Solar Electricity for the Sylvania United Church of Christ

a commitment to our children,
to our community and to our environment

a covenant of faith with our community:

- building good discipleship
- a visible symbol of our commitment toward good stewardship of the resources given in trust to all God's children
- an investment on behalf of our young people
- an investment promoting the health of our community

(This is the first slide of a presentation that loops continuously in our gathering area.)

Overview of Sylvania UCC church and its green activities:

- Building designed into hillside for lower heating and cooling loads,
- Restricted use of lawn chemicals,
- Recycling of bulletins and office paper,
- Installation of a high efficiency AC system that uses ice made during night hours when the system runs more efficiently and electricity demand is lower (although this is not reflected in current rates),
- Using ceramic dinnerware and metal utensils rather than disposables for fellowship period and meetings,
- Upgraded heating system for higher efficiency, and
- Installed a new, high efficiency dishwasher

The PV project was a natural extension of the traditional involvement by the Sylvania UCC in stewardship of creation.

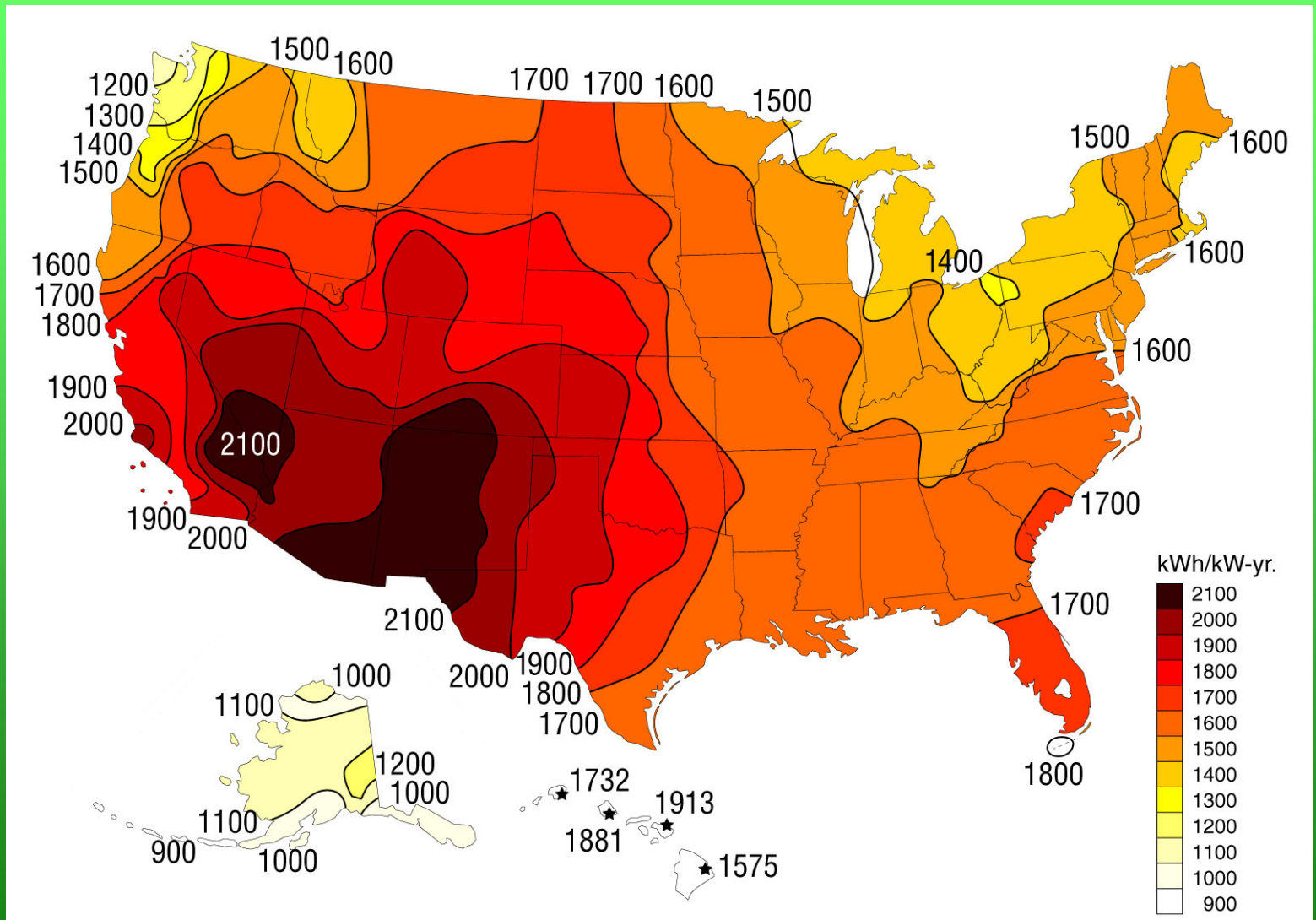
However, PV installations currently are expensive and several factors facilitated a positive decision to proceed with fundraising. In this paper (presented at *Solar 2007*) we describe:

- the process we used to build support for the project,
- difficulties encountered relating to the roof condition,
- selection of the local module manufacturer,
- the installation process,
- the performance of the panels, and
- some of additional activities that have been stimulated at least in part by this PV installation project

Building support for the PV project:

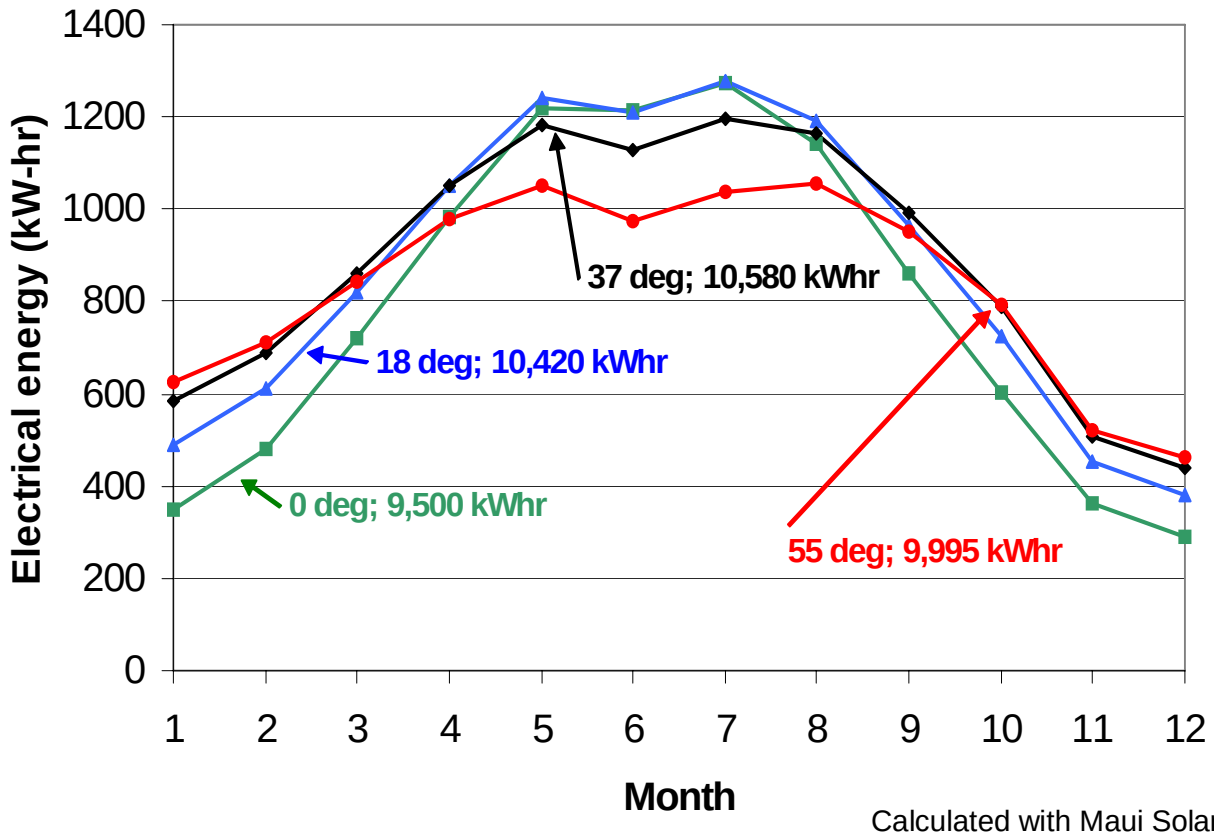
- The idea of rooftop PV was proposed to church members in the mid 1990's with considerable support but the realization that some incentives were needed for financial viability.
- In Spring 2005, Ohio's Department of Development, Office of Energy Efficiency announced a small grant program that would provide a 1:1 cost match.
- Church members and Trustees endorsed the grant proposal for a 6.4 kW rooftop system to use new technology thin-film panels manufactured locally (First Solar) and installed by a local firm (Advanced DG).
- The proposal included a replacement roof (standing seam metal) which was funded by a capital campaign that was enthusiastically supported by members.
- One important step was to inform members that solar cells work well in Ohio! (See next slide.)

PV Energy kWh/kW-yr



Note that 1 kW of panels in Toledo generate 1500 kWh of electricity per year, compared with 1750 kWh in Orlando. That's 86% as much!

The 16º slope of the Sylvania UCC roof is just about ideal for highest PV electricity production



Calculated with Maui Solar Energy Software Corp. PV-DesignPro 4.0

Roof repairs were needed before PV installation!

- In preparation for the PV installation, we discovered that the 25 yr old tar and stone aggregate roof needed replacement.
- After thorough study, we decided to replace the roof with a standing seam stainless steel metal roof. (Stainless to protect from corrosion where metal clamps attached the rails for the PV panels.)
- Details of the PV mounting to the standing seams are shown in the photos

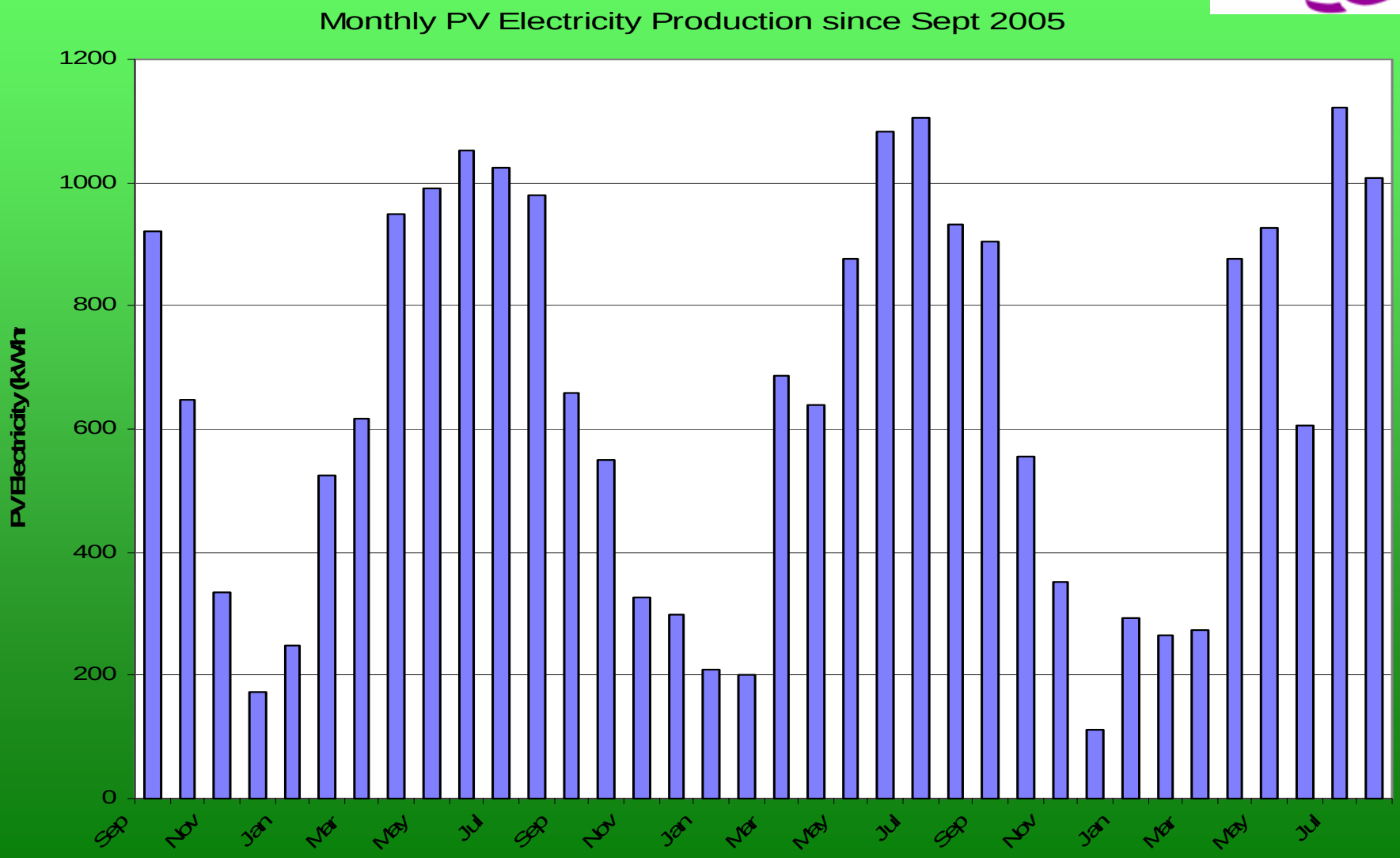
Composite gravel roof becomes standing seam stainless steel with PV panels….

Three inverters convert DC power from the PV array into AC power for the church and synchronize to the grid

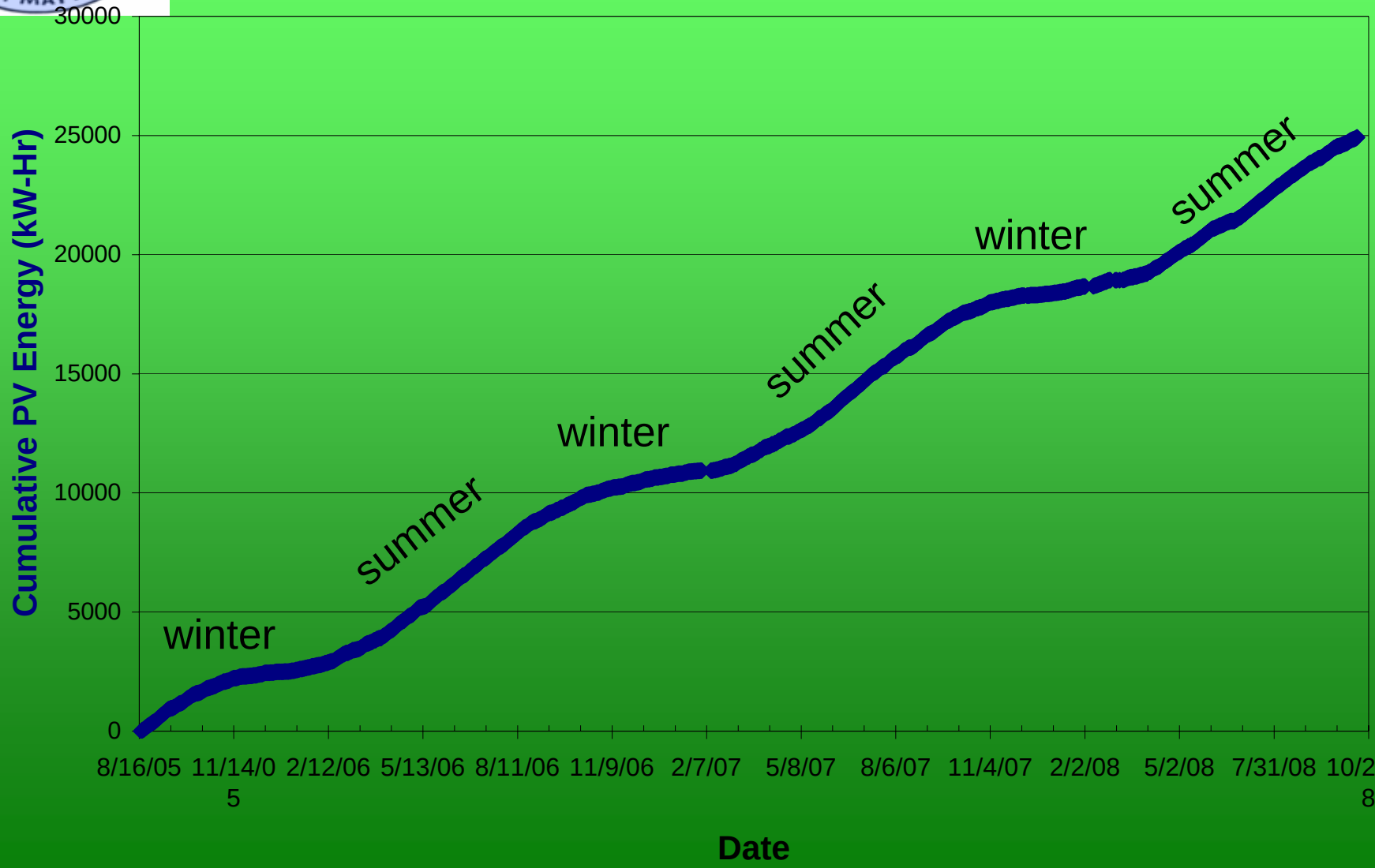
Details of the Sylvania rooftop PV array

- The sanctuary roof faces due south at a 3.5/12 pitch (16 degrees above horizontal)
- The array consists of 126 panels with a thin-film semiconductor coating on glass
- The panels were manufactured in Perrysburg, OH, by First Solar, LLC
- The panels were mounted on rails that were attached to the stainless steel standing seam roofing which replaced the original gravel/tar/composite roof
- System installation was done by Advanced DG of Maumee, OH
- Each 2 ft x 4 ft panel produces about 60 volts and 1 amp at full, direct sun
- The panels are grouped into 21 strings of six panels each wired in series to produce about 360 V and 1 amp or 360 watts.
- There are three inverters (the red boxes mounted on the east side of the sanctuary gable) each of which accepts the dc power from 7 strings (~7 amps) and converts it to 220 V_{ac} (alternating current) which ties into the church's main power panel in the boiler room.
- If the church is not using all of the solar power it feeds out into the Toledo Edison distribution line and the church is credited for the full retail cost (net metering).
- Normally, all the PV electricity is used by church activities.

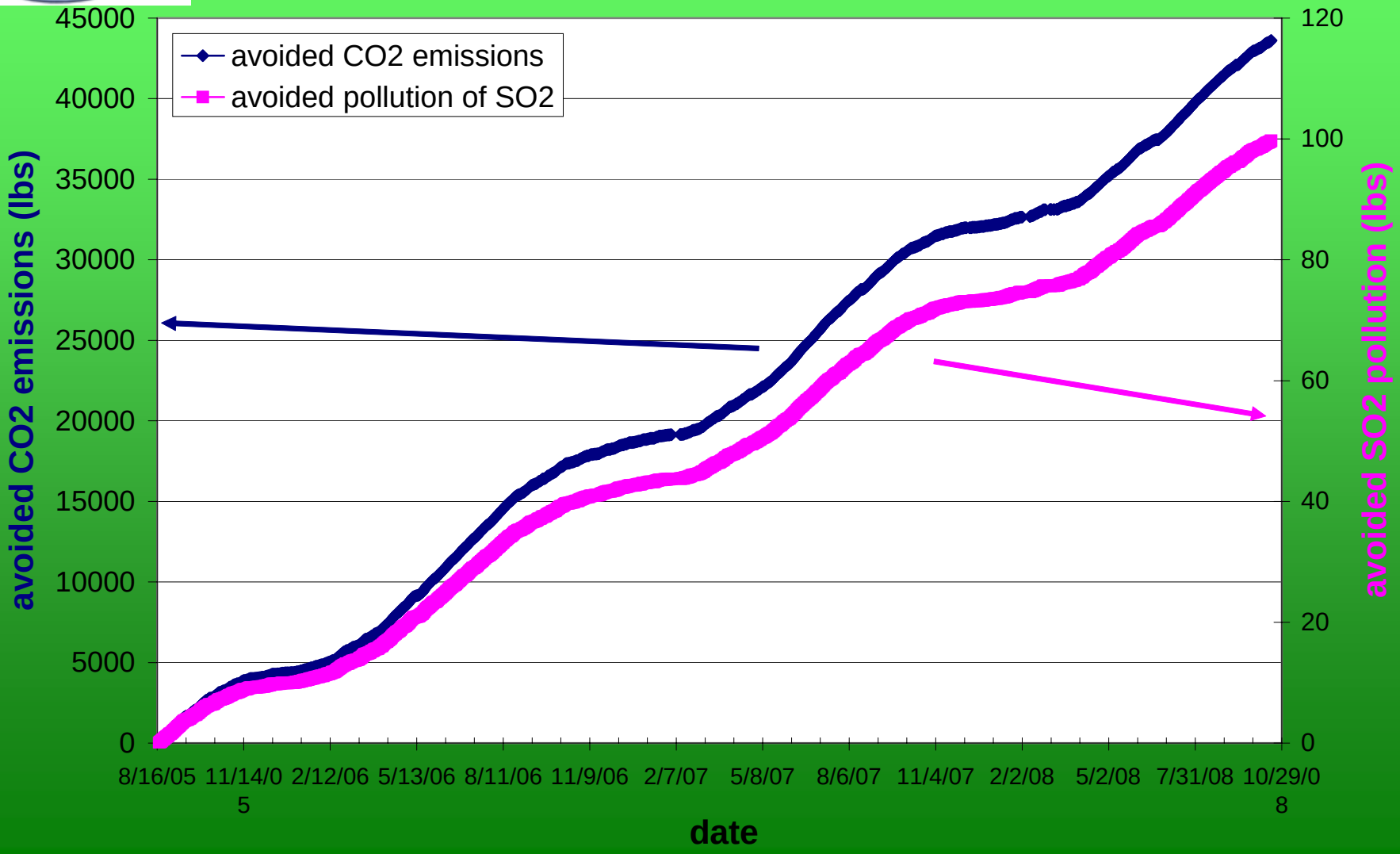
Monthly production is much higher in the summer!



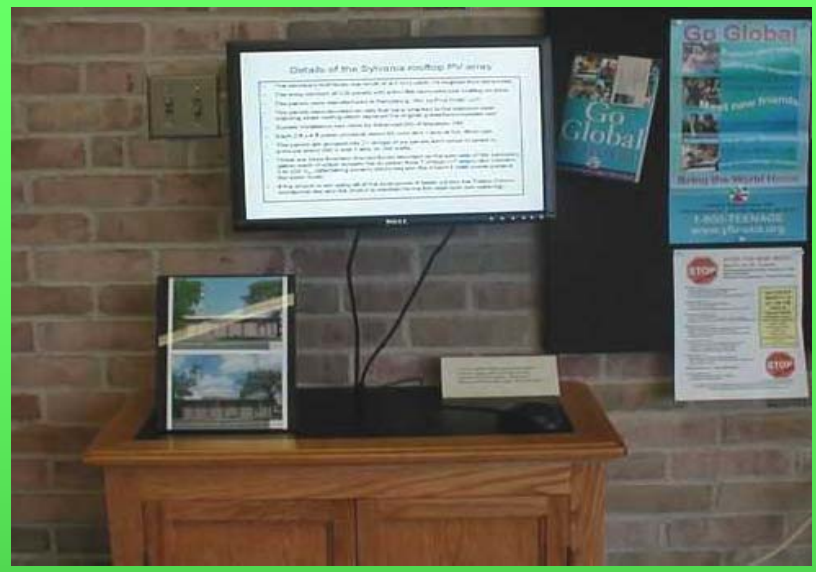
Adding up each day gives us the cumulative electrical energy produced since the PV array was installed on 8/18/05



The PV array reduces our usage of electricity generated from coal, natural gas and nuclear power plants and therefore we have avoided emissions of CO_2 and SO_2 equal to:



Real-time data on the Sylvania UCC PV array is always available through the web:



PV Information kiosk in the gathering area

http://astro1.panet.utoledo.edu/~solar/s1.html

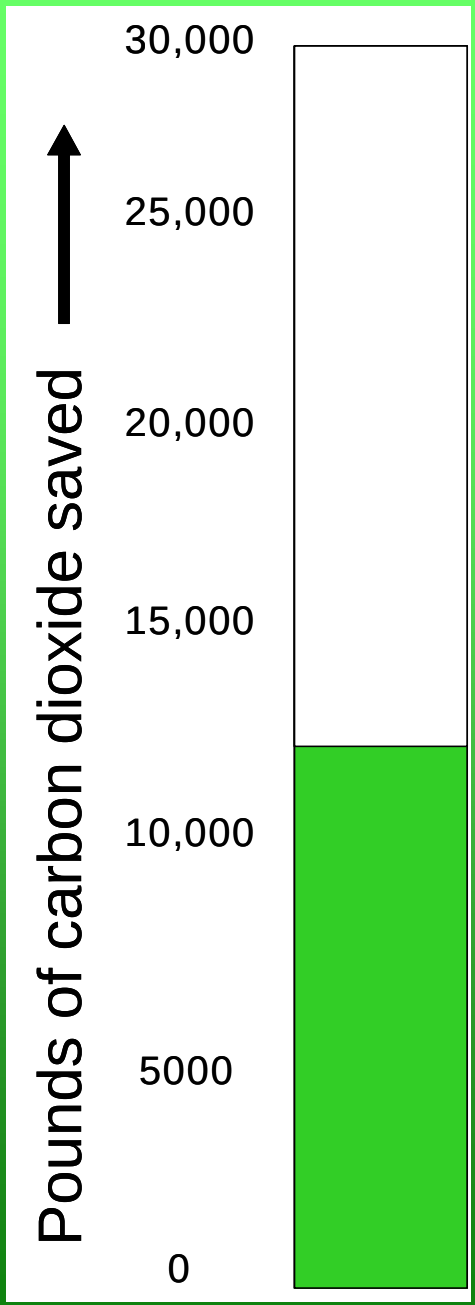
Benefit analysis for first 36 months of operation:

Cost savings for present and future generations of church members was an important consideration, but the primary factor motivating this faith community was environmental stewardship.

- 24,000 kW-hr of electricity generated @$0.125/kW-hr = $3000 (avoided charges)
- 45,800 lbs of avoided CO2 emissions, the most important greenhouse gas
- 388 lbs of avoided SO2 emissions, that cause acid rain
- 95 lbs of avoided NOx emissions that cause smog
- 684 mg of Hg emissions, as strong neurotoxin, from coal smokestacks
- several lbs of particulates smaller than 10 microns that aggravate/cause asthma

carbon dioxide emissions saved each year by Sylvania UCC members using compact fluorescents (CFLs)

Display in the “gathering area” comparing tungsten and CFL lighting



A Christmas lighting suggestion from the Sylvania UCC Green Team...
Use solid state LED lights instead of mini incandescents!

On the table is a meter that will let you compare the current from these two strings of lights.

1. **the string of 100 mini's draws a current of ~370 mA (milliamperes) or an electrical power of**

   Power = current x voltage

   = 0.37 A x 120 V = 44.4 Watts

2. **the string of 35 LEDs draws a current of ~16 mA (milliamperes).**

   100 LEDs would draw a current of 45 mA or an electrical power of

   Power = current x voltage

   = 0.045 A x 120 V = 5.4 Watts

What does this mean in terms of your electrical bill?

If you have 10 strings of 100 lights and you keep them lit for 6 hours per day for 60 days…

10 strings of minis: 444 W x 360 hrs = 160 kW-hr

10 strings of LEDs: 54 W x 360 hrs = 19.4 kW-hr

And your cost, at First Energy's rate of $0.12/kW-hr…

10 strings of minis: $19.20

10 strings of LEDs: $2.33

Bonus: the LEDs will probably never burn out!

The PV project has helped raise environmental and social consciousness

The PV project stimulated the formation of a “Green Team” that continues to lead the church on environmental issues. These have included:

1. informing members of the advantages of compact fluorescent light bulbs and challenging them to make replacements;
    - in three months members have reported that more than 300 incandescents have been replaced with CFLs. We estimate this will save each year about:
        - 44,000 lbs of CO_2 emissions
        - $3000 by church members;
2. working with the Board of Trustees to replace major windows with energy efficient, low emissivity, argon-filled windows;
3. beginning a project to “eat local” to help reduce carbon emissions;
4. challenging and assisting church and community members to recycle old computers, cell phones and other electronics.