MassIPL
FAITH IN ACTION FOR CLIMATE JUSTICE

Everyday Environmental Stewardship

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Solar Panels: Zero Carbon Electricity

Key issue:
Electricity from renewable resources

Stewardship Opportunity
Zero Carbon Electricity

Solar power is clean, environmentally friendly, energy producing, and extremely cool. Over 150 houses of worship in Massachusetts host solar panels. Solar panels can supplement or provide all of your home's or house of worship's electricity. Over the past 10 years, the cost of solar panels has dropped significantly and typically will pay back their cost in 10 years, or as little as 5 years depending on the state and federal incentives that you take advantage of.

Solar power uses the sun's energy to produce electricity (DC) which goes through an inverter that converts the current to AC, the kind of electricity used by our lights, appliances, etc. Most often, you remain connected to the grid so you can draw electricity at night or when the panels don't produce all of the electricity the building needs. In Massachusetts, due to a regulation called "net metering", if your panels produce more than you need, the "excess" is sent onto the power grid and your electric account is credited for the cost of that electricity. As batteries improve and become less expensive, they are commonly added to solar installations to provide additional flexibility and resilience in the event of a power outage.

Environmental Benefits of Solar

Of all electricity producing sources, solar energy has the smallest environmental impact. Solar panels do not take up land when installed on top of houses or places of worship so they conserve land. PV cells do not require massive strip mining for fuel (coal) or produce toxic byproducts. While some energy – and thus carbon emissions – are created during the manufacturing process, these are offset within the first 1 - 4 years of the panels' operation that creates zero carbon emissions.[1] Over the course of 25 years, a 10 kilowatt solar system will save approximately 246 tons of CO_2 from reaching the atmosphere. This is roughly equal to driving 490,000 miles in a car.

[1] US Energy Information Administration, https://www.eia.gov/energyexplained/solar/solar-energy-and-the-environment.php, accessed 6/23/2025

Commented [1]: 543 lbs/MWH times 11 MWHs annually = 5975 lbs = 2.7 metric tons
2.7 metric tons per year x 25 years = 67.5 metric tons = 67,000,000 grams

67,000,000 grams divided by 400 grams per mile = 168,750 miles

Commented [2]: Ajinkya: see if you can verify this calculation

Commented [3]: Step 1: Annual CO_2 Savings per kW of Solar
According to the U.S. Environmental Protection Agency (EPA), 1 kilowatt of solar installed in the U.S. saves about 1.5 metric tons of CO_2 per year on average. This varies by region, but it's a widely used baseline.

10 kW system × 1.5 tons CO_2/year = 15 tons CO_2/year

Over 25 years (typical solar panel life):
→ 15 tons/year × 25 years = 375 tons CO_2 saved

So, a 10 kW system would save approximately 375 tons of CO_2 over its lifetime, not 246 tons.
Step 2: CO_2 Emissions from Driving
According to the EPA:

The average passenger vehicle emits about 404 grams of CO_2 per mile
→ or 0.000404 metric tons/mile

Let's reverse-engineer the "490,000 miles" figure:

246 tons CO_2÷0.000404 tons/mile≈608,910 miles

So:

246 tons CO_2 is more like 609,000 miles, not 490,000 miles.

Alternatively, 490,000 miles × 0.000404 tons/mile = ...

Commented [4]: @jnail@massipl.org

Verify the calculations once again and add a reference.
Add calculations in a sidebar.

Commented [5]: Can you check the assumptions about how many kilowatt hours of electricity one kw of solar panels will produce and how many grams/pounds of carb are emitted per kilowatt hour of electricity

Commented [6]: Hi @jnail@massipl.org

I tried verifying the calculations based on these links
https://pvwatts.nrel.gov/
https://www.epa.gov/egrid/detailed-data
https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

It is extremely difficult to verify the values and the ...

Financial Benefits of Solar

Another significant reason to install solar panels is to reduce the amount your home or house of worship pays for electricity. Since 2015, electricity rates in Massachusetts have risen 75%. If you buy the panels, you will eliminate much, if not all, of your electricity bill. A typical solar array on a house of worship costs $75,000 - $100,000

There are several tax incentives available through the state and federal governments. The North Carolina Clean Energy Technology Center maintains an excellent database of these incentives – Database of State Incentives for Renewables and Efficiency, DSIRE. Click on this link and click on Massachusetts on the map: https://www.dsireusa.org/. With the passage of the Inflation Reduction Act in 2022, non-profits could take advantage of these credits through a provision known as "direct pay"; however, this provision is only available through the end of 2027. But even when this incentive expires, reduced electricity costs will pay back the investment in a solar panel installation in 8 - 9 years.

If your organization can't afford to purchase the panels, financing options such as a lease or a power purchase agreement typically save you 10 - 20% on your electricity bill. (see the MassIPL EES Financing Solar Panels).

Common Solar Installation Types: Roof vs. Ground

When installing a solar energy system, the two most common approaches are roof-mounted and ground-mounted panels. Each has its own advantages, costs, and design considerations.

- Roof mount – The most common installation method, roof-mounted solar panels are attached to a rack system secured to the roof rafters. For flat roofs, the racks are typically ballasted—weighted down without penetrating the roofing material—to resist wind. This option is often the most cost-effective and space-efficient, especially for homes or businesses with ample sun exposure.
- Ground mount – These systems are installed on a standalone structure at ground level, either in open land or as canopies over parking lots. While they offer flexibility in orientation and easier maintenance access, they usually require additional permitting, zoning approvals, and engineering studies, which can increase costs.

Components of a Solar Array

Two main components make up a solar array:

- Solar panels – These are the photovoltaic (PV) modules that convert sunlight into direct current (DC) electricity. Made of silicon cells, solar panels are typically mounted in groups (called arrays) and are responsible for capturing solar energy throughout the day.
- Inverter – The inverter is the device that converts the DC electricity produced by the solar panels into alternating current (AC), which can be used by home appliances or fed into the electric grid.

  There are two main types:
  - **Central (String) Inverter** – A single inverter that handles the power output of multiple panels connected in a series. It's cost-effective but can reduce overall

performance if one panel is shaded or underperforming.

- **Microinverter** – Small inverters are attached to each individual panel. These allow each panel to operate independently, improving system efficiency, especially in shaded or complex roof conditions.

Is my building a good solar site?
Whether for your home or house of worship, there are a few important features the building must have:

- Orientation between east and west, with due south ideal. While north-facing roofs will still produce some electricity, typically it is not enough to justify the cost of panels.
- Little to no shade. Shade from trees, steeples, chimneys, nearby buildings, etc., significantly decreases the amount of electricity the panels produce. While a small amount of shade is acceptable, avoid roofs that will have shade for large parts of the day.
- Roofing material that is less than 10 years old. Solar panels will produce electricity for 25 years or more. It would be expensive to remove them in order to install new roofing, then reinstall them; if your roof is 20 years old, definitely replace it before installing solar. If it is between 10 - 20 years, you may go ahead and replace it or wait a few years.
- Few obstructions on the roof. Ideally, pick a roof with no dormers, gables, plumbing vents, HVAC equipment, skylights, etc., so that the entire roof can be used for solar.

How many solar panels should I install?
The closer you can get to generating 100% of your electricity from your solar panels, the better! Start with understanding how much electricity you use every year – the kWh consumed over the past 12 months can usually be found on your electric bill. Then, the size of your roof is a limiting factor – when a solar installer prepares a proposal, it will show the size of the array and estimate the number of kWh produced annually. Finally, consider how our electricity use might change in the future: Are there energy efficiency projects you can do to decrease usage? Will you install heat pumps to heat and cool the building in the coming years, increasing your electric usage?

What Steps Should My House of Worship Take To Evaluate Solar?
If the idea of your house of worship installing solar panels excites you, take the lead in organizing the efforts to make it happen. Here are steps MassIPL recommends:

1. Identify like-minded congregation members. Begin talking about the idea of installing solar panels with other members. As you get a sense of the level of support the project would have, invite those with high interest to join you in further research.
2. Have an initial conversation with clergy and lay leadership. Let the leadership know about your idea and gauge their interest and support. Let them know what you have heard in your conversations with other congregation members.
3. Get a copy of a recent electric bill. A first step in determining the size of solar array you might install is to know your annual electric usage in kilowatt hours (kwh). The electric bill will list the kwh usage by month for the past 12 months, making it easy to add them up for the annual total.
4. Contact MassIPL for an initial evaluation. Email solar@massipl.org to ask for an initial evaluation. Using Google Earth and other online tools, MassIPL can give you a rough estimate of the size and cost of a solar array on your house of worship. While you will need a more detailed analysis by a solar installer before making a final decision, this

initial evaluation will provide a good foundation for more in-depth discussions in your congregation.

5. Discuss financing options. This is one of the most important discussions to have with the treasurer and other leaders of your congregation. There are a number of ways to finance a solar project, from a capital campaign to raise the money, to taking out a loan, to a lease or a power purchase agreement. These are described in MassIPL's Everyday Environmental Stewardship brief *"Financing Solar Panels"* https://bit.ly/EESFinancingSolar
6. Contact solar installers to ask for proposals. With knowledge of your electricity use, support from your community, and an understanding of what type of financing is likely best for your house of worship, you are well-equipped to engage solar installers for their detailed evaluation and proposals. Cost will, of course, be a significant factor in determining which installer to sign a contract with, but also consider their experience with houses of worship and their understanding and responsiveness to your situation. MassIPL has four solar installer partners that we regularly recommend.

While installing solar panels on your house of worship is a big project, it has many benefits and is very feasible. MassIPL is here to help you take this important step in combating climate change and caring for Creation.