

**Net-zero Energy Plan for  
University Mennonite Church  
Meetinghouse  
State College, Pennsylvania**



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### **Executive summary**

This plan proposes a photovoltaic (solar) power system and key energy conservation measures to make the UMC Meetinghouse a net-zero energy building.

To meet the net-zero goal at lowest cost, energy conservation measures, most significantly for the heating system, are proposed with the aim to reduce usage by about half. A solar power system would then provide annual production to cover the remaining energy usage.

Total cost estimate for the energy conservation measures is \$40,000, the cost for the solar power system is \$55,000, for a **total project budget of \$95,000**. Simple payback for the combined project is about 16 years but a significant reduction in the payback could be realized by selling solar renewable energy credits (SREC) and valuing the replacement of end-of-life equipment (sanctuary air-conditioning units).

A proposed financing strategy for the project is to target \$40,000 in special fundraising. The remaining \$55,000 could be financed on a 15 year term at 4% resulting in annual financing costs of \$5,000, which is close to the offset energy costs, meaning that there would be no annual budget impact.

	<b>Energy cost</b>	<b>Energy (kWh)</b>	<b>CO2 (mT)</b>
<b>CURRENT USAGE</b>	\$5,500	51,000	36.2
<b>Energy savings projects</b>			
	-\$2,600	-25,400	-18.0
<b>Solar power</b>	-\$2,100	-27,000	-19.2
<b>PROPOSED</b>			
	\$800	-1,400	-1.0

### **Energy conservation measures**

The following energy conservation measures are proposed. By far, the most significant project is the addition of heat pumps in the sanctuary and programmable thermostat control to pre-heat the sanctuary overnight when demand charges can be minimized.

project	power (W)	hours/week	hours/yr	kWh per year	new power (W)	energy reduct. (kWh)	demand reduct. (kW)	energy savings	demand savings	total savings	cost	simple payback
Heat pumps for sanctuary	54,000			35,360	22,000	23,295	32	\$1,631	\$719	\$2,350	\$40,000	17.0
LED retrofit Rm 2, 3, pastor office	896	20	1,000	896	336	560	0.56	\$39	\$13	\$52	\$196	3.8
LED retrofit Fellowship Hall	1,536	12	600	922	576	576	0.96	\$40	\$22	\$62	\$336	5.4
LED exit signs	150		8,760	1,314	30	1,051	0.12	\$74	\$3	\$76	\$150	2.0
Scheduled T-stat in fellowship	6,000				0	0	6	\$0	\$135	\$135	\$50	0.4
<b>TOTAL</b>						<b>25,482</b>	<b>40</b>	<b>\$1,784</b>	<b>\$891</b>	<b>\$2,675</b>	<b>\$40,732</b>	<b>15.2</b>

Several quotes were obtained from local HVAC installers with prices ranging from \$20,000 to \$40,000. The existing air conditioning units are about 20 years old and reaching the expected end of their useful life.

### **Net-zero potential**

“Net-zero” refers to a building or facility that produces, through on-site renewable energy, annually, an equivalent amount of energy as that consumed. “Net metering” allows for a facility to export energy at times when usage is low and production is high while drawing energy from the grid when usage is higher than production.

PA law requires that public utilities allow for net metering for a system up to 3 MW on a non-residential facility. In any billing month, if there is a surplus, a credit for the generated energy is carried over to the next month. At the end of an annual period, any annual excess is credited back at the utility's wholesale cost of generated power.

The proposed 26kW system will generate approximately 27,000 kWh annually and achieve net-zero after the assumed reduction in heating energy.

The meetinghouse is fully electric; FY2020 annual budget for electricity was \$7,000 but actual usage in FY2019 was ~\$5,000. If this plan is fully implemented, it is estimated that annual energy cost would be approximately \$1,000 if usage remains similar to 2019. Even though the building would be net-zero energy usage, demand charges and other grid connection fees would continue to be assessed.

### **Solar power system**

Two local solar installers provided proposals to UMC in Q1 2022 for 26kW roof-mounted systems. One proposed an array on the front orientation, which is facing slightly east-northeast, the other provided a proposal for the back roof orientation, west-southwest. However, either could accommodate whichever orientation UMC preferred; both projected similar production.

The west-southwest orientation is better in theory, but a large tree on this side of the building will cause partial shading during some hours of the year. The east-northeast orientation would make the solar panels visible from the street and front entrance to the meeting house.

Below is the proposed front roof orientation with a layout of fifty-six 480 watt solar modules.



The two proposals were between \$50,000 and \$60,000 in cost for similar size and production. Both proposals recommended micro-inverters and equipment with a 25 year warranty.

A 26 kW solar power system would generate approximately 27,000 kWh annually which is the estimated annual electricity usage after improvements are made to reduce the heating and lighting systems.

Generated energy will be credited at the cost of the consumer and credits will be rolled over monthly during the lower usage months to offset usage in the winter. Offset energy cost value is \$0.077/kWh based on 2021 utility rates. Annual generated value will be \$2,100 in the first year. Additional revenue from solar renewable energy credits (SREC), if these are sold, will be in the range of \$1,000 annually, but this is an open market with many variables so value could be much higher or less than this.

### **Utility bill analysis**

UMC is an all-electric building. Heating source is electric resistance. Energy use in the 12-month period October 2018 - September 2019 was **46,832 kWh**. Note that building usage and associated energy costs in 2020 - 2022 were significantly altered due to COVID so this data was not used.

Usage in September 2019 was 945 kWh; review of 12-month utility statements show that this is fairly typical usage in months with no heating and can be taken to represent typical base loads: lighting, receptacle, cooking, ect. Extrapolating this base load to 12 months and deducting from annual usage results in 35,360 kWh assumed for typical heating energy use.

If this electric heating load were to be replaced with heat pump heating with a COP of 3, new annual load projection would be 23,259 kWh. This could be used as an approximate usage after energy conservation measures are applied.

Energy costs for September 2019 were \$183 for an overall unit cost of \$0.19/kWh. The rate directly tied to usage was \$0.07 while significant demand charges increased the total cost. An updated utility review in January 2022 shows that direct usage costs has increased to \$0.077/kWh

Budget records show church electric costs from September 2018 - August 2019 were \$4,780. It's off by a calendar month, but dividing this cost by the aforementioned 12-month usage results in a mixed rate of \$0.10/kWh