Final Scientific/Technical Report

The County of Clark, Nevada

Renewable Energy Initiatives for Clark County Parks and Recreation

DOE AWARD# EE0003180

Principal Investigator: Shane Ammerman

Team Members: Clark County, Anne Johnson AIA, Applied Engineers Inc., Desert Research Institute, Morse Electric

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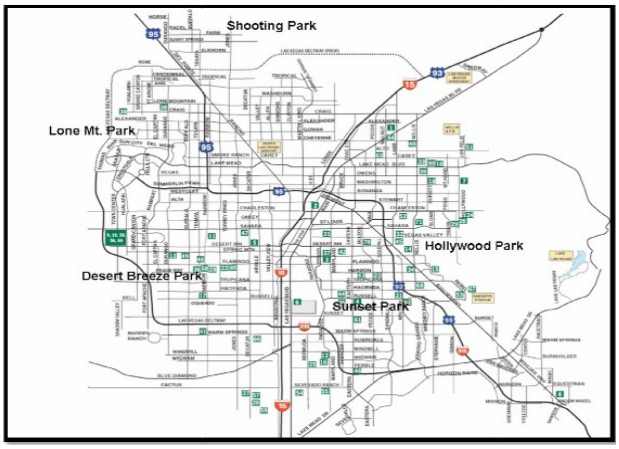
In accordance with the goals of the Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy for promoting solar energy as clean, carbon-free and cost-effective, Clark County (the County) continues to look for ways to utilize solar energy to reduce costs, improve air quality and provide economically produced power to the facilities. The objective of this project was to design, build, and operate solar electricity generation at County facility sites which reflected this and provided educational opportunities. The County has successfully implemented three, net metered, solar photovoltaic sites throughout the County. The most recent project, the Clark County Government Center, was constructed with ARRA funds and completed in 2013.

This project's sites at Desert Breeze Recreational Center and Hollywood Recreational Center (see map below) involved the installation of photovoltaic panels on existing roof structures that exhibited suitable solar exposure as well as accompanying control and metering devices that integrate with the facility's power panel and the electric utility grid system. The generation systems utilize solar energy to create electricity that is used for electricity needs of the facility's lighting system and other electrical requirements. Unused electricity is sent to the electric utility grid, often at peak demand times. Educational signage, kiosks and information are included to inform and expand the public's understanding of solar energy technology. The kiosks have educational data displayed in the form of an interactive dashboard. The kiosks are located inside the specified recreational centers lobbies and are accessible to the public and may be available for field trips. The dashboard is in a URL web format and can be distributed to the Clark County School District for educational outreach. A curriculum was developed with Desert Research Institute (DRI) and the Clark County School District for further classroom education of solar power. The data is sent by a Long Term PV performance monitoring system to NREL (National Renewable Energy Laboratory), located in Golden, CO. This system correlates local solar irradiance and weather with power production.



The original objectives, goals and expectations for this project included the following; **(1)** a demonstration of state of the art technologies for the generation of electricity from solar technology, **(2)** the creation of an informative and educational tool for the County citizens and visitors in regards to the benefits of generating alternative energy, including reduced greenhouse gas emissions, reduced reliance on foreign oil, and cost savings, and **(3)** an impetus for the County to provide a nexus for future facilities energized with solar power, demonstrating leadership in sustainable and environmentally friendly practices while at the same time encouraging operational efficiency and long term operational cost reductions. The expected outcomes were: **(1)** Successful photovoltaic electricity generation technologies to capture solar energy in a useful form of electrical energy. **(2)** Reduction of greenhouse gas emissions and environmental degradation resulting from reduced energy demand from traditional electricity sources such as fossil fuel fired and nuclear power plants. **(3)** Advance the research and development of solar electricity generation. **(4)** The education of the general public in regards to the benefits of environmentally friendly electricity generation and the County's efforts to encourage sustainable living practices. **(5)** To provide momentum for the nexus for future solar generation facilities in the County facilities and buildings. **(6)** To ultimately contribute to the reduction of dependence on foreign oil and other unsustainable sources of energy.

The project has addressed several objectives and goals of the U.S. Department of Energy's Solar Energy Technology Program. It improved the integration and performance of solar electricity directly through implementation of cutting edge technology. The project addressed this goal by laying important ground work and infrastructure for integration into the utility grid in future related projects. There is added security, reliability, and diversity to the energy system by providing and using reliable, secure, distributed electricity in the County facilities as well as sending such electricity back into the utility electric grid. A final major objective met by the Solar Project was the displacement of energy derived by fossil fuels with clean renewable energy created by photovoltaic panels.

The Solar Project accomplished all of the goals and expectations that had been laid out prior to the start. The County's core team (Comprehensive Planning Dept. and Real Property Management Dept.) along with the lead consultant and architect Anne Johnson, Affiliated Engineers Inc (AEI), Desert research Institute (DRI), and Morse Electric worked together throughout the project to design, implement, and bring into full operation the solar electricity generation panels and associated technology. The sites have demonstrated state of the art technologies and an informative educational tool. Both sites have a small section of the solar panel on display that gives the public an up close view of the panels and their mechanisms. The educational kiosks, through AEI's animated story (see exhibit #1), provide an innovative and cutting edge approach to explaining how sunlight turns into electricity. In addition, the Solar Green Boxes (see exhibit #2) created by DRI brings solar power learning into the classroom. The boxes have been in such great demand that DRI created three more. As previously stated, the County has completed three other photovoltaic projects with this being the fourth and most ambitious project with two locations. This project helps keep the momentum moving forward in the County's effort to demonstrating leadership in sustainable and

environmentally friendly practices while at the same time encouraging operational efficiency and long term operational cost reductions.

The additional expected outcomes for the project have also been realized. The technologies to capture solar energy in a useful form of electrical energy and the reduction of greenhouse gas emissions resulting from reduced energy demand from traditional electricity sources go hand in hand. The original calculations for the Desert Breeze location creating 60,400 kW annually and a savings of $5,860 yearly and the Hollywood location creating 58,826 kW and a savings of $5,706 yearly (see exhibit #4) have yet to be verified due to the recent completion and start up in June. However, the early metrics seem to be on par with these assumptions and will be monitored to compare the real time data with original figures. In addition, with data being sent by a Long Term PV performance monitoring system, complete with data transmission to NREL (National Renewable Energy Laboratory), this will help advance the research and development of solar electricity generation.

One of the first steps completed when the County was working with DOE on securing the grant was to identify ideal locations for solar power based on the criteria to demonstrated a photovoltaic project and provide an educational component to the public. The County believed that recreational parks would be an ideal location to showcase this technology. The properties chosen were Desert Breeze Recreational Center located on the west side of Las Vegas and Hollywood Recreational Center located on the northeast side of Las Vegas. Based upon cost of solar, it was decided that the facilities should be the largest structures that the grant's budget could support and among the highest energy users. In addition, this grant has an educational component to it, Clark County felt an additional criteria to select the recreational centers should be "the most visited" with the broadest demographics (children to adults). These facilities are the largest recreation centers within Clark County with Desert Breeze at 43,435 square feet and Hollywood at 43,500 square feet. Desert Breeze consumes 4,309,710 kW/fiscal year and Hollywood consumes 985,830 kW/fiscal year with estimation that 40% is lighting loads, making them large consumers of electricity (see exhibit #3). There are averages of 237,070 people that visit Desert Breeze and 127,153 people that visit Hollywood Rec Centers each year, making these two facilities the top visited (see attachment, PR Annual Monthly Report). Each facility has year round activities and classes for the public bringing in plenty of foot traffic (estimated 400 kids a day during school) for possible viewers to the educational kiosk. Further, structural engineering analysis was completed to ensure that the roofs could hold the weight of the panels. These roofs are also located close to the utility meter in an effort to cut down on costs for runs to source.

Once the construction bid was awarded, an initial kick off meeting was scheduled. Representatives from Clark County Real Property Management and Comprehensive Planning Department along with the consultant (Anne Johnson), Desert Research Institute (DRI) (cooperation with Clark County School District), and Affiliated Engineers Inc. (AEI) met and worked through the milestones and deliverables for this task and discussed site design and technology to be used. During this time, the consultant was tasked with design of the project as well as technology selection and working with DRI

and AEI on the educational component of the project. The consultant made numerous site visits to the recreational centers identifying placement for inverters, controls and monitoring devices. During this time the roof area was reviewed and maximum size and best layout for the photovoltaic was determined (see exhibit #4). The original approach was to start with 40 kW systems with each site with the possibility of expanding up to 80 kW if roof area an budget limits allowed this. Once the consulting engineer took into account the location of panels on buildings, panel distribution, roof area, structural integrity of the building, inverter and control and monitoring location, and budget limitations, it was determined that the 40 kW system for each site was the best alternative.

As a public entity, Clark County competitively bid, per the Federal Davis Bacon requirements, the detailed specifications and the design developed for each site. The project was awarded in accordance with applicable regulations. Morse Electric was selected as the contractor for the project and proceeded with installation in accordance with specifications, construction contracts, and bid documents and continued until the finish of the project at the end of June.

After final installation, the electrical system was tied into the grid with software to help interconnect with the meter and determine energy and cost savings. The County chose to use AlsoEnergy for the monitoring systems and tied this across all of the County's existing display kiosks. This system adds an additional educational component to the package with displays on current power being produced by the system, relationship of sun in sky, historical power production, and current news (see exhibit #7). In addition, data is sent by a Long Term PV performance monitoring system, complete with data transmission to NREL to correlate local solar irradiance and weather with power production for the facilities completed with this grant and existing Clark County facilities.

The educational component was completed through working with working with DRI and AEI. From the inception, AEI was identified as a potential partner by DOE because of their work with a similar grant that was completed with St. Petersburg Florida. After consulting with staff in St. Petersburg, the County determined that AEI's product was the best fit for the project. DRI was tasked with creating the educational component for the Clark County School District and created a Solar Green Box (see exhibit #2). The Green Box program is support to Nevada's preK-12 educators and is science-based, environmental education by providing tools, and resources. These boxes are environmentally focused that emphasize sustainable practices and natural resource conservation. Each green box explores and examines a topic and contains the material and curriculum needed to engage the students with hands-on activities with real life application. AEI was charged with creating the educational component within the recreational centers. This included an interactive dashboard within the lobbies that visitors can interact with and learn the story through animated heroes and villains on how sunlight is turned into electricity. [The attachment shows the landing page for the website (see exhibit #5).]

One of the positive outcomes of this project was the networking and collaborative efforts between all parties involved nationally as well as regionally. Due to the initial idea for

this project and reaching out to St. Petersburg, our staff now has a connection with their Planning Deptartment and has opened up doors in other avenues. In addition, the use of AEI's software to tell the story of how sunlight turns into energy is used by both departments and was developed for both of the grants (St. Petersburg and Clark County). The Solar Green Boxes created by DRI for this grant are a new addition to their Green Box program and have been extremely successful for use in the classroom.

Exhibit #1 - architectural rendering of kiosk signage for both lobbies

Actual signage in lobby of one of the recreational centers

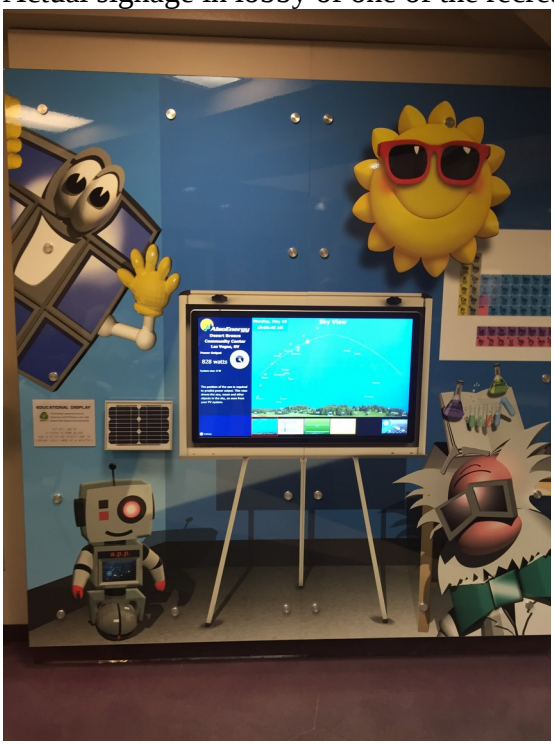


Exhibit #2 - copy of brochure for the DRI Green Box program

GreenPower Education and Outreach

DRI Desert Research Institute

Green Box Program

GreenPower Mission Statement

To support Nevada's preK-12 educators in science-based, environmental education by providing the tools, resources, and knowledge they need.

What is a Green Box?

Developed for K-12 educators, Green Boxes introduce environmentally focused topics that emphasize sustainable practices and natural resource conservation. Each Green Box is centered around a "green" topic written for either a particular grade or range of grade levels. Every box contains the material and curriculum needed to engage students in hands-on activities with real-life applications that are both informative and fun! Best of all, our program is completely free for educators to use. We have a large list of titles available and more coming online all the time.

Who Creates Green Boxes?

Green Boxes are made by educators for educators. Once created, each box is then vetted through our Advisory Green Box Committee, which is comprised of education and environmental experts. Upon committee approval, the Green Boxes then make their way to GreenPower schools.

What Does a Green Box Contain?

- Curriculum aligned to Nevada State, Common Core, and Next Generation Science Standards.
- Enough content for 1–2 weeks of instruction, complete with hands-on activities and projects.
- Most materials needed for activities (both consumables and non-consumables).
- A flash drive with curriculum and supplemental materials.

greenpower

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WITH SUPPORT FROM THE ROBERT S. AND DOROTHY J. KEYSER FOUNDATION

THE DESERT RESEARCH INSTITUTE IS PART OF THE NEVADA SYSTEM OF HIGHER EDUCATION.

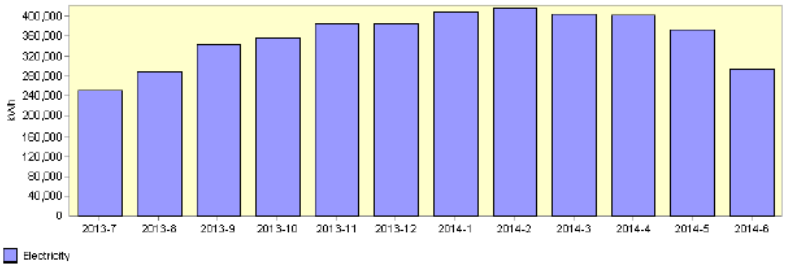
CONTACT
Craig Rosen, Green Box Administrator

LAS VEGAS CAMPUS: 755 E. Flamingo Road, Las Vegas, NV
PHONE: 702/862-5332
EMAIL: greenbox@dri.edu
WEBSITE: dri.edu/greenpower

Exhibit #3 - electrical output for Desert Breeze Recreational Center

Single-level Bill History

Cost Center: DESERT BREEZE
Provider: All providers
Report date: 7/24/2014 11:22:14 AM
Start period: 2013-7 (Jan-13)
End period: 2014-6 (Dec-13)



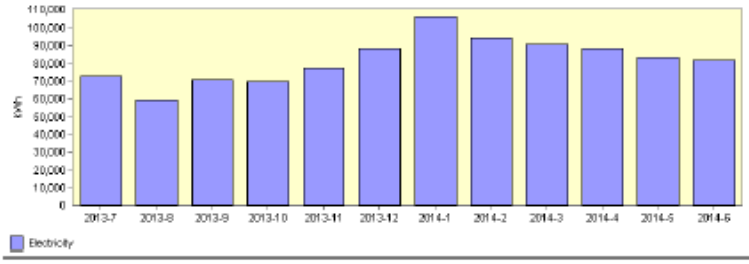
Cost Center	Commodity	Unit	2013-7 (Jan-13)	2013-8 (Feb-13)	2013-9 (Mar-13)	2013-10 (Apr-13)	2013-11 (May-13)	2013-12 (Jun-13)	2014-1 (Jul-13)	2014-2 (Aug-13)	2014-3 (Sep-13)	2014-4 (Oct-13)	2014-5 (Nov-13)	2014-6 (Dec-13)	Totals
DESERT BREEZE	Electricity	kWh	250,712.24	288,077.56	343,715.14	355,795.80	385,313.88	386,623.99	408,888.39	417,171.18	405,440.63	401,436.48	372,243.02	294,292.34	4,309,710.65

Note: Data is prorated to fiscal periods

Electrical output for Hollywood Recreational Center

Single-level Bill History

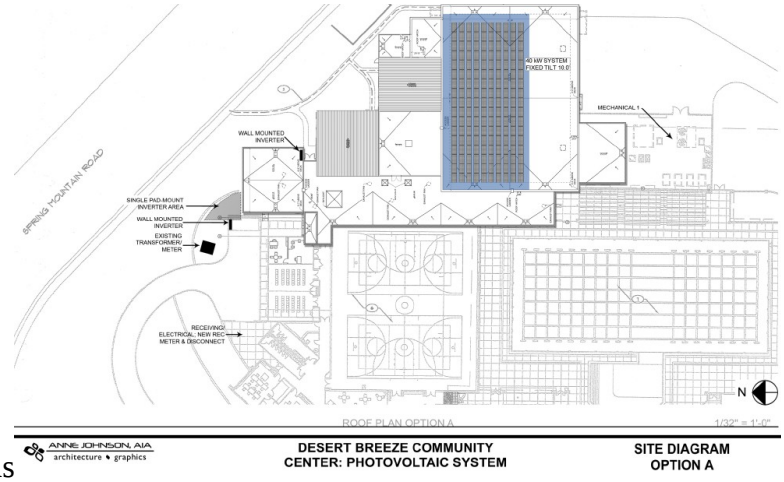
Building: 28695 - HOLLYWOOD REC AND COMMUNITY CENT
City, Region: LAS VEGAS, NV
Provider: All providers
Report date: 7/24/2014 11:26:41 AM
Start period: 2013-7 (Jan-13)
End period: 2014-6 (Dec-13)



Building	Commodity	Unit	2013-7 (Jan-13)	2013-8 (Feb-13)	2013-9 (Mar-13)	2013-10 (Apr-13)	2013-11 (May-13)	2013-12 (Jun-13)	2014-1 (Jul-13)	2014-2 (Aug-13)	2014-3 (Sep-13)	2014-4 (Oct-13)	2014-5 (Nov-13)	2014-6 (Dec-13)	Totals
28695 - HOLLYWOOD REC AND COMMUNITY CENT	Electricity	kWh	72,529.58	59,843.23	71,112.05	70,160.72	77,807.81	88,344.37	106,600.81	94,702.19	90,452.81	88,587.94	83,579.09	82,109.84	985,830.45

Note: Data is prorated to fiscal periods

Exhibit #4 - site plan for Desert Breeze Recreational Center with location of solar panels



panels

Desert Breeze Recreational Center cost savings calculations

PVWatts ... AC Energy & Cost Savings

Cautions for Interpreting the Results

Desert Breeze Option A 40KW

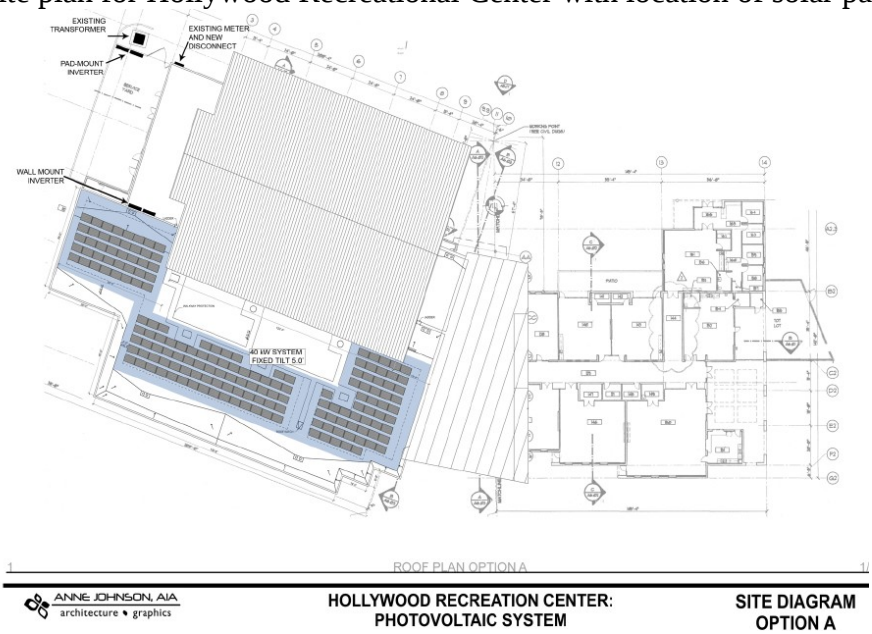
Station Identification	
City:	Las Vegas
State:	Nevada
Latitude:	36.08° N
Longitude:	115.17° W
Elevation:	664 m
PV System Specifications	
DC Rating:	40.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	30.8 kW
Array Type:	Fixed Tilt
Array Tilt:	10.0°
Array Azimuth:	138.0°
Energy Specifications	
Cost of Electricity:	9.7 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	3.59	3242	314.47
2	4.59	3694	358.32
3	5.75	5167	501.20
4	7.22	6142	595.77
5	8.03	6833	662.80
6	8.34	6630	643.11
7	8.14	6547	635.06
8	7.47	6023	584.23
9	6.62	5237	507.99
10	5.20	4496	436.11
11	4.05	3448	334.46
12	3.34	2958	286.93
Year	6.03	60418	5860.55

Output Hourly Performance Data

Output Results as Text

Site plan for Hollywood Recreational Center with location of solar panels



Hollywood Recreational Center cost savings calculations

PVWatts AC Energy & Cost Savings

Cautions for Interpreting the Results

Hollywood - Option A 40 KW

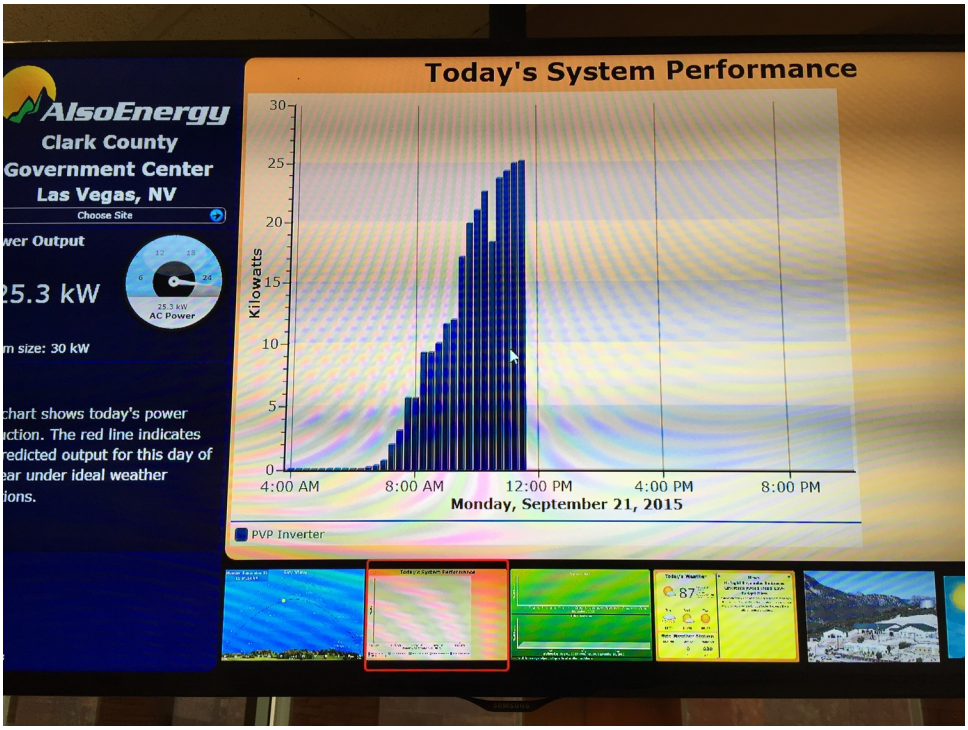
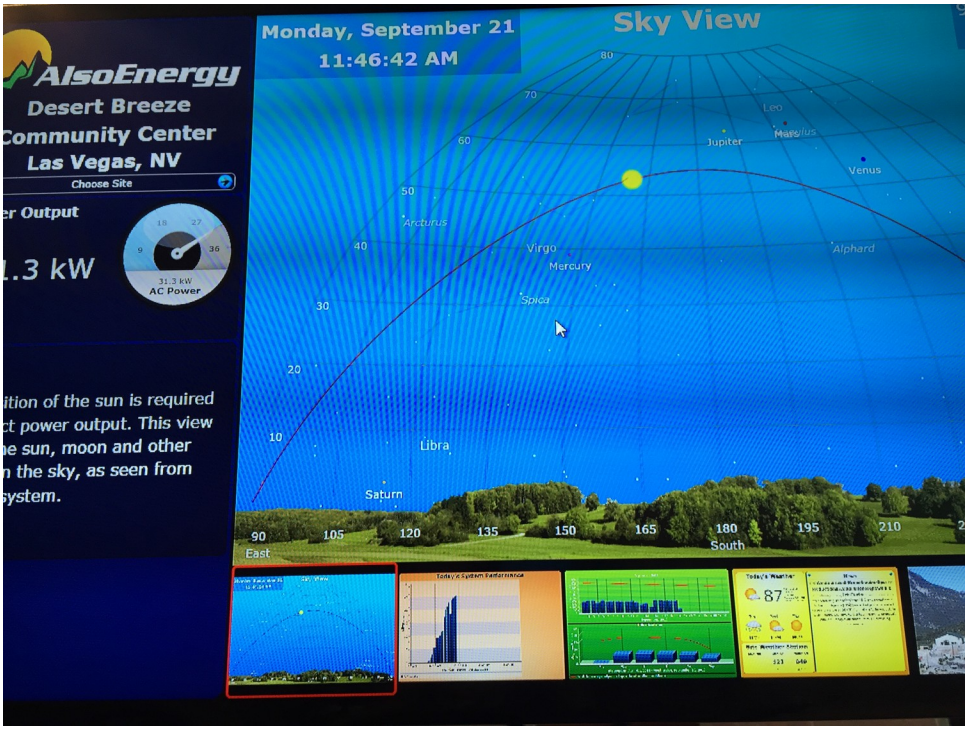
Station Identification	
City:	Las Vegas
State:	Nevada
Latitude:	36.08° N
Longitude:	115.17° W
Elevation:	664 m
PV System Specifications	
DC Rating:	40.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	30.8 kW
Array Type:	Fixed Tilt
Array Tilt:	5.0°
Array Azimuth:	210.0°
Energy Specifications	
Cost of Electricity:	9.7 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	3.38	2986	289.64
2	4.39	3516	341.05
3	5.58	5001	485.10
4	7.09	6015	583.45
5	8.00	6810	660.57
6	8.37	6648	644.86
7	8.14	6577	637.97
8	7.35	5951	577.25
9	6.45	5091	493.83
10	4.99	4270	414.19
11	3.81	3239	314.18
12	3.12	2722	264.03
Year	5.90	58826	5706.12

Output Hourly Performance Data

Output Results as Text

Photo of installed panels at Desert Breeze Recreational Center

Exhibit #5 – landing page for kiosks for story of Solar Array and his friends

Exhibit#6 – AlsoEnergy pages