

FUUSA's Solar Power System

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1 Introduction

On February 1, 2013, the First Unitarian Universalist Society of Albany, New York (FUUSA) became a solar power generation site. A system whose main components are 112 solar photovoltaic panels installed on roof tops of two FUUSA buildings and two inverters installed in a building basement became operational on that date. The inverter components convert the direct current (DC) power produced by the panels to alternating current (AC) compatible with existing building lighting, air conditioning, and other electricity uses. Peak instantaneous power generation of the system is 25,000 watts, or 25 kilowatts (kW), and projected energy production is about 28,433 kilowatt hours (kWh) per year, which is about 40% of the electrical energy typically used by FUUSA during the year.

The solar system is owned and operated by New York Light Energy (NYLE), a private company that has installed and maintains solar systems for many businesses in the Albany area but had not previously worked with any church or other nonprofit institution. NYLE sells generated power to FUUSA, acting much as a (mini) electrical utility company. The contract between FUUSA and NYLE, called a Power Purchase Agreement (PPA), required essentially zero initial investment by FUUSA, and is expected to save FUUSA roughly \$40,000 over the 20 year contract term. Since the solar system only generates power when the sun is shining and has no batteries or other electrical storage capability, FUUSA continues to receive power from “the grid”—in this case via local utility company National Grid—whenever the solar system is not meeting needs. At times when the solar system is producing more power than needed, the excess flows into the grid, “spinning the meter backwards,” resulting in a credit with National Grid.¹

In this report we describe the process by which FUUSA sought and obtained solar power. In a number of ways, the process differed from what ordinarily happens with a residential or business installation, due partly to our status as a tax-exempt organization but also to our church’s strong commitment to environmental and social responsibility. The main aspects of these differences, such as the use of a Power Purchase Agreement rather than buying or leasing the system, and our concern with externalities such as the environmental impact of solar panel production, are discussed in more detail in the following sections, so that other churches interested in going solar might enter into the process with more upfront knowledge than we had.

An important qualifier is that some influences on the process that another church might go through are dependent on state law, so that any church outside of New York State intending to go solar should be aware that both state agency based incentives and certain legal restrictions might be different.

We recognize in hindsight that we could have done some things differently, so in a final section we discuss some “lessons learned.” An appendix describes the system in more detail and documents our experience with it during the more than one year since it was installed.

2 Why a Power Purchase Agreement?

The first question is, why didn’t we just purchase a system outright from one of the many solar vendors? The short answer is that we would not have been able to take advantage of one of the main government incentives for going solar, a federal tax credit.

¹In effect, the excess power generated is credited at the utility’s retail rate, as required by New York State regulations. In other states, the rate at which credit is received might be less, such as the wholesale rate the local utility pays other utilities it imports electricity from. Then the savings to the customer could be substantially reduced.

There are various incentives for adopting solar power that vary over time and place, but the ones that were in force in New York State in 2012, when FUUSA began to give serious consideration to the possibility, were:

- A federal tax credit of 30% of the cost of a solar system. This is still in effect, at least until December 31, 2016.
- A state-sponsored rebate program, administered by New York State Energy Research and Development Authority (NYSERDA), offering at the time a rebate of \$1.50 per watt of installed power. The rebate amount has been on a historically downward trend, corresponding to decreasing actual cost of solar panels.

Although the rebate program is available regardless of tax status, the federal tax credit obviously is not: if an organization pays no taxes, a tax credit does it no good. Not being able to take advantage of the tax credit would mean that a church would be paying a significantly higher cost per kilowatt than a residential or business customer.²

On the other hand, we began hearing of alternative ways to structure an agreement to install solar that would make the federal tax incentive still available to one or more parties to the agreement, who could then pass on the savings to the church. The main alternative considered, and ultimately adopted, is called a Power Purchase Agreement (PPA), under which, as already mentioned, a company owns and maintains the equipment and sells the generated power to the church, with the church still getting some power from the local utility. There were other possibilities, but before describing them, let's first look at how the PPA that FUUSA eventually entered into works financially:

2.1 FUUSA's financial perspective

FUUSA's upfront expenses were essentially \$0. Its ongoing costs are essentially just for the solar-generated kilowatt hours, at a favorable rate compared to the local utility's rate (and likely to become even more favorable as the local utility's rate likely increases in coming years). How is this possible? Let's also look at the other side of the agreement.

2.2 The vendor's financial perspective

The vendor has the following initial and ongoing expenses: cost of panels, inverters, wiring and other equipment; installation; maintenance and monitoring; and company overhead.

Its income from the agreement is also composed of several parts: federal tax credit; accelerated depreciation (a tax deduction, usually taken over several years); NY State rebate (NYSERDA); and ongoing billing for solar energy generated, based on the number of kWh, billed monthly.

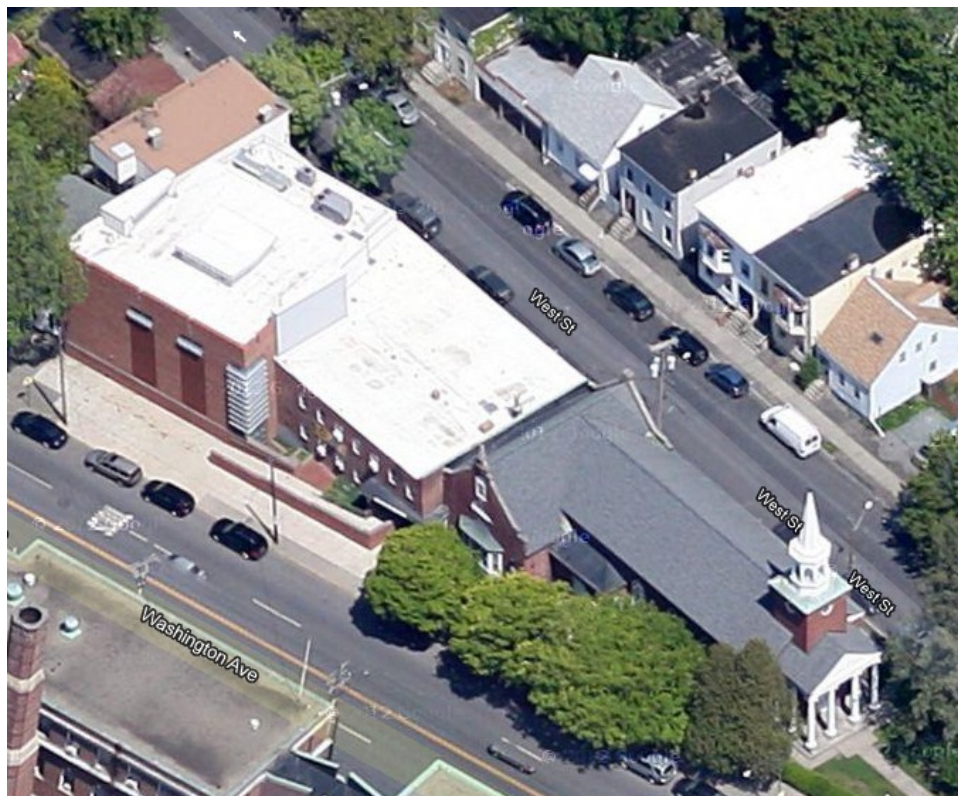
Assuming the company has a large enough federal tax bill, it can take full advantage of the 30% federal tax credit, and, as a business, can also use accelerated depreciation (a deduction not available in the case of residential solar installations). The state rebate is also fully available, assuming NYSERDA approves the submitted paperwork and inspections. From the company's perspective a solar PPA is like any other business deal: it just has to try to ensure that income exceeds expenses, producing a profit.

In our case, the company that supplied the solar equipment and installed it and the company offering the PPA were the same (NYLE), but that was not necessarily the case. We'll see more on the possibility of dealing with separate companies, among other alternatives, in the next section.

²The structure of the incentive as a tax credit can also limit the savings for many private individuals who want to buy a solar power system but do not have a large enough tax bill to fully use the credit.

3 Exploring the possibilities

Solar power has been an ongoing interest of FUUSA's Green Sanctuary Committee (GSC). Several members of the committee have solar photovoltaic systems installed on their home roofs, some for as long as ten years. They have actively promoted home solar to other church members and people in the community, including holding forums held at the church but open to the community. In the spring of 2012, a Solar Subcommittee of the GSC was formed, with the goal of exploring how FUUSA itself could become a solar generation site. (The authors of this report volunteered to co-chair the subcommittee, and there were five other active members.)



Aerial view of FUUSA's buildings. The solar panels would eventually be installed on the two light colored roofs.

3.1 Initial explorations

Recognizing that one of the main problems would be finding a way to realize the federal tax credit, we started looking at various possibilities and interviewing several companies. Early on, two possibilities for structuring a contract seemed appealing but were subsequently abandoned:

1. Several individuals (probably all church members but not necessarily) could form a Limited Liability Company (LLC) and invest in its shares to each become part owners of a solar system that the LLC would purchase and install for the church. The LLC share holders could then apply the federal tax credit to their own individual tax bills. Additionally they would receive payments from the church for the power generated, thus making a small (a few percent) return on their investment, and the church would benefit financially if the rate the LLC charged for power were less than the local utility's rate. Essentially, the LLC would be the company that entered into a Power Purchase Agreement with the church.

2. Leasing a solar system instead of buying it seemed to be a possibility, until we found out that the IRS would treat a lease as being essentially the same as purchase and therefore would disallow the tax credit. (There are exceptions to this rule, which did come into play with a lease deal that we later considered.)

Earlier in the year we had heard that a church in Maryland had successfully pulled off the LLC approach, and we had made contact with some of the persons involved there to get more details. After talking to them, and discussions among ourselves, we decided not to try to go that route, principally because we learned that legal costs for setting up the LLC might be high (perhaps \$10,000 - \$20,000). Even though the Maryland church members generously provided copies of their legal documents and PPA to use as templates, we were concerned that differences in state laws governing LLC formation might still result in large legal bills. After spending a bit of time searching in vain for another church in New York State where such a solar LLC had been formed, we abandoned that approach.

3.2 Vendor interviews

The first interview we held was with representatives of two separate companies working together, call them A and B, A being a vendor of solar systems and B an already existing LLC that offered to enter into a PPA with FUUSA, purchasing the solar equipment from A and paying A to install and maintain it, then charging FUUSA for the power generated. (Company B's representative strongly advised against the idea of FUUSA members forming their own LLC, citing legal costs and other complications.)

The next interview was with a company, call it C, that impressed us with the thoroughness of its proposal for the actual equipment and installation plans, based on a site visit and measurements taken on our building roofs. But on the financial side, company C did not offer a PPA, and its only suggestion for realizing a tax benefit was for individuals to donate money toward the purchase price and take a charitable deduction on their personal income taxes.

We next met with another company, call it D, which offered a Power Purchase Agreement. Confusingly, company D also referred to its agreement as a lease, which seemed to rule it out from any benefit of the tax credit. But we learned that, in fact, a lease agreement would be possible if the company had acquired a portion (it only had to be 5%) of the panels involved under a previous federal grant program (that had since expired for new purchases). Company D qualified on this count, as did another company that we interviewed, E, which structured the contract it offered strictly as a lease agreement.

We also made contact with three other companies, but negotiations with them did not go any further, in most cases because the size of the available roof space would limit the solar system to too small a size for their business model.

Unfortunately, none of the companies other than C made actual measurements of our roof at the time of the initial interviews. Seeking to minimize their pre-contract costs, they sought to estimate system size and layout based only on satellite photos and rough guesses about obstacles that might limit roof space. We come back to this issue, and why it was unfortunate, in the "lessons learned" section.

At this point we had four contenders for the contract, A+B, C, D, and E, and we began the selection process described in the next section. Along the way we revived contact with NYLE, with which we had had very preliminary negotiations in the previous year but had been unimpressed with the size of the system they had estimated they could install, 25 kW. We were now setting our sites on a significantly larger system, since company C's proposal, based on a site visit and actual

measurements, was for a 39 kW system, and the other companies were even talking of a 50 kW system, although not based on a thorough site visit. As it turned out, all of the higher estimates were irrelevant: we wound up only being able to install a 25 kW system after all. But we did not learn of this restriction, and the reason for it, until we were fairly deep into the selection process described next.

4 Selection process

4.1 Complications

Selecting a “winner” was complicated by the unique aspects of each of the five proposals:

- Company C required a large initial outlay by the church.
- The PPA’s offered differed in how they proposed to charge for generated power:
 - Company B would start at a rate below National Grid’s current rate and increase its rate each year according to a table given in the contract, independently of National Grid increases. (The table was puzzlingly irregular in its rate increases but they averaged about 2.85% of the initial rate.)
 - NYLE would also start at a rate below National Grid’s current rate (\$0.06/kWh versus National Grid’s approximately \$0.12/kWh) and increase its rate each year, but according to a simple formula (2.5% of the initial rate [check this])
 - Company D would charge at a rate that was always 25% below National Grid’s rate, adjusted annually.
- Company E’s lease agreement was significantly different in a number of respects from the PPAs, one of the most important being that maintenance would be a responsibility of the church.

Nevertheless, there were several things in common among the proposed contracts:

- No upfront cost to the church, except in the case of company C.
- 20 year term.
- No end-of-term obligation to buy the equipment (though it took several rounds of negotiations with some of the companies to clarify this point).
- Except for company E, maintenance was the responsibility of the company.

4.2 Toward objectivity

The complications in pricing of the generated power presented one problem in evaluating the different proposals, but there were other aspects that we decided we also needed to examine carefully, and as objectively as possible. We came up with a set of selection criteria, which fell in three categories: company viability, externalities, and financial.

4.2.1 Viability

The criteria we considered important in this category were the impression the company made during its interview, thoroughness of the proposed contract, references, and estimated time to completion. We gave the highest weights to impression and contract thoroughness, perhaps because these were the criteria on which we could see the most significant differences. Company D's contract, for example, while briefer than the others, was relatively less precise in its terms and, as previously mentioned, confusingly described itself both as a PPA and as a lease.

4.2.2 Externalities

The criteria in this category were labor impact and environmental impact of equipment production. By labor impact, we mean the pay and treatment of (non-local, usually foreign) workers involved in production of the solar panels and other equipment and of the local workers who would deliver and install the equipment at our site.

The environmental concern was whether production of the panels and other the equipment might have an even more detrimental impact on the environment than continuing to get electricity from burning fossil fuels. We would have preferred that the equipment be manufactured in the U.S., so that U.S. labor standards would apply, with a greater likelihood also that stricter environmental policies would be observed than were reputed to prevail in China, for example. While one of the companies claimed that its panel source was based in North America, that apparently meant mainly in Mexico, and even then it wasn't clear that none of its panels came from China. We were largely frustrated in attempting to get clear answers from some of the companies about their equipment sources or the labor practices of the companies they dealt with. (NYLE, whom we ultimately went with, uses panels manufactured by Kyocera, a Japanese company.)

As for local labor practices, it was also difficult to distinguish among the companies; for example, none used union labor. We thus wound up assigning lower weights to the externality criteria than we would have liked, to avoid giving too much weight where there was so much uncertainty.

From independent reports we found online, it appears that the energy needed to produce a solar panel is significant: it requires about two years of the panel's energy production to offset it. But given that the life of the panels should be 25 years or so, this seems reasonable enough, especially in comparison to the high energy input that is required for extracting fossil fuels from increasingly difficult sources such as tar sands.

4.2.3 Financial

In this category, we included minimal outlay by the church; maximizing the size of the system so that we could fulfill as much of our electricity needs from solar as possible; avoiding future commitment (buyback); and maintenance and warranty. In fact, all of the companies other than company C required essentially \$0 initial outlay. To analyze outlay for purchase of generated power and future buyback cost under various assumptions about system size, the local utility's future rate increases, and other factors, we developed a spreadsheet that modeled for each company the annual outlay over the 20 year contract term, plus 5 more years assuming we would buy the system at the end and keep it in operation. (Production from solar panels degrades over time, typically about 0.8% per year, so that after 25 years they are only producing about 80% of their original rated output. We included this factor in the model.)

The main conclusion from experimenting with various input assumptions in the spreadsheet was that there was no great difference in outcome—with any of the companies’ installations we would realize significant savings versus continuing to draw all of our electricity from the local utility, unless the utility substantially reduced its own rate, and that seemed highly unlikely. (With Company D, which would charge at a rate that was always 25% below the local utility’s rate, we would have realized a savings even then. But if the local utility’s rate went up enough, we might have wound up paying significantly more with Company D than with the companies whose rates rose independently of the local utility.) The spreadsheet is available upon request.

4.3 System size—a crucial factor

The companies we interviewed had different estimates about how large a system our roofs could accommodate, which with all but company C were based only on satellite photos and did not accurately take into account obstacles on the roof that would prevent maximal use of the space. Other factors contributing to maximum system power output include the size and shape of the individual panels; each panel’s maximum power output, which varies from one manufacturer to another; and how the panels could be mounted to optimize the angle to the sun. The companies’ initial estimates are shown in the following table:

A+B	50 kW
C	39 kW
D	50 kW
E	50 kW
NYLE	25 kW

The companies, like us, would have preferred to install as large a system as physically possible, but as it turned out, after we insisted on companies coming back and doing actual measurements on our roofs, the 50 kW size was unachievable.

But company D’s measurements projected we could have a 32 kW system and the 39 kW size company C had projected still seemed physically possible, so how did we wind up with a system that is only 25 kW? The answer is given in the next section, Final Selection, because it was that late in the game when we learned of a limitation that would apply to power being supplied to a church.

4.4 Final selection

We eliminated company C because of the large initial outlay to buy the system and company E (the one with the lease agreement) because it would have put too much future responsibility on the church for maintenance and other problems that might occur. The A+B partnership dropped out of consideration because its initial estimate of a 50 kW system turned out to be infeasible after taking a closer look at our roofs in an on-site inspection, and they decided that a smaller system would not fit their business model.

We were still left with two contenders, company D and NYLE. Based on most of our selection criteria, we felt that we could go with either one, but a deadline was approaching that company D faced for using panels it had purchased under a federal grant. Since we had been dealing with company D for a longer time than with NYLE, we gave it the go-ahead to submit paperwork to the federal and state authorities, for a 32 kW system.

Nevertheless, we continued to talk with NYLE, and they shortly afterward informed us that we should not have a system larger than 25 kW.

The reason for that limit has more to do with New York State regulations and local utility billing policies than with physics, so readers in other states should not be too concerned with the details that follow (but would need to find out what the corresponding limitations, if any, might be in their own state and with their own local utility).

As a simplification, utilities in New York can charge for the electric energy they deliver in two main ways:

- A residential rate, which is based mainly on the total number of kWh used in a billing period (usually a month). For example, if 1000 kWh is used and the per kWh charge is \$0.12, the charge would be \$120 (with a fixed monthly base charge added).
- A commercial rate, also called a demand rate, based on the maximum demand, i.e., peak instantaneous power (or actually, a peak that is sustained over at least a 15-minute period) that occurs during the billing period. For example, if the peak demand is 50 kW, and the per kW demand charge is \$8, the charge would be \$400. There is also a charge for total kWh used, and although it is at a lower rate than for residences, the total bill for electricity can be much higher than for a typical residence.

The demand rate is used for most businesses because their power needs are usually highly variable, causing the utility the extra expense of building large enough power plants to accommodate the peaks.

New York regulations allow churches (and farms) to operate under either a residential or a commercial rate, but if their peak demand exceeds 25 kW on a regular basis, they must be switched to a commercial rate.

FUUSA has always operated under a residential rate, but NYLE informed us that if we installed a system capable of producing more than 25 kW, we would almost certainly be bumped into a commercial rate and would wind up paying much more for electricity than if we just continued without solar power.

We confirmed that this would be the case by speaking with contacts at NYSERDA. Company D, which had been previously unaware of the size restriction, also acknowledged the problem, and agreed not to pursue a contract with us any further.

5 Finalizing the contract and installing the system

On November 15, 2012, the church's Board of Trustees approved contracting with NYLE, subject to revision of some terms of the proposed contract. There ensued several rounds of clarification and modification of contract terms, resulting in the final contract signed by the church president on November 28.

After submitting and obtaining approval of the required paperwork with federal and New York State authorities in December, NYLE installed the system in January, 2013. On February 1, 2013 it was turned on and began producing solar power. Appendix A.3 describes the performance of the system in the first year of operation.

6 Lessons learned: what could we have done differently?

Looking back on our experience, there are several things that we believe we could have done differently to make the exploration and selection process go more smoothly.

- Early on, visit other local churches that have solar photovoltaic systems. We did visit other solar installations in our area to check on the experience customers had with the contracting process and with the operating systems, but only near the end of our selection process did we learn that a couple of local churches had installed solar systems. We visited them and were assured that they were happy with the experience with their vendor (company D), but otherwise we did not learn much that we had not already gleaned from our earlier explorations. (Both were larger churches that had already been under a commercial rate before going solar, so that issue did not affect them.)
- Press vendors to start with site inspections and present detailed system specifications. In our case, this would have eliminated some companies earlier and simplified some of the analysis we carried out toward maximizing the size of our system. We might even have learned earlier of the limitation to 25 kW, and the reasons behind it.
- Learn about government regulations and local utility policies that might limit the range of options for solar power. In our case, no single solar vendor that entered into negotiations with us had complete understanding of these matters, having previously dealt mainly, if not entirely, with commercial or residential customers.

We hope that this report of our experience with obtaining solar power for our church will encourage and help other churches adopt this environmentally beneficial, and at the same time, cost-saving technology.

Acknowledgments: We would like to thank all the other members of the Solar Subcommittee for their diligence and wise council throughout this project: Chris Bystroff, Kathy Harris, Chuck Manning, Dave Metz, and Reese Satin. We also thank the representatives of New York Light Energy, especially Alex Lieb and Mark Richardson, as well as the representatives of all the other, unnamed companies we interviewed, for their professionalism in responding to our many questions and requests.

A Appendix: System description and first year experience

A.1 System design and mounting

The FUUSA solar electric installation is rated at 25,000 watts (25 kW) peak power and at contract time was projected to produce about 28,433 kWh of electrical energy per year. It is comprised of the following key components:

- 112 Kyocera KD245GX-LFB Solar modules
- 2 Fronius IG Plus V Inverters
- Draker Lab Monitoring System

The design of the system is shown in Figure 1. The panels are positioned on two of the church's flat roofs using a ballasted system. These mounting systems rely on weight or ballast to anchor the panels to the roof. No holes needed to be made in the roof. They can also be easily oriented to the sun, and can be repositioned if work needs to be done on the roof in the future. Figure 2 is a depiction of a ballast system for one panel, and Figure 3 shows all of the panels on one of our building roofs.

Before installation, an engineering design review was done to ensure that the structure would support the additional load. This is critical to do on any installation of a solar system. The analysis accounts for snow loads, wind loads, type of framing, age of building, present condition, and solar attachment method.

A.2 Monitoring, maintenance, and code compliance

Monitoring is the essential operational activity. It enables the vendor and owner to see the power output of the solar system. This would most likely be the first place to notice a problem. That is because problems will almost always result in noticeably reduced power output. In the contract, be absolutely clear whose responsibility it is to monitor the production output of the system. For FUUSA, the responsibility belongs to NYLE as the system owner.

Compliance with locally adapted National Electric Code (NEC) regulations is also important to mitigate safety risks like fire and storm damage. For example, for FUUSA labels *must* clearly identify solar PV system components. DC conduit must be labeled every 10 feet, and disconnects must be labeled using reflective labels.

Solar systems must provide for access for:

- Building Maintenance
- PV System Maintenance
- Component Replacement
- Emergency Personnel

Things to look for in a system design include:

- Component Access
- Trouble Spots
 - Ice Damming
 - Debris Collection
 - Mechanical Attachment Placement

Snow removal is not recommended, but rather let the snow melt off the panels. This generally happens more quickly than on other objects, because the solar panels have a large surface area of black color, which absorbs heat and results in the snow melting off, except in cases of deep snow and extended periods of below freezing temperatures.

A.3 Performance in the first year

NYLE predicted that the solar system would produce 28,433 kWh in the first year, from February 1, 2013 to January 31, 2014. The company charged based on its predicted output times the initial contract rate of \$0.06/kWh, or \$1,706 (divided into 12 fixed monthly payments of \$142.17).

The actual production was 25,065 kWh, about 88% of the predicted amount.³ The largest shortfalls from predicted output occurred in the months of February, March, and December 2013

³NYLE guarantees at least 90% of the predicted output, so in this case it must rebate the approximately 2% difference. If production ever exceeds the predicted output, there is no additional charge.

and January 2014, when there was above average snowfall and some long stretches of below freezing temperatures, which probably did leave panels snow-covered for extended periods. (There was no period in which production stopped entirely, as could happen if there was a system malfunction.)

The cost of electricity from the grid during the year remained essentially constant at \$0.13/kWh, so the power produced by the solar system avoided a cost of $25,065 \text{ kWh} \times \$0.13/\text{kWh} = \$3,308$, for a net savings to the church of $\$3,308 - \$1,706 = \$1,602$.

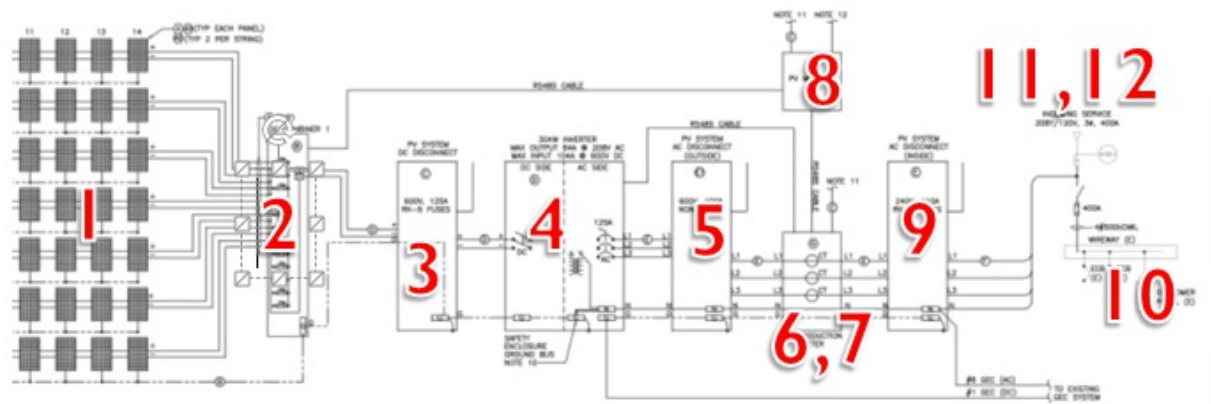
The CO₂-free production of 25,065 kWh of power from solar saved over 33,000 pounds of CO₂ from being emitted into the atmosphere.

A.4 New data on environmental impact of solar panel production

Since FUUSA's Green Sanctuary Committee considered this decision, we have found another information source relevant to the socio-economic and environmental impacts of solar panel production. All panels are not made the same, with the same toxic materials. Some vendors even have a program to recycle their own panels. Guidance in evaluating panels that have a higher environmental/socio-economic rating is available in *2013 SOLAR SCORECARD*, available online at <http://www.solarscorecard.com/2013/2013-SVTC-Solar-Scorecard.pdf>. See Figure 4 for a sample of the ratings from this study.

Given the changing technology, varying local regulations, and unique sources that each solar vendor maintains, it is unlikely that another church will install the exact same system that FUUSA has. However, we hope that our experience and lessons learned contribute to well-informed future solar decisions for churches and other non-profits. Please feel free to contact us if you have additional questions.

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Legend:

1. Panels
2. Combiner Box
3. DC Disconnect
4. Inverter
5. AC Disconnect
6. Production meter
7. Current Transformers
8. Monitoring system
9. AC Disconnect
10. Main service panel
11. Customer meter (“Net Meter”)
12. Utility service

Figure 1: Design of the Solar System at FUUSA

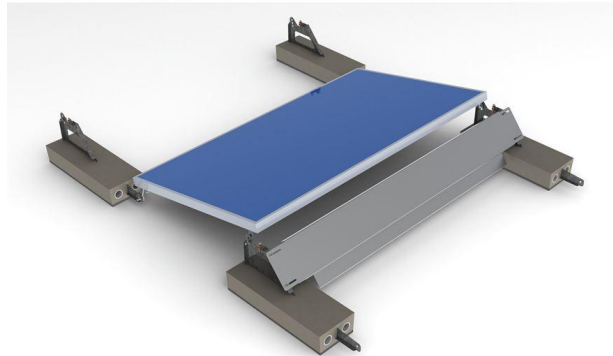


Figure 2: Ballast System for Each Panel



Figure 3: Panels Installed on Our Roof

	EPR	Emissions Transparency	Chemical Reduction Plan	Worker Rights, Health, Safety	Supply Chains	Conflict Minerals	Module Toxicity	C2C Recycling	Prison Labor	Biodiversity	Water	Energy & GHGs	Overall Score
MAXIMUM SCORE	20	10	5	15	10	5	10	5	5	5	5	5	100
Trina	14	5	5	15	7	3	10	4	5	2	3	4	77
Yingli	9	4	5	14	8	3	10	4	5	5	3	5	75
SunPower	7	6	5	14	7	3	10	4	5	3	2	4	69
Upsolar	14	4	0	13	8	3	10	2	3	5	0	4	66
SolarWorld	9	10	5	14	7	0	0	3	5	0	5	5	64

Figure 4: Sample Panel Ratings