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# Final Report
# Micro-Grids for Colonias (TX)


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# Table of Contents

Table of Contents ........ 2
List of Figures ........ 4
List of Tables ........ 5
Acknowledgements ........ 6
Executive Summary ........ 7
Introduction ........ 8
Background ........ 8
Project Objectives ........ 8
Team Members ........ 8
System Description and Capabilities ........ 9
Site Selection ........ 9
System Component Descriptions ........ 11
Power Systems ........ 12
PowerCells ........ 12
Chargers ........ 13
Solar Array ........ 13
Inverters ........ 14
Genset ........ 14
Distribution Grid ........ 15
Controls and Data Acquisition ........ 15
Structure ........ 16
System Specifications ........ 16
Operation ........ 19
Installation ........ 19
System Operation ........ 19
System Performance ........ 21
Power and Efficiency ........ 23
Energy delivered ........ 23
Los Arcos ........ 23
Las Lomas ........ 24
Los Nopalitos ........ 24
Reliability ........ 24
Los Arcos ........ 24
Las Lomas ........ 24
Los Nopalitos ........ 25
Maintainability ........ 25
Cost Benefit Analysis/Economy of Scale ........ 26
Conclusions ........ 29
Bibliography ........ 31

Appendix A: Design Details .......... 32
Appendix B: DOE Status Reports .......... 53
Quarterly Status Report 1 – December 31, 2009 .......... 53
Special Status Report – February 26, 2010 .......... 55
Quarterly Status Report 2 – March 31, 2010 .......... 56
Quarterly Status Report 3 – June 30, 2010 .......... 59
Quarterly Status Report 4 – September 30, 2010 .......... 62
Quarterly Status Report 5 – December 31, 2010 .......... 64
Quarterly Status Report 6 – March 31, 2011 .......... 66
Quarterly Status Report 7 – June 30, 2011 .......... 68
Quarterly Status Report 8 – September 30, 2011 .......... 70
Quarterly Status Report 9 – December 31, 2011 .......... 72
Quarterly Status Report 10 – March 31, 2012 .......... 74
Quarterly Status Report 11 – June 30, 2012 .......... 76
Appendix C: Site Selection Reports .......... 78
Site Selection Report for Los Nopalitos .......... 78
Site Selection report for Los Arcos .......... 84
Site Selection report for Las Lomas .......... 90

# List of Figures

Figure 1. Las Lomas ... 9
Figure 2. Los Nopalitos ... 10
Figure 3. Los Arcos ... 10
Figure 4. 12VDC PowerCells™ Pack ... 12
Figure 5. Battery Chargers ... 13
Figure 6. Los Arcos, Los Nopalitos, Las Lomas Solar Arrays ... 13
Figure 7. Inverters ... 14
Figure 8. Diesel Genset ... 15
Figure 9. Power Stanchion ... 15
Figure 10. PLC Controller and LabView™ Computer ... 16
Figure 11. System Design ... 20
Figure 12. Operation of System-Typical 24 hour period ... 22
Figure 13. Grid Demand ... 23
Figure A-1. System Configuration ... 32
Figure A-2. Genset ... 32
Figure A-3. Genset Dimensions ... 33
Figure A-4. Photovoltaic Arrays Configuration ... 33
Figure A-5. Generation System Trailer ... 34
Figure A-6. Generation System Trailer Dimensions ... 34
Figure A-7. Trailer Component Layout ... 35
Figure A-8. PowerCell® Stack Dimensions ... 35
Figure A-9. PowerCell® Stack Components ... 36
Figure A-10. Las Lomas Grid Configuration ... 36
Figure A-11. Los Arcos Grid Configuration ... 37
Figure A-12. Los Nopalitos Grid Configuration ... 37
Figure C-1. Los Nopalitos Site Location ... 78
Figure C-2. Aerial View of Los Nopalitos Proposed Site Layout ... 79
Figure C-3. Webb County Map Book “Ruiz Tracts” ... 80
Figure C-4. Possible Additional Connection Los Nopalitos ... 81
Figure C-5. Electrical layout of Micro-Grid – Los Nopalitos ... 83
Figure C-6. Los Arcos Site Location ... 84
Figure C-7. Aerial View of Los Arcos Proposed Site Layout ... 85
Figure C-8. Webb County Map Book “Ruiz Tracts” ... 86
Figure C-9. Electrical layout of Micro-Grid – Los Arcos ... 88
Figure C-10. Las Lomas Site Location ... 90
Figure C-11. Aerial View of Las Lomas Proposed Site Layout ... 91
Figure C-12. Webb County Map Book Ranchitos Las Lomas ... 92
Figure C-13. Electrical layout of Micro-Grid – Las Lomas ... 94

# List of Tables

Table 1. Overall Specifications ........ 16
Table 2. PowerCells™ Specification ........ 17
Table 4. Charger Specification ........ 18
Table 5. Genset Specification ........ 18
Table 6. Solar Panel Specifications ........ 19
Table 7. Energy Delivered ........ 23
Table 8. Maintenance or Repair Events ........ 25
Table 9. Total System Cost ........ 26
Table 10. Fuel and Maintenance Costs ........ 27
Table 11. Genset Run Times ........ 28
Table A-1. Bill of Materials for Las Lomas ........ 38
Table A-2. Bill of Materials for Los Arcos ........ 43
Table A-3. Bill of Materials for Los Nopalitos ........ 48
Table C-1. PowerCell™ Characteristics ........ 82
Table C-2. Initial Participants Los Nopalitos: ........ 83
Table C-3. PowerCell™ Characteristics ........ 87
Table C-4. Initial Participants Los Arcos ........ 89
Table C-5. PowerCell™ Characteristics ........ 93
Table C-7. Initial Participants Las Lomas ........ 95

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This project was funded through DOE contract DE-OE-0000038 as a congressionally directed program. The authors gratefully acknowledge the support of DOE throughout this project.

We would also like to acknowledge the support of Congressman Henry Cuellar and his staff throughout this process.

# Executive Summary

This report describes the results of the final implementation and testing of a hybrid micro-grid system designed for off-grid applications in underserved Colonias along the Texas/Mexico border. The project is a federally funded follow-on to a project funded by the Texas State Energy Conservation Office in 2007 that developed and demonstrated initial prototype hybrid generation systems consisting of a proprietary energy storage technology, high efficiency charging and inverting systems, photovoltaic cells, a wind turbine, and bio-diesel generators. This combination of technologies provided continuous power to dwellings that are not grid connected, with a significant savings in fuel by allowing power generation at highly efficient operating conditions.

The objective of this project was to complete development of the prototype systems and to finalize and engineering design; to install and operate the systems in the intended environment, and to evaluate the technical and economic effectiveness of the systems.

The objectives of this project were met. This report documents the final design that was achieved and includes the engineering design documents for the system. The system operated as designed, with the system availability limited by maintenance requirements of the diesel gensets. Overall, the system achieved a 96% availability over the operation of the three deployed systems. Capital costs of the systems were dependent upon both the size of the generation system and the scope of the distribution grid, but, in this instance, the systems averaged \$0.72/kWh delivered. This cost would decrease significantly as utilization of the system increased. The system with the highest utilization achieved a capitol cost amortized value of \$0.34/kWh produced. The average amortized fuel and maintenance cost was \$0.48/kWh which was dependent upon the amount of maintenance required by the diesel generator.

Economically, the system is difficult to justify as an alternative to grid power. However, the operational costs are reasonable if grid power is unavailable, e.g. in a remote area or in a disaster recovery situation. In fact, avoided fuel costs for the smaller of the systems in use during this project would have a payback of the capital costs of that system in 2.3 years, far short of the effective system life.

# Introduction

## Background

In 2007, with funding from the Texas State Energy Conservation Office (SECO), the Texas Center for Applied Technology (TCAT) of the Texas Engineering Experiment Station (TEES) partnered with Xtreme Power, Inc. to begin developing a prototype off-grid hybrid micro-grid power generation and distribution system to meet the needs of underserved communities along the Texas- Mexico border. Several prototype systems were developed and deployed and good progress was made towards a production system (Schneider, Martin, Berry, & Moyer, 2011). In 2009, DOE provided additional funds to continue the development under a congressionally directed program in Texas Congressional District 28. This report presents the results of that effort. Appendix B contains the quarterly status reports to DOE on the project.

## Project Objectives

This project was intended to fully develop prototype renewable based micro-grid power systems for underserved communities in the U.S./Mexico border region that could provide power to dwellings on a temporary basis until an electric grid connection could be made. The goal of the project was to create fully sustainable renewable-based systems at reasonable cost to residents. These systems used a unique combination of revolutionary dry cell power storage technology with wind and solar power systems to provide primary power to a micro-grid. The systems provided reliability using a diesel powered generation system to provide power when renewable sources were unavailable.

## Team Members

Texas Engineering Experiment Station (TEES – the Engineering Research Agency for the State of Texas) was the technology integrator and analyst of the project. TEES was the prime grantee and was responsible for the overall management of the project and coordinated all grant team activities. TEES provided engineering oversight of the design projects submitted by Xtreme Power or other vendors. TEES provided financial control for the project and was responsible for fulfilling all reporting requirements. TEES issued subcontracts to the various grant team members and provided managerial oversight of each grant team member in their activities related to this grant.

The Center for Housing and Urban Development (CHUD) – a center within the Texas A&M University College of Architecture administered the local involvement in the Colonias and provided coordination with local government (Webb County) as required for the installation, testing, and monitoring of the micro grid systems. CHUD provided for the direct technology transfer to the residents of the community, especially the Colonia residents through CHUD's promotores. The promotores are residents of the Colonias that have been trained in outreach and are aware of all the available services and technologies provided for Colonia residents. CHUD also assisted TEES and Xtreme Power in the site selection for the prototype systems. CHUD enlisted promotores to help introduce the new micro grid technology and ensure its proper use through education of the residents.

The Texas RioGrande Legal Aid (TRLA) is a nonprofit organization that provides free legal services to low-income residents in sixty-eight counties of Southwest Texas, and represents migrant and seasonal farm workers throughout the state of Texas and six southern states: Kentucky, Tennessee, Alabama, Mississippi, Louisiana and Arkansas.

Xtreme Power was the technology provider for this project. Xtreme Power provided test and production systems for the micro-grids and coordinated with TEES, CHUD, and Webb County in the installation and operation of the grids.

# System Description and Capabilities

## Site Selection

The systems were deployed in three separate colonias that are in close proximity to each other. All three are located on US Highway 59, 18 miles northeast of the city of Laredo, Texas. The three communities are called Las Lomas, Los Nopalitos, and Los Arcos.

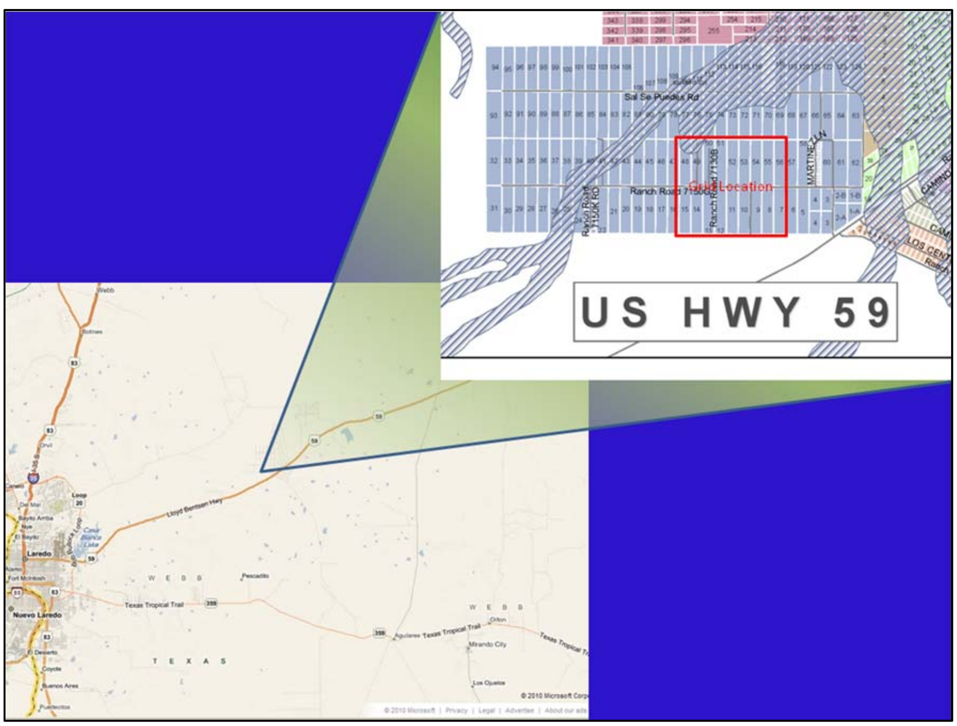



**Figure 1. Las Lomas**

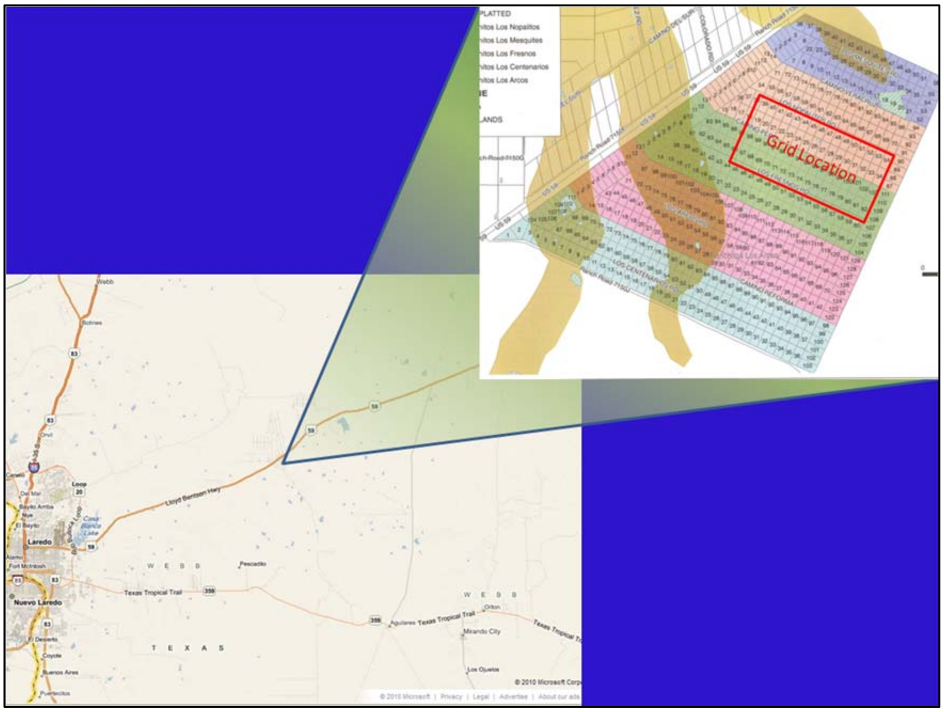



**Figure 2. Los Nopalitos**

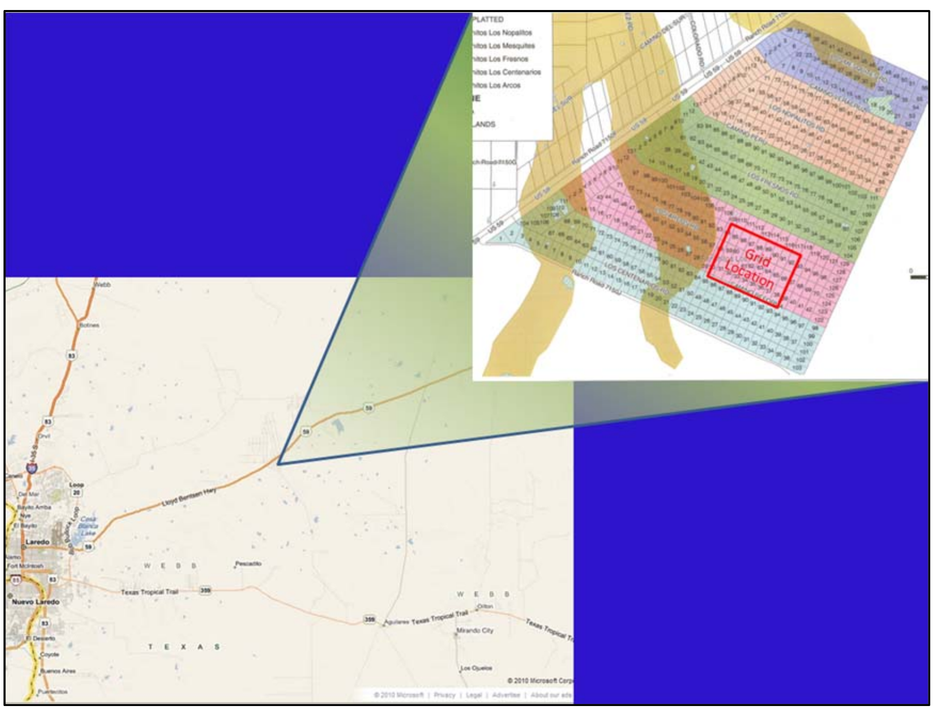



**Figure 3. Los Arcos**

The first year of the project involved the development of the site selection criteria and environmental approval of the project locations. Full funding for the construction and installation of the systems was contingent upon environmental approval of the sites.

The team's initial surveys were discouraging since our community partners were finding it difficult to get the local residents interested. The problem was local politics, a highly contested race for county commissioner in that precinct was underway and residents were hesitant to become involved in an experimental program while the political balance of the area remained unsettled. Upon completion of the local election, the newly (re)-elected commissioner put her full support behind the project and the residents then began accepting the proposals for participating in the project.

Another issue involved site planning as requested by the Webb County, Texas Planning Director. The county was making good progress in getting compliance with existing regulations concerning septic systems in the underdeveloped colonias by making grid connections contingent upon satisfactory licensing of septic systems (rather than cesspools and open trench latrines). To prevent undermining those activities, the planning director requested the provision of power from this project be subject to the same constraints. The project team negotiated with the planning director and agreed that application to get the permits would allow the project to proceed, but if the septic system had not been successfully licensed in 18 months, the power connection to that residence would be removed.

After these issues were resolved, the team continued working in the communities and selected locations in the areas identified above (Los Lomas, Los Nopalitos, and Los Arcos) and developed actual site locations which were then submitted to DOE for environmental review and clearance. No environmental issues were identified during the review. The site selection reports can be found in Appendix C. Environmental approval was obtained in October 2010, the next DOE funding increment was applied, and system design and installation proceeded.

## System Component Descriptions

The systems were sized from 14.4KW to 21.6KW. They consisted of a bank of Xtreme PowerCells™ that provided up to 40KWh of available electricity to the system, several various renewable energy electrical generation systems, a diesel engine powered generator, and the micro-grid distribution and control system. Controlled by a programmable logic controller (PLC), the system provides 24 hour power from the PowerCells™ to a bank of inverters which provide 240VAC power to the distribution system. The PowerCells™ were charged by a hybrid system consisting of a diesel generator, photovoltaic panel, and small wind turbines (if located in an acceptable wind region). When the charge in the cells dropped to a pre-specified, level, the diesel generator started to recharge the cells unless alternative energy power was available (PV or wind) in which case the PowerCells™ are charged by the renewable energy systems. If renewable energy was not available, the system was charged by the generator. The generator was also used to power the micro-grid if the PowerCell™ system developed a fault.

A trailer-park style power stanchion was installed outside each of the dwellings being served. Users could attach extension cords to the stanchion and power the dwelling. Each user received one 20 Amp circuit that could be used to power lighting, refrigeration, small window air conditioners or fans, or other household appliances.

***Power Systems***

The Power systems could be further broken down into the AC components and DC components. The DC components consisted of the power cell pack, the chargers, and the solar array. The AC components consisted of the inverters, the genset, and the grid.

***PowerCells*™**

The PowerCells™ were configured in a series-parallel matrix that takes advantage of the high power density of Xtreme Power's PowerCells™. The pack consisted of 40 PowerCells™ connected by bus bars that were resistance matched to provide an equal and consistent path for power to flow to and from the PowerCells™ pack. The pack was capable of storing 40 kWh of energy and had a nominal voltage of 48 VDC. The Los Arcos system had a storage capacity of 20 kWh.


**Figure 4. 12VDC PowerCells™ Pack**

### *Chargers*

The charging system consisted of four Pioneer Magnetics PM33215B 5 kW power supplies connected in parallel to the PowerCells™ pack. The variable power supply allowed for a proprietary charging algorithm tailored specifically for the PowerCells™. Each power supply was diode isolated to prevent a failed power supply from affecting the bus. The chargers received power from the 20 kW diesel genset at Lomas and Nopalitos and a 15kW at Arcos.

**Figure 5. Battery Chargers**

### *Solar Array*

The solar array consisted of 21- 225 W photovoltaic (PV) panels. The panels were installed on a ground mounted frame. They were connected in a series-parallel configuration that allowed for maximum efficiency. The solar output was regulated by an Outback Power Flexmax 80 charge controllers.

**Figure 6. Los Arcos, Los Nopalitos, Las Lomas Solar Arrays**

### *Inverters*

The inverters are the main provider of power to the grid. They convert the DC power from the batteries into AC power that is supplied to the distribution system. The inverter system consisted of six (four at Los Arcos) Outback Power VFX-3648 inverters arranged in a split phase configuration. This allowed the inverters to output a more efficient 240 VAC to the grid. Each inverter was capable of continuously providing 3600 VA of power with a surge capability of 6000 VA. This gave a continuous total system power capacity of 21.6 kVA with a maximum surge of 36 kVA. Inverter control and communication was accomplished with an Outback Power HUB10 and MATE. During normal operation, the genset and solar array did not provide power to the grid directly, only indirectly through the PowerCells™ pack.


**Figure 7. Inverters**

### *Genset*

The system used a Cummins Diesel genset modified for mobile deployment. The Las Lomas and Los Nopalitos sites used 20kW gensets and consume 1.0 gph at ½ its rated load, 1.5 gph at ¾ its rated load and 1.8 gph at its full rated load. The Los Arcos site used a 15kW genset and consumed 0.88 gph at ½ its rated load, 1.33 gph at ¾ its rated load and 1.77 gph at its full load. Although the gensets were primarily used to power the chargers, they could be used as an auxiliary power source for the grid in the event of an inverter or PowerCells™ failure.

**Figure 8. Diesel Genset**

***Distribution Grid***

The distribution grids were made up of 4,915 ft. (Las Lomas), 3,000 ft. (Los Nopalitos), and 2,305 ft (Los Arcos) of direct burial #2 AWG cable (1/0 AWG for Las Lomas due to the long distribution runs). This size cable allowed for a maximum distance of 1500 ft between the micro grid system and the furthest dwelling. The placement of the micro grid system was very important when the 1,500 ft limitation was taken into consideration. To access the grid, each dwelling had a power stanchion with a single 120 VAC 20 amp circuit.

**Figure 9. Power Stanchion**

***Controls and Data Acquisition***

The micro grid system used PLC-based controls to manage PowerCells™ charging and other functions. The micro grid system was fully automated and only required an operator for maintenance and troubleshooting. Data acquisition was performed by an industrial PC running custom LabView™ software.


**Figure 10. PLC Controller and LabView™ Computer**

***Structure***
All components except for the genset and solar array were housed in a 7' x 14' tandem axle trailer. The PowerCells™ were secured in a steel frame matrix mounted inside the trailer.

## System Specifications

The following tables present the specifications of the system as designed and implemented by Xtreme Power, Inc.

**Table 1. Overall Specifications**

| Specification | Value (Lomas & Nopalitos) | Value (Arcos) |
|---|---|---|
| Output Power | 21.6 kW | 14.4 kW |
| Energy Storage | 40 kWh | 20 kWh |
| Solar Array | 4.725 kW | 4.725 kW |
| Charging Capacity | 20 kW | 10 kW |
| Generator | 20 KW Diesel | 15 kW Diesel |
| Fuel Capacity | 1000 Gallons | 1000 Gallons |
| Structure | 14' Tandem Axle Trailer | 14' Tandem Axle Trailer |
| Dwellings Served | 9 (Lomas), 8 (Nopalitos) | 4 |

**Table 2. PowerCells™ Specification**

| Specification | Value |
|---|---|
| Cell Voltage | 12 VDC |
| Capacity | 1 KWh (85 Ah @ C3 rate) |
| Efficiency | 95%-99% |
| Cycle Life @ 10% Depth of Discharge (DoD) | 250,000 |
| Cycle Life @ 50% DoD | 20,000 |
| Weight | 58 lbs |
| Dimensions | 30”L x 5” W x 5” H |
| Quantity Used in System | 40 (20 for Los Arcos) |

**Table 3. Inverter Specification**

| Specification | Value |
|---|---|
| Nominal DC Input Voltage | 48 VDC |
| DC Input Voltage Range | 42.0 to 68.0 VDC |
| Continuous Power Rating | 3600 VA |
| AC Voltage/Frequency | 120 VAC 60 Hz Pure Sine |
| Typical Efficiency | 93% |
| Maximum Output Current | 70 amps AC |
| AC Overload Capability **Surge** | 6000 VA |
| AC Overload Capability **5 Second** | 5000 VA |
| AC Overload Capability **30 Minutes** | 4000 VA |
| Weight | 61 lbs |
| Quantity Used in System | 6 |

**Table 4. Charger Specification**

| Specification | Value |
|---|---|
| AC Input Range | 180 to 264 VAC @ 47 to 63 Hz |
| Power Factor | .99 @ Full Load |
| Output | 60 VDC @ 83 amps |
| Overvoltage Protection | Yes |
| Overcurrent Protection | Yes |
| Operating Temp | 0 - 50°C |
| Cooling | Forced Air |
| Weight | 14.6 lbs |
| Quantity Used in System | 4 |

**Table 5. Genset Specification**

| Specification | Value (Lomas & Nopalitos) | Value (Arcos) |
|---|---|---|
| Generator | 20 KW @ 60 Hz | 15 KW @ 60 Hz |
| Duty Rating | Prime Power | Prime Power |
| Voltage | 120/240, 1 Phase, 3 Wire | 120/240, 1 Phase, 3 Wire |
| Engine | Cummins Diesel | Cummins Diesel |
| Specific Fuel Consumption | ¼ Load – 0.6 US gph<br>½ Load – 1.0 US gph<br>¾ Load – 1.5 US gph<br>Full Load – 1.8 US gph | ¼ Load – 0.44 US gph<br>½ Load – 0.88 US gph<br>¾ Load – 1.33 US gph<br>Full Load – 1.77 US gph |

**Table 6. Solar Panel Specifications**

| Specification | Value |
|---|---|
| Power Rating | 225 W |
| Peak Efficiency | 13.5% |
| Imp | 7.7 A |
| Vmp | 29.1 V |
| Isc | 8.3 A |
| Voc | 36.6 V |
| Max System Voltage | 600 V |
| Weight | 42.8 lbs |
| Quantity Used in System | 21 (Per Site) |

# Operation

## Installation

As noted before, the installation was delayed due to a political race for the County Precinct Commissioner; therefore, the community was reluctant to become involved in this project. Our community advocacy partners, TRLA and CHUD, put together a marketing plan together to actively move into the colonias area of interest. The project team did extensive interviews and visits to locate an adequate cluster of homes. With the re-election of the incumbent county commissioner in Webb County coupled with the marketing effort, we were able to overcome the delay and the sites were selected.

The team identified three clusters of dwellings in the proposed service area. The site selection reports and environmental surveys for the three areas were submitted to DOE. Los Arcos was commissioned on 7/14/2011, Las Lomas on 8/31/201,1and Los Nopalitos on 9/28/2011.

## System Operation

Figure 11 shows the system design. Except in the case of system failure, all power that feeds into the distribution system comes from the batteries through the inverters. The control system monitors the charge of the batteries and charges the batteries upon need. The charging system will charge from the renewable energy producer (PV array and/or a wind turbine, if present) and will not activate the genset as long as there is enough power from the renewables to both maintain the load on the grid and keep the PowerCells™ pack at an acceptable voltage.  Since the batteries can only store DC power, the AC power from the generator is rectified (AC converted to DC) to provide the power to charge the batteries.  This function is performed by the battery chargers.  To use the PV array and/or the wind turbine to charge the batteries, a solar/wind turbine charge controller is connected in parallel to the AC charge controllers.  The control system monitors the output of the solar array (or wind turbine) and while the solar array has sufficient output, it is used to charge the batteries and the generator remains off.  When the output of the renewable source drops below that necessary to charge the batteries, the control system starts the genset and engages the AC chargers.  If there is a failure in the battery system, the control system can also use the generator as primary power to the grid through the backup power transfer switch.

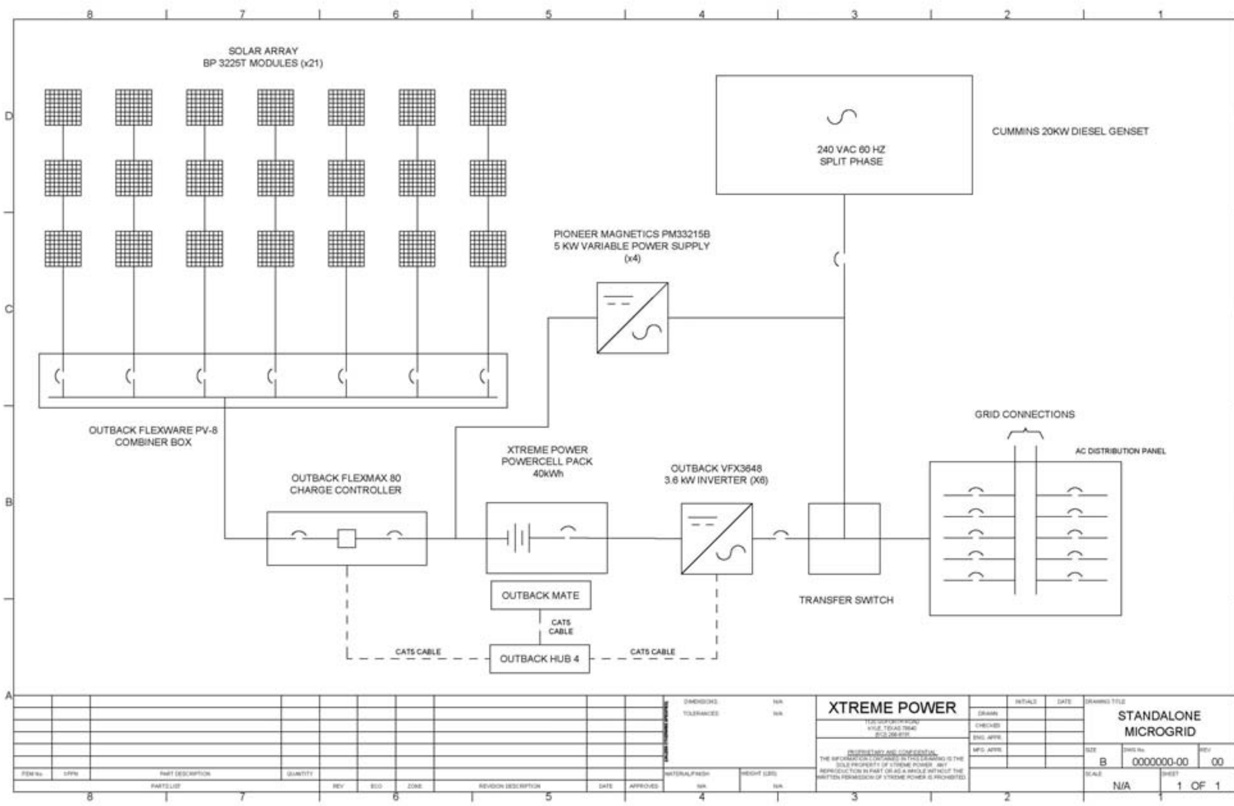



**Figure 11.  System Design**

The power delivered to each dwelling was a standard 120VAC, 20 amp circuit with the peak demand limited to 2.4 KW.  This was sufficient to power most small appliances and lights. There were several residences that used the power to run a small air conditioner, but this was usually on an exclusive basis, that is, while the air conditioner was running, no other electrical usage could occur in the residence.  If either the maximum current or peak demand limit was exceeded, the system would trip the circuit breaker at the stanchion and the resident would reduce the load and reset the breaker.

Data was gathered on all aspects of system operation. The total power generated from all sources was measured and recorded as well as the total power distributed across the grid. Battery charge status, engine run state, engine fuel usage, PV panel voltages, and currents were also monitored. Data was stored in a file and was available for retrieval during regular maintenance. Additional design information is contained in Appendix A.

## System Performance

During normal operation, all power provided to the grid came from the batteries through the inverters. The batteries constantly received charging power from the solar array during daylight hours. If the load on the grid was less than the power provided by the solar array then the system ran completely on renewables. If the load on the grid was greater than what the solar array could provide, then the extra power was drawn from the batteries. The genset was operated when the batteries reach a 50% state of charge (SOC) at which time the control system engaged the charging cycle. The genset normally did not provide any power directly to the grid; it only supplied power to the charging system upon need. AC power from the genset was rectified and controlled through the variable power supplies to provide charging power to the batteries. The control system was responsible for monitoring and controlling the voltage and current from the variable power supplies to ensure the charge cycle stayed within acceptable parameters.

Although the genset does not provide any power to the grid during normal operation, if there is ever a malfunction in the inverters, charging system or batteries, then the control system can start the genset and actuate an automatic transfer switch that will allow the genset to power the grid in emergencies. Conversely, if there is ever a malfunction with the genset, then the control system will allow the system to run during daylight hours while the solar array is providing power. Once the sun goes down, the system would continue to operate off of power stored in the batteries until the batteries reached 25% SOC. Once this occurs, the system will stop output power and enter a standby mode until the solar array charged the batteries back up to 75% SOC.

An example of the daily performance can be seen in the following graphs of data. Figure 12 shows the operation of the system, specifically the operation of the battery pack, solar array and charging system during a typical 24-hour period.

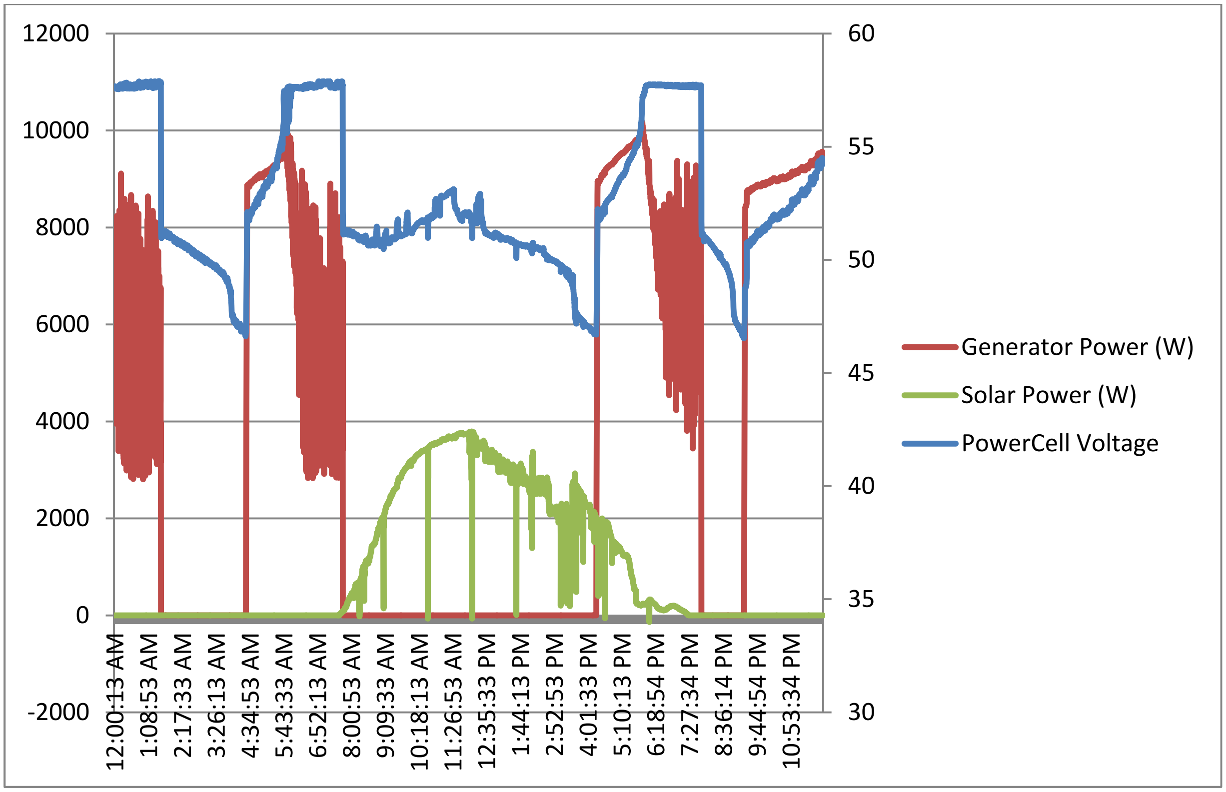



**Figure 12. Operation of System-Typical 24 hour period**

The graph starts at midnight during a charge cycle as the graph shows the genset to be active as well as the battery pack voltage at its peak value. At about 1:10 A.M. the charge cycle completes and the grid is run completely off of energy stored in the battery pack until the next charge cycle begins. At sunrise, the solar array begins to produce power and provides enough power throughout the day to keep up with grid demand until about 4:30 P.M. At this point solar production tapers off and is no longer enough to keep up with grid demand and the control system engages another charge cycle. Figure 13 below is a graph of AC output power to the grid during the same 24 hour period as the preceding graph.

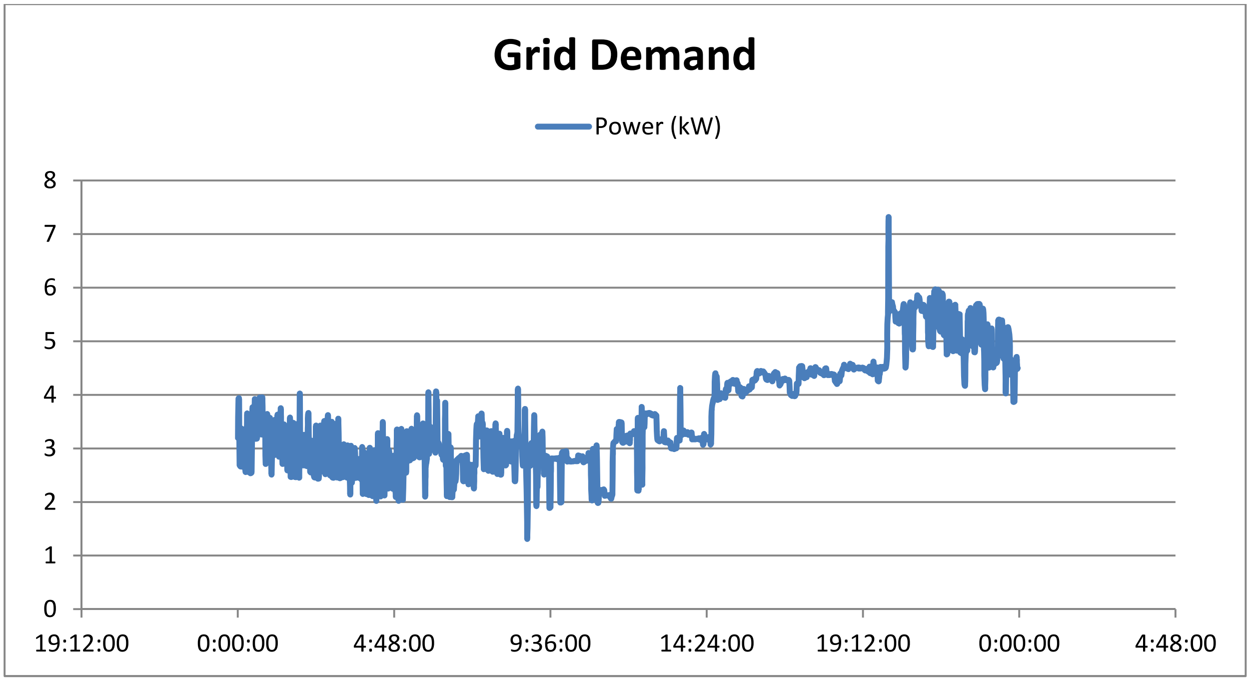



**Figure 13. Grid Demand**

## Power and Efficiency

### *Energy delivered*

Table 7 below summarizes the energy delivered by various components within each system.

**Table 7. Energy Delivered**

| Location | Genset Energy Delivered (kWh) | Inverter Energy Delivered (kWh) | Solar Energy Delivered (kWh) | System Efficiency |
|---|---|---|---|---|
| Los Arcos | 12262.2 | 11090.7 | 2528.1 | 75% |
| Las Lomas | 6329 | 6644.2 | 3271.9 | 69% |
| Los Nopalitos | 6987.1 | 7144 | 3100.3 | 71% |

### *Los Arcos*

Based upon the data above, the overall efficiency of the system (ratio of power provided to power produced) was measured to be 75%. The average utilization of power per residence was 528.1 kWh/month. The 25% loss in power came mostly from the conversion from DC current to AC current and vice versa. Power was lost at the inverters when they converted the DC power in the batteries into AC power for the grid. Power was also lost at the genset and chargers when renewables were not enough to maintain the system (e.g. the power lost through the chargers converting AC power from the genset into DC power for the PowerCells, then back to AC power through the inverters for the grid). The rest of the efficiency power losses can be traced back to voltage line losses on the grid and battery charging efficiency.

***Las Lomas***
Based on the above data, the overall efficiency of the system was measured to be 69%. The average utilization of power per residence was 94.91 kWh/month. The Las Lomas grid was the largest that we ever attempted and it stretched the limits of the inverters and transmission equipment. The extra inefficiency of this system was likely due to the extremely long transmission line runs that were needed for this site.

***Los Nopalitos***
Based on the above data, the overall efficiency of the system was measured to be 71%. The average utilization of power per residence was 170.1 kWh/month.

It was interesting to note that the highest utilization was from the smallest cluster. We surmise that the utilization was due to a high social connection for that site. All the residents for the Los Arcos site were related and had a high level of social contact on a continuing basis. This then led to a higher awareness of the system's capacity across the entire user base which resulted in a higher instance of overall utilization.

## Reliability

Overall, the systems performed well; especially when considering that the sites were completely automated and there was no staff on site. However, as expected, the system reliability was not as high as the commercial grid. System availability is defined as the ratio of uptime to the sum of the uptime and the downtime:

***Los Arcos***
Using the runtime data, the system availability was 93% (16 days downtime/241 total days). This is not to say that the residents went without power during downtime. Whenever there was a failure with the system as a whole, the generator was switched over to auxiliary mode and provided the power to run the grid. When examining the percentage of time that the residents were without power, due to other factors such as late fuel delivery and generator failure, the system availability comes in at 97% (7 days without power/241 total days).

***Las Lomas***
Using the runtime data, the system availability was 92% (20 days downtime/241 total days). The percentage of time that the residents were without power was 5% (11 days without power/241 days); a 95% overall availability.

***Los Nopalitos***

Using the runtime data, the system availability was 90% (23 days downtime/241 total days). The percentage of time that the residents were without power was 5% (13 days without power/241 days), a 95% overall availability.

## Maintainability

A majority of the components in the Hybrid Trailer were solid state devices so there was very little maintenance involved. The genset was by far the most maintenance intensive component of the system, and also the main source of failure. Like any engine, the genset requires regular oil, oil filter, and air filter changes. In addition to the maintenance costs, there were a few occasions when the genset failed at each site. One of the failures was covered under warranty at no additional cost, but other failures happened after the warranty period and were quite expensive. The total maintenance costs for each site to date are shown in Figure 14. The oil and filter changes were performed bi-monthly by Xtreme Power staff. The only other maintenance required was a periodic cleaning of the solar panels if there had been no rain to rinse accumulated dust from the array.

**Table 8. Maintenance or Repair Events**

| Maintenance or Repair Events | Costs |
|---|---|
| **Los Arcos** | |
| Oil, Oil Filter and Air filter changes | $811.00 |
| Fuel Filter Changes | $90.40 |
| Genset Parts, labor, and mileage | $932.00 |
| **Total** | $1,833.40 |

| | |
|---|---|
| **Las Lomas** | |
| Oil, Oil Filter and Air filter changes | $811.00 |
| Fuel Filter Changes | $90.40 |
| Genset Parts, labor, and mileage | $0.00 |
| **Total** | $1,001.40 |

| | |
|---|---|
| **Los Nopalitos** | |
| Oil, Oil Filter and Air filter changes | $811.00 |
| Fuel Filter Changes | $90.40 |
| Genset Parts, labor, and mileage | $1,245.60 |
| **Total** | $2,247.00 |

## Cost Benefit Analysis/Economy of Scale

There are two approaches to examining the return on investment (ROI). The first is on the overall cost and the ability to amortize the cost of the overall system. The second assumes that the initial costs are subsidized and the operational and maintenance costs are paid by the users. In this particular case, we have not and will not receive reimbursement from the residents.

The total system cost (not including labor to assemble and test) is shown in Table 8.

**Table 9. Total System Cost**

| | Base Components | Distribution Grid | Total |
|---|---|---|---|
| Los Arcos | $60,019.76 | $8,615.80 | $68,635.56 |
| Las Lomas | $75,019.76 | $70,346.60 | $145,366.36 |
| Los Nopalitos | $75,019.76 | $15,119.60 | $90,139.36 |

If the system only consisted of the minimal generator system and grid (that is, for a non-hybrid system running exclusively on a diesel generator), the price for the distribution portion of the system should remain the same. The cost for gensets used in this project was approximately $15,000. Of concern is the actual lifetime of the equipment involved. The diesel genset that was used in this system has a warrantee period of one year from "date in service" (with unlimited hours, a possible maximum of 8,760 hours). Internet searches have resulted in useful lifetimes of diesel generators of this class in the range of 10,000 to 40,000 hours depending upon usage. The most common usage is as standby generators, rather than prime power providers and most have seen 8 hours-per-day rather than the 24 hour continuous duty cycle these microgrid systems experienced. These estimates are also contingent upon proper maintenance.

If one uses the optimistic estimate of 40,000 hours of life, this results in a maximum lifetime of the genset itself of 4.5 years. Thus, the amortized value of the genset is about $3,333 per year (at 24 hour operation with no depreciation). However, Xtreme Power's experience in the lifecycles of the PowerCells shows that the batteries will last six years at the charge/discharge rate that was being utilized in this project. With proper maintenance, the system will last an estimated six years before the PowerCells require replacement. During this time, the genset itself will have a runtime of 2.7 years (around 23,600 hours), assuming an equivalent runtime that we have experienced during the operation of the grid to date. Assuming the same load characteristics over the lifetime, this provides a per kilowatt hour capital cost of **$0.34/KWh** for Los Arcos, **$1.16/KWh** for Las Lomas, **$0.68/KWh** for Los Nopalitos (normalizing the collected load to a year and dividing by the projected 4.5 year life). These figures do not include fuel and maintenance costs.

Table 9 shows the fuel costs for the system up to the time that the data was collected for this report. Normalizing the data for fuel consumption during the data gathering period, fuel and maintenance costs over that time totals to $11,356 for Las Lomas, $17,925 for Los Arcos and $18,762 for Los Nopalitos (at the time of the data, very little fuel from the last fill had been used). From Table 7, the total amount of genset power generated over the 7 – 9 month period was 12,263 KWh for Los Arcos, 6,329 KWh for Las Lomas and 6,987 KWh for Los Nopalitos which results in an actual kilowatt hour cost of **$0.85/KWh, $1.05/KWh and $1.57/KWh,** respectively. Using the normalized total amount of power generated (44,368 KWh for Los Arcos, 27,849 KWh for Las Lomas and 29,540 KWh for Los Nopalitos), the cost figure is **$0.40/KWh, $0.41/KWh and $0.64/KWh,** respectively.

**Table 10. Fuel and Maintenance Costs**

| **Las Lomas Fuel** | Volume | Cost | Maintenance Cost |
|---|---|---|---|
| 8/12/2011 | 950 gallons | $3,548.48 | $1,001.40 |
| 11/16/2011 | 60 gallons | $214.09 | |
| 1/16/2012 | 370 gallons | $1,301.66 | |
| 3/27/2012 | 500 gallons | $1,838.55 | |
| **Los Arcos Fuel** | | | |
| 7/7/2011 | 1000 gallons | $3,640.50 | $1,833.40 |
| 11/16/2012 | 331 gallons | $1,181.07 | |
| 1/28/2012 | 1000 gallons | $3,568.20 | |
| 3/27/2012 | 1000 gallons | $3,679.00 | |
| **Los Nopalitos Fuel** | | | |
| 9/19/2011 | 975 gallons | $3,549.49 | $2,247.00 |
| 11/16/2011 | 790 gallons | $2,824.09 | |
| 1/16/2012 | 240 gallons | $844.32 | |
| 3/27/2012 | 657 gallons | $2,415.85 | |

During this analysis, the team noted that the operational cost for the Los Nopalitos grid was significantly higher than costs for the other two grids. Analysis determined that the cost is sensitive to the runtime of the genset. At the Los Nopalitos location, there was a significant amount of time (around fifteen days) that a fault of the system caused the genset to run without generating power that was logged by the control system (the auxiliary transfer switch failed to operate). The genset ran at no load and consumed fuel which was included in fuel costs. This was significant enough to raise the per kilowatt-hour cost significantly. We also observed that the genset was actually running in the ¼ standby regime when it was running the grid in auxiliary mode (storage and renewable systems off and genset powering the grid directly). This was not an efficient use of the generators capacity in the auxiliary mode. Further study is required to determine if overall fuel costs could be lower by optimizing the size of the genset. A smaller genset would require less fuel, but would require more runtime to give an equivalent charge to the PowerCell™ pack. However, the net fuel usage could be lower in that situation. A smaller genset would also run more efficiently when powering the grid in auxiliary mode.

These figures show that the fuel and maintenance costs are approximately equivalent to the capital costs of the system over its life. There was a significant variance in capital costs driven by the area being served. The smaller system was significantly less expensive in terms of the distribution grid. At an investment level, it would be hard to justify systems of this type without a justification that overrides economic considerations.

Another important observation could have large on the economics by using the actual runtimes of the gensets in this application. Table 11 shows the actual runtimes of the gensets during the test period of 241 days (5,784 total hours). Normal utilization of a genset without the hybrid system in this application would require the genset to run continuously to provide 24-hour availability of electricity. This shows that the hybrid system significantly reduced runtimes and fuel and maintenance costs. Note that in Table 11, the genset runtime for Los Nopalitos is about double that of Las Lomas, where in Table 7, shows the energy produced for the two grids is close to the same. This shows the effect of the control failure causing the genset to run in a no-load condition at Los Nopalitos continuously for fifteen days thus increasing the fuel and maintenance costs for that grid compared to Las Lomas. This is about $30K in avoided fuel costs for Los Arcos alone which is a 2.6 year simple payback on the avoided fuel costs alone. This reduction in runtime also extends the life of the system to the life of the inverts which adds ½ to 1½ years to the life of the system, further reducing the per kWh capitals costs as well.

**Table 11. Genset Run Times**

| Location | Genset Run Time (Hours) | Percent Reduction From Continuous Operation |
|---|---|---|
| Los Arcos | 2,080 | 64% |
| Los Nopalitos | 1,043 | 82% |
| Las Lomas | 501 | 91% |

One solution that residents of the Colonias previously employed was the use of small portable generators to provide power to their homes. It is interesting to note the comparison of the fuel costs of running a portable generator with the fuel costs of the micro-grid system. A Honda GX340 was chosen to make this comparison. The GX340 has a rating of 4500 W, which if run continuously provides 108 kWh of power at full load over a 24 hour period. The current average price of gas in Laredo is $3.50 per gallon. Over a 24 hour period, the GX340 uses 19 gallons of gas. Using this data, the resident can expect to pay **$0.62/kWh** which provides availability of electricity for the resident only when it is running, not on a 24 hour/day basis (generally the fiuel tank only holds 1 – 2 gallons. When comparing fuel costs, we found that, on average between all systems, we achieved a **$0.43/kWh** fuel cost while maintaining 24-hour availability. This allowed the residents to use appliances, such as a refrigerator, which required a constant electrical supply.

# Conclusions

This project allowed for Xtreme Power to complete a "near production" set of prototype hybrid micro-grid systems for off-grid applications. Small modifications to the control and utilization of grid compatible inverters would allow these systems to act as grid-connected distributed generation sources as well since all power is routed through the battery storage system. We also state the following observations/conclusions:

- While we were able to show that the fuel cost per kilowatt-hour is reduced over using single standby generators, the capital costs are hard to justify on an economic basis for a reasonable payback in a colonia situation.
- In situations requiring 24 hour availability without grid connection, these hybrid systems significantly reduce fuel costs and can make an economic return on investment in avoided fuel costs alone.
- Power availability is adequate; however, maintenance issues can reduce availability of power.
- Power was made available to residents at no cost due to Texas utilities code requirements. If power is provided for fees, then the issues that cause residents to not have grid connections come into play and will prevent connections to systems such as this. As such, the model employed in this project is unsustainable.
- A system design was finalized and documented. The system performance was qualified and demonstrated high availability, however, it is well short of the availability normally achieved with grid distribution with many redundancies. Therefore, the availability of power was well beyond that of using a small standby generator at each residence for a few hours a day and providing continuous electric service necessary for food refrigeration and small climate control devices.
- Overall the system achieved a 96% availability rate. This rate was primarily driven by maintenance requirements of the diesel gensets.
- Capital costs were dependent upon the size of the generation system and the scope of the distribution system. Capital costs averaged $0.72/kWh delivered over the life of the systems; however, this number is skewed by the large cost of one of the distribution systems; however, the cost of a more constrained system that minimizes distribution loss throughout the system would be somewhat less. The two larger systems were also

underutilized, which increased the per kWh cost since fewer kWh were produced by those systems.

- Fuel and maintenance costs were commensurate but slightly lower than the capital costs with an average of $0.48/kWh but were significantly less than using an individual gasoline generator for a few hours while maintaining the advantage of continuously available electric power for continuous loads such as food refrigeration.

# Bibliography

[1] Schneider, D., Martin, M., Berry, R., & Moyer, C. (2011). *Renewable Energy Powered Mobile Micro-grid Installations for Border Colonias.* San Antonio: Texas Engineering Experiment Station.

# Appendix A:  Design Details

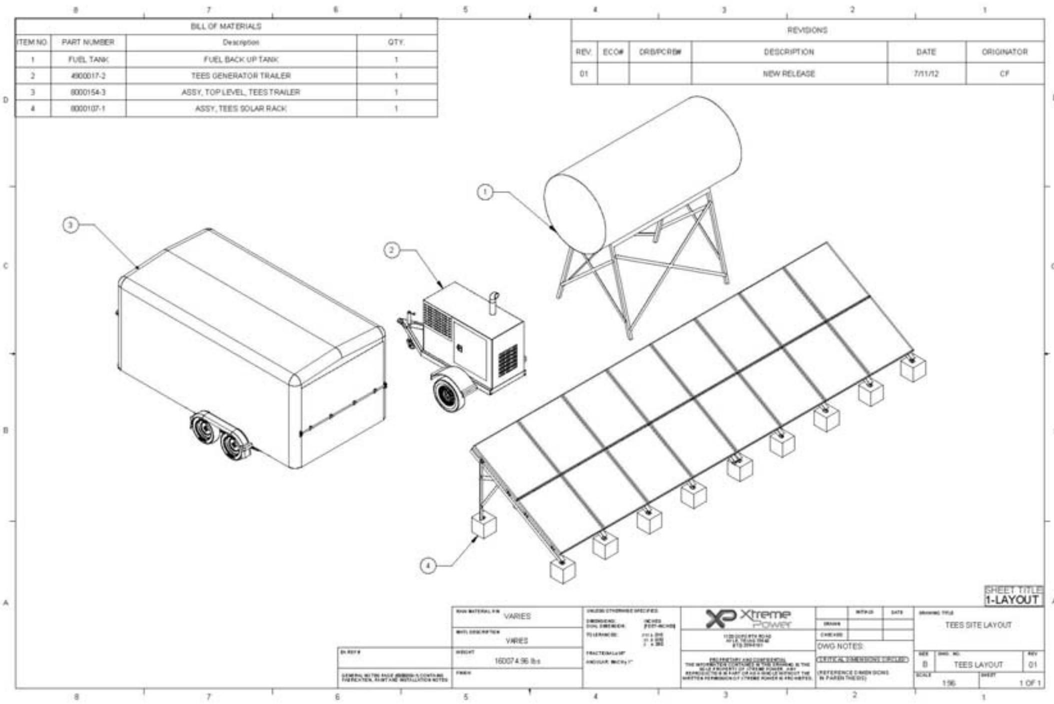



**Figure A-1.  System Configuration**

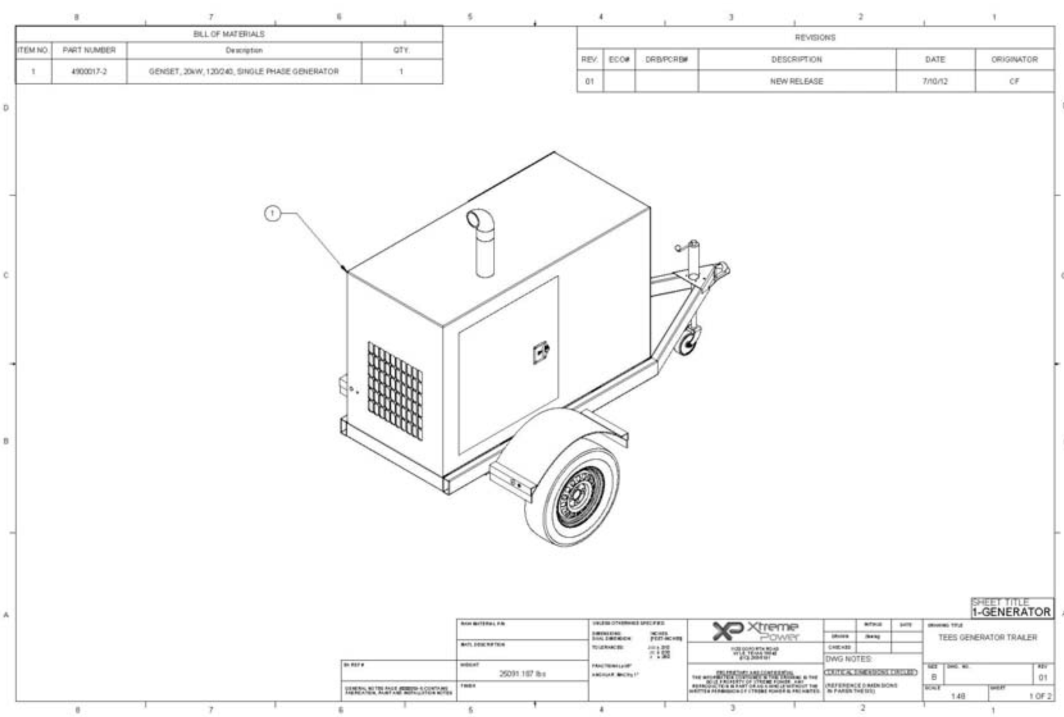



**Figure A-2.  Genset**

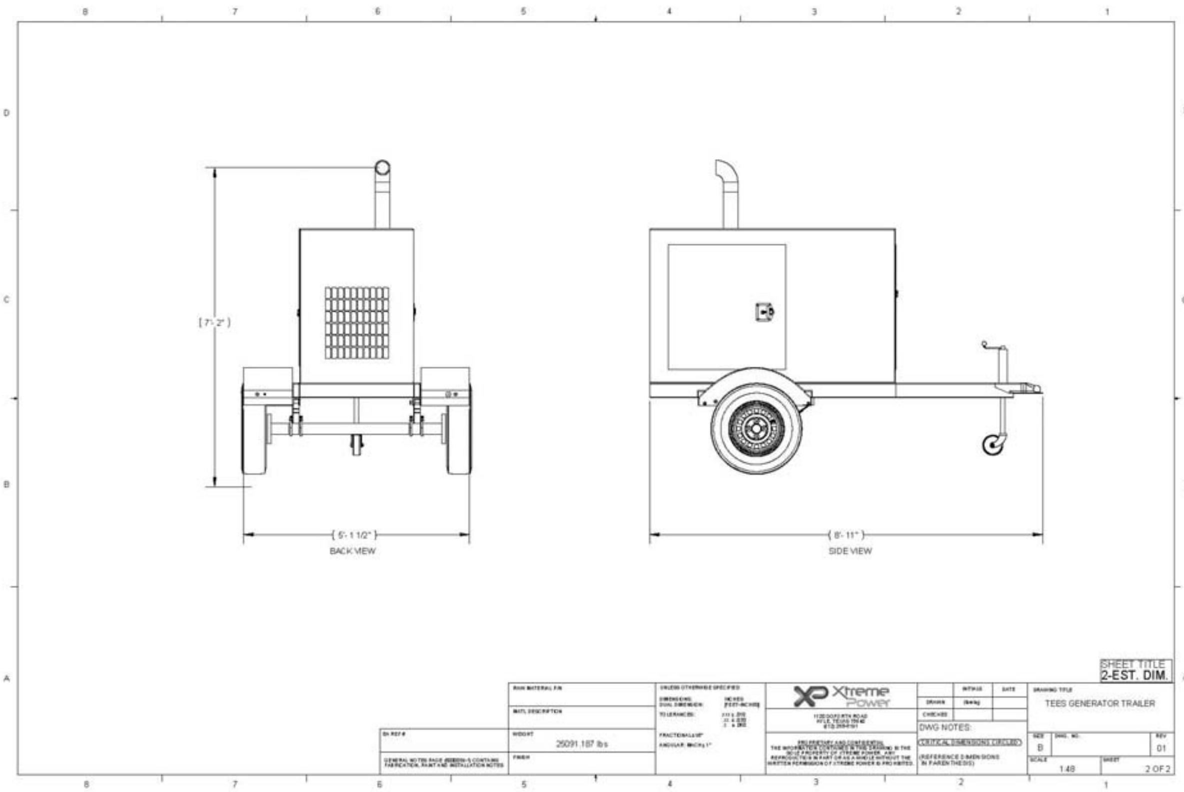



**Figure A-3. Genset Dimensions**

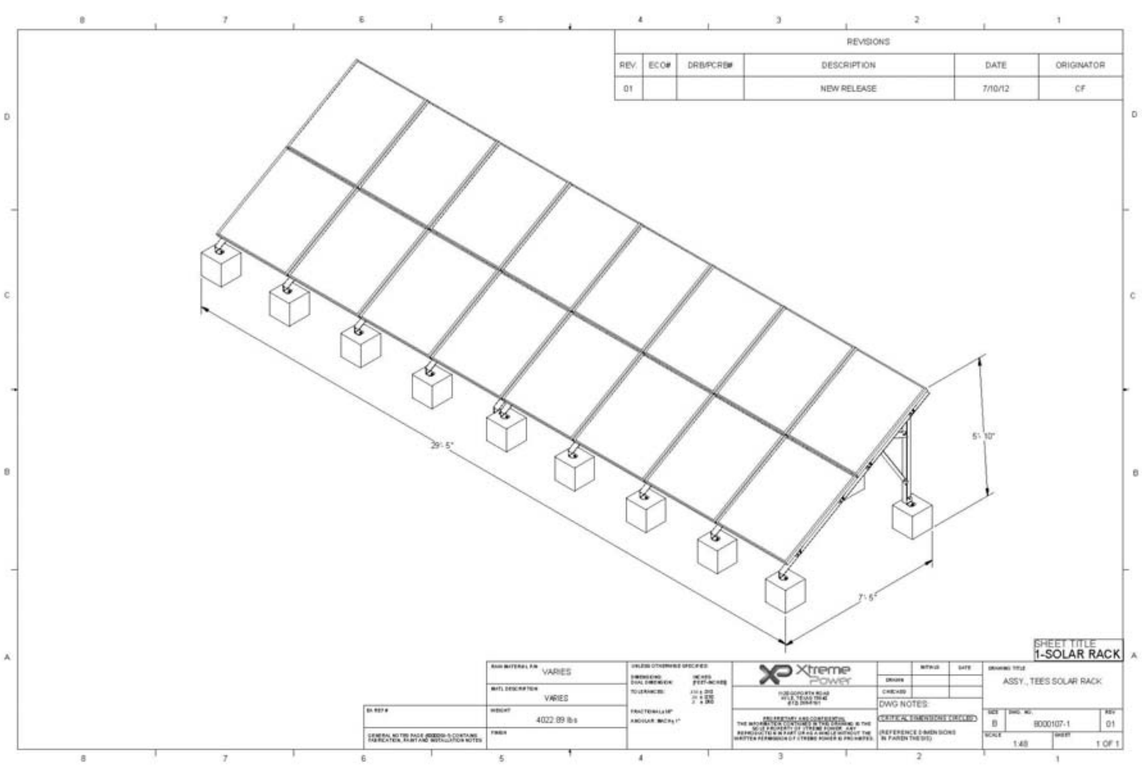



**Figure A-4. Photovoltaic Arrays Configuration**

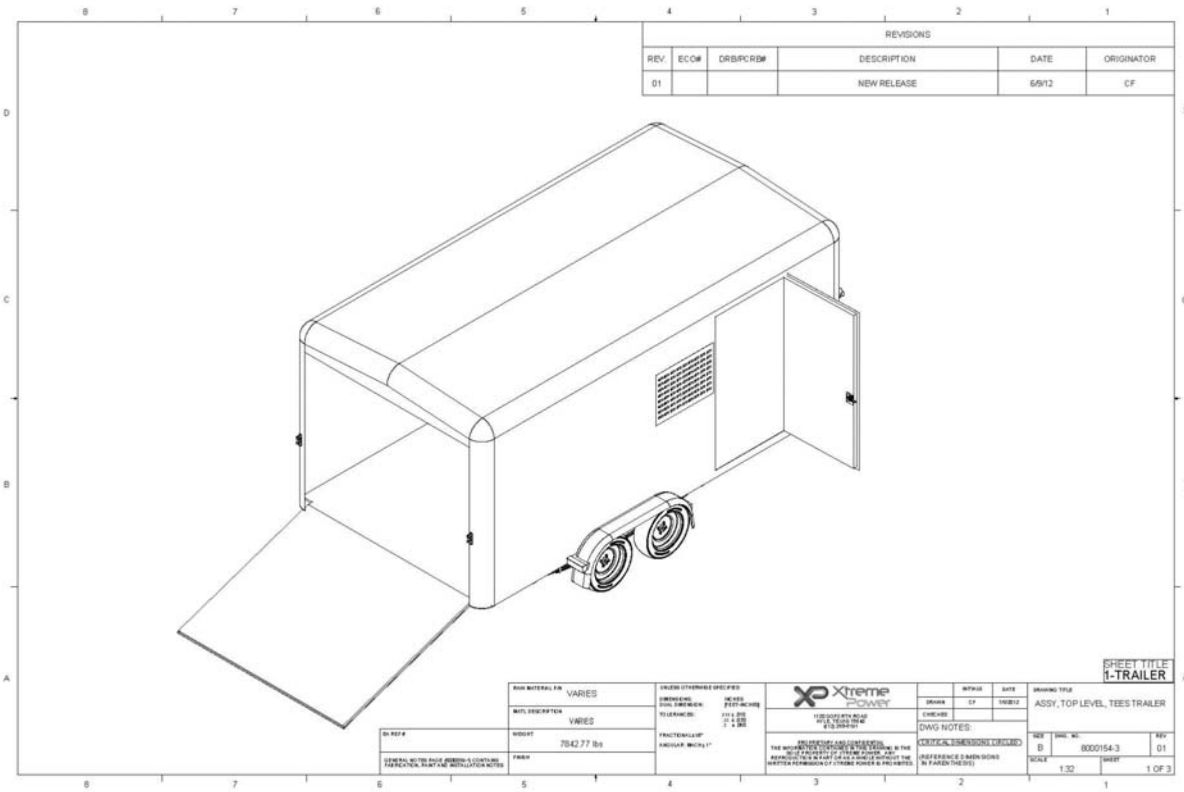



**Figure A-5. Generation System Trailer**

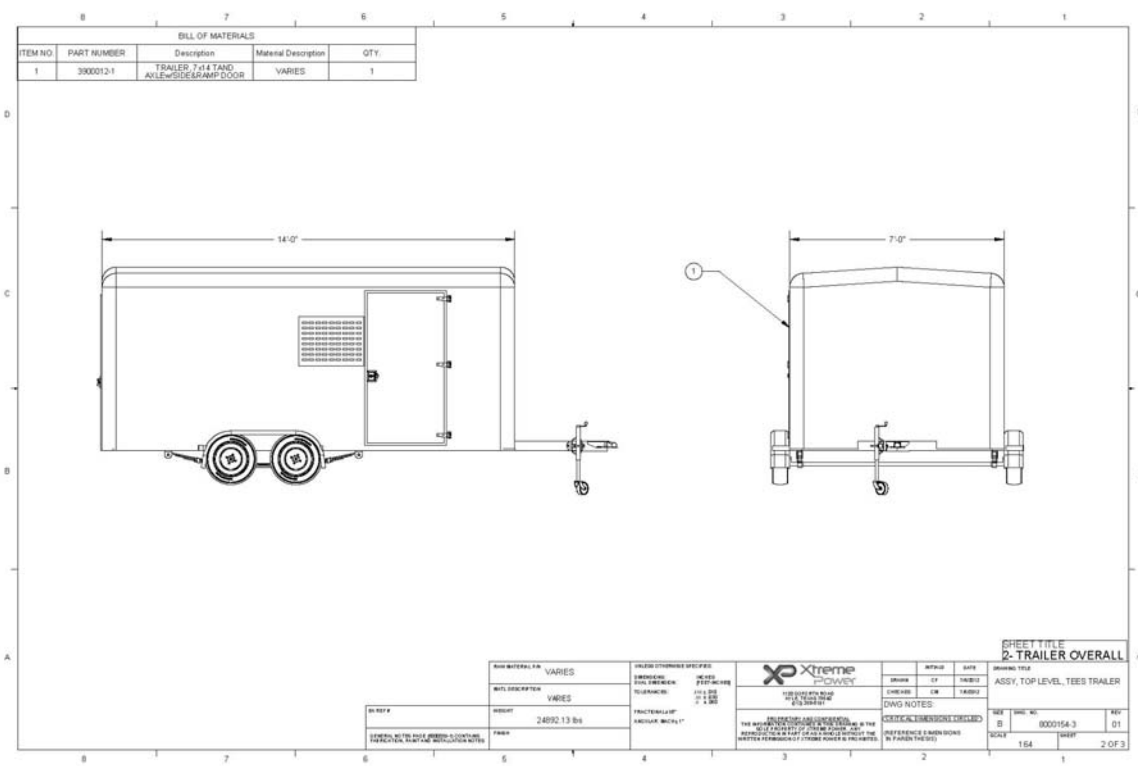



**Figure A-6. Generation System Trailer Dimensions**

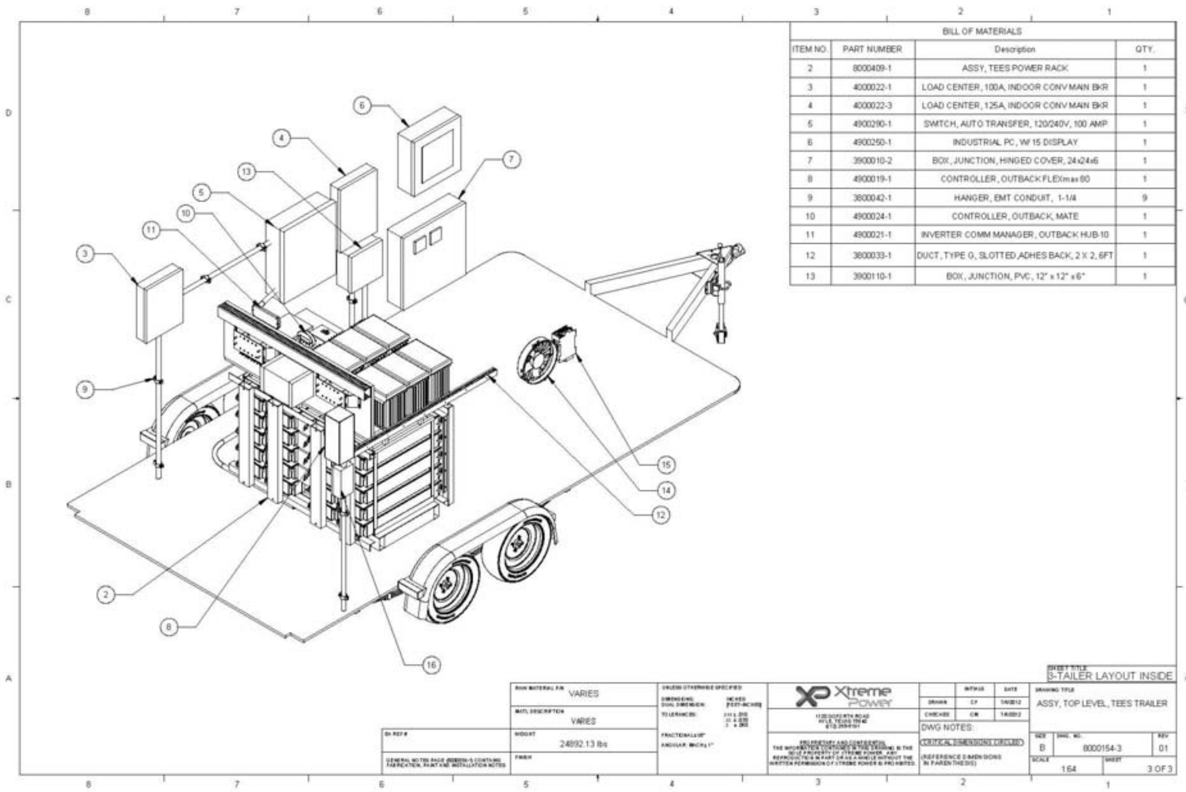



**Figure A-7. Trailer Component Layout**

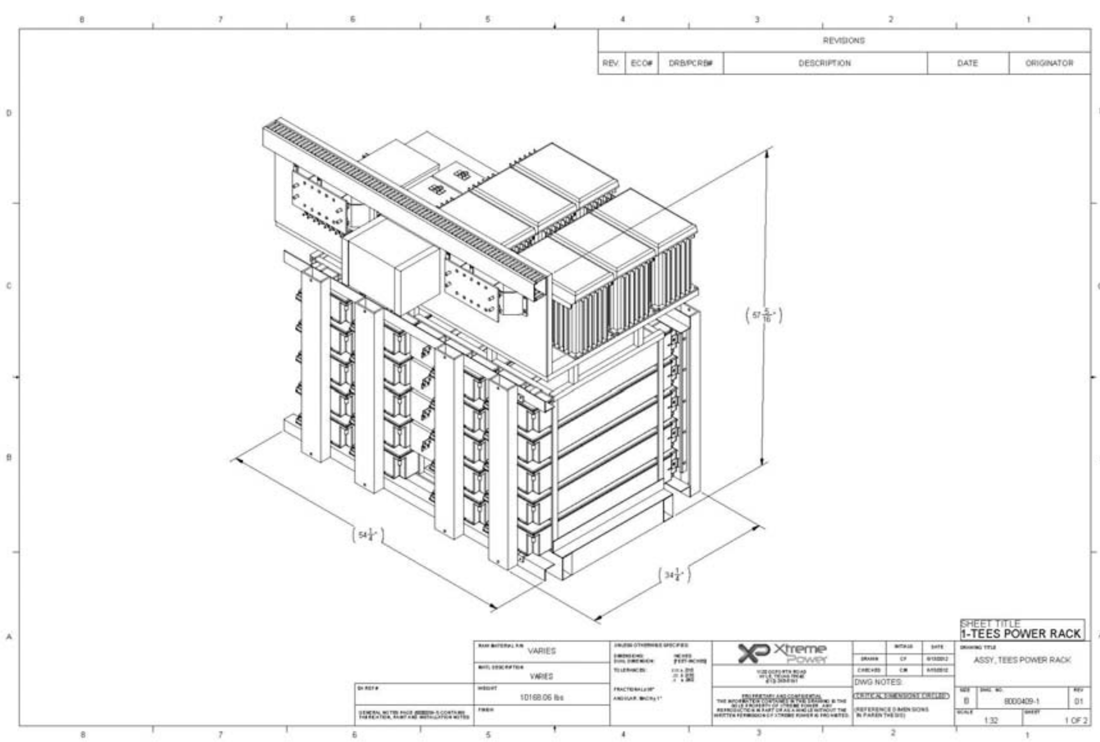
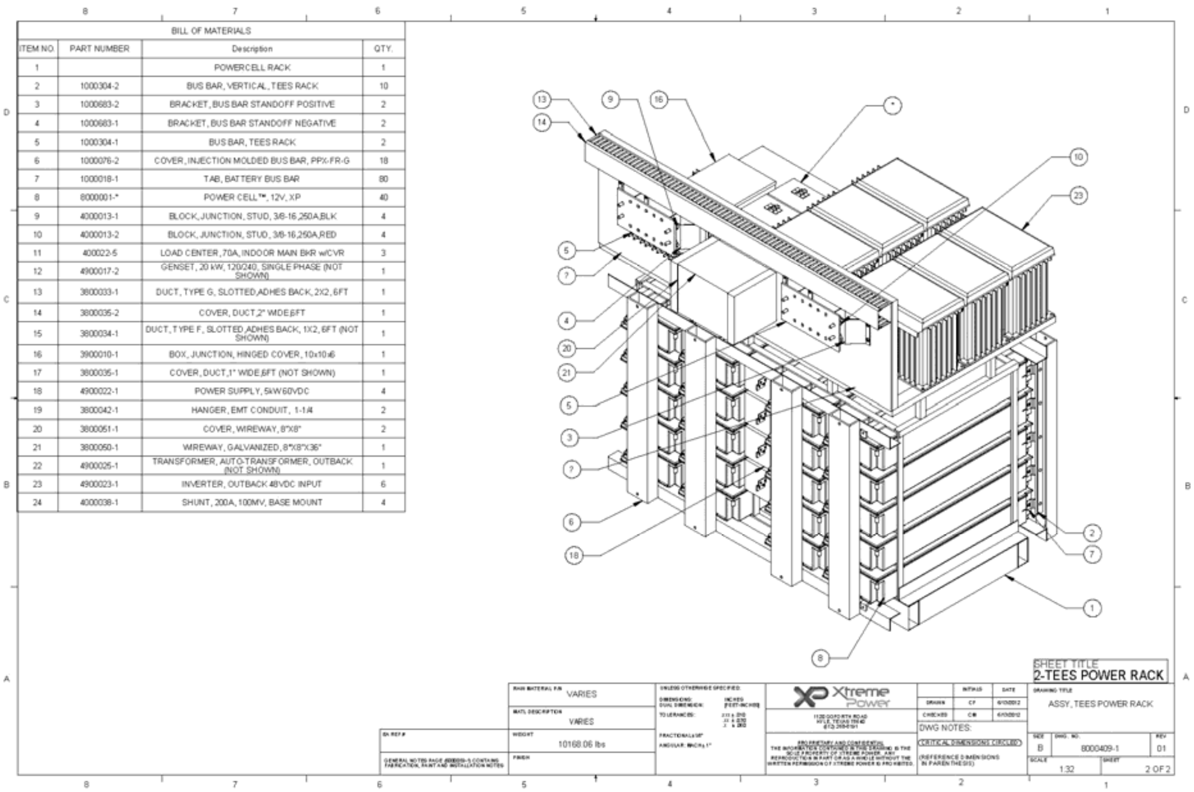



**Figure A-8. PowerCell® Stack Dimensions**



| ITEM NO. | PART NUMBER | Description | QTY. |
|---|---|---|---|
| 1 | | POWERCELL RACK | 1 |
| 2 | 1000304-2 | BUS BAR, VERTICAL, TEES RACK | 10 |
| 3 | 1000683-2 | BRACKET, BUS BAR STANDOFF POSITIVE | 2 |
| 4 | 1000683-1 | BRACKET, BUS BAR STANDOFF NEGATIVE | 2 |
| 5 | 1000304-1 | BUS BAR, TEES RACK | 2 |
| 6 | 1000076-2 | COVER, INJECTION MOLDED BUS BAR, PPX-FR-G | 18 |
| 7 | 1000018-1 | TAB, BATTERY BUS BAR | 80 |
| 8 | 8000001-* | POWER CELL™, 12V, XP | 40 |
| 9 | 4000013-1 | BLOCK, JUNCTION, STUD, 3/8-16,250A,BLK | 4 |
| 10 | 4000013-2 | BLOCK, JUNCTION, STUD, 3/8-16,250A,RED | 4 |
| 11 | 400022-5 | LOAD CENTER, 70A, INDOOR MAIN BKR w/CVR | 3 |
| 12 | 4900017-2 | GENSET, 20 kW, 120/240, SINGLE PHASE (NOT SHOWN) | 1 |
| 13 | 3800033-1 | DUCT, TYPE G, SLOTTED,ADHES BACK, 2X2, 6FT | 1 |
| 14 | 3800035-2 | COVER, DUCT,2" WIDE,6FT | 1 |
| 15 | 3800034-1 | DUCT, TYPE F, SLOTTED,ADHES BACK, 1X2, 6FT (NOT SHOWN) | 1 |
| 16 | 3900010-1 | BOX, JUNCTION, HINGED COVER, 10x10x6 | 1 |
| 17 | 3800035-1 | COVER, DUCT,1" WIDE,6FT (NOT SHOWN) | 1 |
| 18 | 4900022-1 | POWER SUPPLY, 5kW 60VDC | 4 |
| 19 | 3800042-1 | HANGER, EMT CONDUIT, 1-1/4 | 2 |
| 20 | 3800051-1 | COVER, WIREWAY, 8"X8" | 2 |
| 21 | 3800050-1 | WIREWAY, GALVANIZED, 8"X8"X36" | 1 |
| 22 | 4900025-1 | TRANSFORMER, AUTO-TRANSFORMER, OUTBACK (NOT SHOWN) | 1 |
| 23 | 4900023-1 | INVERTER, OUTBACK 48VDC INPUT | 6 |
| 24 | 4000038-1 | SHUNT, 200A, 100MV, BASE MOUNT | 4 |



**Figure A-9. PowerCell® Stack Components**

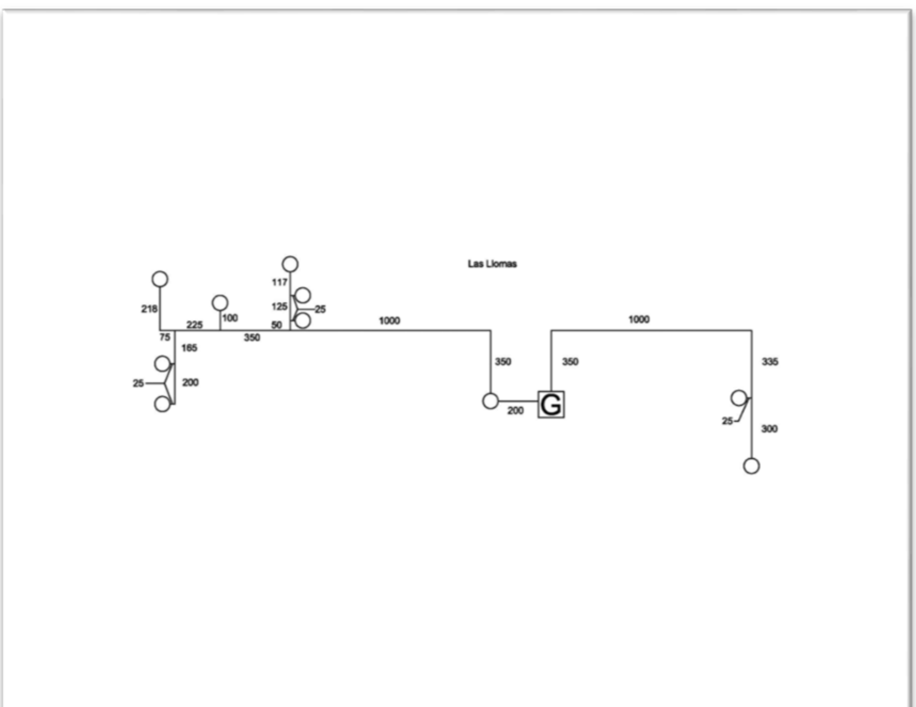




**Figure A-10. Las Lomas Grid Configuration**

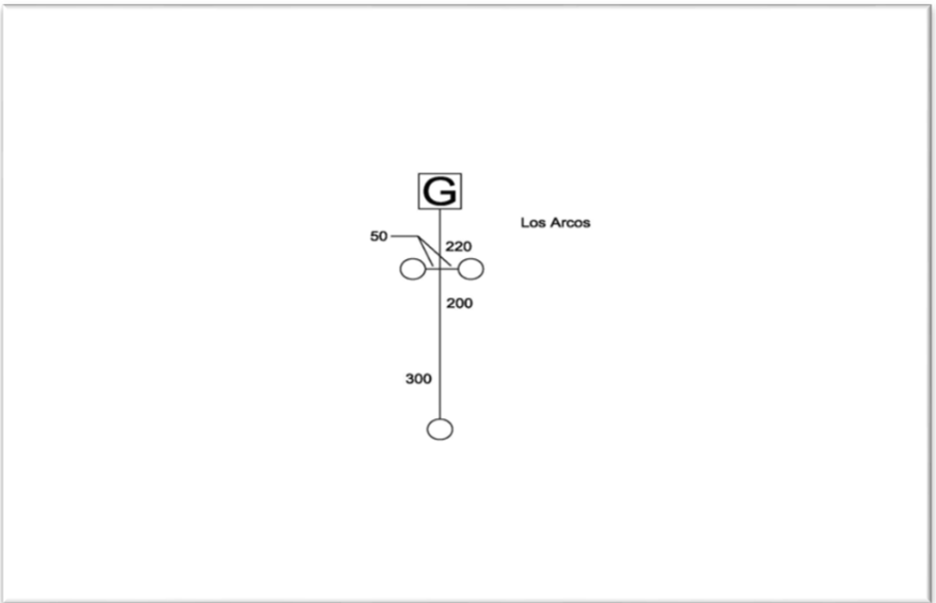



**Figure A-11. Los Arcos Grid Configuration**

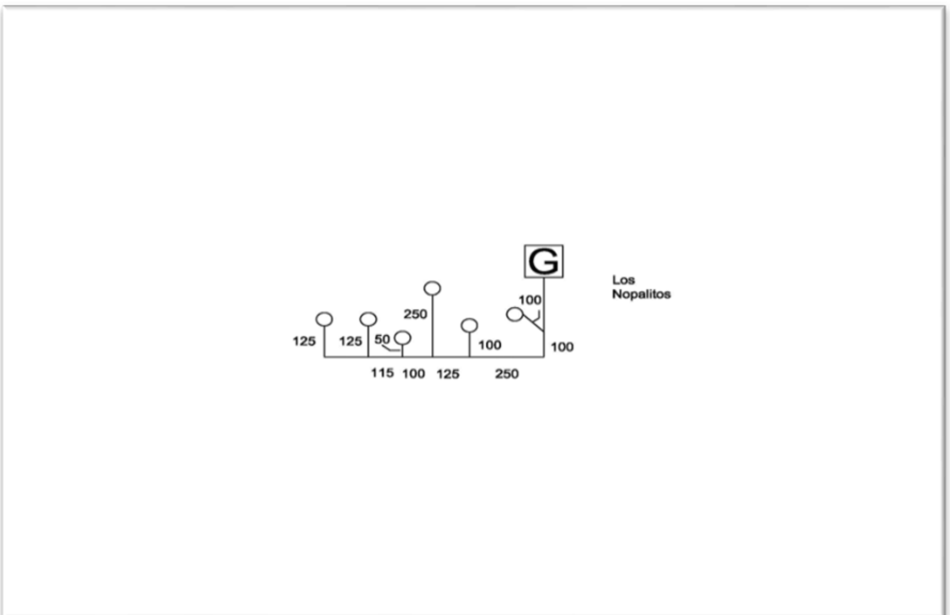



**Figure A-12. Los Nopalitos Grid Configuration**

## Table A-1. Bill of Materials for Las Lomas

| XPS Bill of Materials | | | | | | |
|---|---|---|---|---|---|---|
| **TEES #A7801 (Grid 1 - Las Lomas)** | | | | | | |
| **Part #** | **Part Name** | **Qty.** | **Vendor** | **Vendor Part No.** | **Lead Time** | |
| | **Trailer/Structural** | | | | | |
| 3900012-1 | TRAILER, 7x14 TAND AXLEw/SIDE&RAMP DOOR | 1 | Magnum Trailers | need part number/ | In Stock | |
| | **Battery/Inverter Rack** | | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 2 x 23" | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 1 x 8" | | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 20" | | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 55-1/2" | | | | |
| 7000029-2 | L-BAR,1"x1"x1/4"x20' A36 | 10 x 23" | | | | |
| 7000010-1 | STRUCT TUBING,1"SQx11GAx20',A500 GR-A | 1 x 49" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 21" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 4 x 56.375" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 31.375" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 1 x 14" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 18" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 13.25" | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 27.375" | | | | |
| 1000024-1 | LATTICE, NOTCHED VERTICAL | 8 | | | | |
| 7000017-2 | HR FLAT BAR, 2"x1/4"x20' A36 | 2 | | | | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4Fiberglass Sheet 24 x 30 | | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4 Fiberglass Sheet 56.375 x 18 | | |
| 7000001-01 | FIBERGRATE, SQUARE TUBE, 4x4x1/4 | 5 x 32.313 | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 4 x 54.25" | | | | |
| 7000027-1 | CR FLAT SHEET, 4'x8'X16GA LOW CARBON STL | 2 | | | | |
| | | | | | | |
| | **Genset Trailer** | | | | | |
| 4900017-2 | GENSET, 20 kW, 120/240, SINGLE PHASE | 1 | Cummins | 20DSKBA | | |
| | Diesel | 1000 | Arguindegui Oil | | | |
| | Fuel Tank Delivery | | Arguindegui Oil | | | |
| | Bio-Diesel | 1000 | Arguindegui Oil | | | |
| 7000013-2 | STRUCT TUBING,4x2x1/4x20',A500 GR-B | 1 | | | | |
| 7000030-1 | L-BAR,1.5"x1.5"x1/8"x20' A36 | 1 | | | | |
| 3900004-1 | TIRE, 15X5-4.5,W/S,ST20575D15C | 2 | Southwest Wheel | CTW M017C-215512 | | |
| 3900005-1 | AXLE, 48.5 | 1 | Southwest Wheel | DXA S3548.5 | | |
| 3900006-1 | SPRING, LEAF, 25-1/4",DOUBLE EYE | 2 | Southwest Wheel | EMC SW4B | | |
| 3900007-1 | KIT, 2-3/8 U-BOLT,FOR 2-3/4" ROUND AXLE | 1 | Southwest Wheel | HAY APUBR238BX | | |
| 3900008-1 | KIT, SINGLE AXLE,1-3/4" DOUBLE EYE SPRNG | 2 | Southwest Wheel | HAY APS1BX | | |
| 3900009-1 | COUPLER, 2" A-FRAME 5000# W/HOLE | 1 | Magnum Trailer | | | |
| 3900009-2 | FENDER, 9x32X48, w/12” BACK, SINGLE AXLE | 2 | Magnum Trailer | | | |
| 3900009-3 | KIT, LIGHT FOR TRAILER | 1 | Magnum Trailer | | | |
| 3900009-4 | JACK, 2K TOP WIND A-FRAME | 1 | Magnum Trailer | | | |
| 3900009-5 | CHAINS, SAFETY, 3/16X30" w/HOOK&LATCH | 2 | Magnum Trailer | | | |
| 3900009-6 | BRACKET, 7/16 CHAIN EYELET | 2 | Magnum Trailer | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Solar Array** | | | | | |
| | **Solar Panels** | | | | | |
| 4900018-2 | 225W/24 V Solar Panels | 21 | Ameresco Solar | | | |
| 4900260-1 | CABLE ASSY, T4 MC OUTPUT, 35' | 7 | Ameresco Solar | | | |
| 4900020-1 | MODULE, PSPV COMBINER BOX FLEXware PV-8 | 1 | Ameresco Solar | | | |
| 4000021-1 | BREAKER, 15 AMP, 150VDC, DIN RAIL MOUNT | 7 | Ameresco Solar | | | |
| 4900261-1 | CABLE ASSY, OUTPUT W/FLEX CONDUIT, #6 1x20' | 2 | Ameresco Solar | | | |
| 4900019-1 | CONTROLLER, OUTBACK FLEXmax 80 | 1 | Ameresco Solar | | | |
| 4000020-1 | BREAKER, 80 AMP, 150VDC, PANEL MOUNT | 2 | Ameresco Solar | OBB-80-150-VDC-PNL | | |
| 5000001-02 | CABLE, WELDING, 420X30, 4AWG, BLK | 50' | | | | |
| 4800006-2 | TERM, LUG, 4AWG, 5/16" TIN PLATE | 18 | | | | |
| 4800006-3 | TERM, LUG, 4AWG, 3/8" TIN PLATE | 6 | | | | |
| 5000017-02 | HEAT SHRINK, 1/2", RED | 5" | | | | |
| 5000017-10 | HEAT SHRINK, 1/2", BLACK | 14" | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | **Solar Panel Rack** | | | | | |
| 1000311-1 | SUPPORT, L-BAR, ALUM, 3"X3"X148" | 8 | | | | |
| 1000207-1 | BRACKET, L-BAR, ALUM, 2.5"X2.5"X3" | 48 | | | | |
| 1000312-1 | UPPER CROSS BEAM, L-BAR, ALUM, 2"X 2"X 231" | 3 | | | | |
| 1000312-3 | MIDDLE CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | |
| 1000312-4 | LOWER CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | |
| 1000208-1 | BRAKET, FOOT, L-BAR, ALUM, 2" X 2" X 3" | 16 | | | | |
| 1000204-1 | ANCHOR, CONCRETE | 16 | | | | |
| 1000313-1 | SUPPORT, UPRIGHT, L-BAR, ALUM, 2.5" X 2.5" X 52.75" | 8 | | | | |
| 1000314-1 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 70 " | 2 | | | | |
| 1000314-2 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 73 " | 12 | | | | |
| 3000182-1 | SCREW, HEX CAP, ZINC, .375"-16 X 1" | 122 | | | | |
| 3000185-1 | NUT, HEX, ZINC, .375"-16 | 122 | | | | |
| 3000033-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1" | 56 | | | | |
| 3000020-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1.5" | 32 | | | | |
| 3000066-1 | NUT, HEX, ZINC, .25"-20 | 88 | | | | |
| 3000219-1 | ANCHOR, SLEEVE STUD, HEX .3125"-18 X 3" | 16 | | | | |
| 3000263-1 | WASHER, FLAT, .25", .281" ID, .625" OD | 2 | | | | |
| 3000262-1 | SCREW, MACHINE, TORX, .3125"-18 X 1" | 84 | | | | |
| 3000067-1 | NUT, HEX, .3125"-18 | 84 | | | | |
| 3000002-4 | WASHER, FLAT, ZINC, .25" | 88 | | | | |
| 3000002-5 | WASHER, FLAT, ZINC, .3125" | 84 | | | | |
| 3000002-1 | WASHER, FLAT, ZINC, .375" | 122 | | | | |
| | | | | | | |
| | **Solar Panel Rack Tools** | | | | | |
| 3900115-1 | KIT, ANCHOR TIE DOWN | 2 | | | | |
| Y56450256FL0 | T-15 TORX SECURITY DRIVER | 5 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Trailer DC** | | | | | |
| 8000001-4 | POWER CELL™, 12V, XP, 12D2000A | 40 | Xtreme Power | Power Cell | In Stock | |
| 4900022-1 | POWER SUPPLY, 5kW 60VDC | 4 | Pioneer Magnetics | PM33215B-5-1-5-H | 4-6 weeks | |
| 1000304-1 | BUS BAR, TEES RACK | 10 | | | | |
| 1000018-1 | CLIP, BATTERY BUS BAR | 80 | | | | |
| 3000012-1 | NUT, NYLK, ZNC,GR2, 3/8-16 | 70 | | | | |
| 3000016-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1-1/2 | 50 | | | | |
| 3000017-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1" | 20 | | | | |
| 3000002-1 | WASHER, FLAT, ZINC PLATE, 3/8" SAE | 100 | | | | |
| 3000014-1 | NUT, NYLK, ZNC,GR2, 5/16-18 | 8 | | | | |
| 3000018-1 | SCREW, CAP, HEX HD, ZNY, GR8, 5/16-18 x 3/4 | 8 | | | | |
| 3000009-1 | WASHER, FLAT, 18-8 SS, 5/16 x 7/8", | 8 | | | | |
| 3000013-1 | NUT, NYLK, ZNC,GR2, 1/4-20 | 60 | | | | |
| 3000019-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3" | 20 | | | | |
| 3000020-1 | SCREW, CAP, HEX HD, ZNC, GR5, 1/4-20 x 1-1/2" | 8 | | | | |
| 3000021-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 1" | 16 | | | | |
| 300006-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3/4 | 16 | | | | |
| 3000002-4 | WASHER, FLAT, ZINC PLATE, 1/4" SAE | 72 | | | | |
| 4000013-2 | BLOCK, JUNCTION, STUD, 3/8-16,250A,RED | 4 | | | | |
| 4000013-1 | BLOCK, JUNCTION, STUD, 3/8-16,250A,BLK | 4 | | | | |
| 5000017-10 | HEAT SHRINK, 1/2", RED | 18" | | | | |
| 5000017-02 | HEAT SHRINK, 1/2", BLACK | 39" | | | | |
| 4000019-1 | BREAKER, 125 AMP, 125VDC, PANEL MOUNT | 6 | Ameresco Solar | OBB-125-125VDC-PI | 7-10 days | |
| 7000004-1 | COPPER BUS BAR,6"x1/4"x6', A110,BSS | 2 X 11" | | WIP Paul | | |
| 5000001-03 | CABLE, WELDING, 665X30, 2AWG, BLK | 120' | | | | |
| 4800007-2 | TERM, LUG, 2AWG, 5/16" TIN PLATE | 24 | | | | |
| | | | | | | |
| | | | | | | |
| | **Trailer AC** | | | | | |
| 4900010-1 | SWITCH, TRANSFER, 100A | 1 | Iota | ITS-100R | 2 weeks | |
| 4000022-3 | LOAD CENTER, 125A, INDOOR CONV MAIN BKR | 1 | Grainger | Q0124M125 | | |
| 4000022-4 | COVER FOR 4000022-03 | 1 | Grainger | QOC24US | | |
| 4000022-1 | LOAD CENTER, 100A, INDOOR CONV MAIN BKR | 1 | Grainger | QO116M100 | | |
| 4000022-2 | COVER FOR 4000022-01 | 1 | Grainger | QOC20U100S | | |
| 4000022-06 | BREAKER, 20A, 1-POLE, 120/240VAC, 3/4" | 1 | Grainger | QO120 | | |
| 4000022-07 | BREAKER, 30A, 1-POLE, 120/240VAC, 3/4" | 6 | Grainger | QO130 | | |
| 4000022-10 | BREAKER, 30A, 2-POLE, 120/240VAC, 3/4" | 4 | Grainger | QO230 | | |
| 4000022-08 | BREAKER, 100A, 2-POLE, 120/240VAC, 3/4" | 2 | Grainger | QO2100 | | |
| 4000022-5 | LOAD CENTER, 70A, INDOOR MAIN BKR w/CVR | 3 | Grainger | QO24L70S | | |
| 4000130-1 | BLOCK, POWER DISTRIB, 600VAC, 4 POLE | 1 | Graybar | | | |
| 4900023-1 | INVERTER, OUTBACK 48VDC INPUT | 6 | Ameresco Solar | VFX3648 | 2 weeks | |
| 4900024-1 | CONTROLLER, OUTBACK, MATE | 1 | Ameresco Solar | MATE | 2 weeks | |
| 4900021-1 | INVERTER COMM MANAGER, OUTBACK HUB-10 | 1 | Ameresco Solar | HUB-10 | | |
| 4900025-1 | TRANSFORMER, AUTO-TRANSFORMER, OUTBACK | 1 | Ameresco Solar | FW-X240 | 2 weeks | |
| 3900010-1 | BOX, JUNCTION 10x10x6 HINGED COVER | 1 | Allied | 806-0778 | 7 days | |
| 3900110-1 | BOX, JUNCTION, PVC, 12" x 12" x 6" | 1 | | | | |
| 3800049-1 | CONN, LIQTIGHT, NON-INSUL, STL, 1" | 2 | Fastenal | 0720947 | | |
| 3800038-1 | CONDUIT BODY, TYPE LB, AL, 1-1/4 | 4 | Fastenal | 0703826 | 2-3 days | |
| 3800039-1 | COVER, CONDUIT BODY, 1-1/4 - 1-1/2 | 4 | Fastenal | 0700312 | 2-3 days | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3800040-1 | FITTING, CONN EMT SET SCREW, ZN, 1-1/4 | 10 | Fastenal | 0700103 | 2-3 days | |
| 3800041-1 | FITTING, COUPLING EMT, ZN,1-1/4 | 4 | Fastenal | 0700163 | 2-3 days | |
| 3800042-1 | HANGER, EMT CONDUIT, 1-1/4 | 10 | Fastenal | 44543 | 2-3 days | |
| 3800048-1 | FITTING, NIPPLE, GALV STL,1-1/4X2-1/2 S40 | 2 | Fastenal | 0700655 | 2-3 days | |
| 3800044-1 | FITTING, INSULATED BUSHING, 1-1/4" | 1 | Fastenal | 0700611 | 2-3 days | |
| 3800045-1 | CONDUIT, LIQTIGHT,PVC GRAY, 1"x100' | 50' | Fastenal | 0708538 | 2-3 days | |
| 3800069-1 | CONDUIT, LIQTIGHT, PVC, GRAY, 1-1/4" x 50' | 50' | | | | |
| 3800046-1 | FITTING, INSULATED BUSHING, 1" | 1 | Fastenal | 0700610 | 2-3 days | |
| 3800047-1 | HANGER, EMT CONDUIT, 1" | 4 | Fastenal | 44542 | 2-3 days | |
| 3800050-1 | WIREWAY, GALVANIZED, 8*X8"X36" | 1 | Elliott | | 2-3 days | |
| 3800051-1 | COVER, WIREWAY, 8"X8" | 4 | Elliott | | 2-3 days | |
| 3800072-1 | NIPPLE, GALV STL, 1-1/4 x 3" S40 | 3 | Elliott | 114X3 | 2-3 days | |
| 3800037-1 | FITTING, LOCKNUT, 1-1/4" | 18 | Elliott | 104S | 2-3 days | |
| 3800036-1 | CONDUIT,EMT, STEEL, 1-1/4 x10' | 30' | Elliott | EMT114 | 2-3 days | |
| 3800055-1 | FITTING, CONN EMT, SET SCREW, ZN, 1-1/4 | 3 | Elliott | 233DC | 2-3 days | |
| 3800056-1 | FITTING, COUP EMT, SET SCREW, ZN, 1-1/4 | 2 | Elliott | 243DC | 2-3 days | |
| 3800058-1 | FITTING, 2-HOLE EMT STRAP, STEEL, 1-1/4" | 5 | Elliott | 1923 | 2-3 days | |
| 3800059-1 | NIPPLE, GALV STL, 1-1/4 " x CLOSE, SCH40 | 2 | Elliott | | 2-3 days | |
| 5000006-09 | WIRE, 10AWG,TIN,105X30,600V,105C,WHITE | 68' | | | | |
| 5000006-05 | WIRE, 10AWG,TIN,105X30,600V,105C,GREEN | 65' | | | | |
| 5000006-02 | WIRE, 10AWG,TIN,105X30,600V,105C,RED | 65' | | | | |
| 5000006-05 | WIRE, 8AWG,TIN,133X29,600V,105C,GREEN | 21' | | | | |
| 5000005-02 | WIRE, 8AWG,TIN,133X29,600V,105C,RED | 21' | | | | |
| 5000005-09 | WIRE, 8AWG,TIN,133X29,600V,105C,WHITE | 21' | | | | |
| 5000005-10 | WIRE, 8AWG,TIN,133X29,600V,105C,BLK | 21' | | | | |
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | **Trailer Controls** | | | | | |
| | **PLC** | | | | | |
| 3900010-2 | BOX, JUNCTION 24x24x6 HINGED COVER | 1 | Allied | | | |
| 4900011-1 | SIGNAL CONDITIONER, 24V OUT,65VIN, | 1 | Omega Engineering | DRF-VDC-24VDC-65V-0/10 | | |
| 4000017-1 | SHUNT, DC, 100A/50mV BASE-MOUNTED | 4 | Mouser | 580-3020-01099-0 | | |
| 4000017-2 | SHUNT, DC, 50A/50mV BASE-MOUNTED | 2 | Mouser | 580-3020-01096-0 | | |
| 4900011-3 | SIGNAL CONDITIONER, 0-75mVDC IN, 0-10 OUT | 5 | Omega Engineering | DRF-VDC-24VDC-75MV-0/10 | | |
| 4900199-1 | SENSOR, TEMP, CONDUIT BOX MNT | 1 | Omega Engineering | EWS-TX M3500/0209 | | |
| 4900070-9 | CONTROLLER, MICROLOGIX 1100 | 1 | Reynolds Co | 1763-L16DWD | | |
| 4900070-10 | MODULE, DIGITAL INPUT, 100/120 VAC | 1 | Reynolds Co | 1762-IA8 | | |
| 4900070-2 | MODULE, 4-CH VOLT/CURRENT ANALOG INPUT | 2 | Reynolds Co | 1762-IF4 | | |
| 4900070-5 | MODULE, 4-CH VOLT/CURRENT ANALOG OUTPUT | 1 | Reynolds Co | 1762-OF4 | | |
| 4000024-2 | FUSE BLOCK,15MM DIN RAIL | 20 | Allied | 502-3776 | | |
| 4000024-2 | FUSE BLOCK END PLATE, DIN RAIL | 5 | Allied | 502-3312 | | |
| 4000024-4 | JUMPER, 3-POLE, INTERNAL, DIN RAIL | 7 | Allied | 502-3284 | | |
| 4800002-1 | CONN, 25 PIN DSUB | 5 | Allied | 720-3321 | | |
| 4800003-1 | CONN, 25 DSUB BACK SHELL | 5 | Allied | 720-0022 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5000016-1 | CABLE, 24AWG,7X32,1 PR, SHIELDEDx100' | 500' | Allied | 708-0576 | | |
| 5000016-2 | CABLE, 24AWG,7X32,3 PR, SHIELDEDx100' | 500' | Allied | 708-0582 | | |
| 5000016-3 | CABLE, 24AWG,7X32,6 PR, SHIELDEDx100' | 500' | Allied | 708-0591 | | |
| 3000022-1 | ANCHOR, CABLE TIE,ADHESIVE, WHT, .75x.75 | 1 | Allied | 805-2003 | | |
| 3000025-1 | TUBING, CORR, WIRE LOOM BLACK 1/4" | 100' | Allied | 381-0019 | | |
| 3000025-2 | TUBING, CORR, WIRE LOOM BLACK 1/2" | 100' | Allied | 381-0020 | | |
| 3800033-1 | DUCT, TYPE G, SLOTTED,ADHES BACK, 2X2, 6FT | 2 | Allied | 381-0590 | | |
| | | | | | | |
| 3800034-1 | DUCT, TYPE F,SLOTTED,ADHES BACK,1X2, 6FT | 1 | Allied | 381-0528 | | |
| 3800035-2 | COVER, DUCT,2" WIDE,6FT | 2 | Allied | 381-0500 | | |
| 3800035-1 | COVER, DUCT,1" WIDE,6FT | 1 | Allied | 381-0498 | | |
| 4000014-1 | RELAY, SPDT, 6A, 24VDC | 6 | Allied | 502-0775 | | |
| 4000025-2 | RELAY, 3PDT, 15A, 24VDC | 2 | Allied | 850-0044 | | |
| 4000026-2 | SOCKET, SCREW TERM, DIN RAIL, 11 PIN | 2 | Allied | 850-0805 | | |
| 4000016-1 | RELAY, DPDT, 40A, 24VDC | 4 | Allied | 850-3113 | | |
| 3900011-2 | DIN RAIL, 35mmx7.5mm DEEPx1m LONG | 1 | Allied | 502-0156 | 1-2 days | |
| 3900011-1 | DIN RAIL, 15mmx5.5mm DEEPx1m LONG | 1 | Allied | 502-0159 | 1-2 days | |
| 4000031-1 | CONVERTER, DC-DC, 48 TO 24V, 150W | 1 | Powerstream | PST-DC4824 | 3-5 days | |
| | | | | | | |
| | **Data Acquisition** | | | | | |
| 4900033-1 | SENSOR, MICRO-FLOW, FOR LOW WATER APP | 2 | Omega Engineering | FP-5061 | | |
| | | | | | | |
| 4900250-1 | Industrial Panel PC | | Beckhoff | CP6202-0001-0020 | | |
| | Intel® Atom™ 1.6 GHz | | Beckhoff | C9900-C536 | | |
| | OPTION, for -1,SATA HARD DISK 2.5" 40GB | | Beckhoff | C9900-H148 | | |
| | Microsoft Windows Embedded Standard | | Beckhoff | C9900-S326-0033 | | |
| ? | Microsoft Office Standard Edition | | | | | |
| 4900262-1 | HUB, ETHERNET, 4 PORT, 10Mbps | 1 | ZDTronic | EN 104TP | | |
| 4900029-1 | KEYBOARD, w/TOUCHPAD | 1 | Allied | 908-0072 | | |
| 4900251-1 | POWER METER, ACUVIM 3 PHASE | 2 | PowerMeterStore | AE Acuvim-II | | |
| 4900252-1 | TRANSFORMER, CURRENT, SPLIT CORE, 200A, 5A OUT | 4 | PowerMeterStore | H6810-200A-5A | | |
| 4900264-1 | MODULE, ACUVIM ETHERNET COMM | 2 | PowerMeterStore | AE AXM-NET | | |
| | | | | | | |
| | **Grid** | | | | | |
| | WIRE, 1/0AWG,TIN,600V,DRECT BURIAL | 9884' | | | | |
| | WIRE, 8AWG,TIN,600V,DRECT BURIAL | 4942' | | | | |
| | DISTRIBUTION PANEL, 40 AMP | 9 | | | | |
| | BREAKER, 20 AMP | 9 | | | | |
| | PANEL, GROUND BAR KIT | 9 | | | | |
| | RECEPTACLE, NON-GFCI | 9 | | | | |
| | 12"X12"X6" JUNCTION BOX,NEMA 3R | 10 | | | | |
| | CONDUIT,1-1/2" RIGID PVC,10' STICK | 10 | | | | |
| | CONNECTOR,MALE,1-1/2" PVC | 20 | | | | |
| | CONDUIT,FLEX,NON-METALLIC,3/4" | 50' | | | | |
| | GROUNDING ELECTRODE | 1 | | | | |
| | 4'X4'X8' TREATED LUMBER | 9 | | | | |

## Table A-2. Bill of Materials for Los Arcos

| XPS Bill of Materials | | | | | |
|---|---|---|---|---|---|
| **TEES #A7801 (Grid 3 - Los Arcos)** | | | | | |
| **Part #** | **Part Name** | **Qty.** | **Vendor** | **Vendor Part No.** | **Lead Time** |
| | **Trailer/Structural** | | | | |
| 3900012-1 | TRAILER, 7x14 TAND AXLEw/SIDE&RAMP DOOR | 1 | Magnum Trailers | need part number/( | In Stock |
| | **Battery/Inverter Rack** | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 2 x 23" | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 1 x 8" | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 20" | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 55-1/2" | | | |
| 7000029-2 | L-BAR,1"x1"x1/4"x20' A36 | 10 x 23" | | | |
| 7000010-1 | STRUCT TUBING,1"SQx11GAx20',A500 GR-A | 1 x 49" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 21" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 4 x 56.375" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 31.375" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 1 x 14" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 18" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 13.25" | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 27.375" | | | |
| 1000024-1 | LATTICE, NOTCHED VERTICAL | 8 | | | |
| 7000017-2 | HR FLAT BAR, 2"x1/4"x20' A36 | 2 | | | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4Fiberglass Sheet 24 x 30 | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4 Fiberglass Sheet 56.375 x 18 | |
| 7000001-01 | FIBERGRATE, SQUARE TUBE, 4x4x1/4 | 5 x 32.313 | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 4 x 54.25" | | | |
| 7000027-1 | CR FLAT SHEET, 4'x8'X16GA LOW CARBON STL | 2 | | | |
| | | | | | |
| | | | | | |
| | **Genset Trailer** | | | | |
| 4900017-3 | GENSET, 15 kW, 120/240, SINGLE PHASE | 1 | Cummins | 15DSKAB | |
| | Diesel | 1000 | Arguindegui Oil | | |
| | Fuel Tank Delivery | | Arguindegui Oil | | |
| | Bio-Diesel | 1000 | Arguindegui Oil | | |
| 7000013-2 | STRUCT TUBING,4x2x1/4x20',A500 GR-B | 1 | | | |
| 3900004-1 | TIRE, 15X5-4.5,W/S,ST20575D15C | 2 | Southwest Wheel | CTW M017C-215512 | |
| 3900005-1 | AXLE, 48.5 | 1 | Southwest Wheel | DXA S3548.5 | |
| 3900006-1 | SPRING, LEAF, 25-1/4",DOUBLE EYE | 2 | Southwest Wheel | EMC SW4B | |
| 3900007-1 | KIT, 2-3/8 U-BOLT,FOR 2-3/4" ROUND AXLE | 1 | Southwest Wheel | HAY APUBR238BX | |
| 3900008-1 | KIT, SINGLE AXLE,1-3/4" DOUBLE EYE SPRNG | 2 | Southwest Wheel | HAY APS1BX | |
| 3900009-1 | COUPLER, 2" A-FRAME 5000# W/HOLE | 1 | Magnum Trailer | | |
| 3900009-2 | FENDER, 9x32X48, w/12" BACK, SINGLE AXLE | 2 | Magnum Trailer | | |
| 3900009-3 | KIT, LIGHT FOR TRAILER | 1 | Magnum Trailer | | |
| 3900009-4 | JACK, 2K TOP WIND A-FRAME | 1 | Magnum Trailer | | |
| 3900009-5 | CHAINS, SAFETY, 3/16X30" w/HOOK&LATCH | 2 | Magnum Trailer | | |
| 3900009-6 | BRACKET, 7/16 CHAIN EYELET | 2 | Magnum Trailer | | |

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|---|---|---|---|---|---|---|
| | **Solar Array** | | | | | |
| | **Solar Panels** | | | | | |
| 4900018-2 | 225W/24 V Solar Panels | 21 | Ameresco Solar | | | |
| 4900260-1 | CABLE ASSY, T4 MC OUTPUT, 35' | 7 | Ameresco Solar | | | |
| 4900020-1 | MODULE, PSPV COMBINER BOX FLEXware PV-8 | 1 | Ameresco Solar | | | |
| 4000021-1 | BREAKER, 15 AMP, 150VDC, DIN RAIL MOUNT | 7 | Ameresco Solar | | | |
| 4900261-1 | CABLE ASSY, OUTPUT W/FLEX CONDUIT, #6 1x20' | 2 | Ameresco Solar | | | |
| 4900019-1 | CONTROLLER, OUTBACK FLEXmax 80 | 1 | Ameresco Solar | | | |
| 4000020-1 | BREAKER, 80 AMP, 150VDC, PANEL MOUNT | 2 | Ameresco Solar | OBB-80-150-VDC-PNL | | |
| 5000001-02 | CABLE, WELDING, 420X30, 4AWG, BLK | 50' | | | | |
| 4800006-2 | TERM, LUG, 4AWG, 5/16" TIN PLATE | 18 | | | | |
| 4800006-3 | TERM, LUG, 4AWG, 3/8" TIN PLATE | 6 | | | | |
| 5000017-02 | HEAT SHRINK, 1/2", RED | 5" | | | | |
| 5000017-10 | HEAT SHRINK, 1/2", BLACK | 14" | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | **Solar Panel Rack** | | | | | |
| 1000311-1 | SUPPORT, L-BAR, ALUM, 3"X3"X148" | 8 | | | | |
| 1000207-1 | BRACKET, L-BAR, ALUM, 2.5"X2.5"X3" | 48 | | | | |
| 1000312-1 | UPPER CROSS BEAM, L-BAR, ALUM, 2"X 2"X 231" | 3 | | | | |
| 1000312-3 | MIDDLE CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | |
| 1000312-4 | LOWER CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | |
| 1000208-1 | BRAKET, FOOT, L-BAR, ALUM, 2" X 2" X 3" | 16 | | | | |
| 1000204-1 | ANCHOR, CONCRETE | 16 | | | | |
| 1000313-1 | SUPPORT, UPRIGHT, L-BAR, ALUM, 2.5" X 2.5" X 52.75" | 8 | | | | |
| 1000314-1 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 70 " | 2 | | | | |
| 1000314-2 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 73 " | 12 | | | | |
| 3000182-1 | SCREW, HEX CAP, ZINC, .375"-16 X 1" | 122 | | | | |
| 3000185-1 | NUT, HEX, ZINC, .375"-16 | 122 | | | | |
| 3000033-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1" | 56 | | | | |
| 3000020-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1.5" | 32 | | | | |
| 3000066-1 | NUT, HEX, ZINC, .25"-20 | 88 | | | | |
| 3000219-1 | ANCHOR, SLEEVE STUD, HEX .3125"-18 X 3" | 16 | | | | |
| 3000263-1 | WASHER, FLAT, .25", .281" ID, .625" OD | 2 | | | | |
| 3000262-1 | SCREW, MACHINE, TORX, .3125"-18 X 1" | 84 | | | | |
| 3000067-1 | NUT, HEX, .3125"-18 | 84 | | | | |
| 3000002-4 | WASHER, FLAT, ZINC, .25" | 88 | | | | |
| 3000002-5 | WASHER, FLAT, ZINC, .3125" | 84 | | | | |
| 3000002-1 | WASHER, FLAT, ZINC, .375" | 122 | | | | |
| | | | | | | |
| | **Solar Panel Rack Tools** | | | | | |
| 3900115-1 | KIT, ANCHOR TIE DOWN | 2 | | | | |
| Y56450256FL0 | T-15 TORX SECURITY DRIVER | 5 | | | | |
| | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | **Trailer DC** | | | | |
| 8000001-4 | POWER CELL™, 12V, XP, 12D2000A | 20 | Xtreme Power | Power Cell | In Stock |
| 4900022-1 | POWER SUPPLY, 5kW 60VDC | 2 | Pioneer Magnetics | PM33215B-5-1-5-H | 4-6 weeks |
| 1000304-1 | BUS BAR, TEES RACK | 5 | | | |
| 1000018-1 | CLIP, BATTERY BUS BAR | 40 | | | |
| 3000012-1 | NUT, NYLK, ZNC,GR2, 3/8-16 | 40 | | | |
| 3000016-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1-1/2 | 25 | | | |
| 3000017-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1" | 10 | | | |
| 3000002-1 | WASHER, FLAT, ZINC PLATE, 3/8" SAE | 50 | | | |
| 3000014-1 | NUT, NYLK, ZNC,GR2, 5/16-18 | 8 | | | |
| 3000018-1 | SCREW, CAP, HEX HD, ZNY, GR8, 5/16-18 x 3/4 | 8 | | | |
| 3000009-1 | WASHER, FLAT, 18-8 SS, 5/16 x 7/8", | 8 | | | |
| 3000013-1 | NUT, NYLK, ZNC,GR2, 1/4-20 | 30 | | | |
| 3000019-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3" | 20 | | | |
| 3000020-1 | SCREW, CAP, HEX HD, ZNC, GR5, 1/4-20 x 1-1/2" | 8 | | | |
| 3000021-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 1" | 16 | | | |
| 300006-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3/4 | 16 | | | |
| 3000002-4 | WASHER, FLAT, ZINC PLATE, 1/4" SAE | 72 | | | |
| 4000013-2 | BLOCK, JUNCTION, STUD, 3/8-16,250A,RED | 4 | | | |
| 4000013-1 | BLOCK, JUNCTION, STUD, 3/8-16,250A,BLK | 4 | | | |
| 5000017-10 | HEAT SHRINK, 1/2", RED | 18" | | | |
| 5000017-02 | HEAT SHRINK, 1/2", BLACK | 39" | | | |
| 4000019-1 | BREAKER, 125 AMP, 125VDC, PANEL MOUNT | 6 | Ameresco Solar | OBB-125-125VDC-PI | 7-10 days |
| 7000004-1 | COPPER BUS BAR,6"x1/4"x6', A110,BSS | 2 X 11" | | WIP Paul | |
| 5000001-03 | CABLE, WELDING, 665X30, 2AWG, BLK | 120' | | | |
| 4800007-2 | TERM, LUG, 2AWG, 5/16" TIN PLATE | 24 | | | |
| | | | | | |
| | | | | | |
| | **Trailer AC** | | | | |
| 4900010-1 | SWITCH, TRANSFER, 100A | 1 | Iota | ITS-100R | 2 weeks |
| 4000022-3 | LOAD CENTER, 125A, INDOOR CONV MAIN BKR | 1 | Grainger | Q0124M125 | |
| 4000022-4 | COVER FOR 4000022-03 | 1 | Grainger | QOC24US | |
| 4000022-1 | LOAD CENTER, 100A, INDOOR CONV MAIN BKR | 1 | Grainger | QO116M100 | |
| 4000022-2 | COVER FOR 4000022-01 | 1 | Grainger | QOC20U100S | |
| 4000022-06 | BREAKER, 20A, 1-POLE, 120/240VAC, 3/4" | 1 | Grainger | QO120 | |
| 4000022-07 | BREAKER, 30A, 1-POLE, 120/240VAC, 3/4" | 3 | Grainger | QO130 | |
| 4000022-10 | BREAKER, 30A, 2-POLE, 120/240VAC, 3/4" | 2 | Grainger | QO230 | |
| 4000022-08 | BREAKER, 100A, 2-POLE, 120/240VAC, 3/4" | 2 | Grainger | QO2100 | |
| 4000022-5 | LOAD CENTER, 70A, INDOOR MAIN BKR w/CVR | 2 | Grainger | QO24L70S | |
| 4000130-1 | BLOCK, POWER DISTRIB, 600VAC, 4 POLE | 1 | Graybar | | |
| 4900023-1 | INVERTER, OUTBACK 48VDC INPUT | 3 | Ameresco Solar | VFX3648 | 2 weeks |
| 4900024-1 | CONTROLLER, OUTBACK, MATE | 1 | Ameresco Solar | MATE | 2 weeks |
| 4900021-1 | INVERTER COMM MANAGER, OUTBACK HUB-10 | 1 | Ameresco Solar | HUB-10 | |
| 4900025-1 | TRANSFORMER, AUTO-TRANSFORMER, OUTBACK | 1 | Ameresco Solar | FW-X240 | 2 weeks |
| 3900010-1 | BOX, JUNCTION 10x10x6 HINGED COVER | 1 | Allied | 806-0778 | 7 days |
| 3900110-1 | BOX, JUNCTION, PVC, 12" x 12" x 6" | 1 | | | |
| 3800049-1 | CONN, LIQTIGHT, NON-INSUL, STL, 1" | 2 | Fastenal | 0720947 | |
| 3800038-1 | CONDUIT BODY, TYPE LB, AL, 1-1/4 | 4 | Fastenal | 0703826 | 2-3 days |

| | | | | | |
|---|---|---|---|---|---|
| 3800039-1 | COVER, CONDUIT BODY, 1-1/4 - 1-1/2 | 4 | Fastenal | 0700312 | 2-3 days |
| 3800040-1 | FITTING, CONN EMT SET SCREW, ZN, 1-1/4 | 10 | Fastenal | 0700103 | 2-3 days |
| 3800041-1 | FITTING, COUPLING EMT, ZN,1-1/4 | 4 | Fastenal | 0700163 | 2-3 days |
| 3800042-1 | HANGER, EMT CONDUIT, 1-1/4 | 10 | Fastenal | 44543 | 2-3 days |
| 3800048-1 | FITTING, NIPPLE, GALV STL,1-1/4X2-1/2 S40 | 2 | Fastenal | 0700655 | 2-3 days |
| 3800044-1 | FITTING, INSULATED BUSHING, 1-1/4" | 1 | Fastenal | 0700611 | 2-3 days |
| 3800045-1 | CONDUIT, LIQTIGHT,PVC GRAY, 1"x100' | 50' | Fastenal | 0708538 | 2-3 days |
| 3800069-1 | CONDUIT, LIQTIGHT, PVC, GRAY, 1-1/4" x 50' | 50' | | | |
| 3800046-1 | FITTING, INSULATED BUSHING, 1" | 1 | Fastenal | 0700610 | 2-3 days |
| 3800047-1 | HANGER, EMT CONDUIT, 1" | 4 | Fastenal | 44542 | 2-3 days |
| 3800050-1 | WIREWAY, GALVANIZED, 8*X8"X36" | 1 | Elliott | | 2-3 days |
| 3800051-1 | COVER, WIREWAY, 8"X8" | 4 | Elliott | | 2-3 days |
| 3800072-1 | NIPPLE, GALV STL, 1-1/4 x 3" S40 | 3 | Elliott | 114X3 | 2-3 days |
| 3800037-1 | FITTING, LOCKNUT, 1-1/4" | 18 | Elliott | 104S | 2-3 days |
| 3800036-1 | CONDUIT,EMT, STEEL, 1-1/4 x10' | 30' | Elliott | EMT114 | 2-3 days |
| 3800055-1 | FITTING, CONN EMT, SET SCREW, ZN, 1-1/4 | 3 | Elliott | 233DC | 2-3 days |
| 3800056-1 | FITTING, COUP EMT, SET SCREW, ZN, 1-1/4 | 2 | Elliott | 243DC | 2-3 days |
| 3800058-1 | FITTING, 2-HOLE EMT STRAP, STEEL, 1-1/4" | 5 | Elliott | 1923 | 2-3 days |
| 3800059-1 | NIPPLE, GALV STL, 1-1/4 " x CLOSE, SCH40 | 2 | Elliott | | 2-3 days |
| 5000006-09 | WIRE, 10AWG,TIN,105X30,600V,105C,WHITE | 68' | | | |
| 5000006-05 | WIRE, 10AWG,TIN,105X30,600V,105C,GREEN | 65' | | | |
| 5000006-02 | WIRE, 10AWG,TIN,105X30,600V,105C,RED | 65' | | | |
| 5000006-05 | WIRE, 8AWG,TIN,133X29,600V,105C,GREEN | 21' | | | |
| 5000005-02 | WIRE, 8AWG,TIN,133X29,600V,105C,RED | 21' | | | |
| 5000005-09 | WIRE, 8AWG,TIN,133X29,600V,105C,WHITE | 21' | | | |
| 5000005-10 | WIRE, 8AWG,TIN,133X29,600V,105C,BLK | 21' | | | |
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| | | | | | |
| | **Trailer Controls** | | | | |
| | **PLC** | | | | |
| 3900010-2 | BOX, JUNCTION 24x24x6 HINGED COVER | 1 | Allied | | |
| 4900011-1 | SIGNAL CONDITIONER, 24V OUT,65VIN, | 1 | Omega Engineering | DRF-VDC-24VDC-65V-0/10 | |
| 4000017-1 | SHUNT, DC, 100A/50mV BASE-MOUNTED | 2 | Mouser | 580-3020-01099-0 | |
| 4000017-2 | SHUNT, DC, 50A/50mV BASE-MOUNTED | 2 | Mouser | 580-3020-01096-0 | |
| 4900011-3 | SIGNAL CONDITIONER, 0-75mVDC IN, 0-10 OUT | 3 | Omega Engineering | DRF-VDC-24VDC-75MV-0/10 | |
| 4900199-1 | SENSOR, TEMP, CONDUIT BOX MNT | 1 | Omega Engineering | EWS-TX M3500/0209 | |
| 4900070-9 | CONTROLLER, MICROLOGIX 1100 | 1 | Reynolds Co | 1763-L16DWD | |
| 4900070-10 | MODULE, DIGITAL INPUT, 100/120 VAC | 1 | Reynolds Co | 1762-IA8 | |
| 4900070-2 | MODULE, 4-CH VOLT/CURRENT ANALOG INPUT | 1 | Reynolds Co | 1762-IF4 | |
| 4900070-5 | MODULE, 4-CH VOLT/CURRENT ANALOG OUTPUT | 1 | Reynolds Co | 1762-OF4 | |
| 4000024-2 | FUSE BLOCK,15MM DIN RAIL | 20 | Allied | 502-3776 | |
| 4000024-2 | FUSE BLOCK END PLATE, DIN RAIL | 5 | Allied | 502-3312 | |
| 4000024-4 | JUMPER, 3-POLE, INTERNAL, DIN RAIL | 7 | Allied | 502-3284 | |
| 4800002-1 | CONN, 25 PIN DSUB | 3 | Allied | 720-3321 | |
| 4800003-1 | CONN, 25 DSUB BACK SHELL | 3 | Allied | 720-0022 | |
| | | | | | |

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|---|---|---|---|---|---|
| 3000022-1 | ANCHOR, CABLE TIE,ADHESIVE, WHT, .75x.75 | 1 | Allied | 805-2003 | |
| | | | | | |
| | | | | | |
| 3800033-1 | DUCT, TYPE G, SLOTTED,ADHES BACK, 2X2, 6FT | 2 | Allied | 381-0590 | |
| | | | | | |
| 3800034-1 | DUCT, TYPE F,SLOTTED,ADHES BACK,1X2, 6FT | 1 | Allied | 381-0528 | |
| 3800035-2 | COVER, DUCT,2" WIDE,6FT | 2 | Allied | 381-0500 | |
| 3800035-1 | COVER, DUCT,1" WIDE,6FT | 1 | Allied | 381-0498 | |
| 4000014-1 | RELAY, SPDT, 6A, 24VDC | 6 | Allied | 502-0775 | |
| 4000025-2 | RELAY, 3PDT, 15A, 24VDC | 2 | Allied | 850-0044 | |
| 4000026-2 | SOCKET, SCREW TERM, DIN RAIL, 11 PIN | 2 | Allied | 850-0805 | |
| 4000016-1 | RELAY, DPDT, 40A, 24VDC | 2 | Allied | 850-3113 | |
| 3900011-2 | DIN RAIL, 35mmx7.5mm DEEPx1m LONG | 1 | Allied | 502-0156 | 1-2 days |
| 3900011-1 | DIN RAIL, 15mmx5.5mm DEEPx1m LONG | 1 | Allied | 502-0159 | 1-2 days |
| 4000031-1 | CONVERTER, DC-DC, 48 TO 24V, 150W | 1 | Powerstream | PST-DC4824 | 3-5 days |
| | | | | | |
| | **Data Acquisition** | | | | |
| 4900033-1 | SENSOR, MICRO-FLOW, FOR LOW WATER APP | 2 | Omega Engineering | FP-5061 | |
| | | | | | |
| 4900250-1 | Industrial Panel PC | | Beckhoff | CP6202-0001-0020 | |
| | Intel® Atom™ 1.6 GHz | | Beckhoff | C9900-C536 | |
| | OPTION, for -1,SATA HARD DISK 2.5" 40GB | | Beckhoff | C9900-H148 | |
| | Microsoft Windows Embedded Standard | | Beckhoff | C9900-S326-0033 | |
| ? | Microsoft Office Standard Edition | | | | |
| 4900262-1 | HUB, ETHERNET, 4 PORT, 10Mbps | 1 | ZDTronic | EN 104TP | |
| 4900029-1 | KEYBOARD, w/TOUCHPAD | 1 | Allied | 908-0072 | |
| 4900251-1 | POWER METER, ACUVIM 3 PHASE | 2 | PowerMeterStore | AE Acuvim-II | |
| 4900252-1 | TRANSFORMER, CURRENT, SPLIT CORE, 200A, 5A OUT | 4 | PowerMeterStore | H6810-200A-5A | |
| 4900264-1 | MODULE, ACUVIM ETHERNET COMM | 2 | PowerMeterStore | AE AXM-NET | |
| | | | | | |
| | **Grid** | | | | |
| | WIRE, 2AWG,TIN,600V,DRECT BURIAL | 4670' | | | |
| | WIRE, 8AWG,TIN,600V,DRECT BURIAL | 2335' | | | |
| | DISTRIBUTION PANEL, 40 AMP | 5 | | | |
| | BREAKER, 20 AMP | 5 | | | |
| | PANEL, GROUND BAR KIT | 5 | | | |
| | RECEPTACLE, NON-GFCI | 5 | | | |
| | 12"X12"X6" JUNCTION BOX,NEMA 3R | 6 | | | |
| | CONDUIT,1-1/2" RIGID PVC,10' STICK | 6 | | | |
| | CONNECTOR,MALE,1-1/2" PVC | 10 | | | |
| | CONDUIT,FLEX,NON-METALLIC,3/4" | 50' | | | |
| | GROUNDING ELECTRODE | 1 | | | |
| | 4'X4'X8' TREATED LUMBER | 5 | | | |

## Table A-3. Bill of Materials for Los Nopalitos

| XPS Bill of Materials | | | | | | | |
|---|---|---|---|---|---|---|---|
| TEES #A7801 (Grid 2 - Los Nopalitos) | | | | | | | |
| **Part #** | **Part Name** | **Qty.** | **Vendor** | **Vendor Part No.** | **Lead Time** | **Cost Ea** | **Total** |
| | **Trailer/Structural** | | | | | | |
| 3900012-1 | TRAILER, 7x14 TAND AXLEw/SIDE&RAMP DOOR | 1 | Magnum Trailers | need part number/( | In Stock | 3,380.00 | 3,380.00 |
| | **Battery/Inverter Rack** | | | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 2 x 23" | | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 1 x 8" | | | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 20" | | | | | |
| 7000013-1 | STRUCT TUBING,4x2x11GAx20',A500 GR-B | 2 x 55-1/2" | | | | | |
| 7000029-2 | L-BAR,1"x1"x1/4"x20' A36 | 10 x 23" | | | | | |
| 7000010-1 | STRUCT TUBING,1"SQx11GAx20',A500 GR-A | 1 x 49" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 21" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 4 x 56.375" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 31.375" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 1 x 14" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 18" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 13.25" | | | | | |
| 7000039-1 | STRUCT TUBING, 2"x1"x11GAx20',A500 GR-A | 2 x 27.375" | | | | | |
| 1000024-1 | LATTICE, NOTCHED VERTICAL | 8 | | | | | |
| 7000017-2 | HR FLAT BAR, 2"x1/4"x20' A36 | 2 | | | | | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4Fiberglass Sheet 24 x 30 | | | |
| 7000001-02 | FIBERGRATE, SHEET 1/4"x4'x8' | 1 | | 1/4 Fiberglass Sheet 56.375 x 18 | | | |
| 7000001-01 | FIBERGRATE, SQUARE TUBE, 4x4x1/4 | 5 x 32.313 | | | | | |
| 7000032-1 | L-BAR,2"x2"x1/8"x20' A36/A529-50 | 4 x 54.25" | | | | | |
| 7000027-1 | CR FLAT SHEET, 4'x8'X16GA LOW CARBON STL | 2 | | | | | |
| | | | | | | | |
| | **Genset Trailer** | | | | | | |
| 4900017-2 | GENSET, 20 kW, 120/240, SINGLE PHASE | 1 | Cummins | 20DSKBA | | | |
| | Diesel | 1000 | Arguindegui Oil | | | | |
| | Fuel Tank Delivery | | Arguindegui Oil | | | 150.00 | 150.00 |
| | Bio-Diesel | 1000 | Arguindegui Oil | | | | |
| 7000013-2 | STRUCT TUBING,4x2x1/4x20',A500 GR-B | 1 | | | | | |
| 3900004-1 | TIRE, 15X5-4.5,W/S,ST20575D15C | 2 | Southwest Wheel | CTW M017C-215512 | | 99.85 | 199.70 |
| 3900005-1 | AXLE, 48.5 | 1 | Southwest Wheel | DXA S3548.5 | | 108.00 | 108.00 |
| 3900006-1 | SPRING, LEAF, 25-1/4",DOUBLE EYE | 2 | Southwest Wheel | EMC SW4B | | 21.89 | 43.78 |
| 3900007-1 | KIT, 2-3/8 U-BOLT,FOR 2-3/4" ROUND AXLE | 1 | Southwest Wheel | HAY APUBR238BX | | 16.20 | 16.20 |
| 3900008-1 | KIT, SINGLE AXLE,1-3/4" DOUBLE EYE SPRNG | 2 | Southwest Wheel | HAY APS1BX | | 15.56 | 31.12 |
| 3900009-1 | COUPLER, 2" A-FRAME 5000# W/HOLE | 1 | Magnum Trailer | | | 25.50 | 25.50 |
| 3900009-2 | FENDER, 9x32X48, w/12" BACK, SINGLE AXLE | 2 | Magnum Trailer | | | 22.50 | 45.00 |
| 3900009-3 | KIT, LIGHT FOR TRAILER | 1 | Magnum Trailer | | | 24.25 | 24.25 |
| 3900009-4 | JACK, 2K TOP WIND A-FRAME | 1 | Magnum Trailer | | | 14.00 | 14.00 |
| 3900009-5 | CHAINS, SAFETY, 3/16X30" w/HOOK&LATCH | 2 | Magnum Trailer | | | 5.19 | 10.38 |
| 3900009-6 | BRACKET, 7/16 CHAIN EYELET | 2 | Magnum Trailer | | | 1.95 | 3.90 |

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|---|---|---|---|---|---|---|---|---|
| | **Solar Array** | | | | | | | |
| | **Solar Panels** | | | | | | | |
| 4900018-2 | 225W/24 V Solar Panels | 21 | Ameresco Solar | | | 511.00 | | |
| 4900260-1 | CABLE ASSY, T4 MC OUTPUT, 35' | 7 | Ameresco Solar | | | 29.00 | | |
| 4900020-1 | MODULE, PSPV COMBINER BOX FLEXware PV-8 | 1 | Ameresco Solar | | | 104.00 | | |
| 4000021-1 | BREAKER, 15 AMP, 150VDC, DIN RAIL MOUNT | 7 | Ameresco Solar | | | 13.00 | | |
| 4900261-1 | CABLE ASSY, OUTPUT W/FLEX CONDUIT, #6 1x20' | 2 | Ameresco Solar | | | 23.00 | | |
| 4900019-1 | CONTROLLER, OUTBACK FLEXmax 80 | 1 | Ameresco Solar | | | 509.00 | | |
| 4000020-1 | BREAKER, 80 AMP, 150VDC, PANEL MOUNT | 2 | Ameresco Solar | OBB-80-150-VDC-PNL | | 24.00 | 144.00 | |
| 5000001-02 | CABLE, WELDING, 420X30, 4AWG, BLK | 50' | | | | | | |
| 4800006-2 | TERM, LUG, 4AWG, 5/16" TIN PLATE | 18 | | | | | | |
| 4800006-3 | TERM, LUG, 4AWG, 3/8" TIN PLATE | 6 | | | | | | |
| 5000017-02 | HEAT SHRINK, 1/2", RED | 5" | | | | | | |
| 5000017-10 | HEAT SHRINK, 1/2", BLACK | 14" | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | **Solar Panel Rack** | | | | | | | |
| 1000311-1 | SUPPORT, L-BAR, ALUM, 3"X3"X148" | 8 | | | | | | |
| 1000207-1 | BRACKET, L-BAR, ALUM, 2.5"X2.5"X3" | 48 | | | | | | |
| 1000312-1 | UPPER CROSS BEAM, L-BAR, ALUM, 2"X 2"X 231" | 3 | | | | | | |
| 1000312-3 | MIDDLE CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | | | |
| 1000312-4 | LOWER CROSS BEAM, L-BAR, ALUM, 2" X 2" X 231" | 3 | | | | | | |
| 1000208-1 | BRAKET, FOOT, L-BAR, ALUM, 2" X 2" X 3" | 16 | | | | | | |
| 1000204-1 | ANCHOR, CONCRETE | 16 | | | | | | |
| 1000313-1 | SUPPORT, UPRIGHT, L-BAR, ALUM, 2.5" X 2.5" X 52.75" | 8 | | | | | | |
| 1000314-1 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 70 " | 2 | | | | | | |
| 1000314-2 | CROSS BRACE, FLAT, ALUM, 2.5" X .25" X 73 " | 12 | | | | | | |
| 3000182-1 | SCREW, HEX CAP, ZINC, .375"-16 X 1" | 122 | | | | | | |
| 3000185-1 | NUT, HEX, ZINC, .375"-16 | 122 | | | | | | |
| 3000033-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1" | 56 | | | | | | |
| 3000020-1 | SCREW, HEX CAP, ZINC, .25"-20 X 1.5" | 32 | | | | | | |
| 3000066-1 | NUT, HEX, ZINC, .25"-20 | 88 | | | | | | |
| 3000219-1 | ANCHOR, SLEEVE STUD, HEX .3125"-18 X 3" | 16 | | | | | | |
| 3000263-1 | WASHER, FLAT, .25", .281" ID, .625" OD | 2 | | | | | | |
| 3000262-1 | SCREW, MACHINE, TORX, .3125"-18 X 1" | 84 | | | | | | |
| 3000067-1 | NUT, HEX, .3125"-18 | 84 | | | | | | |
| 3000002-4 | WASHER, FLAT, ZINC, .25" | 88 | | | | | | |
| 3000002-5 | WASHER, FLAT, ZINC, .3125" | 84 | | | | | | |
| 3000002-1 | WASHER, FLAT, ZINC, .375" | 122 | | | | | | |
| | | | | | | | | |
| | **Solar Panel Rack Tools** | | | | | | | |
| 3900115-1 | KIT, ANCHOR TIE DOWN | 2 | | | | | | |
| Y56450256FL0 | T-15 TORX SECURITY DRIVER | 5 | | | | | | |
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| | **Trailer DC** | | | | | | |
| 8000001-4 | POWER CELL™, 12V, XP, 12D2000A | 40 | Xtreme Power | Power Cell | In Stock | | |
| 4900022-1 | POWER SUPPLY, 5kW 60VDC | 4 | Pioneer Magnetics | PM33215B-5-1-5-H | 4-6 weeks | 1,839.00 | 7,356.00 |
| 1000304-1 | BUS BAR, TEES RACK | 10 | | | | | |
| 1000018-1 | CLIP, BATTERY BUS BAR | 80 | | | | | |
| 3000012-1 | NUT, NYLK, ZNC,GR2, 3/8-16 | 70 | | | | | |
| 3000016-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1-1/2 | 50 | | | | | |
| 3000017-1 | SCREW, CAP, HEX HD, ZNY, GR8, 3/8-16 x 1" | 20 | | | | | |
| 3000002-1 | WASHER, FLAT, ZINC PLATE, 3/8" SAE | 100 | | | | | |
| 3000014-1 | NUT, NYLK, ZNC,GR2, 5/16-18 | 8 | | | | | |
| 3000018-1 | SCREW, CAP, HEX HD, ZNY, GR8, 5/16-18 x 3/4 | 8 | | | | | |
| 3000009-1 | WASHER, FLAT, 18-8 SS, 5/16 x 7/8", | 8 | | | | | |
| 3000013-1 | NUT, NYLK, ZNC,GR2, 1/4-20 | 60 | | | | | |
| 3000019-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3" | 20 | | | | | |
| 3000020-1 | SCREW, CAP, HEX HD, ZNC, GR5, 1/4-20 x 1-1/2" | 8 | | | | | |
| 3000021-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 1" | 16 | | | | | |
| 300006-1 | SCREW, CAP, HEX HD, ZNY, GR8, 1/4-20 x 3/4 | 16 | | | | | |
| 3000002-4 | WASHER, FLAT, ZINC PLATE, 1/4" SAE | 72 | | | | | |
| 4000013-2 | BLOCK, JUNCTION, STUD, 3/8-16,250A,RED | 4 | | | | | |
| 4000013-1 | BLOCK, JUNCTION, STUD, 3/8-16,250A,BLK | 4 | | | | | |
| 5000017-10 | HEAT SHRINK, 1/2", RED | 18" | | | | | |
| 5000017-02 | HEAT SHRINK, 1/2", BLACK | 39" | | | | | |
| 4000019-1 | BREAKER, 125 AMP, 125VDC, PANEL MOUNT | 6 | Ameresco Solar | OBB-125-125VDC-PI | 7-10 days | 46.00 | 276.00 |
| 7000004-1 | COPPER BUS BAR,6"x1/4"x6', A110,BSS | 2 X 11" | | WIP Paul | | | |
| 5000001-03 | CABLE, WELDING, 665X30, 2AWG, BLK | 120' | | | | | |
| 4800007-2 | TERM, LUG, 2AWG, 5/16" TIN PLATE | 24 | | | | | |
| | | | | | | | |
| | | | | | | | |
| | **Trailer AC** | | | | | | |
| 4900010-1 | SWITCH, TRANSFER, 100A | 1 | Iota | ITS-100R | 2 weeks | 341.00 | |
| 4000022-3 | LOAD CENTER, 125A, INDOOR CONV MAIN BKR | 1 | Grainger | Q0124M125 | | 145.00 | 145.00 |
| 4000022-4 | COVER FOR 4000022-03 | 1 | Grainger | QOC24US | | 7.00 | 7.00 |
| 4000022-1 | LOAD CENTER, 100A, INDOOR CONV MAIN BKR | 1 | Grainger | QO116M100 | | 62.50 | 62.50 |
| 4000022-2 | COVER FOR 4000022-01 | 1 | Grainger | QOC20U100S | | 7.00 | 7.00 |
| 4000022-06 | BREAKER, 20A, 1-POLE, 120/240VAC, 3/4" | 1 | Grainger | QO120 | | | |
| 4000022-07 | BREAKER, 30A, 1-POLE, 120/240VAC, 3/4" | 6 | Grainger | QO130 | | | |
| 4000022-10 | BREAKER, 30A, 2-POLE, 120/240VAC, 3/4" | 4 | Grainger | QO230 | | 3.50 | 35.00 |
| 4000022-08 | BREAKER, 100A, 2-POLE, 120/240VAC, 3/4" | 2 | Grainger | QO2100 | | 35.50 | 35.50 |
| 4000022-5 | LOAD CENTER, 70A, INDOOR MAIN BKR w/CVR | 3 | Grainger | QO24L70S | | 8.50 | 25.50 |
| 4000130-1 | BLOCK, POWER DISTRIB, 600VAC, 4 POLE | 1 | Graybar | | | 92.50 | 92.50 |
| 4900023-1 | INVERTER, OUTBACK 48VDC INPUT | 6 | Ameresco Solar | VFX3648 | 2 weeks | 1,837.00 | |
| 4900024-1 | CONTROLLER, OUTBACK, MATE | 1 | Ameresco Solar | MATE | 2 weeks | 251.00 | |
| 4900021-1 | INVERTER COMM MANAGER, OUTBACK HUB-10 | 1 | Ameresco Solar | HUB-10 | | 263.00 | 263.00 |
| 4900025-1 | TRANSFORMER, AUTO-TRANSFORMER, OUTBACK | 1 | Ameresco Solar | FW-X240 | 2 weeks | 340.00 | |
| 3900010-1 | BOX, JUNCTION 10x10x6 HINGED COVER | 1 | Allied | 806-0778 | 7 days | 33.15 | 33.15 |
| 3900110-1 | BOX, JUNCTION, PVC, 12" x 12" x 6" | 1 | | | | | |
| 3800049-1 | CONN, LIQTIGHT, NON-INSUL, STL, 1" | 2 | Fastenal | 0720947 | | | |
| 3800038-1 | CONDUIT BODY, TYPE LB, AL, 1-1/4 | 4 | Fastenal | 0703826 | 2-3 days | 17.47 | 69.89 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3800039-1 | COVER, CONDUIT BODY, 1-1/4 - 1-1/2 | 4 | Fastenal | 0700312 | 2-3 days | 4.66 | 18.62 |
| 3800040-1 | FITTING, CONN EMT SET SCREW, ZN, 1-1/4 | 10 | Fastenal | 0700103 | 2-3 days | 1.94 | 19.44 |
| 3800041-1 | FITTING, COUPLING EMT, ZN,1-1/4 | 4 | Fastenal | 0700163 | 2-3 days | 2.20 | 8.80 |
| 3800042-1 | HANGER, EMT CONDUIT, 1-1/4 | 10 | Fastenal | 44543 | 2-3 days | 0.62 | 6.21 |
| 3800048-1 | FITTING, NIPPLE, GALV STL,1-1/4X2-1/2 S40 | 2 | Fastenal | 0700655 | 2-3 days | 0.65 | 1.30 |
| 3800044-1 | FITTING, INSULATED BUSHING, 1-1/4" | 1 | Fastenal | 0700611 | 2-3 days | 0.50 | 0.50 |
| 3800045-1 | CONDUIT, LIQTIGHT,PVC GRAY, 1"x100' | 50' | Fastenal | 0708538 | 2-3 days | 2.56 | 128.00 |
| 3800069-1 | CONDUIT, LIQTIGHT, PVC, GRAY, 1-1/4" x 50' | 50' | | | | | |
| 3800046-1 | FITTING, INSULATED BUSHING, 1" | 1 | Fastenal | 0700610 | 2-3 days | 0.46 | 0.46 |
| 3800047-1 | HANGER, EMT CONDUIT, 1" | 4 | Fastenal | 44542 | 2-3 days | 0.56 | 2.26 |
| 3800050-1 | WIREWAY, GALVANIZED, 8*X8"X36" | 1 | Elliott | | 2-3 days | | |
| 3800051-1 | COVER, WIREWAY, 8"X8" | 4 | Elliott | | 2-3 days | | |
| 3800072-1 | NIPPLE, GALV STL, 1-1/4 x 3" S40 | 3 | Elliott | 114X3 | 2-3 days | 1.66 | |
| 3800037-1 | FITTING, LOCKNUT, 1-1/4" | 18 | Elliott | 104S | 2-3 days | 0.03 | |
| 3800036-1 | CONDUIT,EMT, STEEL, 1-1/4 x10' | 30' | Elliott | EMT114 | 2-3 days | 0.72 | |
| 3800055-1 | FITTING, CONN EMT, SET SCREW, ZN, 1-1/4 | 3 | Elliott | 233DC | 2-3 days | 0.70 | |
| 3800056-1 | FITTING, COUP EMT, SET SCREW, ZN, 1-1/4 | 2 | Elliott | 243DC | 2-3 days | 0.82 | |
| 3800058-1 | FITTING, 2-HOLE EMT STRAP, STEEL, 1-1/4" | 5 | Elliott | 1923 | 2-3 days | 0.29 | |
| 3800059-1 | NIPPLE, GALV STL, 1-1/4 " x CLOSE, SCH40 | 2 | Elliott | | 2-3 days | 1.31 | |
| 5000006-09 | WIRE, 10AWG,TIN,105X30,600V,105C,WHITE | 68' | | | | | |
| 5000006-05 | WIRE, 10AWG,TIN,105X30,600V,105C,GREEN | 65' | | | | | |
| 5000006-02 | WIRE, 10AWG,TIN,105X30,600V,105C,RED | 65' | | | | | |
| 5000006-05 | WIRE, 8AWG,TIN,133X29,600V,105C,GREEN | 21' | | | | | |
| 5000005-02 | WIRE, 8AWG,TIN,133X29,600V,105C,RED | 21' | | | | | |
| 5000005-09 | WIRE, 8AWG,TIN,133X29,600V,105C,WHITE | 21' | | | | | |
| 5000005-10 | WIRE, 8AWG,TIN,133X29,600V,105C,BLK | 21' | | | | | |
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| | **Trailer Controls** | | | | | | |
| | **PLC** | | | | | | |
| 3900010-2 | BOX, JUNCTION 24x24x6 HINGED COVER | 1 | Allied | | | 152.03 | 152.03 |
| 4900011-1 | SIGNAL CONDITIONER, 24V OUT,65VIN, | 1 | Omega Engineering | DRF-VDC-24VDC-65V-0/10 | | 175.00 | 175.00 |
| 4000017-1 | SHUNT, DC, 100A/50mV BASE-MOUNTED | 4 | Mouser | 580-3020-01099-0 | | 23.45 | 93.80 |
| 4000017-2 | SHUNT, DC, 50A/50mV BASE-MOUNTED | 2 | Mouser | 580-3020-01096-0 | | 23.45 | 46.90 |
| 4900011-3 | SIGNAL CONDITIONER, 0-75mVDC IN, 0-10 OUT | 5 | Omega Engineering | DRF-VDC-24VDC-75MV-0/10 | | 189.00 | 945.00 |
| 4900199-1 | SENSOR, TEMP, CONDUIT BOX MNT | 1 | Omega Engineering | EWS-TX M3500/0209 | | | |
| 4900070-9 | CONTROLLER, MICROLOGIX 1100 | 1 | Reynolds Co | 1763-L16DWD | | | |
| 4900070-10 | MODULE, DIGITAL INPUT, 100/120 VAC | 1 | Reynolds Co | 1762-IA8 | | | |
| 4900070-2 | MODULE, 4-CH VOLT/CURRENT ANALOG INPUT | 2 | Reynolds Co | 1762-IF4 | | | |
| 4900070-5 | MODULE, 4-CH VOLT/CURRENT ANALOG OUTPUT | 1 | Reynolds Co | 1762-OF4 | | | |
| 4000024-2 | FUSE BLOCK,15MM DIN RAIL | 20 | Allied | 502-3776 | | 0.50 | 25.00 |
| 4000024-2 | FUSE BLOCK END PLATE, DIN RAIL | 5 | Allied | 502-3312 | | 0.19 | 3.80 |
| 4000024-4 | JUMPER, 3-POLE, INTERNAL, DIN RAIL | 7 | Allied | 502-3284 | | 0.61 | 12.20 |
| 4800002-1 | CONN, 25 PIN DSUB | 5 | Allied | 720-3321 | | 0.87 | 4.35 |
| 4800003-1 | CONN, 25 DSUB BACK SHELL | 5 | Allied | 720-0022 | | 2.61 | 13.05 |
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|---|---|---|---|---|---|---|---|
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| 3000022-1 | ANCHOR, CABLE TIE,ADHESIVE, WHT, .75x.75 | 1 | Allied | 805-2003 | | 33.53 | 33.53 |
| | | | | | | | |
| | | | | | | | |
| 3800033-1 | DUCT, TYPE G, SLOTTED,ADHES BACK, 2X2, 6FT | 2 | Allied | 381-0590 | | 47.96 | 47.96 |
| | | | | | | | |
| 3800034-1 | DUCT, TYPE F,SLOTTED,ADHES BACK,1X2, 6FT | 1 | Allied | 381-0528 | | 42.06 | 42.06 |
| 3800035-2 | COVER, DUCT,2" WIDE,6FT | 2 | Allied | 381-0500 | | 12.24 | 24.48 |
| 3800035-1 | COVER, DUCT,1" WIDE,6FT | 1 | Allied | 381-0498 | | 7.96 | 7.96 |
| 4000014-1 | RELAY, SPDT, 6A, 24VDC | 6 | Allied | 502-0775 | | 12.11 | 60.55 |
| 4000025-2 | RELAY, 3PDT, 15A, 24VDC | 2 | Allied | 850-0044 | | | |
| 4000026-2 | SOCKET, SCREW TERM, DIN RAIL, 11 PIN | 2 | Allied | 850-0805 | | | |
| 4000016-1 | RELAY, DPDT, 40A, 24VDC | 4 | Allied | 850-3113 | | 20.80 | 83.20 |
| 3900011-2 | DIN RAIL, 35mmx7.5mm DEEPx1m LONG | 1 | Allied | 502-0156 | 1-2 days | 4.10 | 4.12 |
| 3900011-1 | DIN RAIL, 15mmx5.5mm DEEPx1m LONG | 1 | Allied | 502-0159 | 1-2 days | 3.12 | 3.12 |
| 4000031-1 | CONVERTER, DC-DC, 48 TO 24V, 150W | 1 | Powerstream | PST-DC4824 | 3-5 days | 135.00 | 135.00 |
| | | | | | | | |
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| | **Data Acquisition** | | | | | | |
| 4900033-1 | SENSOR, MICRO-FLOW, FOR LOW WATER APP | 2 | Omega Engineering | FP-5061 | | 306.00 | 612.00 |
| | | | | | | | |
| 4900250-1 | Industrial Panel PC | | Beckhoff | CP6202-0001-0020 | | | |
| | Intel® Atom™ 1.6 GHz | | Beckhoff | C9900-C536 | | | |
| | OPTION, for -1,SATA HARD DISK 2.5" 40GB | | Beckhoff | C9900-H148 | | | |
| | Microsoft Windows Embedded Standard | | Beckhoff | C9900-S326-0033 | | | |
| ? | Microsoft Office Standard Edition | | | | | | |
| 4900262-1 | HUB, ETHERNET, 4 PORT, 10Mbps | 1 | ZDTronic | EN 104TP | | 43.75 | 87.50 |
| 4900029-1 | KEYBOARD, w/TOUCHPAD | 1 | Allied | 908-0072 | | 199.66 | 199.66 |
| 4900251-1 | POWER METER, ACUVIM 3 PHASE | 2 | PowerMeterStore | AE Acuvim-II | | | |
| 4900252-1 | TRANSFORMER, CURRENT, SPLIT CORE, 200A, 5A OUT | 4 | PowerMeterStore | H6810-200A-5A | | | |
| 4900264-1 | MODULE, ACUVIM ETHERNET COMM | 2 | PowerMeterStore | AE AXM-NET | | | |
| | | | | | | | |

# Appendix B:  DOE Status Reports

## Quarterly Status Report 1 – December 31, 2009

1. Award & Recipient:  DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator:  Microgrids for Colonias (OE 14.09), PI:  Dean Schneider

3. Date of Report:  January 29, 2010
   Period Covered by Report:  October 1, 2009 – December 31, 2009

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1:  Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1:  Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | |
| Task 2.2:  System Sizing and Site Selection<br>**Deliverable 2a:  Site Selection Report due 28 Feb 10** | |
| Task 2.3:  Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | |
| Public Comment Period (if required)<br>Completion by 31 August 10 | |
| Budget Period 2 | |
| Task 3:  System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | |
| Task 4:  Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | |
| Task 5:  Operation<br>**Deliverable 5:  Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | |

| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | |
|---|---|

Explanation (if any): None for this period.

5. Discussion on Accomplishments during Reporting Period. The major activity during the first reporting period included finalizing contracts with the subawardees. These negotiations have been completed and subcontracts have been issued to Xtreme Power and the Texas Rio Grande Legal Aid (TRLA). A subproject was put in place for the Center for Housing and Urban Development (CHUD) since they are a Texas A&M University System agency. Contracting was completed by the end of October with awards taking place on 16 Oct 09. TEES then coordinated with the other subawardees to finalize the Program Management Plan (Deliverable 1). An intial site visit was made for a team meeting in Laredo, TX on 13 Oct 09. Deliverable 1 was completed and Dr. Schneider from TEES and Mr. Moyer from Xtreme Power travel to NETL Pittsburg to brief Mr. Darshan Goswami, the DOE Project Officer at the Kickoff meeting held on 24 Nov 09. The Program Management Plan was approved by Mr. Goswami and was submitted as final on 30 Nov 09. Site selection started on 1 Dec 09 and an initial site visit and orientation meeting was held in Laredo, TX on 15-16 Dec 09. The team met at the La Presa Community Center in Webb County on the 15$^{th}$ and defined the community recruitment plan of action. The resulting plan will allow for initial site selection and community meeting by the end of January 2010. On the 16$^{th}$, Dr. Schneider and Mr. Reyna from TRLA met with the Webb County Planning Department on permitting and related issues.

6. Cost Status (as of 31 Dec 09) – Budget Period #1 funded at $80,680.00.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $29,009.41 | $5,864.16 | $5,864.16 | $23,145.25 |
| Travel | $2,832.00 | $1,202.97 | $1,202.97 | $1,629.03 |
| Subcontract | $32,887.59 | - | - | $32,887.59 |
| Indirect | $15,951.00 | $3,368.99 | $3,368.99 | $12,582.01 |
| Total | $80,680.00 | $10,436.12 | $10,436.12 | $70,243.88 |

7. Schedule Status. On schedule per Program Management Plan.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: None.

10. Description of Product Produced: None during this period.

11. Attachment: Program Management Plan submitted on 30 Nov 09.

## Special Status Report – February 26, 2010

**Purpose of Report:** To report delay in schedule and provide information on recovery actions.

**Circumstance:** The word of mouth campaign that has been running in the Colonia has not shown adequate results. There are two problems right now; first is that it is political season in Laredo and the area where we are looking has a 3 way primary race for County Precinct Commissioner, one of which is the incumbent, one is the prior commissioner and the other is a well known community member. This has the entire area at loggerheads and no one is really talking to anyone else. Our community advocacy partners TRLA and CHUD are putting together a marketing plan over the next couple of weeks and will actively move into the area with their own staffs and do direct marketing. Our contact with Congressman Cuellar's office is also going to ask the congressman if there are any areas that he wants us to examine to see if possible clusters exists for service.

**Impact:** Site Selection for the micro-grids is delayed one month. Site Selection Report (Deliverable 2A for Milestone Task 2.2) is delayed until 31 March 2010.

## Quarterly Status Report 2 – March 31, 2010

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: April 27, 2010
   Period Covered by Report: January 1, 2010 – March 31, 2010

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Ongoing |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Ongoing |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | |
| Public Comment Period (if required)<br>Completion by 31 August 10 | |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | |

Explanation: A Special Status Report was filed on 26 Feb 10. We reported that the word of mouth campaign that has been running in the Colonia has not shown adequate results. There are two problems right now; first is that it is political season in Laredo and the area where we are looking has a 3 way primary race for County Precinct Commissioner, one of which is the incumbent, one is the prior commissioner and the other is a well known community member. This has the entire area at loggerheads and no one is really talking to anyone else. Our community advocacy partners TRLA and CHUD are putting together a marketing plan over the next couple of weeks and will actively move into the area with their own staffs and do direct marketing. Our contact with Congressman Cuellar's office is also going to ask the congressman if there are any areas that he wants us to examine to see if possible clusters exists for service.

5. Discussion on Accomplishments during Reporting Period. The project team made extensive interviews and visits to locate an adequate cluster of homes. As reported in the Special Status report, we had much difficulty in establishing rapport with the community members. An initial meeting was obtained on 28 Jan 10 and we were only able to attract 2 families to the meeting. These two families remain interested; however, the current political climate remained in flux due to the pending primary runoff between candidates for County Precinct Commissioner. The team also met with the Webb County Planning Dept on February 16, 2010. The planning Department requested us to formally determine the applicability of the project to the Texas Utility Code and Septic System requirements. We will continue the planning process while the issues raised by the planning department are resolved. A conference call was held on March 4, 2010 and the team was requested by Webb County to request a formal determination of the applicability of the Texas Utility Code to the project. We are working to resolve this issue and we anticipate a favorable outcome. If the issue is not resolved favorably, we will not be able to continue with our current plan of activities. This has delayed the project and we anticipate site selection in May depending upon our ability to resolve the issue in April. We have received feedback from the Office of the Attorney General of the State of Texas that leads us to believe that we will successful and that the Texas Utility Code will be deemed not applicable in to this project. The Runoff election is scheduled for April 13$^{th}$, 2010 and should resolve community reluctance to become involved in the project.

6. Cost Status (as of 31 Mar 10) – Budget Period #1 funded at $80,680.00. (Note this includes a correction that occurred to the previous reporting period data)

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $29,009.41 | $3,798.52 | $17,563.69 | $11,445.72 |
| Travel | $2,832.00 | $1,005.89 | $2,208.86 | $623.14 |
| Subcontract | $32,887.59 | | | $32,887.59 |
| Indirect | $15,951.00 | $2,234.05 | $9,194.24 | $6,756.76 |

| | | | | |
|---|---|---|---|---|
| Total | $80,680.00 | $7,038.46 | $17,474.58 | $63,205.42 |

7. Schedule Status. Delayed – See Updated Program Management Plan published on Feb 26, 10.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: Once the Code issue is resolved the project will proceed to site selection and environmental surveys. We anticipate site selection to resume in April with final determinations made in May.

10. Description of Product Produced: None during this period.

**Quarterly Status Report 3 – June 30, 2010**

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: July 14, 2010
Period Covered by Report: April 1, 2010 – June 30, 2010

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | In Progress |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Waiting on DOE<br>determination |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | In Progress |
| Public Comment Period (if required)<br>Completion by 31 August 10 | |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | |

Explanation: The political issues described in the previous reports have been resolved with the re-election of the current incumbent County Commissioner in Webb County on 13 April 10. Coupled with the marketing effort that our community advocacy partners have engaged in, we have overcome the delay and have selected sites.

5. Discussion on Accomplishments during Reporting Period. The project team made excellent progress during this reporting period. The team identified 3 clusters of dwellings in the proposed service area and has submitted site selection reports and environmental surveys for the Los Nopalitos and Los Arcos sites. The Site selection report and environmental surveys are attached. The third area, Las Lomas, has much longer line lengths and the property records and persons dwelling in the residences are murkier than the other two sites. This site selection report will be finalized the week of 12 July 10 and will be transmitted to DOE for review. Our legal partner, TRLA, is drafting the easements for the property owners and those easements will be completed and signed by the end of September 2010.

   We are waiting on review from DOE of the environmental questionnaires to determine if an environmental assessment (EA) will be required. If an assessment will be required, we will request an extension to the project to account for the time necessary to accomplish the EA.

   One of the requirements that the Webb County planning dept has imposed on the project is to assist the residents that are served by the project in obtaining the necessary legal sewage systems that are the pre-requisite to grid connection. The project team met with local representatives from the US Dept of Dept of Agriculture (USDA) who administer several programs to assist low income residents in obtaining legal sewage systems and had developed a process that will encourage residents to take advantage of those programs. Our community advocacy partners have developed a process to evaluate our participants for grants and/or loans to obtain a legal septic system and we have agreed with the Planning Department to incentivize participants by providing service for an 18 months period and to cut off service if a legal septic system is not obtained in that time.

6. Cost Status (as of 30 Jun 10) – Budget Period #1 funded at $80,680.00.

| Cost Category | Budget | Qtrly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| **TEES (A7800)** | | | | |
| Labor | $ 26,767 | $ 4,062 | $ 21,626 | $ 5,141 |
| Travel | $ 2,832 | $ 612 | $ 1,982 | $ 850 |
| Indirect | $ 13,765 | $ 2,173 | $ 10,978 | $ 2,787 |
| **Total TEES** | $ 43,364 | $ 6,848 | $ 34,585 | $ 8,779 |
| **Subcontract** | | | | |
| Xtreme (A7801) | $ 20,770 | $ - | $ - | $ 20,770 |
| Indirect | $ 9,658 | $ - | $ - | $ 9,658 |
| CHUD (A780A) | $ 4,702 | $ - | $ - | $ 4,702 |
| Indirect | $ 2,186 | $ - | $ - | $ 2,186 |
| **Total Subcontract** | $ 37,316 | $ - | $ - | $ 37,316 |

| | | | | |
|---|---|---|---|---|
| **Total Project** | **$ 80,680** | **$ 6,848** | **$ 34,585** | **$ 46,095** |

Note: Subcontract Invoices not yet received. Subcontractor will submit invoices in July 2010 for prior work.

7. Schedule Status. On schedule. Continuing funding application is in progress and should be submitted mid July 2010. Awaiting DOE NEPA review determination.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: Once the Code issue is resolved the project will proceed to site selection and environmental surveys. We anticipate site selection to resume in April with final determinations made in May.

10. Description of Product Produced: Site Selection reports and Environmental Questionnaires.

**Quarterly Status Report 4 – September 30, 2010**

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: October 22, 2010
   Period Covered by Report: Jul 1, 2010 – September 30, 2010

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | In Progress pending<br>NEPA Determination |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Waiting on DOE NEPA<br>Determination |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Pending NEPA<br>Determination |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | |

5. Discussion on Accomplishments during Reporting Period. Site selection and initial layout is completed. We are waiting on notification of approval for NEPA compliance by DOE/NETL prior to proceeding.

6. Cost Status (as of 30 Sep 10) – Budget Period #1 funded at $80,680.00.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 29,009.41 | $ 3,397.04 | $ 24,843.42 | $ 1,923.58 |
| Travel | $ 2,832.00 | $ 255.97 | $ 2,237.70 | $ 594.30 |
| Subcontract | $ 32,887.59 | $ 13,400.05 | $ 9,146.79 | $ 16,325.21 |
| Indirect | $ 15,951.00 | $ 1,698.65 | $ 16,929.50 | $ 8,679.50 |
| Total | $ 80,680.00 | $ 18,751.71 | $ 53,157.41 | $ 27,522.59 |

7. Schedule Status. On schedule. Continuing funding application is in progress and should be submitted mid July 2010. Awaiting DOE NEPA review determination.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: we anticipate NEPA approval of the projects sites in early October. This timely approval is necessary to keep to our anticipated schedule. Planned distribution

| Location | Distribution Grid Installation |
|---|---|
| Ranchitos Las Lomas | Week of 15 Nov 10 |
| Ranchitos Los Nopalitos | Week of 6 Dec 10 |
| Ranchitos Los Arcos | Week of 13 Dec 10 |

10. Description of Product Produced: None this period.

## Quarterly Status Report 5 – December 31, 2010

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: Jan 24, 2011
   Period Covered by Report: Oct 1, 2010 – Dec 31, 2010

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | In Progress |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | In Progress |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | |

5. Discussion on Accomplishments during Reporting Period. Planning Phase has been completed. Full NEPA Approval was received on 18 Oct 10. Final Easements were obtained in Nov 10. We initially scheduled the installation of the distribution grids for late Novembers, early December, however, DOE did not formally issue the additional funding until late November. This delayed installation of the distribution system since the subcontractor could not purchase materials until the subcontract award had been modified for the additional funding. This was completed in December and the parts are ordered. Installation is scheduled to begin in January 2011.

6. Cost Status (as of 31 Dec 10) – Budget Period #1 & 2 funded at $475,750.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557.00 | $ 11,287.36 | $ 36,130.78 | $ 51,426.22 |
| Travel | $ 4,494.00 | $ 758.21 | $ 2,995.91 | $ 1,498.09 |
| Other | $ 5,350.00 | $ 5,350.00 | $ 5,350.00 | $ - |
| Subcontract | $ 317,562.00 | $ - | $ 13,400.05 | $ 308,415.21 |
| Indirect | $ 60,787.00 | $ 8,088.94 | $ 25,018.44 | $ 35,768.56 |
| Total | $ 475,750.00 | $ 25,484.51 | $ 82,895.18 | $ 397,108.08 |

7. Schedule Status. On schedule. After funding was received in Nov 10, Installation is scheduled to be completed by March 2011.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: Revised installation schedule is as follows:

| Location | Distribution Grid Installation |
|---|---|
| Ranchitos Las Lomas | Week of 17 Jan 11 |
| Ranchitos Los Nopalitos | Week of 24 Jan 11 |
| Ranchitos Los Arcos | Week of 31 Jan 11 |

Installation of Hybrid systems will commence upon completion of the trailer systems in late February and March 2011

10. Description of Product Produced: None this period.

**Quarterly Status Report 6 – March 31, 2011**

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: April 6, 2011
   Period Covered by Report: Jan 1, 2011 – Mar 31, 2011

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | In Progress<br>Anticipate 15 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | In Progress<br>Installation anticipated completed by 31 May 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | Anticipate POP extension request to 31 May 12 due to procurement delays |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 Mar 12** | Anticipate moving due date to 31 May 12 |

5. Discussion on Accomplishments during Reporting Period. Distribution grid installation in the Las Lomas and Los Arcos colonias is complete. Distribution grid installation for Los Nopalitos was delayed due to some property ownership questions that were raised by the county planning department. Our community partner TRLA is working with the planning department to finalize the permits so that grid installation can start. We anticipate installation of the Los Nopalitos grid in Mid April. All components of the hybrid generation station were ordered before the end of last year, however some components were backordered. The diesel gensets and battery chargers will be received in May and we anticipate deployment of the hybrid systems by the end of May 2011. Upon installation, we will request a no-cost extension to the contract through May 31, 2012 to allow for 1 year of operation of the systems to obtain 1 year of data (as noted in the management plan).

6. Cost Status (as of 31 Mar 11) – Budget Period #1 & 2 funded at $475,750. No Subcontract invoices were received during this period.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ 22,533 | $ 58,664 | $ 28,894 |
| Travel | $ 4,494 | $ 696 | $ 3,692 | $ 802 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ - | $ 22,547 | $ 317,562 |
| Indirect | $ 60,787 | $ 10,801 | $ 38,698 | $ 22,089 |
| Total | $ 475,750 | $ 34,030 | $ 128,951 | $ 369,346 |

7. Schedule Status. Delayed two months due to component backorders. We anticipate installation of the hybrid systems to be completed by May 31, 2011.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: As noted in sections 5 and 7. Parts delays have delayed construction of the hybrid systems. Installation of hybrid systems will commence upon completion of the trailer systems in May 2011. We anticipate installation to be completed by May 31, 2011.

10. Description of Product Produced: None this period.

**Quarterly Status Report 7 – June 30, 2011**

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: Jul 8, 2011
   Period Covered by Report: April 1, 2011 – June 30, 2011

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | Completed<br>26 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | In Progress<br>Grid Installation completed<br>Hybrid system installed<br>15 Jul 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | Data logging to begin upon installation of hybrid systems |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | POP Extension request submitted 1 Jun 11<br>Approved 24 Jun 11<br>Extended to 31 Jul 2012 |
| Task 6: Assessment and Analysis | Final Report Due Date now |

| Deliverable 6: Final Report due 31 Mar 12 | 31 Jul 12 |
|---|---|

5. Discussion on Accomplishments during Reporting Period. Distribution grid installation in Nopalitos is completed. Trailer assembly is completed, however a power supply in one trailer failed during test. Spares were on-hand and Xtreme Power is consulting with the supply manufacturer to identify and correct failure cause. Hybrid trailer installation is scheduled for 11 Jul 2011.

6. Cost Status (as of 30 Jun 11) – Budget Period #1 & 2 funded at $475,750. No Subcontract invoices were received during this period – subcontractor plans to invoice after installation in July 2012.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ 12,304 | $ 70,967 | $ 16,590 |
| Travel | $ 4,494 | $ - | $ 3,692 | $ 802 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ - | $ 13,400 | $ 308,415 |
| Indirect | $ 60,787 | $ 5,240 | $ 25,645 | $ 35,142 |
| Total | $ 475,750 | $ 17,544 | $ 119,054 | $ 360,949 |

7. Schedule Status. Delayed two months due to prior component backorders. We anticipate installation of the hybrid systems to be completed by July 31, 2011. Period of performance has been extended to 31 Jul 2012.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: As noted in Section 5.

10. Description of Product Produced: None this period.

## Quarterly Status Report 8 – September 30, 2011

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: Oct 25, 2011
   Period Covered by Report: July 1, 2011 – September 30, 2011

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | Completed<br>26 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | Completed<br>31 Aug 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | In Progress |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | Completed<br>24 Jun 11 |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 July 12** | In Progress |

5. Discussion on Accomplishments during Reporting Period. All installation work complete. All hybrid generation systems installed and operating. Data is being collected.

6. Cost Status (as of 31 Mar 11) – Budget Period #1 & 2 funded at $475,750. Subcontractor invoice of $300,090.21 has been received and is in process of validation and payment.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ 12,973 | $ 83,940 | $ 3,617 |
| Travel | $ 4,494 | $ 100 | $ 3,793 | $ 702 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ - | $ 13,400 | $ 308,415 |
| Indirect | $ 60,787 | $ 6,210 | $ 31,854 | $ 28,933 |
| Total | $ 475,750 | $ 19,283 | $ 138,337 | $ 341,667 |

7. Schedule Status. On schedule.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: None.

10. Description of Product Produced: None this period.

## Quarterly Status Report 9 – December 31, 2011

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: January 30, 2012
   Period Covered by Report: October 1, 2011 – December 31, 2011

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | Completed<br>26 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | Completed<br>31 Aug 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | In Progress |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | Completed<br>24 Jun 11 |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 July 12** | In Progress |

5. Discussion on Accomplishments during Reporting Period. All installation work complete. All hybrid generation systems installed and operating. Data is being collected.

6. Cost Status (as of 31 Dec 11) – Budget Period #1 & 2 funded at $475,750.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ 2,322 | $ 86,262 | $ 1,295 |
| Travel | $ 4,494 | $ - | $ 3,793 | $ 702 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ 319,591 | $ 332,991 | $ 46 |
| Indirect | $ 60,787 | $ 12,348 | $ 59,837 | $ 950 |
| Total | $ 475,750 | $ 334,261 | $ 488,232 | $ 2,993 |

7. Schedule Status. On schedule.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: None.

10. Description of Product Produced: None this period. In operational/Data acquisition.

## Quarterly Status Report 10 – March 31, 2012

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: April 1, 2012
   Period Covered by Report: January 1, 2012 – March 31, 2012

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | Completed<br>26 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | Completed<br>31 Aug 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | In Progress |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | Completed<br>24 Jun 11 |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 July 12** | In Progress |

5. Discussion on Accomplishments during Reporting Period. All installation work complete. All hybrid generation systems installed and operating. Data is being collected.

6. Cost Status (as of 31 Mar 12) – Budget Period #1 & 2 funded at $475,750.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ - | $ 86,262 | $ 1,295 |
| Travel | $ 4,494 | $ - | $ 3,793 | $ 702 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ - | $ 332,991 | $ 46 |
| Indirect | $ 60,787 | $ - | $ 59,837 | $ 950 |
| Total | $ 475,750 | $ - | $ 488,232 | $ 2,993 |

7. Schedule Status. On schedule. We will be requesting property transfer to TEES at the end of the project during this quarter.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: None.

10. Description of Product Produced: None this period. In operational/Data acquisition.

## Quarterly Status Report 11 – June 30, 2012

1. Award & Recipient: DE-OE0000038 Texas Engineering Experiment Station

2. Title & Principal Investigator: Microgrids for Colonias (OE 14.09), PI: Dean Schneider

3. Date of Report: July 31, 2012
   Period Covered by Report: April 1, 2012 – June 30, 2012

4. Comparison of Actual Accomplishments with Established Project Goals

| Milestone | Accomplished |
|---|---|
| Budget Period 1 – Initial Planning, Development, and Environmental Analysis | |
| Project Start (all subcontracts executed)<br>1 Nov 09 | Completed 16 Oct 09 |
| Task 1: Program Management Plan<br>**Deliverable 1: PMP due 30 Nov 09** | Completed 30 Nov 09 |
| Task 2.1: Initial Assessment and Survey of Needs<br>Completion by 31 Jan 10 | Completed<br>10 Jun 10 |
| Task 2.2: System Sizing and Site Selection<br>**Deliverable 2a: Site Selection Report due 28 Feb 10** | Completed<br>10 Jun 10 |
| Task 2.3: Community Meetings/Easement acquisition –<br>Completion by 30 April 10 | Completed<br>31 Aug 10 |
| Environmental Assessment (if required)<br>Completion by 30 Jun 10 | Not Required<br>NEPA Approval 10/18/10 |
| Continuing Funding Application submitted to DOE<br>Completion by 31 July 10 | Approved 9/30/10 |
| Public Comment Period (if required)<br>Completion by 31 August 10 | Not Required<br>NEPA Approval 10/18/10 |
| Budget Period 2 | |
| Task 3: System Development and Design<br>**Deliverable 3: System Design Specification due 28 Feb 11** | Completed<br>26 Apr 11 |
| Task 4: Installation completion by 31 March 11<br>**Deliverable 4: Quarterly Reporting during installation and operation** | Completed<br>31 Aug 11 |
| Task 5: Operation<br>**Deliverable 5: Test Results for Micro-grid system due quarterly** | In Progress |
| Request for Extension of Period of Performance<br>Completion by 31 May 11<br>*To acquire a full year of operational data for economic analysis, the project will require extension from 30 Sep 11 to 31 March 12* | Completed<br>24 Jun 11 |
| Task 6: Assessment and Analysis<br>**Deliverable 6: Final Report due 31 July 12** | In Progress |

5. Discussion on Accomplishments during Reporting Period. All installation work complete. All hybrid generation systems installed and operating. Data is being collected.

6. Cost Status (as of 30 June 12) – Budget Period #1 & 2 funded at $475,750.

| Cost Category | Budget | Quarterly Expense | Expense to Date | Budget Remaining |
|---|---|---|---|---|
| Labor | $ 87,557 | $ - | $ 86,262 | $ 1,295 |
| Travel | $ 4,494 | $ - | $ 3,793 | $ 702 |
| Other | $ 5,350 | $ - | $ 5,350 | $ - |
| Subcontract | $ 317,562 | $ - | $ 332,991 | $ 46 |
| Indirect | $ 60,787 | $ - | $ 59,837 | $ 950 |
| Total | $ 475,750 | $ - | $ 488,232 | $ 2,993 |

7. Schedule Status. On schedule. We requested property transfer to TEES at the end of the project during this quarter, but no response from DOE has yet been received.

8. Changes in Approach: None.

9. Actual/Anticipated Problems or Delays: None.

10. Description of Product Produced: None this period. In operational/Data acquisition. Data Analysis begun by subcontractor.

# Appendix C:  Site Selection Reports

## Site Selection Report for Los Nopalitos

**Microgrids for Colonias (DE-OE-0000038)**

**Site Selection Report Number 1**
**Ranchitos Los Nopalitos**
**Webb County, Texas**

**Purpose of Report:**
To report site selection for initial site for installation of microgrid systems in the Colonias of Webb County, Texas.

**Site Location:**
The site is situated in what is termed by the Webb County Planning Department as the "Ruiz Tracts" along US Highway 59, 18 miles northeast of Laredo, Texas.  The location of the site is shown below in relation to Laredo, TX.

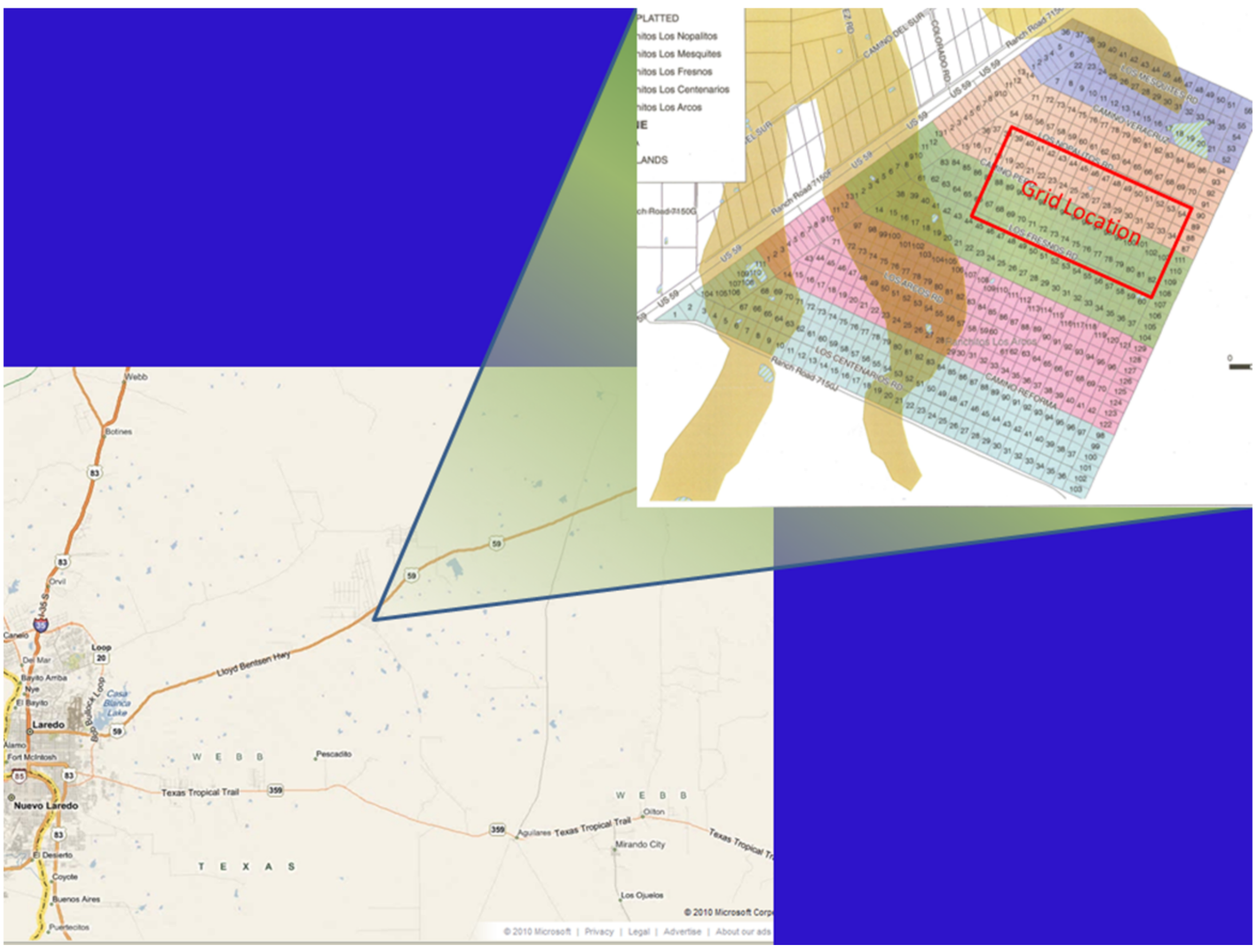


**Figure C-1.  Los Nopalitos Site Location**

In this area we have identified seven dwellings without power serving approximately eight families that have agreed to participate in the project. There are additional possible connections in the immediate area that can raise the number of connections to 13. The initial site layout is shown below. The green square represents the location of the generator enclosure. The red squares represent dwellings served. The orange dots represents the locations of the power stanchions. The location of the generator is at 27º 37.085'N by 99º 12.357'W. The initial connections are on Los Nopalitos lots 22, 23, 24, 25 and Los Fresnos lots 67 and 102 in the Ranchitos Los Fresnos. The location of the lots is shown on the Webb County map book included after the Site layout.

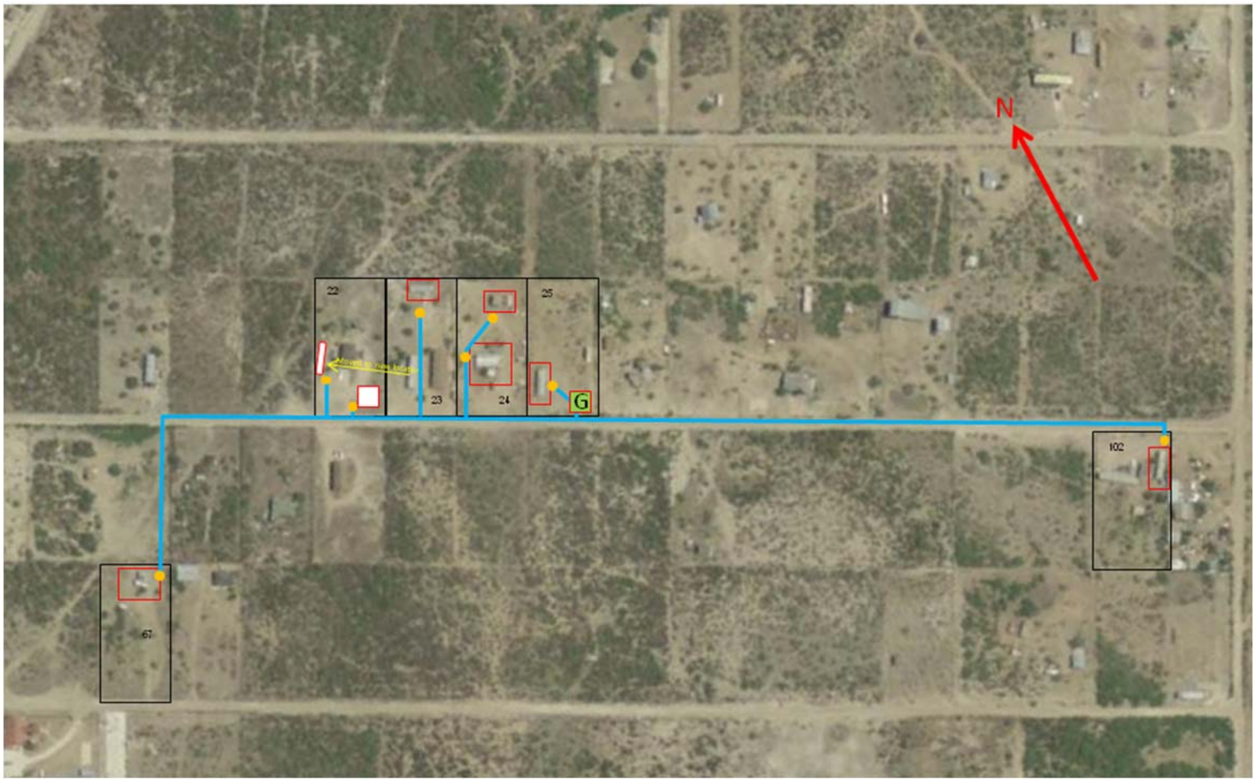


**Figure C-2. Aerial View of Los Nopalitos Proposed Site Layout**

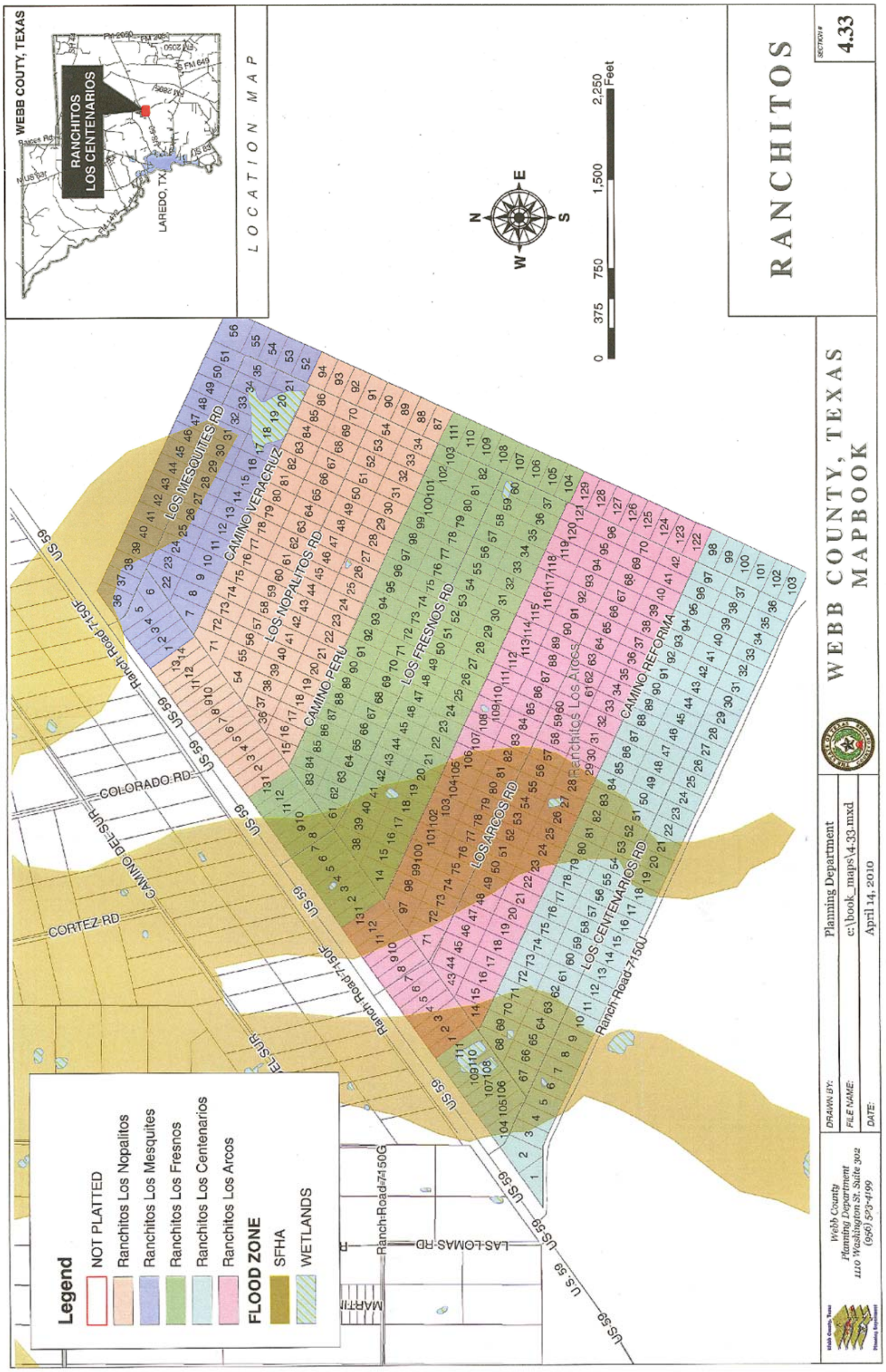


**Figure C-3. Webb County Map Book "Ruiz Tracts"**

The possibility exists that additional connections can be made to the current layout. The one possible additional service would be for Los Nopalitos Lot #2. The decision is technical on whether or not the system can support the line length to Lot #2.

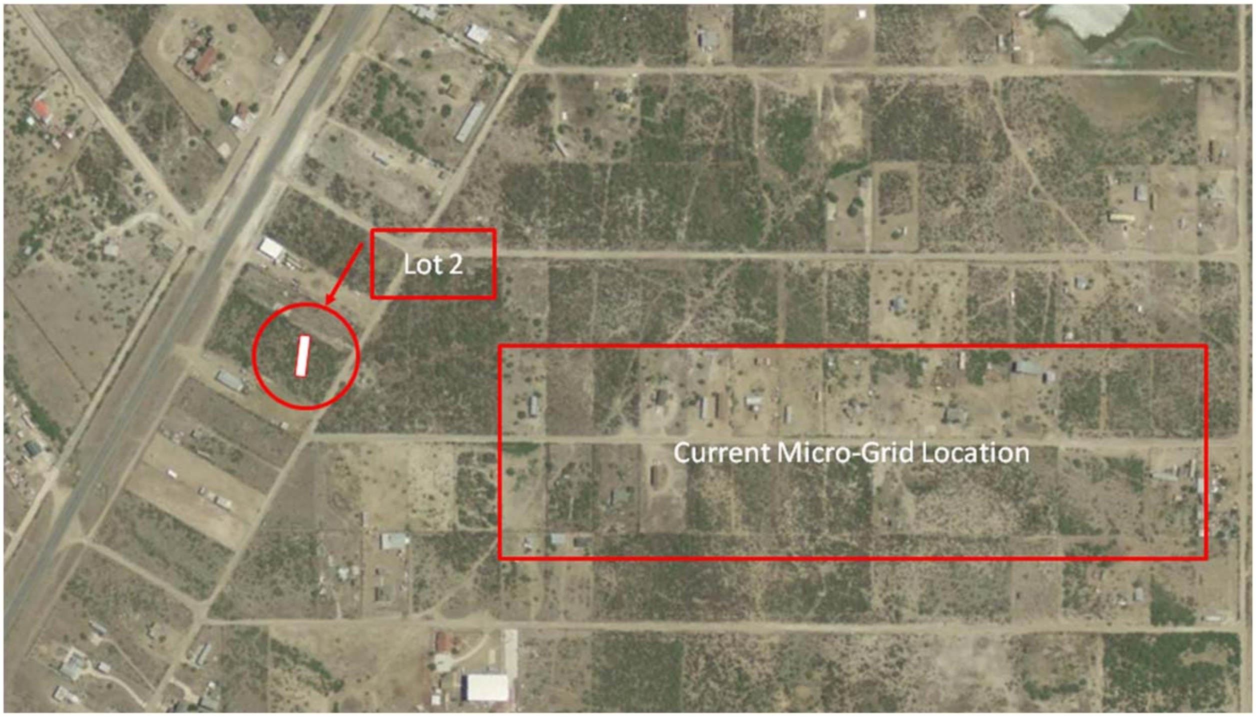


**Figure C-4. Possible Additional Connection Los Nopalitos**

**System Configuration Description:**

*Power Cells*

The Xtreme Power™ PowerCell™ is a 12 volt, 1kWh advanced dry cell battery utilizing an innovative and unique solid-state, battery design and chemistry that is safe for both transport and stationery uses. The PowerCell™ building blocks have unique characteristics that are ideally suited to provide hundreds of megawatts of power capability. Figure 2 describes the performance characteristics of the PowerCell™.

**Table C-1. PowerCell™ Characteristics**

| PowerCell™ Capabilities and Characteristics | |
|---|---|
| **Energy Production** | 1 kWh at 3 hour rate |
| **Instant Power Capacity** | 50 kW |
| **Product Dimensions** | 5” x 5” x 30” (12.7cm x 12.7cm x 76.2cm) |
| **Product Weight** | 57 lbs (25.9 kg) |
| **Cell Voltage** | 12 V DC |
| **Current** | 2500 Amps for 30 seconds (Pass/Fail Test) |
| **Cycle Efficiency** | 95% to 99% |
| **Recyclable Component Potential** | 85 to 95% |

The highly uniform characteristics of PowerCellsTM allow thousands of these building blocks to be assembled in massive parallel and series matrices. The PowerCellTM array for the Colonias project consists of 40 PowerCellsTM capable of storing 40 kWh of power.

*Generator*

Xtreme Power uses Cummins generators in its micro-grid applications. Cummins Power Generation Inc. is a worldwide provider of electrical generators and power generation systems, components and services in standby power, distributed power generation, as well as auxiliary power in mobile applications to meet the needs of a diversified customer base. Cummins Power Generation products include diesel and alternative-fueled electrical generator sets.

The generator in the micro-grid system is a 25 kW bio-diesel generator. Its sole task is to provide power to the AC-DC converters that keep the PowerCell™ array fully charged when solar or wind power is not enough to overcome demand. The generator also acts a source of emergency auxiliary power if the system experiences any critical errors.

*Solar Array*

Each micro-grid in the Colonias project will have its own solar array. Each array will consist of eighteen 195 W solar panels for a total of 3.51 kW of solar power. The power from each solar array does not go directly into the micro-grid; it is used to charge the PowerCell™ array.

*Micro-Grid*

The micro-grid is powered by inverters that convert the DC power from the PowerCell™ array into AC power usable by the Colonias residents. The inverters at this site will be capable of continuously outputting 21 kW to support the micro-grid. Each dwelling will have a power stanchion that provides 20 amps of 120 VAC power. The micro-grid will consist of a total of 6,630 feet of #2 AWG direct burial cable for AC power transmission and 3,315 feet of #8 AWG direct burial cable for grounding. Below is a simple drawing displaying where the physical lines will be buried in relation to the generation station and where each power stanchion will be located (represented by the circles).

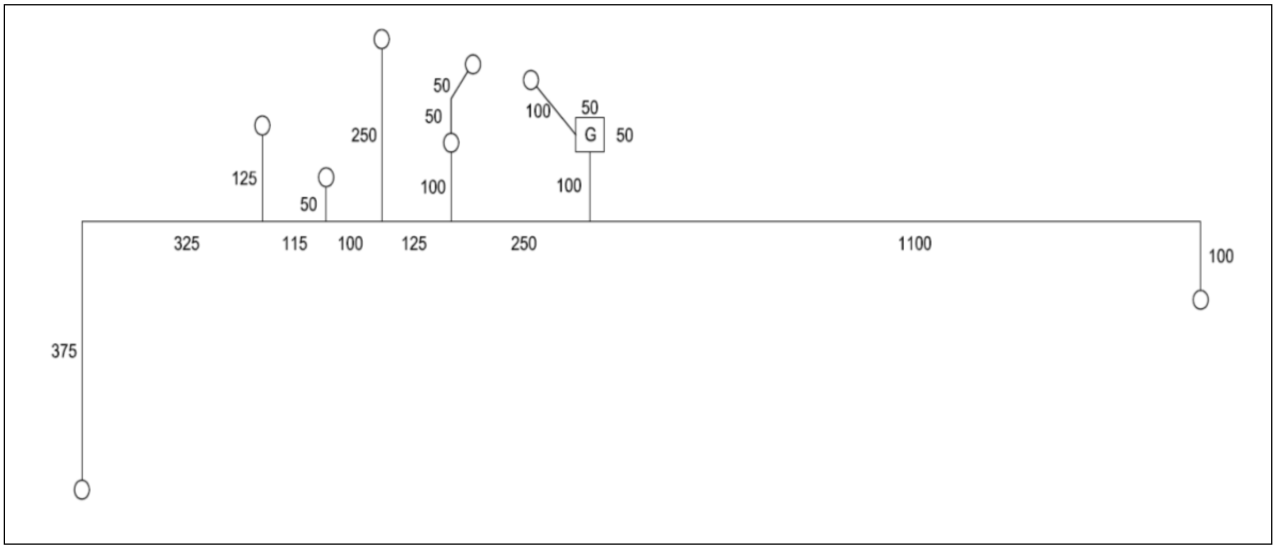


**Figure C-5. Electrical layout of Micro-Grid – Los Nopalitos**

**Table C-2. Initial Participants Los Nopalitos:**

| **Name** | **Section and Lot** |
|---|---|
| Juan Mendoza family | Los Nopalitos #22 |
| Daniel De La O family | Los Nopalitos #22 |
| Noe De La O family | Los Nopalitos #23 |
| Lizzeth Alvarado family | Los Nopalitos #24 |
| Elizzabeth De La O family | Los Nopalitos #24 |
| Maria Rojas | Los Nopalitos #25 (generator site) |
| Nora Del La O family | Los Fresnos #102 |
| Marco Antonio Cruz and Enebelia Delgado | Los Fresnos #67 |

## Site Selection report for Los Arcos

**Microgrids for Colonias (DE-OE-0000038)**

**Site Selection Report Number 2**
**Ranchitos Los Arcos**
**Webb County, Texas**

**Purpose of Report:**
To report site selection for initial site for installation of microgrid systems in the Colonias of Webb County, Texas.

**Site Location:**
The site is situated in what is termed by the Webb County Planning Department as the "Ruiz Tracts" along US Highway 59, 18 miles northeast of Laredo, Texas. The location of the site is shown below in relation to Laredo, TX.

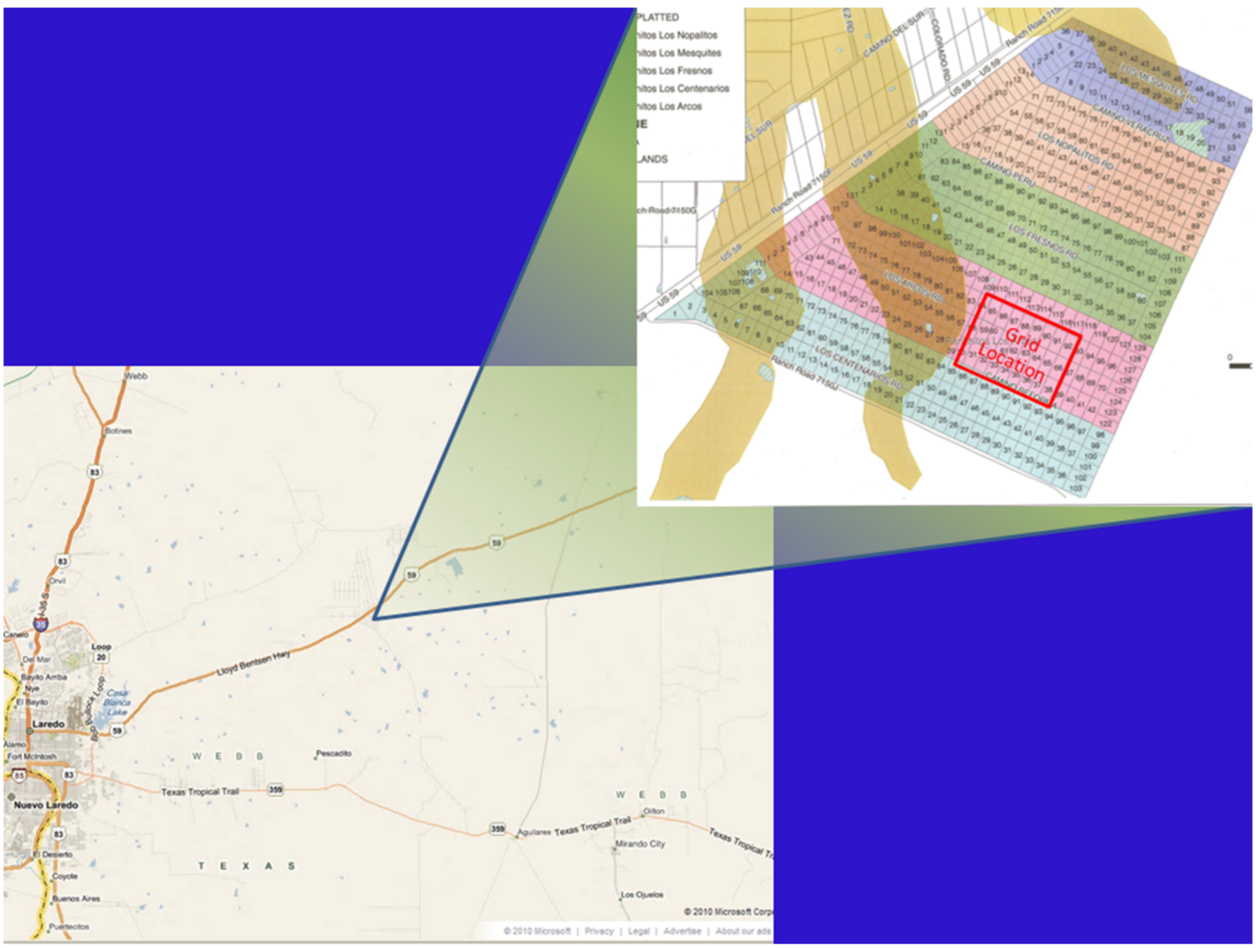


**Figure C-6. Los Arcos Site Location**

In this area we have identified five dwellings without power serving approximately five families that have agreed to participate in the project. The initial site layout is shown below. The green square represents the location of the generator enclosure. The red squares represent dwellings served. The orange dots represents the locations of the power stanchions. The location of the generator is at 27º 36.741'N by 99º 12.476'W. The initial connections are on Los Arcos lots 30, 35, and 88. The location of the lots is shown on the Webb County map book included after the Site layout.


**Figure C-7. Aerial View of Los Arcos Proposed Site Layout**

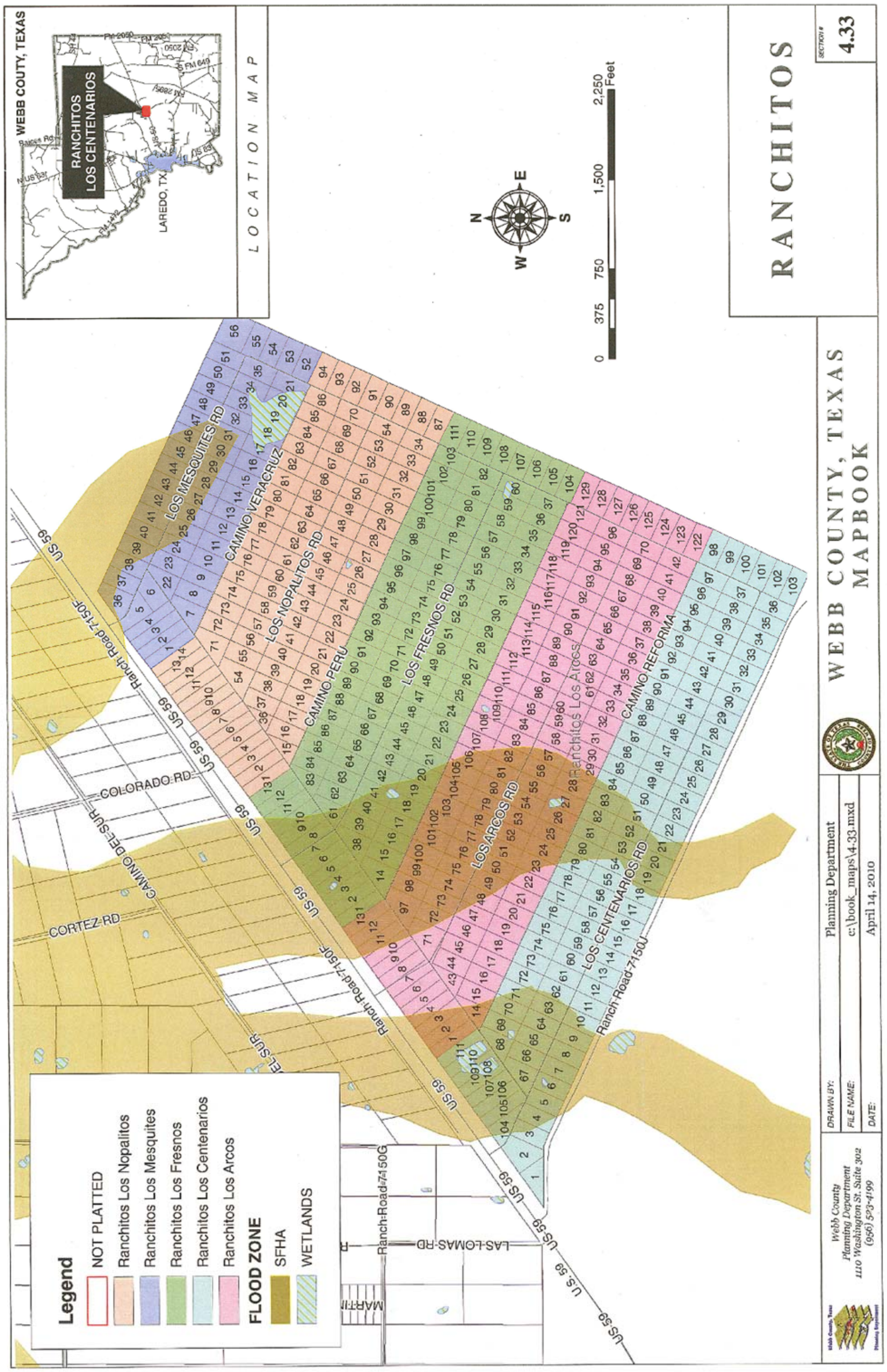


**Figure C-8. Webb County Map Book "Ruiz Tracts"**

**System Configuration Description:**

*Power Cells*

The Xtreme Power™ PowerCell™ is a 12 volt, 1kWh advanced dry cell battery utilizing an innovative and unique solid-state, battery design and chemistry that is safe for both transport and stationery uses. The PowerCell™ building blocks have unique characteristics that are ideally suited to provide hundreds of megawatts of power capability. Figure 2 describes the performance characteristics of the PowerCell™.

**Table C-3.  PowerCell™ Characteristics**

| PowerCell™ Capabilities and Characteristics | |
|---|---|
| **Energy Production** | 1 kWh at 3 hour rate |
| **Instant Power Capacity** | 50 kW |
| **Product Dimensions** | 5" x 5" x 30" (12.7cm x 12.7cm x 76.2cm) |
| **Product Weight** | 57 lbs (25.9 kg) |
| **Cell Voltage** | 12 V DC |
| **Current** | 2500 Amps for 30 seconds (Pass/Fail Test) |
| **Cycle Efficiency** | 95% to 99% |
| **Recyclable Component Potential** | 85 to 95% |

The highly uniform characteristics of PowerCellsTM allow thousands of these building blocks to be assembled in massive parallel and series matrices.  The PowerCellTM array for the Colonias project consists of 40 PowerCellsTM capable of storing 40 kWh of power.

*Generator*

Xtreme Power uses Cummins generators in its micro-grid applications.  Cummins Power Generation Inc. is a worldwide provider of electrical generators and power generation systems, components and services in standby power, distributed power generation, as well as auxiliary power in mobile applications to meet the needs of a diversified customer base. Cummins Power Generation products include diesel and alternative-fueled electrical generator sets.

The generator in the micro-grid system is a 25 kW bio-diesel generator.  Its sole task is to provide power to the AC-DC converters that keep the PowerCell™ array fully charged when solar or wind power is not enough to overcome demand.  The generator also acts a source of emergency auxiliary power if the system experiences any critical errors.

*Solar Array*

Each micro-grid in the Colonias project will have its own solar array. Each array will consist of eighteen 195 W solar panels for a total of 3.51 kW of solar power. The power from each solar array does not go directly into the micro-grid; it is used to charge the PowerCell™ array.

*Micro-Grid*

The micro-grid is powered by inverters that convert the DC power from the PowerCell™ array into AC power usable by the Colonias residents. The inverters at this site will be capable of continuously outputting 21 kW to support the micro-grid. Each dwelling will have a power stanchion that provides 20 amps of 120 VAC power. The micro-grid will consist of a total of 4,040 feet of #2 AWG direct burial cable for AC power transmission and 2,020 feet of #8 AWG direct burial cable for grounding. Below is a simple drawing displaying where the physical lines will be buried in relation to the generation station and where each power stanchion will be located (represented by the circles).

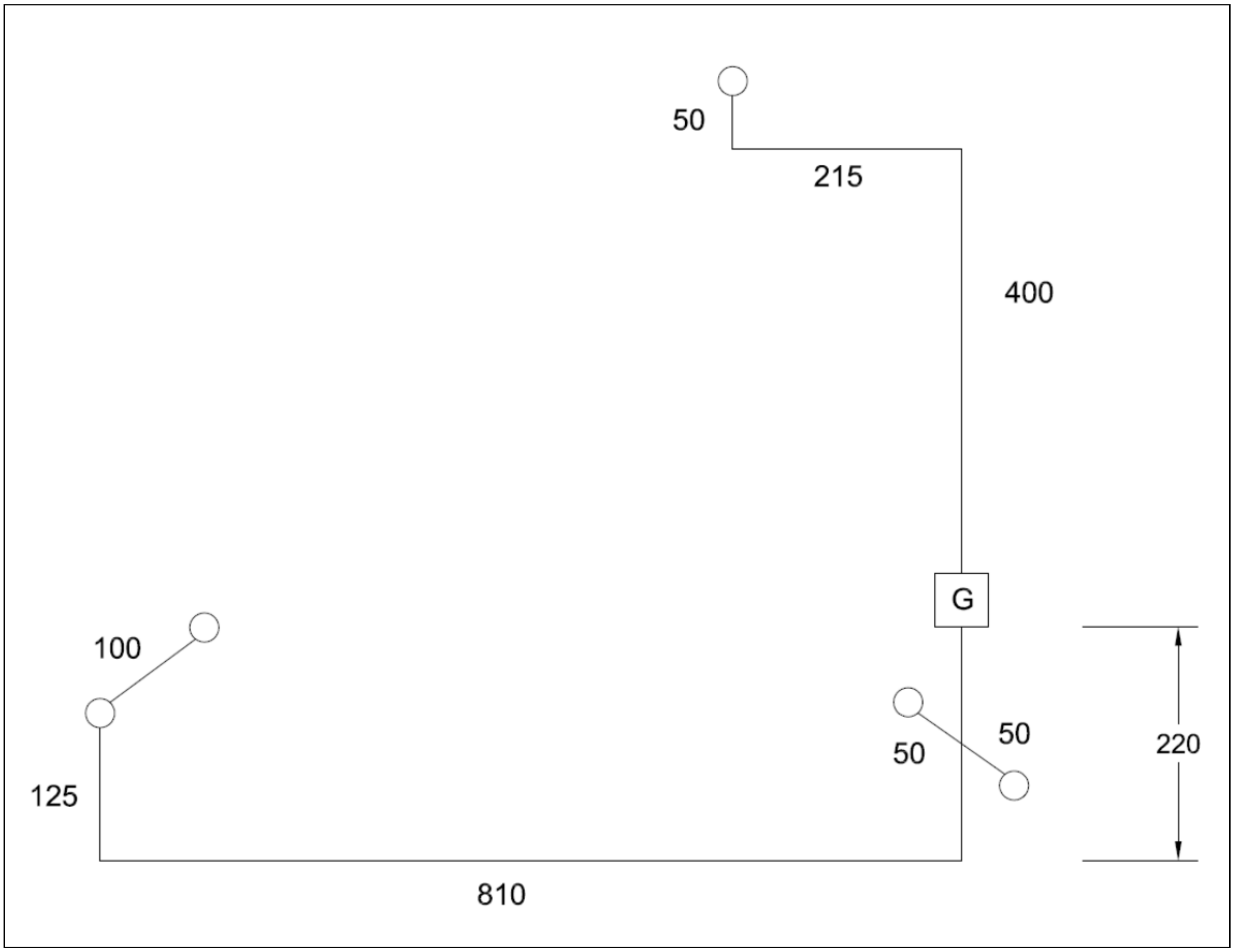


**Figure C-9. Electrical layout of Micro-Grid – Los Arcos**

**Table C-4. Initial Participants Los Arcos**

| Name | Section and Lot |
|---|---|
| Alejandro Escamilla family | Los Arcos #88 |
| Oscar Avila family (2 dwellings) | Los Arcos #30 |
| Eduardo Avendano family | Los Arcos #35 |
| Feliciano Arroyo family | Los Arcos #35 |

## Site Selection report for Las Lomas

**Microgrids for Colonias (DE-OE-0000038)**

**Site Selection Report Number 3**
**Ranchitos Las Lomas**
**Webb County, Texas**

**Purpose of Report:**
To report site selection for initial site for installation of microgrid systems in the Colonias of Webb County, Texas.

**Site Location:**
The site is situated in what is termed by the Webb County Planning Department as the "Ruiz Tracts" along US Highway 59, 18 miles northeast of Laredo, Texas. The location of the site is shown below in relation to Laredo, TX.

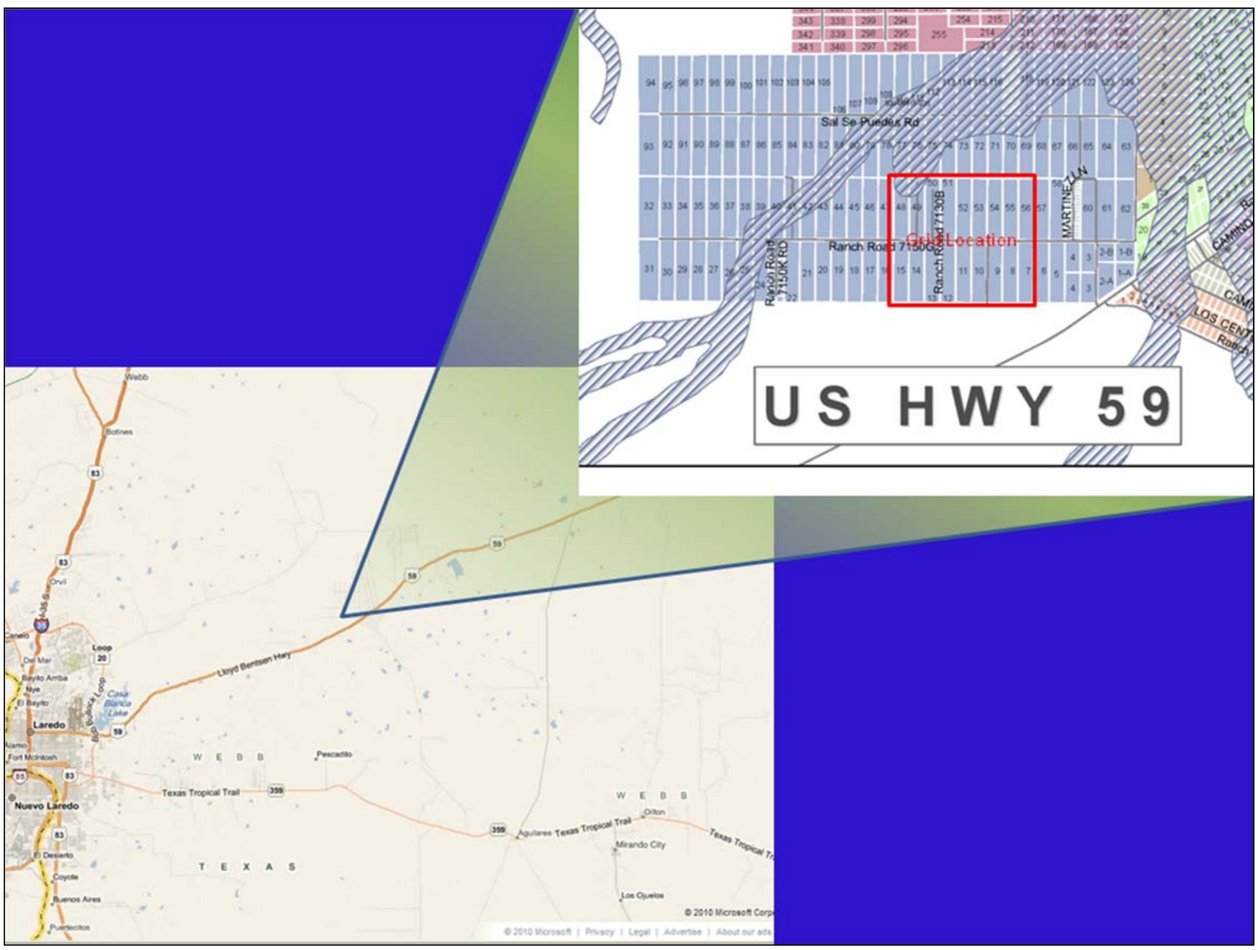


**Figure C-10. Las Lomas Site Location**

In this area we have identified ten dwellings without power serving approximately ten families that have agreed to participate in the project. The initial site layout is shown below. The green square represents the location of the generator enclosure. The red squares represent dwellings served. The orange dots represent the locations of the power stanchions. The location of the generator is at 27º 37.095’N by 99º 13.793’W and is proposed to be on the site of a Webb County photovoltaic cell powered reverse osmosis water treatment plant. We are in negotiation with Webb County to allow the generator at this site. The initial connections are on Las Lomas lots 6, 15, 48, 49, and 50. The location of the lots is shown on the Webb County map book included after the Site layout.

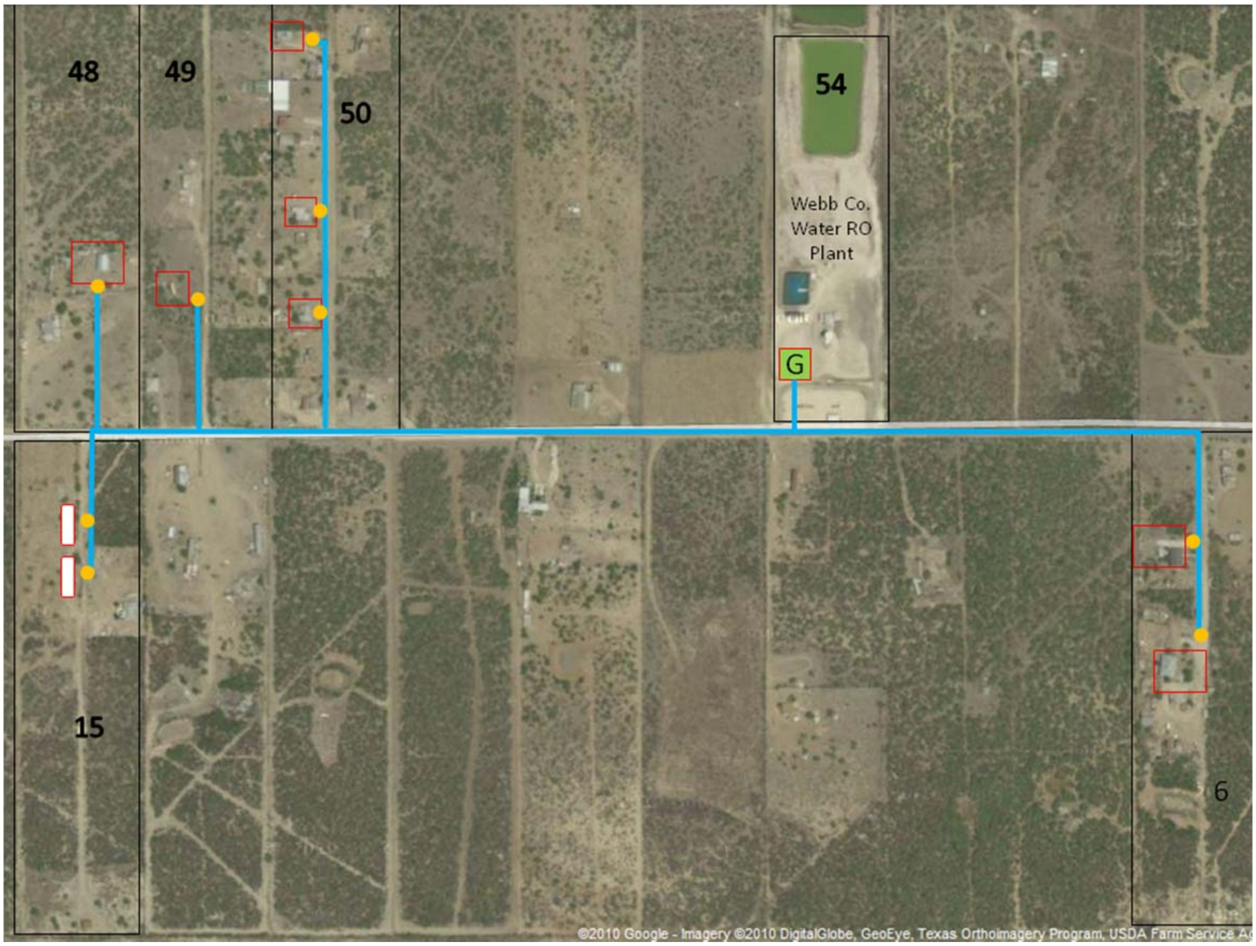


**Figure C-11. Aerial View of Las Lomas Proposed Site Layout**

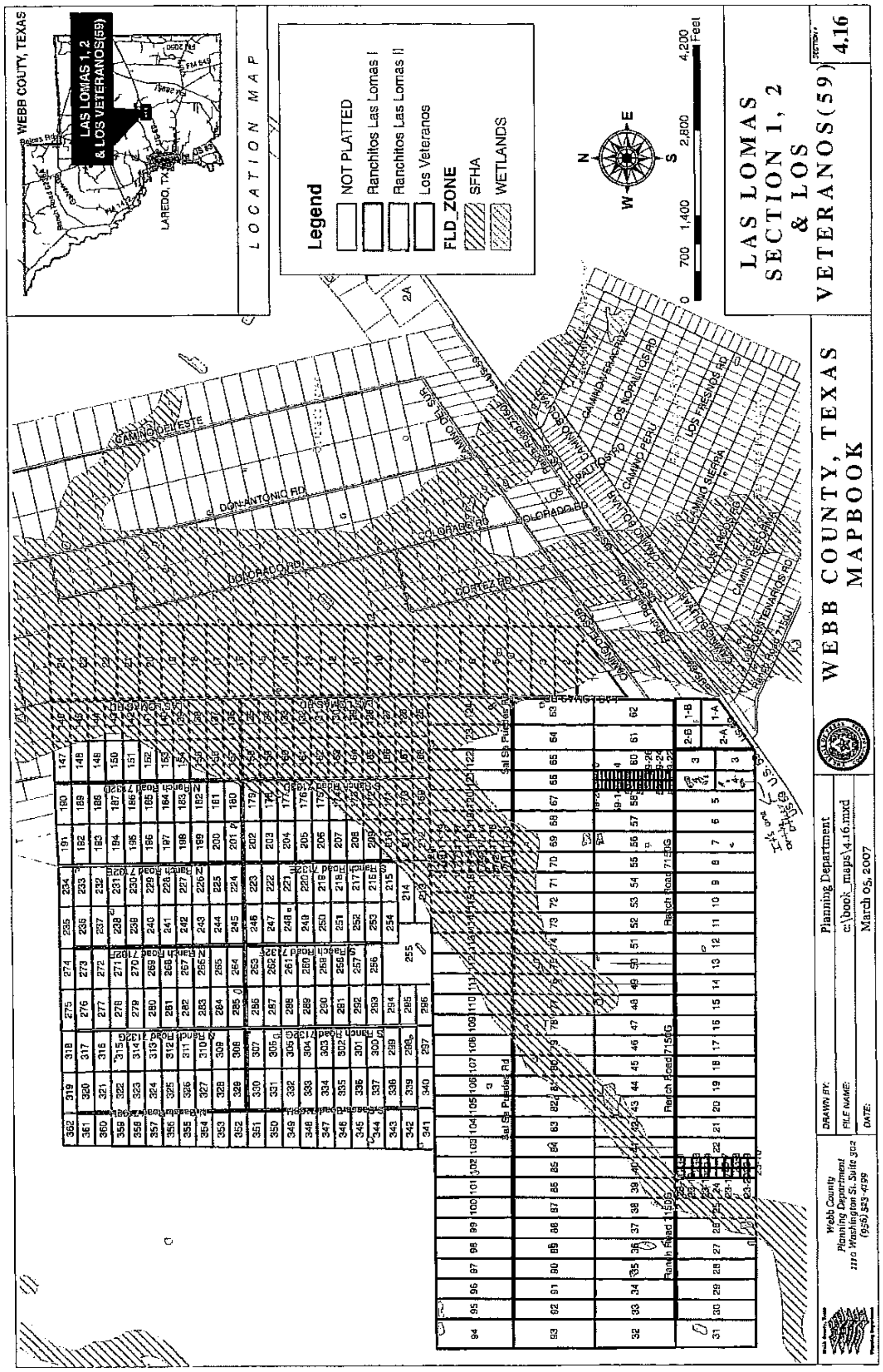


**Figure C-12. Webb County Map Book Ranchitos Las Lomas**

**System Configuration Description:**

*Power Cells*

The Xtreme Power™ PowerCell™ is a 12 volt, 1kWh advanced dry cell battery utilizing an innovative and unique solid-state, battery design and chemistry that is safe for both transport and stationery uses. The PowerCell™ building blocks have unique characteristics that are ideally suited to provide hundreds of megawatts of power capability. Figure 2 describes the performance characteristics of the PowerCell™.

**Table C-5. PowerCell™ Characteristics**

| PowerCell™ Capabilities and Characteristics | |
|---|---|
| **Energy Production** | 1 kWh at 3 hour rate |
| **Instant Power Capacity** | 50 kW |
| **Product Dimensions** | 5” x 5” x 30” (12.7cm x 12.7cm x 76.2cm) |
| **Product Weight** | 57 lbs (25.9 kg) |
| **Cell Voltage** | 12 V DC |
| **Current** | 2500 Amps for 30 seconds (Pass/Fail Test) |
| **Cycle Efficiency** | 95% to 99% |
| **Recyclable Component Potential** | 85 to 95% |

The highly uniform characteristics of PowerCellsTM allow thousands of these building blocks to be assembled in massive parallel and series matrices. The PowerCellTM array for the Colonias project consists of 40 PowerCellsTM capable of storing 40 kWh of power.

*Generator*

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The generator in the micro-grid system is a 25 kW bio-diesel generator. Its sole task is to provide power to the AC-DC converters that keep the PowerCell™ array fully charged when solar or wind power is not enough to overcome demand. The generator also acts a source of emergency auxiliary power if the system experiences any critical errors.

*Solar Array*

Each micro-grid in the Colonias project will have its own solar array. Each array will consist of eighteen 195 W solar panels for a total of 3.51 kW of solar power. The power from each solar array does not go directly into the micro-grid; it is used to charge the PowerCell™ array.

*Micro-Grid*

The micro-grid is powered by inverters that convert the DC power from the PowerCell™ array into AC power usable by the Colonias residents. The inverters at this site will be capable of continuously outputting 21 kW to support the micro-grid. Each dwelling will have a power stanchion that provides 20 amps of 120 VAC power. The micro-grid will consist of a total of 10,230 feet of #2 AWG direct burial cable for AC power transmission and 5,115 feet of #8 AWG direct burial cable for grounding. Below is a simple drawing displaying where the physical lines will be buried in relation to the generation station and where each power stanchion will be located (represented by the circles).

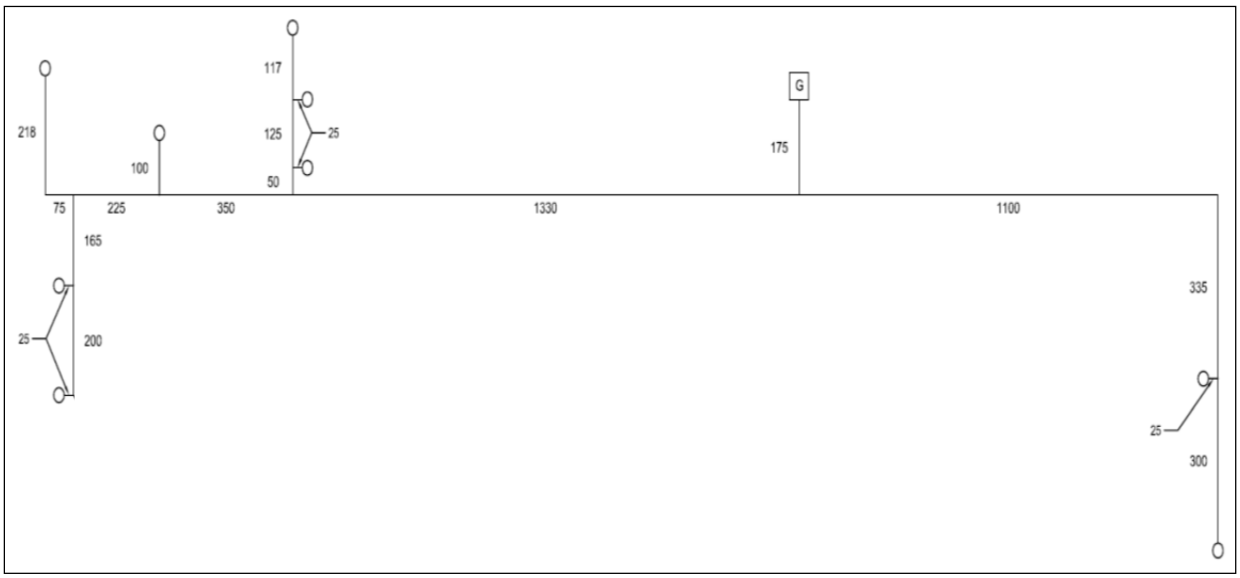


**Figure C-13. Electrical layout of Micro-Grid – Las Lomas**

**Table C-7. Initial Participants Las Lomas**

| Name | Section and Lot |
|---|---|
| Jose Moreno Family | Las Lomas #15 |
| Enrique Terrazas Family | Las Lomas #15 |
| Enrique Mota Family | Las Lomas #48 |
| Jose Baldemar Garcia Family | Las Lomas #49 |
| Eduardo Rodriguez Family | Las Lomas #50 |
| Alfonso Martinez Family | Las Lomas #50 |
| Ramiro Martinez Family | Las Lomas #50 |
| Maria Ibarra Family | Las Lomas #6 |
| Maria Ibarra Family | Las Lomas #6 |