Sunshine Acres Children’s Home: Solar Planning and Monitoring

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ABSTRACT

In 2008, Sunshine Acres Children’s Home (SA), a 110 acre ranch with approximately 40 buildings and fostering about 70 displaced children, embarked to go net zero in 10 years while rapidly expanding their infrastructure in order to eventually accommodate up to 210 kids. This paper documents the history of the completed solar installations, the current options for completing the ten year mission, and future opportunities for research and development.

INDEX TERMS

Sunshine Acres, Net Zero, Utility Purchase Agreements, Monitoring

INTRODUCTION

Sunshine Acres Children’s Home (SA) is a unique Christian based institution in that it accepts no federal funding and is solely a product of the SA boutique and private donations. SA opened the remote ranch in 1954 and since then has seen the City of Mesa move in and around it like a rising tide in the last several decades. With the development of the city around it, Sunshine Acres has had to learn to adapt in this new physical landscape and function more intelligently to stay true to its family orientated mission of being a safe and positive place for children in need of a stable home.

It was in 2008 that SA developed a master plan that would enable them to grow their infrastructure of about 40 buildings accommodating about 70 children to approximately 68 buildings that could eventually house up to 210 kids. While focusing the goal to undertake this massive expansion, SA made the decision to do it sustainably by reaching net zero status within ten years.

Since then, four different solar systems have been implemented alongside the development of several expansion projects on the 110 acre ranch. Today SA is a about a third of the way to its goal with four solar systems totaling 342kW with more donated modules on the sidelines waiting to be installed. The purpose of this paper is to first focus on the challenges and the achievements of the solar systems in place. Second, the process SA is using to plan the future solar installations through negotiations involving the utility, city, and the community. Lastly, it will highlight the ever expanding future opportunities for research and development.

MASTER PLAN

In 2008, SA evolved from a growth derived from sporadic donations into one that followed a strategic mission expanding smarter within its now designated borders. Every step that SA will take must keep its rural ranch and family feel, believing that the history of the property is just as important as its future. When the idea of going solar was brought up in front of the board of directors, Joe Woods, a local developer on the board, was able to step up and ran with idea.

With implementing such a new technology come countless ways to install it and things quickly got complicated. For a non-profit like SA, there are a myriad of opportunities that range from a power purchase agreements (PPA) to outright grants. The incentives that enable solar affordability require complex analysis of the tax code, finance models, and engineering. All of which were skills outside of the management in place.
SA learned long ago that the key to its success was to leverage its community network and in 2009 it was able to bring together a solar board of advisors who would be able to make the right decisions for how to get the job done and discern “haphazard” from “smart” growth. On this board are Dr. Chuck Backus, Milt Laflen, Dr. David Scheatzle, Garry Paulus, and Rudy Campell.

**Energy Audit:**

With the move to go solar, it is important to understand the energy needs of the building that it is being net metered. One of the primary tasks of this committee was to conduct an energy audit of the campus. The purpose was to reduce the potential wasted energy of the different buildings. A sub-committee was formed in 2011 and it was found that SA could reduce their energy usage by about 20%. Measures that the sub-committee recommended were installing fluorescent or LED lighting, double pane window upgrades, shading, increased insulation, and thermostat adjustments of buildings throughout the campus. Most recommendations were well received and SA is currently in the process of making these improvements and implementing energy saving methods into future growth as well.

**Dining Hall Installation:**

The first order of business for the solar board was to weigh the different options and make a first step. As the dining hall was the biggest energy user on the campus it was deemed the first building of focus for the board. In 2009 the board was reviewing two options. The first option was a power purchase agreement, where SA would allow an outside company to install, own, and maintain a solar system on the dining hall and SA would buy the power that was cheaper than their current utility, The Salt River Project (SRP), could provide it. The second option was receiving an installed solar system through an SRP program called the EarthWise Solar Energy

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**Figure 1. The SA Master Plan developed in 2008**

**INSTALLED SYSTEMS**

This section will outline the history and learning curve of the different installed systems at SA. A spreadsheet in the appendix elaborates on the energy usage and solar installations in place onsite.

**Figure 2. A sketch of the existing solar installations and the buildings that they net meter.**

**Figure 3. Location of the dining hall 10kW installation.**
Incentive Program. This second option was a turnkey 10kW solar system that SA, as owners, would be responsible for in terms of long term maintenance and power production.

In the end the committee decided that ownership of the system would be best and SRP delivered. The 10kW systems came with a weather station and monitoring capabilities, but the monitoring was not accessible in a way SA could utilize. It does store a limited amount of data and can be accessed through a computer with adequate software.

The crux of the system, although beneficial in that SA saves money on all energy produced, is that the energy production of the solar installed on the roof does not meet the demand of a large energy use building, still leaving SA with a rather large electric bill for the building that supplies food for the entire campus. As future energy production methods were explored for the building, there were new challenges associated with providing solar energy to a building that is already net metered.

Office Installation:

Figure 4: Location of the Office 8.2kW installation

The second largest energy user on the campus was the front office. The office installation was the result of a grant received from the Arizona Department of Commerce. The solar committee did not get the grant the first time it applied, it had to be reworded to be approved. The proposal had to be reworked and resubmitted before it was approved in 2010. The grant awarded $50,000 and in coordination $27,000 in SRP incentive funding and $3000 from the SA solar committee the funding enabled the installation of an 8.3kW solar system on the roof of the office and eight solar water heaters. Six of the water heaters were distributed two located on the dining hall and six distributed.

The 8.2kW array net metering the office is also a turnkey system that SA is solely responsible. Just as with the dining hall SRP EarthWise system, the energy produced from the array does not meet the energy needs of the building and energy efficiency solutions are not enough to get them there.

24kW TUV Array Installation:

Figure 5: Location of the 24kW TUV Array

In 2011, the Tempe based solar testing facility TUV Rheinland-PTL (TUV), a joint ASU and TUV Rhienland partnership, donated 150 various modules totaling about 24kW to SA. The modules were a miss match of modules that had gone through the TUV testing procedures. This presented several problems around installation that had to be overcome before they could start producing energy for SA.

First, the tested modules were not UL certified, so therefore could not be installed on top of a building for safety reasons. This left a ground mount array as the only option for installation. Second, SRP will not allow non UL listed module to connect to their grid. The solar committee was able to negotiate a special agreement with SRP that as long the modules were connected to the grid through UL listed equipment before it gets to the grid, they would accept the electricity produced from the array. Also, the mismatched modules had to be configured such that the modules under a certain voltage could be installed using micro inverters, while the remaining high voltage modules were grouped into similar
current outputs and strung together to be inverted by a central inverter.

The array was then net metered to the adjacent chapel and two side buildings that sit in the courtyard. Like the dining hall and the office, they will own all electricity produced but the array will have to be maintained by SA. A monitoring system in place is the best way to ensure that everything is functioning properly to protect this upfront investment. Since the modules were donated, the cost of this system was entirely taken up by the basis of system costs. These costs include the multiple inverter costs (both micro and string), trenching, wire, and electrical components that make the processes work, totaling about $2.00 per watt.

300kW GreenChoice Installation:

Figure 6: The location of the GreenChoice 300kW array.

In 2011, SA decided that a power purchase agreement (PPA) would be the best next step in bringing solar on to the property. The committee went with the company GreenChoice to provide a 300kW array on SA property that would produce enough energy to net meter eight different buildings on campus. SA would purchase the electricity for 10% cheaper than current energy rates and the contract stipulated that this rate would increase at 1% a year for 20 years, while utility rates are estimated to rise at 3% to 4%. SA also has the opportunity to buy the system outright at the five and 20 year mark of the system.

This system net meters eight different buildings as seen in Fig. 2. and this is important because the standing policy of SRP is to not allow more than three independent meters per field array. Because of the goodwill of SA, it was able to skirt this policy and utilize its resources to the fullest. This system has no upfront cost for SA and the savings are immediate. Also, GreenChoice will supply all monitoring and maintenance for the array for the time that they own the system. In the short term the immediate energy savings are ideal, while if they owned the system, the long term savings may have been more beneficial. Without a large donation, SA is not able to make the numbers work to save long term on their electricity consumption since they are a non-profit and cannot harvest the tax incentives that a company like GreenChoice can.

With the policies in place for the utility, a field cannot be net metered independently and must be net metered through a building specifically. This adds great costs trenching and running wires to the buildings that can best harvest the electricity being produced. Also, when a distribution system needs to be produced to net meter the power, large inefficiencies result and energy is lost in the process causing the system that needs to be oversized, adding cost to the process.

MONITORING

Having this access to the systems in place is important for several reasons. First, with any large upfront investment such as solar, if anything goes awry regarding the power production, it is important that the information is available to notify and remedy any unforeseen circumstances. Secondly, as SA is a product of the community, the sustainability message it displays publicly facilitates the mission and branding of the campus, letting the outside world know that their present and future contributions matter and are being utilized to the fullest.

Each installation had a unique set of issues. For one, each system has a different inverter (in some cases two different inverters on the same array) so there were no uniform options to measure all the systems as a whole. There were logistical challenges as well since these solar systems were all installed differently on different areas of the campus by different installers. Finally, the internet connection to the monitors was not always available so creative and cost efficient solutions had to be derived.

Monitoring of the Dining Hall:

Although the system had a complex monitoring system in place, it brought significant complexity to an organization
whose primary mission is helping children. The monitoring system installed by SRP consisted of a Campbell Scientific CR10X unit that is measuring wind speed, irradiance, temperature, and DC voltage and current from the array. The monitoring system would need a dedicated computer, weatherized housing for the computer, and several expensive software purchases that although will get the job done, are outside the realm of affordability in the several thousand dollar range for a project such as this. Also, with such a complicated system come hundreds of points of potential failure. The system has already ceased to operate, requiring experienced PV monitoring expertise that is not typically available to an organization like SA. In the appendix there is a procedure of a potential use of the weather station in the interim before automation process can be implemented. It consists of a computer equipped with LoggerNet, the Campbell Scientific software, which is able to collect the data being stored by the CR10X unit. The data is relatively crude to start and with very minimal massaging I have created a spreadsheet that can be used for educational purposes. For the educational and knowledgeable reasons that a system like this can provide, in the future it will be advantageous to fix and invest in automation adding redundancy to the monitoring of the power and auxiliary information necessary to analyze system performance.

The system utilizes a Fronius inverter and the company has a relatively inexpensive piece of monitoring hardware, the Fronius Datalogger Easy Box, which talks directly to the inverter. Once connected to the internet, the information that the inverter outputs are displayed and recorded on a Fronius sanctioned website, enabling access from anywhere that there is internet access. This piece of equipment connects to a communications card, a piece of hardware physically inside the inverter, which can or cannot come standard. In the case of SA, the inverter does not have this piece of hardware and will need to be purchased and installed in order for the datalogger to be installed.

**Monitoring of the Office:**

The Office utilized an SMA inverter that utilizes a SMA proprietary monitoring system called “Sunny Portal” with a piece of hardware called a “Sunny Webbox.” There is a hardwired and Bluetooth version of the device and both of them need a communications card on the version of the inverter installed at sunshine acres. Newer versions of the SMA inverters come with Bluetooth standard. There was also wireless internet signal near the inverter but as the Sunny Webbox needs to be hardwired to the internet, the easiest and cheapest solution was to run conduit from the inverter and into the dropped ceiling about 20 feet away. From the dropped ceiling location, a wire could be run about 30 more feet into the office service room where the Sunny Webbox could easily reach an Ethernet connection. This solution did require a 50ft wire run, but it avoided building a weather proof box on the exterior of the building and engineering a wireless method to attach the Sunny Webbox to the internet, creating additional cost and introducing new points of failure in the system.

The reason the Bluetooth option was not chosen was for several reasons. First, it was several hundred dollars more expensive and even though the Bluetooth range was registered at 300ft unobstructed, we had to go through a stucco exterior wall, as well as several interior walls, to reach the server room. If this signal was inadequate, there would have been additional costs and engineering that would have gone into finding a solution.

Once the system was online and registered, SA was able to access the inverter information through the Sunny Portal website and from there linked to the sustainability page of the sunshine acres website.

**Monitoring of the 24kW TUV Array:**

Since the TUV array used two different brands of inverter, the monitoring of the entire system would not be as simple as with the office and the dining hall. The easiest solution of just monitoring the inverter now required two different systems and two different web interfaces to monitor the same array. Other challenges include no internet access and a relatively large distance to the net metered building.

With all of the variables in the equation, it was important to realize the immediate need of SA. They need to know if the system is operating, they needed to track production to plan for future energy use and production, and as a product of the community, it is important to get the message of proactive long term investment such as a solar project in a presentable fashion on the website.

The two types of inverters used on the array were the Enphase 215 micro inverter and the Power-One Aurora PVI-6000 inverter. Each system needs to be directly connected to an internet connection and require indoor use or a weatherproof box.

The Enphase system is unique in that it does not connect to the inverter through a hard wire, but plugs into a wall socket of the building being net metered to monitor the health of the
system. Since SA is in the process of bringing internet access to the entire campus in the next several months this system would be a relatively low cost solution that can be installed near the internet modem when it is installed. After consulting with an Enphase representative they informed me that there is a chance that this system may not be able to talk to the inverters if it is too far from the array. If the building is too far from the array and cannot connect, then a plug will need to be wired into the system near the array in a weatherproof box and either trenched Ethernet wire or a wireless internet connection will need to be utilized.

The Power-One Aurora Universal monitoring system can be installed two different ways. The first would be to install the monitor near a hard wired internet connection indoors of the net metered building (assumed to be in the same location as the Enphase Envoy unit adjacent the modem) and have a wire trenched to the inverter. The other option is to install it inside a weatherproof box near the inverter and install power for a wireless internet solution once SA installs a wireless network to link to or purchasing a cell phone internet connection and paying a monthly fee.

It should be noted that the Power-One system does have an output of power production on the inverter that can be read, where the Enphase micro inverters do not. Both systems in an ideal world would be monitored but since the micro inverters do not have a physical output screen, it seemed like an obvious first choice for monitoring as well as potential ease of installation. This monitoring system would meet two of the three needs of SA showing that the system was operational as well as providing an interface that can be used to advertise the progress that SA is making with the solar arrays it has been able to install.

The Enphase Envoy was purchased but is on hold until the system goes live and SA updates the campus with an internet connection with which the system can connect. There may be issues with how far away the unit is from the array but that can only be determined once the system goes live.

The third option that seems outside the realm of reasonable is to build a data acquisition system (DAS) similar to the one located in the dining hall with a CR1000 or similar Campbell Scientific unit that can monitor the information coming off of the array. This option is available but will cost several thousand dollars in components and man hours to fabricate in order to measure the array. Although this system is expensive, if a standard box can be assembled for the needs of SA, then a system can be put into place to measure all solar production in one format and can be standardized and simplified for the purpose of monitoring and research.

**Monitoring of the GreenChoice Array and Beyond:**

Since this system is a PPA, all monitoring will be done by GreenChoice for SA. Although the system is maintained by GreenChoice, they are waiting for the internet infrastructure to monitor the system and it will need to be integrated onto a user interface that can be displayed with the other systems eventually.

One option for SA is a web based platform named Locus. It is a site that can take multiple arrays monitored over several different interfaces and puts them in one place. The other option, mentioned above, is to either create a DAS or to contract with a company to do all monitoring from a standardized DAS box configuration to gather information specific to the needs of SA. This option standardizes the information and opens up various opportunities to partner with an outside organization to research the harvested data from these systems and how they function and perform over time with the different ways each was installed (different components and field versus rooftop installation for example).

**PLANNING THE SOLAR INFRASTRUCTURE**

Having so much land and buildings is both a blessing and a curse for SA. Each building has an individual meter but SA pays a lump sum for all the energy used for the entire campus. For each solar installation, there has to be a building to net meter per the utility SRP’s policy in place. Being a non-profit organization, SA has had the opportunity to receive donated modules from several different organizations that are not UL listed. Also, the energy use of the buildings cannot be supported by the solar that will fit on the rooftop as seen with the dining hall installation which only offset about 10% of the current energy use. Finally, because this is a children’s home, there are safety issues with a field arrays scattered across the campus for each building’s total energy use. The GreenChoice and TUV array were the first attempt of SA experimenting with field installations. While the TUV array was able to net meter one building, the GreenChoice 300kW array was such that it was able to net meter eight different buildings on campus. Although the design of 300kW array would be more cost efficient to fully net meter for all the buildings it connected to, it created a scenario of a spider web of trenching (and hitting an unknown water pipe that needed to be fixed) and running wires across the property that contribute to loss of power and has added cost to the project.
overall. With more solar modules waiting in the wings to be installed, it was looking like SA would have to run another series of undesirable trenches across the property.

**Exploring New Options:**

With all of the frustrations surrounding the net metering of each building that came with the PPA, the solar committee was looking into alternative options that would be better for SA. They needed to develop a solution to cover the next series of installations. The modules waiting in the wings were not UL listed so rooftop installation for a limited amount of power production was out of the question for logistic power production and code compliance issues. One thing that was plaguing the committee was that the entire campus was already connected by overhead lines owned by SRP. The trenching was therefore redundant and if they could net meter at a utility electric pole, they could utilize the existing infrastructure to distribute the power being produced by an array saving both time and money on an installations and shoudering the utility with potential power losses regarding the distribution of power generated from the array.

Initial meetings with SRP proved that although they were willing to bend over backwards to help SA, they would not be interested in net metering an array without a building to net meter. Since the electric infrastructure is a “distribution island,” meaning that power lines terminate on the campus and therefore power can only enter and exit through two lines at the front of the property, it was then brought up to SRP the possibility that SA would purchase the last several poles and own the existing distribution near the proposed array that they needed to distribute to the nearby buildings. SRP was not willing to sell part of their distribution network, it was all or nothing. Once SA realized they could purchase the electric distribution on the campus for under $75,000, the solar committee needed to regroup and research the opportunities and challenges that would come with that ownership.

It was about this time that SA recruited Dave Watson of MW Engineering to donate some of his time to help with the design of the solar panels that were waiting in the wings to be installed. Dave also has the technical knowledge to design and analyze the pros and cons of the potential purchase of the distribution system and quickly became involved in the discussions. With Dave’s office I set about updating the electric and building infrastructure in conjunction with the SA master plan. This was an important step because any decisions made need to be relevant to existing and future connections and solar energy production.

**The Options:**

With the knowledge gained from the first several installations and the realization that SA could install multiple more solar fields it was time to sit down and plan for a scenario of a net zero campus in conjunction with the expansive infrastructure goals that were already getting underway. Meetings between Dave Watson, the solar committee, and I categorized the future solar installation methodology into three basic directions. Each direction had pros and cons but facilitated the net zero goal of SA.

The first direction would be to keep the status quo. They would keep installing future solar arrays in the exact fashion that they have been by trenching to and net metering each building individually. To achieve net zero status they would need to connect to every building one by one creating a spider web of wires underground. Concurren to SRP policy only one solar system can be connected to a meter meaning SA would have one shot to net meter each building This has become an issue with both the dining hall and the office, two systems that require more solar to cover their energy needs. As mentioned above, this would add cost of wire, conduit, and trenching as well as loss efficiency because of the array net metered so far away from the source of production. The advantages to this direction are that SRP would allow SA to continue installing solar with limited reservations and the solar waiting in the wings could be installed immediately.

The second direction would be to net meter each array individually at a power pole nearest the array. As mentioned above, this would solve the problem of installing unneeded parallel trenched wires and meter the energy before any incidental distribution efficiency losses can be inferred to transport the energy to the entire campus making the system more valuable. The downside of this would be that SRP will only net meter buildings and not arrays. Also this adds a level of compliation that SRP is not typically willing to shoulder as well as safety issues associated with how it is done.

The third and unprecedented direction would involve SA net metering at one location at the front of the property and owning everything downstream of the meter. For safety reasons all of the solar production would need a cutoff switch at the master meter to ensure no electricity on the line during SRP maintenance operations. This could be done with underground wire looping around the property acting like a “solar spine” connecting every solar system to and net metering with the master meter at the front of the property. With every new system that SA installs, it need only be
connected to the spine to begin net metering for the campus. Also, demand charges would be averaged across the entire campus and costs to that effect would potentially be mitigated.

To implement the purchase of the distribution system several things would need to be considered before a decision could be made because if it were too expensive it might be the wrong decision for SA. Some initial questions were how would SA maintain the micro grid that is currently operating past the master meter and how much would that cost? Would SRP allow it from a safety and logistical perspective? How much does a solar spine cost? How would this affect the GreenChoice PPA agreement? Although this option has the most uncertainty it was the direction that SA considered as the best case scenario

**Shoot The Moon:**

The first step was to set up a meeting with SRP's distribution and renewable energy engineers to see the feasibility of the solar spine in conjunction with the master meter. The engineers in the room agreed to follow up with our requests but only agreed to move forward if SA could get the City of Mesa to sign off on the project as this is something that has never been done before and they have never allowed it in the past. Once SRP transfers ownership of the distribution system to SA, they would no longer be under the umbrella of SRP and would be accountable to the City of Mesa and the National Electric Code (NEC). Since SRP is so experienced in the distribution of power they can operate their grid below the standards of the NEC and if there are any code violations, SA could potentially have to spend a large amount of money upfront to update the system the day it is transferred. It was also clarified what exactly SA would receive when they purchased the distribution system. The items to be sold were the poles, the wires, and the transformers. The meters currently installed on the buildings would be removed since SRP will no longer need to read them. What SA owns already is the trenching and conduit used in the underground distribution as well as everything past the meter on a building.

The next step was a meeting with Department Director, Planning Division representative, and a City Council Woman who sits on the SA board of directors of the City of Mesa to discuss the cost impacts of code compliance, permitting, and feasibility. SA serves an immense service to the children in need of a home and the City of Mesa and the community at large appreciate that service. When the solar spine and master meter proposal was presented to the city as a way to grow the mission and help that many more children, the city was able to work with SA in the following ways. First, they thought it reasonable that SA own and operate its own electric grid. Second, upon review of a licensed electrical engineer, if the existing distribution network met the standard of care typical to existing grid infrastructure could deliver adequate and safe power, it could operate without being NEC compliant. Third, all new grid infrastructure would have to conform to the adopted NEC standards. Fourth, that permit fees would be billed on an hourly basis for review rather than on a percentage of cost basis. Finally, even though the City of Mesa does not require a permit for solar installations done through SRP, it will need to get a permit once it takes ownership of the distribution system and all modules will need to be UL listed.

As this process evolved, SA’s solar spine plan had been evolving as well. SA expressed a desire to eventually put the entire overhead infrastructure underground for safety, aesthetic, and functionality reasons. This would serve a parallel service in that the underground distribution systems need significantly less maintenance than the overhead wires, meaning that the cost feasibility of ownership of the system would be more achievable. SA has had to have power poles moved to accommodate new construction of children’s residences and an underground grid would facilitate that growth. Since the solar spine would run the length of the property and a majority of the cost is in trenching, it was decided that also having another wire in the trench for energy use in the loop would be a way to eventually connect all the buildings to and phase out the overhead lines. This system would also accommodate for future build out as specified in the master plan to grow SA.

Once it was clear that SA could move forward with the project it, was brought back to SRP for engineering and logistical requirements. The meeting involved SRP’s distribution and renewable engineer, the SRP account manager for SA, the SRP commercial and residential incentive representatives, and two representatives from Royal Solar, a solar installation company that is familiar with SA. The result of the meeting was that although SRP does not allow more than one array per meter, in the situation with a master meter, they would allow it and are ready to move forward with a review of an engineered system for the master meter. Since SA plans to eventually get the distribution underground, rather than purchase the overhead wires, SA could move forward with the underground loop and after it was complete and switched over. Rather than purchasing the distribution system, SRP could just remove it rather than sell it saving the cost of the purchase price for SA. Since this process of the
solar spine will take at least a year to implement, it was also agreed to with SRP that SA could install the modules on hand and use them to offset the remaining power usage of the dining hall and the office, which was previously not an option or net meter any other building on campus until the loop could be constructed and the array switched over to it.

The path to attain net zero status is not complete but much closer. Issues that still need to be worked out are the finalized engineering of the “spine,” incentive monitoring of the GreenChoice PPA, and specific costs of the project. This approach is currently doable with the heavy lifting surrounding the policy and engineering restraints out of the way. The business model at SA is to take care of the children who need them and let the community come together and provide the necessities for SA to operate and grow.

**OPPORTUNITIES AT SUNSHINE ACRES**

There are multiple opportunities for University driven projects available to be explored which will leave a lasting contribution to this vital aspect of the community. With the endless goodwill around the mission of SA and its willingness to think outside the box for creative solutions, projects not feasible elsewhere can be built and tested.

Projects available now are streamlining of the solar monitoring mentioned above, ranging from troubleshooting installation of hardware to graphic and a cohesive interface. There is ample opportunity surrounding the distribution loop that still needs completion. SA would also like to assemble an educational solar program for the children of SA. There are solar ready projects that are ready currently for install that need creative solutions such as covered parking and other multi-use technology applications that have not been thought of yet. Finally, with all of the different systems installed there is an incredible amount of data that can be harvested to research performance and characteristics of power production across all of the variation. On the TUV array alone there are micro inverters monitoring a medley of different modules side by side with a central inverter that if researched, could lend to performance results that may or may not fall in line with assumed industry standards.

SA is a product of the community and the solar mission and support from that community are a testament to the amazing “miracle in the desert” that is Sunshine Acres.
### APPENDIX

**-Inverter summary-**

**Inverter Summary**  
Sunshine Acres - 6/5/2012

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*Possible to link to a computer via Bluetooth antenna*
Open Loggernet

Go to “Main,” then go to “Setup”

First step is to click “Add” and click on CR10X
Step 2. Go to “Main,” then click on “Connect”

Step 3: Click on the hardware that you just created.
Next Step is to Connect to the CR10X.

Once connected, hit “Collect” to retrieve data.
The data should pop up under C drive: Campbellsci: LoggerNet: etc...

Data needs to be comma delimited...
Once Delimited with “Text to Column” function in Excel, the data can then be labeled as seen above.
Sample graphs made from the data collected above.