pm		
Evening								
Name	**Office, Pastor**							
Morning	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon	9am>noon		
Afternoon	noon>4pm	noon>4pm	noon>4pm	noon>4pm	noon>4pm	noon>4pm		
Evening				4pm>10pm				
Name	**Office, Music**							
Morning	9am>noon				9am>noon			
Afternoon								
Evening								
Name	**Office, VGP Director**							
Morning		8am>noon	8am>noon	8am>noon	8am>noon	8am>noon		Saturday 1x month
Afternoon		noon>6pm	noon>6pm	noon>6pm	noon>6pm	noon>6pm		
Evening								
Name	**Room, Craft**							
Morning					9am>noon			inconsistent use - varies
Afternoon								
Evening								

Name	**Office, Assoc Pastor**							
Morning	9am>noon		9am>noon	9am>noon	9am>noon	9am>noon		
Afternoon			noon>6pm	noon>6pm	noon>6pm	noon>6pm		
Evening								
Name	Room 1, VGP							
Morning		8am>noon	8am>noon	8am>noon	8am>noon	8am>noon		end of June closes until September
Afternoon		noon>3pm	noon>3pm	noon>3pm	noon>3pm	noon>3pm		occassional teacher use during summer months
Evening					7pm> 10pm			Thursday 1x month - suspended during summer months
Name	**Room 2, Multi-use**							
Morning	9am>noon	8am>noon	8am>noon	8am>noon	8am>noon	8am>noon		
Afternoon	1pm>5pm	noon>3pm	noon>3pm	noon>3pm	noon>3pm	noon>3pm		
Evening	7pm>8:30pm	7pm>10pm	7pm>10am	7pm>10pm	6pm>8pm			
Name	**Room, Teacher Lounge/Supplies**							
Morning		8am>noon	8am>noon	8am>noon	8am>noon	8am>noon		mid June closes until September
Afternoon		noon>3pm	noon>3pm	noon>3pm	noon>3pm	noon>3pm		occassional teacher use during summer months
Evening								
Name	**Room Nursery**							
Morning	9am>noon							
Afternoon								Monday - Saturday random days and time ~12x year
Evening								

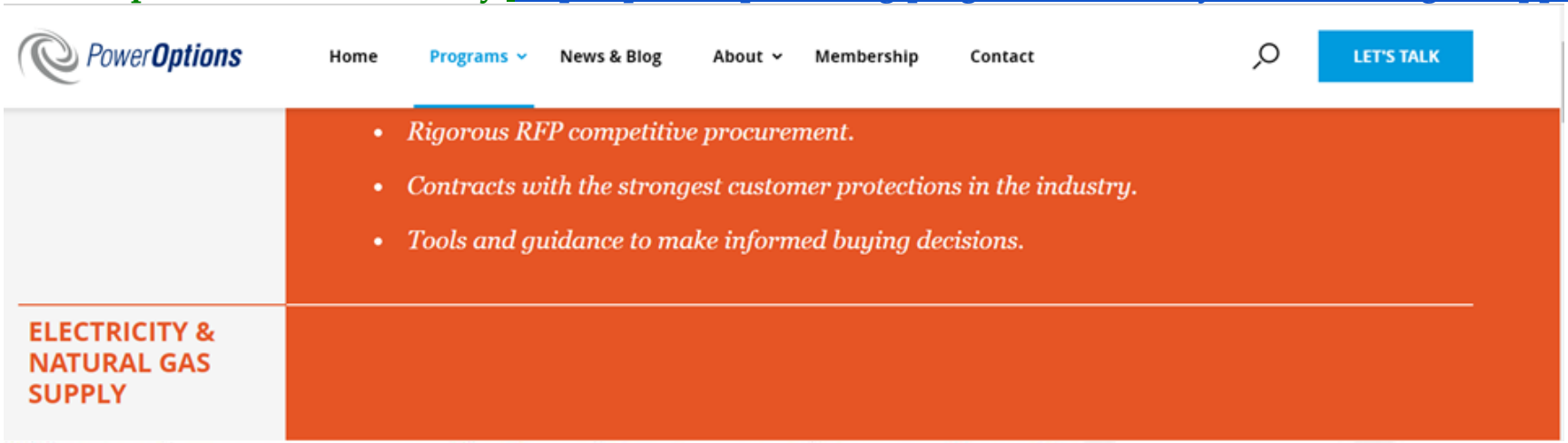
Name	**Parish Hall**							
Morning	9am>2pm	9am>11am	6:30am>noon				8am>noon	Saturday 1x month
Afternoon	noon>5pm						noon>3pm	Sunday 3x year
Evening		6pm>10pm	5pm>9pm	4pm>8pm	7pm>9pm	7pm>9pm		Random use funerals, weddings, craft fairs ~6x year
Name	**Stage**							
Morning	10:30am>noon						10am>noon	Sundays: multi-purpose use 8x year
Afternoon	noon>1pm						noon>4pm	Rehearsals, days vary, July thru September and
Evening		6pm>9pm	6pm>9pm	6pm>9pm	6pm>9pm	6pm>9pm	6pm> 9pm	February through March
Name	**Work Area: Sexton & Custodial**							
Morning		9am>noon	9am>noon	9am>noon	9am>noon	9am>noon		
Afternoon		3pm>6pm	3pm>6pm	3pm>6pm	3pm>6pm	3pm>6pm		
Evening								Saturday 2x month 8am>3pm
Name	**Kitchen**							
Morning	9am>noon						8am> noon	Saturday 2x month FIL/Mens Brkfast
Afternoon	noon>2pm	noon>1pm	noon>1pm	noon>1pm	noon>1pm	noon>1pm	noon>4pm	Random use funerals, weddings, craft fairs ~6x year
Evening			3pm>6pm					
Name	**Houghton Room**							
Morning	11am>12pm				10am>noon		8am>10am	Saturday 1x month
Afternoon							noon>5pm	Random use funerals, weddings, events ~6x year
Evening					6pm>8pm			

Name	**PH Foyer**							
Morning	9am>2pm	9am>11am	5:30am>noon				8am>noon	Saturday 1x month
Afternoon	noon>5pm						noon>5pm	Sunday 3x year
Evening		6pm>10pm	5pm>9pm	4pm>8pm	7pm>9pm	7pm>9pm		Randon use funerals, weddings, events ~6x year
Name	**Chapel**							
Morning	11am>noon							
Afternoon								
Evening		7pm>9pm			6pm>9pm			Monday 2x a month; Thursday 1x month
Name	**Room B-5**							
Morning								
Afternoon	3pm>5pm							
Evening								
Name	**Room B-4 storage**							
Morning								
Afternoon								
Evening								
Name	**Room B-3 storage**							
Morning								
Afternoon								

Name	**Room B-3 storage**							
Morning								
Afternoon								
Evening								
Name	**Room B-2**							
Morning								
Afternoon	3pm>5pm							
Evening					6pm>7pm			
Name	**Room B1**							
Morning	11am>noon							
Afternoon								
Evening					7pm>8pm			

Appendix C — Bulk Purchase

PowerOptions Gas & Electricity https://poweroptions.org/programs/electricity-and-natural-gas-supply/



What makes up our nonprofit electricity & natural gas programs?

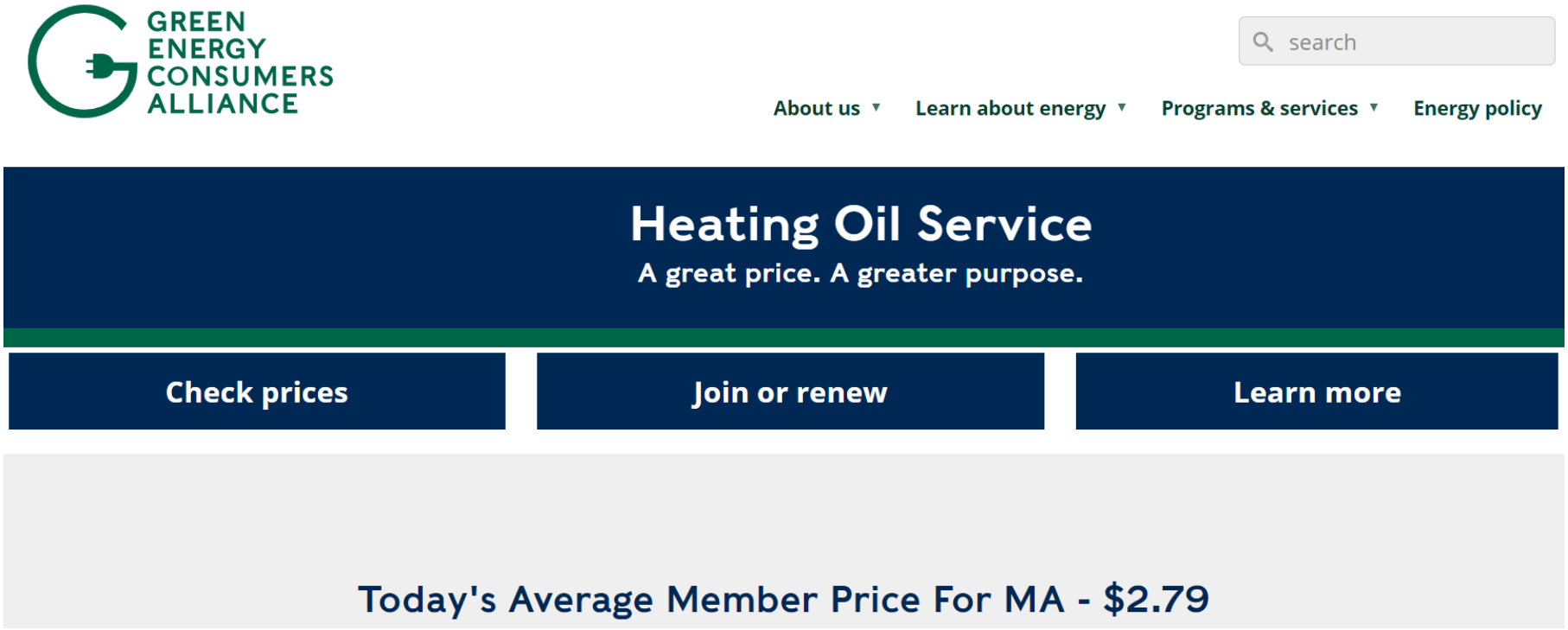
Our electricity and natural gas programs have been designed around the needs of our members. Here's what's included:

- **Competitive RFP electricity & natural gas procurement –** Our robust competitive procurement process results in multiple proposals from the largest suppliers in the region.
- **Guaranteed competitive price –** Your price through PowerOptions is based on the day's energy market and your organization's particular load. And we verify and monitor suppliers' prices for accuracy against negotiated pricing.
- **Protections against unexpected costs –** A low price is only as good as the contract that protects it. Our pre-negotiated contract has the strongest customer protections in the market.
- **Pricing options that reflect your risk tolerance –** These range from fixed all-in, to a layered buying approach, to wholesale market access.
- **Our "Market Watch" tool –** The unique Market Watch tool allows you to watch and track your indicative price over time before making a decision, allowing you to lock-in at advantageous times.
- **Strike pricing –** Set a strike price to automatically purchase when the price is right.

Appendix C — Bulk Purchase

Green Energy Consumers Alliance

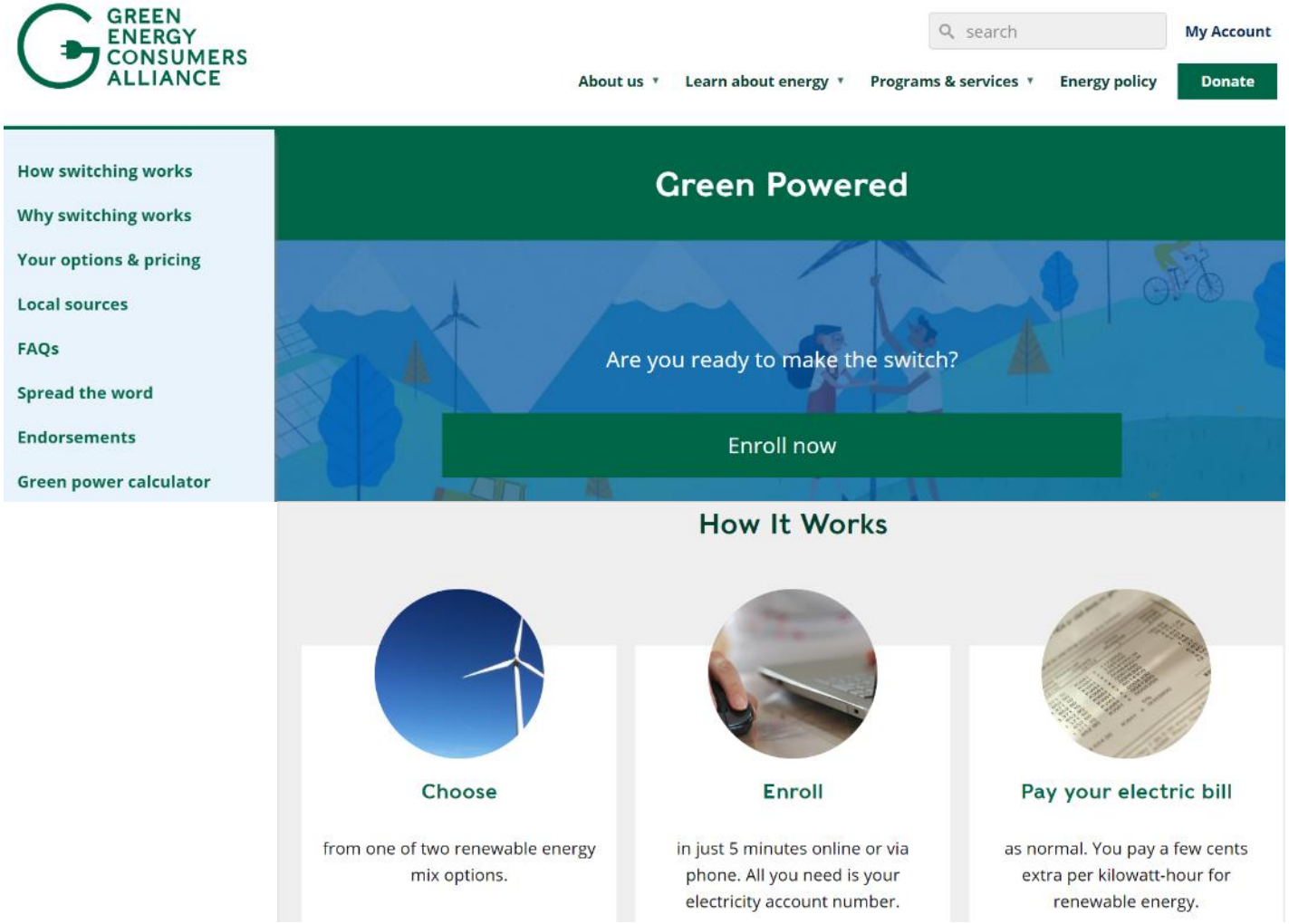
https://www.greenenergyconsumers.org/heatingoil



(Price as of September 2021. Check the web site above for current pricing.)

Appendix D — Green Electricity

Massachusetts Clean Energy Consumers Alliance
https://www.greenenergyconsumers.org/greenpowered



Check the site listed above for current pricing.

Appendix D – Green Electricity: Community Solar

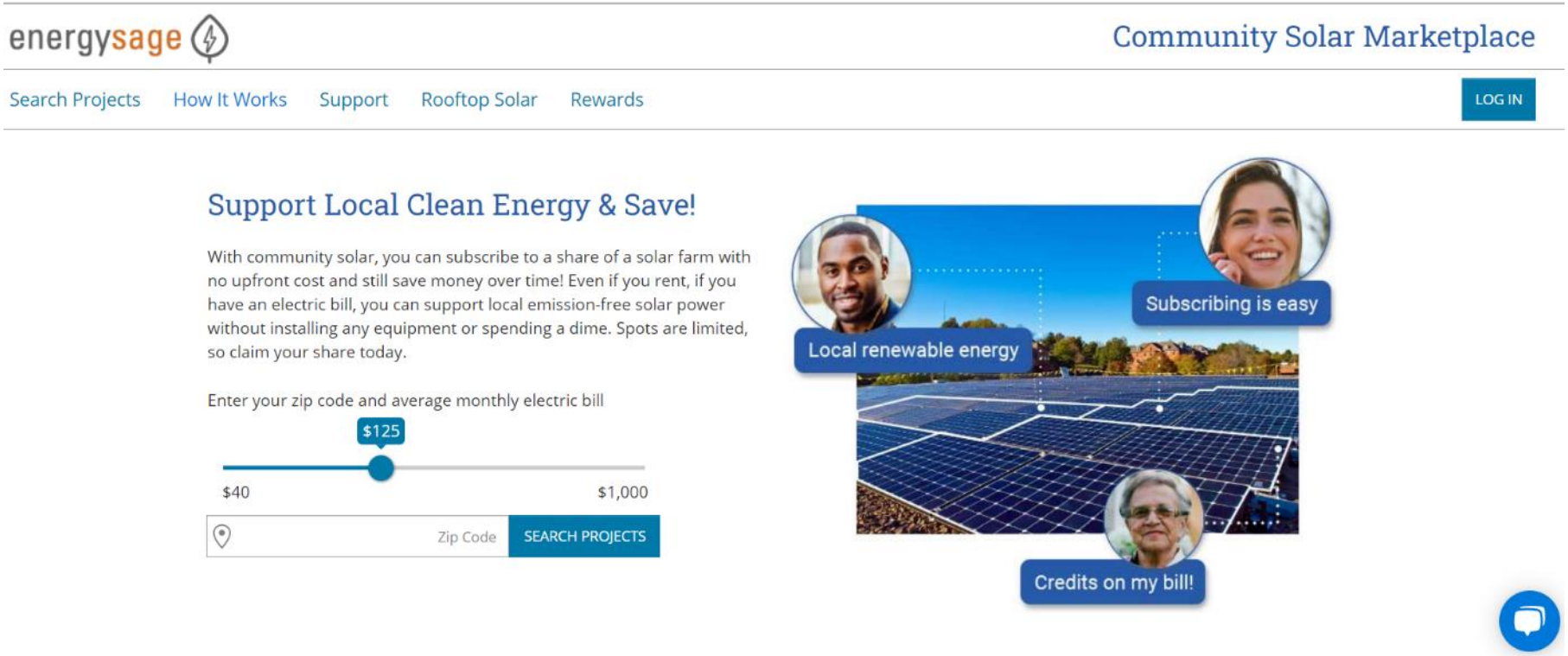
https://hampshirepower.com/

Faith Communities Meet Community Solar

Hampshire Power and Massachusetts Interfaith Power & Light are bringing the green economy to low-income communities for a more equitable, cleaner grid in the Commonwealth.

Contact: Stephen Condon, stephen@hampshirepower.com, 603-583-0228

https://communitysolar.energysage.com/



Appendix E — Efficiency Budget

As the example below illustrates, if you make no changes, you can expect energy costs to increase at least at the rate of inflation; here we have assumed 3%. If you take some actions, for example beginning with the simple, behavioral actions such as lowering the thermostat, turning off lights, signing up for bulk purchase of gas or electricity. The savings from those actions fund the Energy Efficiency budget line and provides funds in Year 2 for more extensive actions that in turn generate more savings for year 3 for more actions. Continue this process until you have achieved Net Zero carbon emissions then use the ongoing savings to fund your mission!

Illustrative **EFFICIENCY BUDGET**

	2021	% of Total	2022	% of Total	2023	% of Total	2024	% of Total
TOTAL Budget 3% inflation	**$23,600**		**$24,308**		**$25,037**		**$25,788**	
Electricity	$8,700	36.9%	$7,395	30.4%	$6,286	25.1%	$6,411	24.9%
Gas	$12,300	52.1%	$10,455	43.0%	$8,364	33.4%	$8,029	31.1%
Water & Sewer	$2,600	11.0%	$1,820	7.5%	$1,638	6.5%	$1,671	6.5%
Efficiency Budget $s saved	*$0*	0.0%	*$4,638*	19.1%	*$8,749*	34.9%	*$9,677*	37.5%
Actions for Saving$	*Low-Hanging Fruit* Behavior changes		LED lighting Smart Stats Boiler Outdoor Reset 0.8 gpf Flush Toilets 0.35 gpm aerators		On-Demand DHW Heating zones		Hire ME to plan heating & cooling system upgrade *Efficiency Budget $s to pay HVAC loan*	