Description of document: Defense Logistics Agency (DLA) Solar Photovoltaic (PV) Feasibility Study Report, Defense Fuel Support Point (DFSP), Tampa, Florida provided under Contract Number SP0600-15-C-9305 by Alares, LLC, 2015

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SEP 2 5 2019

This letter is in response to your Freedom of Information Act request received on January 28, 2019, for a copy of the final report provided by contractor Alares LLC under contract SP060015C9305, awarded on January 5, 2015. The awarding office was DLA Energy and the subject of the contract was a Feasibility Study to Identify DLA Sites that have the Highest Potential for Solar Technology Applications.

The records are partially withheld pursuant to the FOIA, 5 U.S.C. §552(b)(6), personal privacy; and 5 U.S.C. §552(b)(7)(f), protects records compiled for law enforcement which could endanger the life or physical safety of an individual.

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You have the right to appeal this partial denial. An appeal must be made in writing to DLA General Counsel within 90 calendar days from the date of this letter, and no later than 5:00 pm Eastern Standard Time. The appeal should include your reasons for reconsideration and enclose a copy of this letter. An appeal may be submitted at https://foiaonline.gov/foiaonline/action/public, emailed to FOIA.liaison@dla.mil or mailed. Appeals are to be addressed to the Information Governance and Compliance Office, Defense Logistics Agency, Suite 1552, ATTN: J67C (FOIA/PA), 8725 John J. Kingman Road, Fort Belvoir, Virginia 22060-6221.

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Sincerely,

ALBERT G. MILLER
Brigadier General, USAF
Commander

Solar PV Feasibility Study Report

Defense Logistics Agency

Defense Fuel Support Point
Tampa, Florida

Contract Number SP0600-15-C-9305

Prepared for:

Defense Logistics Agency
8725 John J. Kingman Road
Fort Belvoir, VA 22060

Prepared by:

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April 2015

Defense Logistics Agency

Defense Fuel Support Point
Tampa, Florida

Contract Number SP0600-15-C-9305

Project Manager/Engineer: ______________________

(b) (6) [redacted]

Solar Engineer: ______________________

(b) (6) [redacted]

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APPENDCIES

ABBREVIATIONS AND ACRONYMS

BLCC	Building life cycle cost (computer program)
CEA	Critical Environmental Area
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	Contracting Officer
COR	Contracting Officers Representative
CO_2	carbon dioxide
DOE	U.S. Department of Energy
EA	Environmental Assessment
EISA	Energy Independence and Security Act
EO	Executive Order
EPAct 2005	Energy Policy Act of 2005
ESCO	Energy Service Company
°F	degrees Fahrenheit
FONSI	Finding of No Significant Impact
FS	Feasibility Study
FY	fiscal year
GHG	greenhouse gas
HASP	Health and Safety Plan
kW	kilowatt
kWh	kilowatt hour
LCCA	life cycle cost analysis
mWh	megawatt hour
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act
PV	photovoltaic
SME	Subject Matter Expert
SPCC	Spill Prevention Control and Countermeasure
SWPPP	Stormwater Pollution Prevention Plan
W	Watt

1.0 EXECUTIVE SUMMARY

Alares LLC (Alares) conducted a solar feasibility study for the Defense Logistics Agency (DLA) at the Defense Fuel Support Point (DFSP Tampa), 5313 North Boundary Boulevard, MacDill AFB, FL 33621. The purpose of this study was to assess the technical and economic feasibility for the potential installation of a solar photovoltaic (PV) system at the DFSP. Alares also determined the potential energy consumption reduction and cost savings of the PV system.

In accordance with the contract, this study takes into consideration site conditions, existing electrical systems conditions and economics. In the performance of this study, Alares gathered all pertinent information from the site, analyzed the electrical operating profile of the facility and the consequent suitability for a solar PV system including the potential for alternative financing.

Methodology

The method and approach conducted by Alares to accomplish the project objectives were as follows:

- A site visit was conducted to gather facility information.
- Utility information was compiled and evaluated.
- Site conditions were evaluated.
- A technical analysis was conducted.
- An economic analysis was conducted.

Technical Evaluation and Results

The following parameters were used as guidelines to determine the technical feasibility of the solar system:

- Existing Equipment (can the solar system be connected to the current electrical system);
- Solar Shading Analysis (are there any obstructions that may limit a solar system); and
- Available Land Area (what is the maximum potential system size for the available land area).

The potential site is the area of former aboveground fuel oil tanks. Based on our technical evaluation, this DFSP site has year round solar illumination and is a suitable location for a solar PV system. The solar system can be connected into the existing electrical system. A 465 kW solar system can be installed to produce enough energy for the facility to achieve a net-zero energy posture. For 2014, the facility consumed 196,514 kWh per year. A 465 kW solar system can produce 668,361 kWh per year.

There is also enough land area to expand the solar PV system. It is recommended the solar system installation be installed in two phases. The first phase can be installed to satisfy the electrical demand of the DFSP facility. The second phase can be installed at later date if additional electrical production is desired.

The following figure shows the proposed layout of the solar system for the first phase.

The second phase can be expanded an additional1,247,440 W DC producing 1,792,991 kWh AC. The following figure shows the proposed layout of the solar system for the second phase.

The total power production if the two phases are installed is 1,712,440 watts DC for power production of 2,461,352 kWh AC.

Economic Evaluation

Life Cycle Cost Analysis (LCCA) was used to evaluate the economic feasibility of the solar system. The following methodology was used to conduct the LCCA:

1. Simulated annual performance and energy consumption for the proposed solar system.
2. Detailed cost for the solar system was developed.
3. Building Life-Cycle Cost (BLCC) software was used to calculate the LCC.
4. Recommendations were made based on LCC results.

A summary of LCCA data derived from this study is provided in the following table.

Phase	Installation Costs	Annual Savings	Simple Payback (yrs)	SIR	Annual GHG (MT CO_2)
Phase 1	$1,274,292	$66,836	20	1.0	436
Phase 2	$3,105,925	$179,299	18	1.13	1,172
Total	**$4,380,217**	**$246,135**	**19**	**1.1**	**1,608**

Currently, there is a federal tax credit of 30% through 2016 for solar PV installations. However a federal agency is not allowed to take the credit. Instead the credit may be assigned to the installer. The financial implications if the 30% tax credit is available are shown below.

Phase	Installation Costs	Annual Savings	Simple Payback (yrs)	SIR	Annual GHG (MT CO_2)
sPhase 1	$876,355	$66,836	14	1.46	436
Phase 2	$2,174,147	$179,299	13	1.57	1,172
Total	**$3,050,503**	**$246,135**	**13.5**	**1.52**	**1,608**

Alternate Financing

Alares evaluated three alternate financing options including:

- Energy Savings Performance Contract (ESPC)
- Utility Energy Services Contract (UESC)
- Enhanced Use Lease (EUL)

For the ESPC, based on our analysis, the Energy Service Company (ESCO) would have to charge the facility $0.09 per kWh to receive target IRR 10%. Since the facility is currently being charged $0.10 per kWh, it is unlikely an ESCO would be interested in this type of an arrangement. However if the target IRR is lower to 6% then the ESCO would need to charge the facility $0.06 per kWh. Therefore depending on the ESCO's target IRR, they may be interested in the project. We recommend exploring the solar project with a federal ESCO to gauge interest in the project.

For the UESC, the DLA enters into partnership with the Utility to implement the solar project. Since DLA leases the land and pays MacDill a flat electric rate, it is unlikely the Utility will be interested in the Phase 1 solar project. They may be interested in the larger projects but the Utility would have to deal directly with MacDill.

It is unlikely that the EUL option is feasible for the DLA since the DLA does not own the land at the facility.

Conclusion

Based on the results of the feasibility evaluation, a solar PV system is recommended for this facility. The Phase 1 system is technically and financially feasible. The facility can achieve net-zero energy status by constructing the solar PV system.

2.0 INTRODUCTION

The Defense Logistics Agency (DLA) retained Alares LLC to evaluate whether a Solar Photovoltaic (PV) system is feasible at the DFSP Tampa facility. This feasibility analysis will document relevant information on existing conditions of the facility electrical systems, identify potential site locations for installing the Solar PV, and determine the Solar PV system capacity and operating characteristics that brings value to the Facility. In addition, four financing alternatives will be evaluated including:

1. Direct Funding
2. Energy Savings Performance Contract (ESPC)
3. Utility Energy Savings Contract (UESC)
4. Enhanced Use Lease Contract (EUL)

Also the DLA desires to achieve the Energy Policy Act renewable energy goals through the use of solar PV systems. Section 203 of the EPAct 2005 requires that of the total amount of electric energy the Federal government consumes during any fiscal year, the following amounts shall be renewable energy:

(a) Not less than 3 percent in fiscal years 2007 through 2009,
(b) Not less than 5 percent in fiscal years 2010 through 2012, and
(c) Not less than 7.5 percent in fiscal year 2013 and each fiscal year thereafter.

For purposes of determining compliance, the amount of renewable energy shall be doubled if:

(a) The renewable energy is produced and used on-site at a Federal facility;
(b) The renewable energy is produced on Federal lands and is used at a Federal facility; or
(c) The renewable energy is produced on Indian land and used at a Federal facility.

This report documents the measures that Alares identified during the site survey and provides estimates of the savings potential and order of magnitude costs. Some of the assumptions used in this analysis may have a significant impact on project economics and should be confirmed before project implementation. The optimal methods to accomplish the recommended measures or alternate measures should be determined during the implementation phase.

Construction of the solar system will require more detailed engineering feasibility and constructability analysis. This study does not include specific design instructions. It is not intended as a design document.

ACKNOWLEDGMENTS

Alares gratefully acknowledges the assistance of Kristi Yu, the DLA DFSP Site Energy Manager, as well as the following personnel.

Stephen Rebetsky	DLA (HQ Renewable Energy Manager)
John Sprenkle	DLA (Site Engineer)
Ronnie Brock	DLA (Site QAR)
Chris Ray	Hammer, Inc. (Terminal Manager)
Alan Watkins	Hammer, Inc. (Terminal Specialist)

3.0 ENERGY GOALS

This section discusses the federal goals as they relate to renewable energy. The DLA is required to meet the renewable energy requirements of the Energy Policy Act (EPact), the Executive Orders (EOs), and the Energy Independence & Security Act (EISA).

- In 2005, Congress passed Epact and Section 203 of this Act requires that, of the total amount of electrical energy the federal government consumes during any fiscal year (FY), specific amounts shall be from renewable energy sources. Renewable energy sources include wind, solar, geothermal, and other sustainable sources. Section 203 of the Energy Policy Act requires that for FY 2013 and beyond, not less than 7.5 percent of the federal agency's consumed energy must be renewable in nature. In addition, the Act specifies that, "For the purposes of determining compliance, the amount of renewable energy saved shall be doubled if: (a) The renewable energy is produced and used *on site* at a federal facility; (b) The renewable energy is produced on federal lands and is used at a federal facility; or (c) The renewable energy is produced on Indian land and used at a federal facility."

- Executive Order 13693, Planning for Federal Sustainability in the Next Decade (March 19, 2015), sets goals with regard to environmental and energy management. This EO requires that federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically, and fiscally sound, efficient, and sustainable manner. Specifically, as the order relates to renewable energy, federal agencies must achieve the following:

  Ensure that the percentage of the total amount of building electric energy consumed by the agency that is renewable electric energy is:

  (i) not less than 10 percent in fiscal years 2016 and 2017;
  (ii) not less than 15 percent in fiscal years 2018 and 2019;
  (iii) not less than 20 percent in fiscal years 2020 and 2021;
  (iv) not less than 25 percent in fiscal years 2022 and 2023; and
  (v) not less than 30 percent by fiscal year 2025 and each year thereafter;

- The Energy Independence & Security Act of 2007 requires that all new federal buildings have at least 30 percent of the hot water demand met with a solar hot water system if it is life-cycle cost effective. The EISA also establishes a requirement for all new federal buildings to have a reduced dependence on fossil fuels. According to the EISA, "...(new) buildings shall be designed so that the fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in FY 2003."

4.0 SCREENING ANALYSIS

4.1 Scope

The purpose of the study is to determine whether the installation of a solar PV system at the DFSP Tampa is both technically and economically viable. The contract required gathering information from the site, analyzing and providing insight into the operating profile of the facilities and determine the consequent suitability for a solar PV system.

4.2 Technical Analysis Methodology

The method and approach conducted by Alares to accomplish the project objectives are summarized as follows:

- Conduct a site visit to collect site data,
- Compile and review the collected data,
- Conduct a technical analysis of the alternatives, and
- Conduct an economic analysis.

To determine whether a solar system is feasible, screening was based on the following:

1. *Land Areas:* The available land area is evaluated in the context of solar PV applications.

2. *Existing Electrical Systems:* The existing systems are evaluated for laying the groundwork for describing how the solar system could be connected to the electrical system.

3. *Existing Energy Consumption:* Annual energy consumption is analyzed. Modeling is used to determine energy savings.

4. *Economic Evaluation:* An economic evaluation was conducted including cost estimates, and the use of life cycle cost analysis (LCCA).

4.3 Site Visit

A site visit was conducted by Alares on January 26 and January 27, 2015 to observe and evaluate existing field conditions and collect relevant data as necessary to conduct the feasibility evaluation. Alares met with facility management to discuss the proposed solar system and information required for the feasibility study. Based on discussions with facility management, the potential location for the solar system is the former location of the aboveground storage tanks. This location offers minimal shading and provides limited impact to facility operations. This location is further discussed in the next section.

5.0 EXISTING CONDITIONS

5.1 Existing Facility

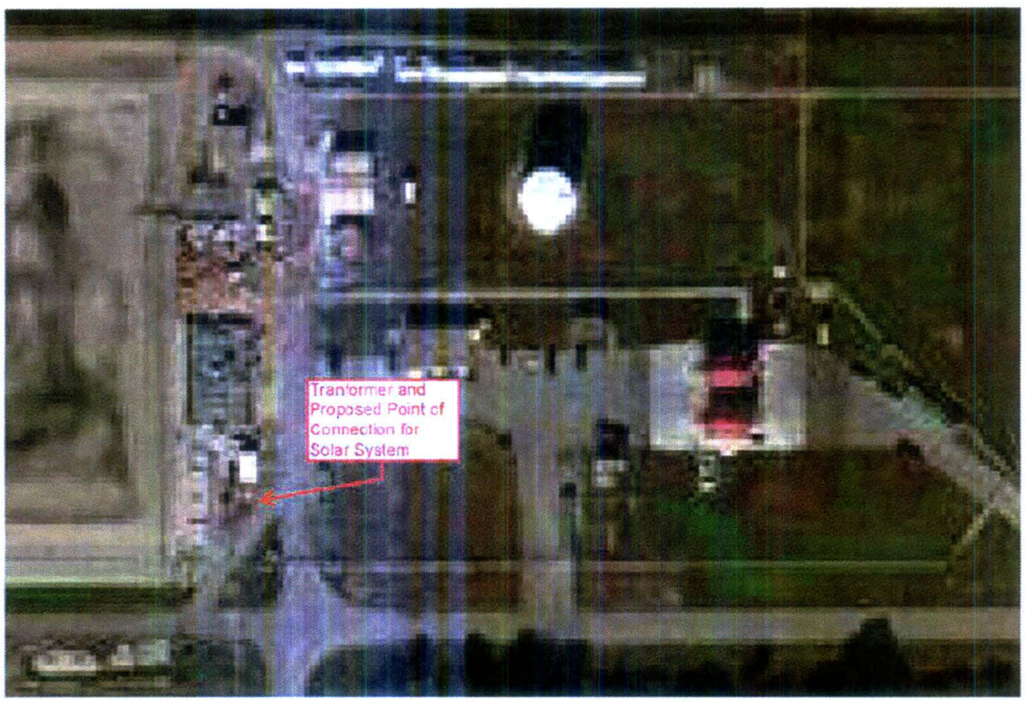
The DFSP Tampa consists of a main operations building plus three aboveground storage tanks with an associated pumping station. The layout of the facility is shown in the below figure.

The southern portion of the site contained four aboveground storage tanks that have been removed. This area of the former tanks is the proposed location of the solar system as shown below.

The Facility's plans for expansion and future additions were discussed at the site visit. There are no future expansion plans for the proposed area for the former aboveground storage tanks. There are plans for the construction of a new operations building but the new building should not impact the proposed solar system.

5.2 Existing Electrical System

A review of site electrical system was conducted to determine whether the proposed solar system can be connected to the existing electrical system. (b) (7)(F) [redacted] The distribution switchgear is energized by an aboveground 13.2 kV feeder that is connected to a transformer. The distribution switchgear serves the electric energy requirements of all the Facility buildings and pump gear. The electric utility meter is located on the main transformer. Power is distributed from the transformer to the main switchgear where the power is stepped down to 480V. Therefore power to the facility is 480V/400 amps. Our analysis indicates the existing site electrical structure would not impede the solar PV system connection for Phase 1. However the transformer will need to be upgraded for the Phase 2 solar system to match the increased load. The location of the existing transformer and main switchgear is shown below.



There are three options for connecting the solar system to the electrical system. These are:

1. Connect the solar system to the main electrical power system at the main switchgear
2. Connect to the automatic transfer switch to the back-up power system.
3. Create an island mode to create back-up power in case of a power outage.

If the solar system is connected to the main electrical power system, the power generated from the solar system would supplement the incoming main power. If the solar system power is greater than the facility power consumption then electric power would be sent back to the grid. In other words the main facility meter would spin backwards. If the solar system is off such as at night then the utility would provide the required power. (b) (7)(F) [redacted] When utility power is restored, the solar system inverters will detect the power and turn back on providing power to the grid. The solar system would also have a smart electric meter in addition to the main electric meter. The smart meter would be connected to the solar system's data acquisition system for remote monitoring.

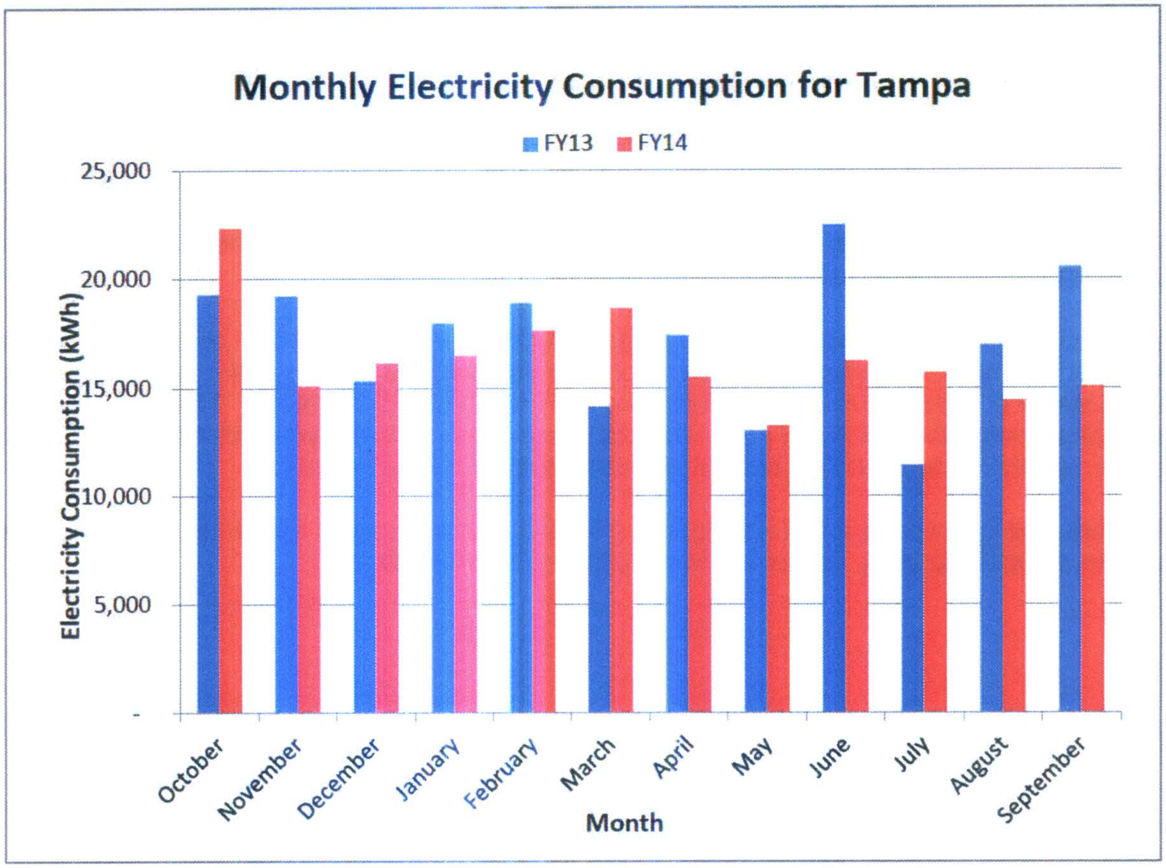
There is a possibility that the solar system can be connected directly to the automatic transfer switch in the generator building. In this case, the solar system will supplement the back-up power in case the facility loses utility power. This arrangement will require additional costs and design. The added benefit does not outweigh the additional cost.

The last scenario is the solar system can act in "island mode" if the facility loses utility power. In this case, the back-up generators would not be required. The solar system would include a battery system. This arrangement will require additional costs and design. The added benefit does not outweigh the additional cost. Also the facility management stated that battery back-up would probably not be an option since they just installed a new generator.

Therefore, the optimal electrical arrangement for the proposed solar system is to connect the power to the existing utility switchgear to supplement incoming power.

6.0 ELECTRIC CONSUMPTION ANALYSIS

Alares conducted an analysis of the electric consumption for the facility. Monthly electrical consumption data was provided by the DLA DFSP Site Energy Engineer for FY2013 and FY2014. The following chart shows monthly electric consumption at the Facility.



The monthly electric consumption for the Facility ranges between 11,000 kWh to 23,000 kWh with an average monthly consumption of approximately 16,800 kWh. The electrical consumption for the last two fiscal years is shown below.

	FY13	FY14
Total Electricity Consumption (kWh)	206,501	196,514

The facility purchases its electricity from the MacDill Air Base and pays $ 0.10 per kWh.

For purposes of system sizing and financial analysis, an annual consumption rate of 210,000 kWh at a cost of $ 0.10 per kWh was used.

7.0 TECHNICAL ANALYSIS

As previously discussed, the area of the former aboveground tanks is available for a potential solar PV system. This section discusses the technical aspects of the potential system to determine whether the solar PV system is technically feasible in this area. In order to evaluate whether the system is technically feasible, the following areas were assessed:

- Solar Exposure
- Solar Glare
- Potential Power Production
- Solar Panel Mounting
- Electric Point of Connection

Each is further discussed in the following sections.

7.1 Solar Exposure

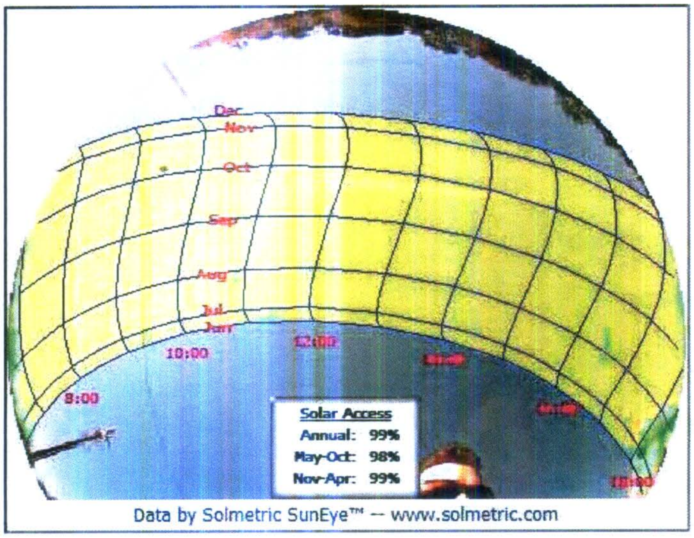
Solar PV system performance is dependent on season (highest output in spring and fall), weather conditions (highest output in full sun), and time of day (highest output at mid-day). In order to maximize potential energy output from the PV system, the system should be located in an area that maximizes the amount of sunlight it receives daily, without shading from adjacent structures or trees. To determine the suitability of this area, solar insolation was evaluated. Solar is a measurement of solar radiation at the potential site on a daily basis.

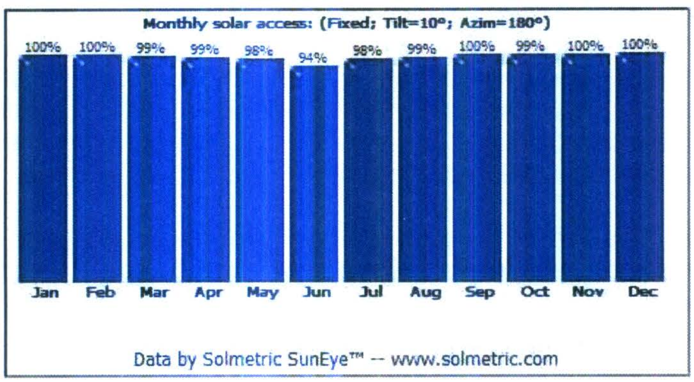
Expressed in kWh/m^2/day, this parameter is an important input to the technical analysis of the system. Solar Insolation is a key measure of how successful a PV project would be in a given geographical region. The higher the Solar Insolation values the higher the energy generation of each photovoltaic panel of the Solar PV system.

A Suneye instrument was used to measure solar incident radiation. The measurement results from the site visit are included in **Appendix A.** An example of a Suneye report is shown below.

Sky03 -- 1/27/2015 10:33 -- (no skyline note)

Panel Orientation: Tilt=10° – Azimuth=180° – **Skyline Heading=175°**
Solar Access: Annual: 99% – Summer (May-Oct): 98% – Winter (Nov-Apr): 99%
TSRF: 94% – **TOF:** 95%





The results indicate the former aboveground tank location offers excellent solar exposure for the proposed solar system.

7.2 Solar Glare

Since the solar system would be located near the MacDill Air Base, solar glare from the solar modules was evaluated. Solar glare refers to light that is reflected off of surfaces. Glare can cause a brief loss of vision. Solar modules normally do not produce significant reflection or glare, as they are manufactured with glass that is specifically designed as "non-reflective." Solar glass is intended to minimize reflected light and instead allow light to pass through to the cells and be converted to useful electrical power in the module. See Technical Bulletin from SolarWorld included in **Appendix B**. To limit reflection, solar PV panels are constructed of dark, light-absorbing materials and covered with an anti-reflective coating.

In November 2010, the FAA prepared a report titled "Technical Guidance for Evaluating Selected Solar Technologies on Airports" that provides a checklist of FAA procedures to ensure that proposed photovoltaic or solar thermal hot water systems are safe and pose no risk to pilots, air traffic controllers, or airport operations. The report documents airports where solar PV systems have been installed such as at Denver, Boston Logan, San Francisco and Houston.

The Department of Energy's Solar Glare Hazard Analysis Tool (SGHAT) v. 2E was used to evaluate solar glare for the potential solar system. Two flight paths at MacDill Air Force Base were evaluated. The analysis tool results indicate no glare for the first flight path direction of 40°. For the second flight path, the analysis tool results indicate no glare for direction of 220°. The analysis tool reports for both flight paths are included in **Appendix C.**

Based on the location of the solar PV system at the DFSP facility, solar glare from the solar panels will not pose a glare risk to pilots. Since the solar PV project will be subject to review by MacDill Air Base Engineering, additional requirements for solar glare may be required during the design process.

7.3 Potential Power Production

The potential land area for the solar PV system is approximately 9.0 acres. It is recommended the solar system installation be installed in two phases. The first phase can be installed to satisfy the current and future electrical demand for the DFSP Tampa facility. The second phase can be installed at later date if additional electrical production is desired.

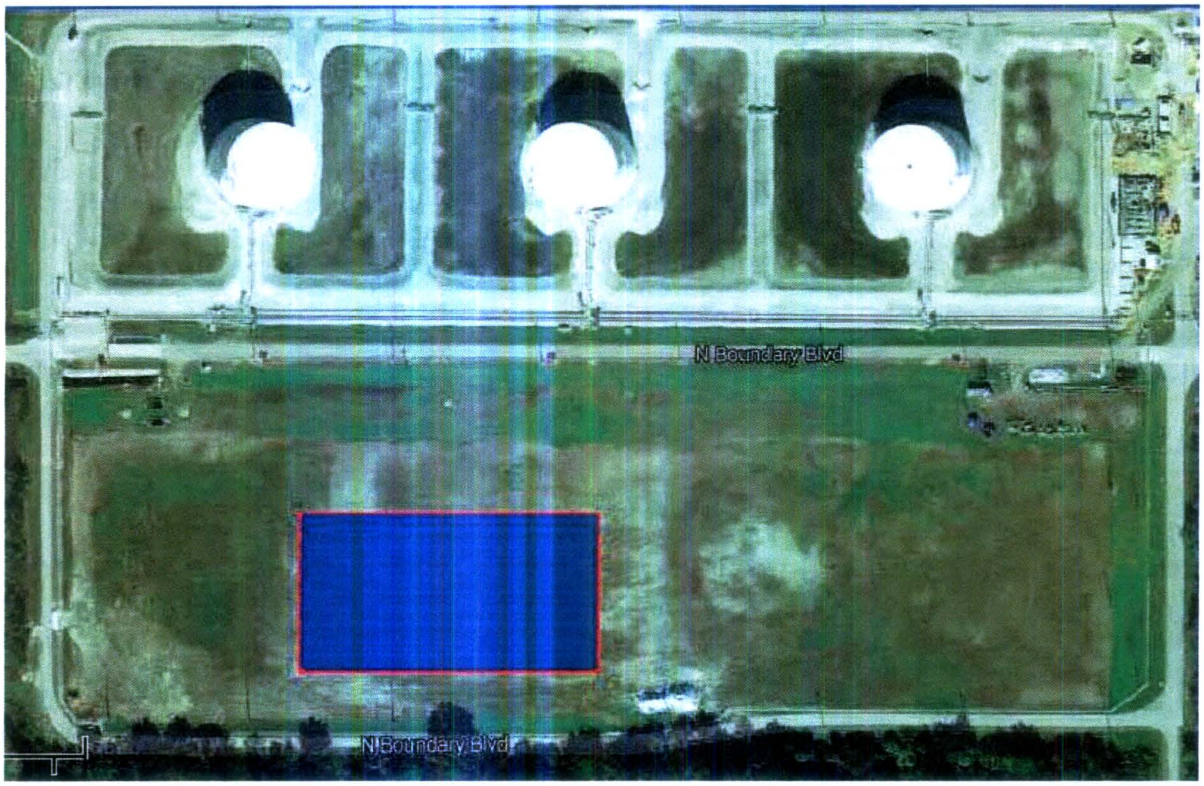
Based on the data collected from the site visit and the solar exposure study, a conceptual design for the potential solar array was developed. For design purposes, a 10 foot setback was used around the array to provide truck access. Phase 1 was designed to satisfy the current and future electric requirements of the DFSP facility. Phase 2 was designed to utilize the additional available space in the former tank area not currently being utilized (b) (7)(F) [redacted]

For Phase 1, a 465 kW solar system can be installed to produce enough energy for the facility to achieve a net-zero energy posture. For 2014, the facility consumed 196,514 kWh per year. A 465 kW solar system can produce 668,361 kWh per year to easily meet the current and future electric needs of the facility. Power could be fed back to the main utility grid. (b) (7)(F) [redacted]

The system specifics for a fixed mount system are as follows:

- 1,500 - 310W solar panel modules
- 150 strings of 10 modules in series
- Modules mounted on fixed tilt at 10 degrees
- (1) 500 kW AC Inverters
- New power from the inverters will be installed overhead using the existing light poles and interconnected to the existing facility electrical transformer adjacent to the generator building.

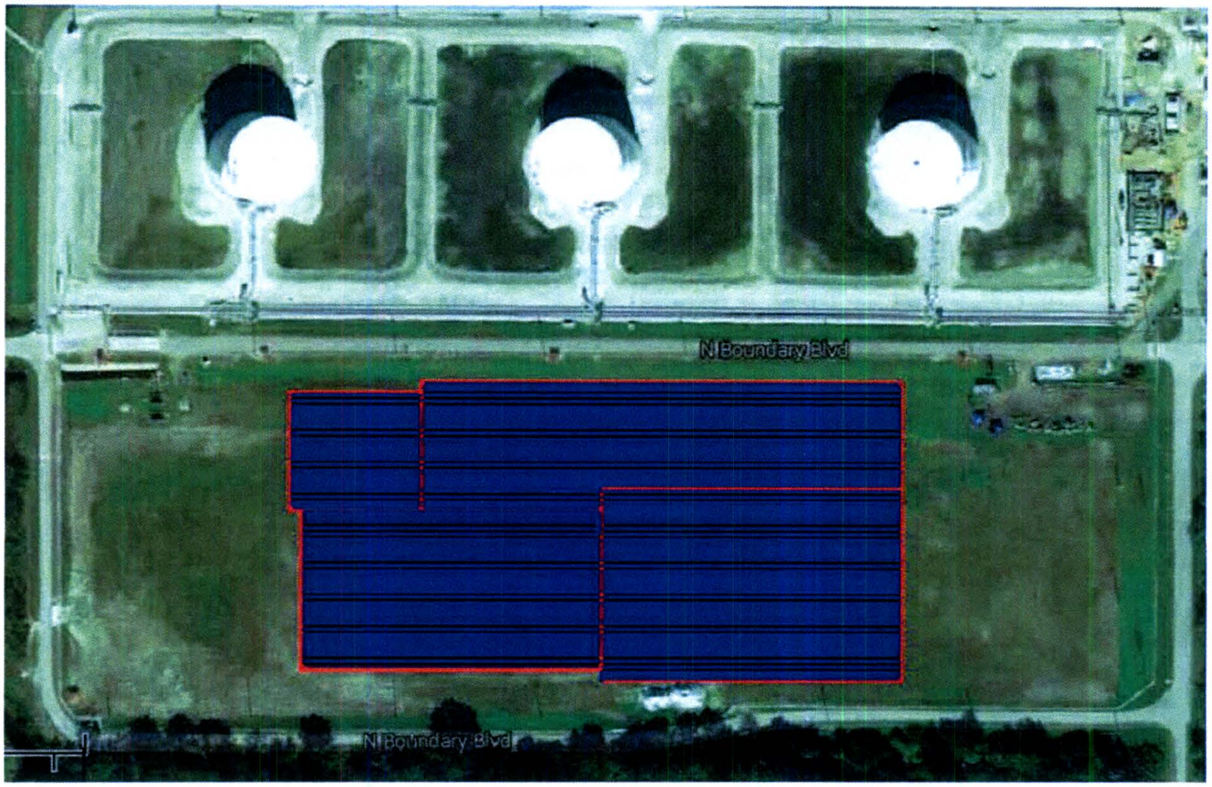
The following figure shows the proposed layout of the solar system for the first phase.



The second phase can be expanded an additional 1,247,440 W DC producing 1,792,991 kWh AC. The system specifics are as follows:

- 4,024 - 310W solar panel modules
- Modules mounted on fixed tilt at 10 degrees
- (2) 500 kW AC Inverters
- (2) 75 kW AC Inverters
- New power from the inverters will be installed overhead using the existing light poles and interconnected to the existing facility electrical transformer adjacent to the generator building. The poles will require additional support for the overhead electric lines.

The following figure shows the proposed layout of the solar system for the second phase.



The total power production if all the phases are installed is 1,712,440 watts DC for power production of 2,461,352 kWh AC. The annual power production for all three phases was calculated using NREL's PV Watts modeling software using a derate factor of 0.81. Power production outputs for each phase are included in **Appendix D**.

The electrical one-line diagram for each of the phases is included in **Appendix E**. The one-line diagram for Phase 1 is shown below.

(b) (7)(F)

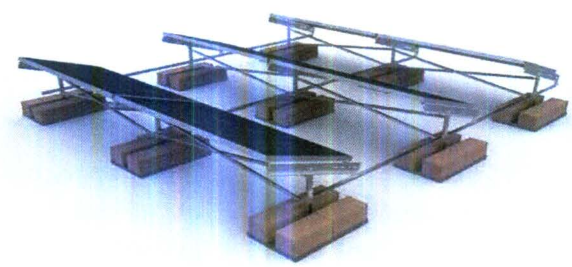
[redacted]

7.4 Solar Panel Mounting

Several solar mounting systems are available for mounting the solar panels to a structure. Considering the site conditions and discussions with facility personnel, the two mounting systems evaluated were the fixed mount and tracker mount systems.

The fixed surface mount solar panel racking solution consists of steel sections that are formed to produce high bending strength while using light gauge material, which results in an overall light weight system. The racks are placed on the ground surface which does not require any intrusions in the subsurface soils. The racks are held in place by concrete blocks. For maintenance around the panel racks, Alares recommends using geotechnical fabric and crushed gravel/stone to eliminate ground maintenance.

Since the solar system may be installed near Tampa Bay, the materials of construction should be corrosion resistant. The recommended materials should be galvanized steel. An example of a fixed mount system is shown below.

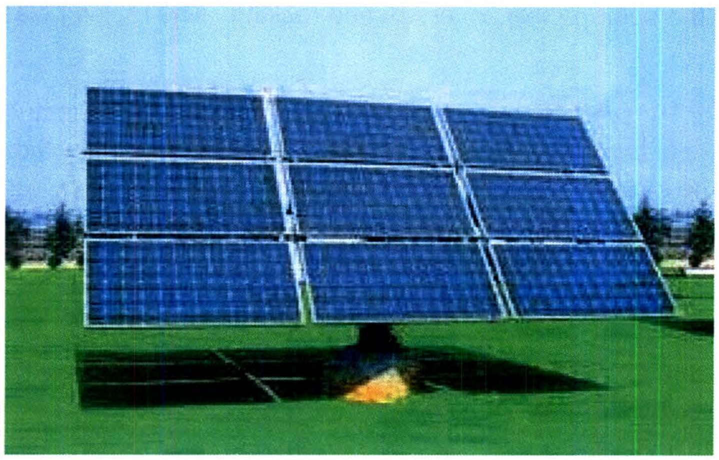


The advantages of a ballasted mounting system is that is has a low profile and can withstand wind speeds up to 160 mph. Also this method does not require piles or drilling. It also has a low load profile of 7 to 12 pounds per square foot (PSF). An installation example is shown below.

Tracker Mounts

A tracker system on the other hand is a device that orients the solar panels towards the sun. A tracker system is more efficient than a fixed system since the panels receive more solar insolation and therefore produce more power.

A geotechnical study will need to be performed in order to determine the proper foundation support structure for the tracker mount system. Drilled pier concrete foundations are preferred for the tracker mount and will require intrusions into the subsurface soils and the generation of excess soils that will require disposal. The depth of the piers could be up to 20 feet depending on soil conditions and size of tracker. An example of a tracker mount system is shown below.



Trackers have some disadvantages as detailed below:

- O&M costs are higher-outside contractors will be required to conduct maintenance
- Land use for trackers can be 4 to 5 acres per MW, as a comparison, MacDill's nine acres can fit 2.7 MW of ballasted racking.
- Trackers cost about $0.36/Watt more than fixed arrays
- With moving parts there is more chance of failures
- O&M roughly $12.00 to $30.00 per kW per year, as compared with a fixed array at $8.00 to $15.00 per kW per year
- Locations with high wind speed require additional strength and size in steel components as well as a "stow" position to protect against wind related damage

The table below is comprised of data regarding production of Fixed Arrays vs. Tracker Arrays.

	Fixed MWh	Tracker MWh	Percent Increase
Phoenix, AZ	2,128	2,593	21.85%
Bakersfield, CA	2,106	2,643	25.50%
Seville, Espania	1,906	2,389	25.34%
Palermo, Italia	1,853	2,300	24.12%
Toronto, Canada	1,501	1,780	18.59%
Munchen, Deutschland	1,095	1,236	12.88%

At a minimum a single axis tracking array will cost 20% more than a fixed array, and the production will likely only be in the 20 to 25% range. This is not taking into account the additional cost of maintenance and down time due to failures of the tracker's assemblies.

Therefore, a tracker system is not recommended for the DFSP Tampa site.

7.5 Solar System and Major Components

This section provides information on the solar system and major components. The major components consist of the solar panels, inverters and racking. The racking was discussed in the previous section.

The recommended solar PV system consists of solar panels that are connected in strings of 10 or 11 solar panels. Multiple panel strings are connected to combiner boxes with appropriate DC disconnect switches. The combiner boxes are then connected to inverter power conversion stations. The inverters and medium voltage equipment should be installed on a covered concrete pad with a security fence. Power from the inverter station is then transferred to the facility's main transformer either by trenching new power line conduits or using the existing light poles for overhead transmission. There are existing poles on the north side of the proposed location that could be used to install the overhead power. The use of the light poles is recommended and will require additional supports for the electric lines. A photo of the light poles on the site is shown below.

Solar Modules

For sizing the solar system, SolarWorld (American-Made) solar modules were used as the basis of design. These modules were used for illustrative purposes and are not necessarily recommended for the solar system. The data for these modules are shown below.

Mechanical Data

Technology: Mono
Panel Dimensions: 78.15 × 38.98 × 1.81 inches
Panel Weight: 49.6 pounds
Cells Per Module: 72
Frame Material: Clear aluminum
Backsheet Material: White
Module Connector: MC4

Electrical Characteristics

System Rating: 310 Watts
Watts (PTC): 271.1 Watts
Max Power Voltage (Vmpp): 36.6 Volts
Max Power Current (Impp): 8.56 Amps
Open Circuit Voltage (Voc): 45.8 Volts
Short Circuit Current (Isc): 9.09 Amps
Max System Voltage: 1000 Volts
Series Fuse Rating: 16Amps
Module Efficiency: 15.77%

Solar panel information is included in **Attachment F.**

Inverter

The inverter is a three-phase power conversion system for grid-connected photovoltaic arrays. The inverter converts direct current (DC) electricity generated by the photovoltaic arrays into usable alternating current (AC) electricity. An example of an inverter is shown below.

Data Acquisition System

The Data Acquisition Systems (DAS) is a monitoring system that provides an internet portal for analyzing, reporting, and displaying performance and environmental data. The system consists of a smart meter and other data collection devices. The monitoring system will provide the capability to view photovoltaic system data over the Ethernet LAN through a web based portal. The monitoring system should, at a minimum, measure and report Solar irradiance, DC power, AC real power, AC current, AC voltage, power factor, ambient air temperature, PV cell temperature and AC kWh energy produced (hourly, daily, monthly yearly). Logging can be recorded in 15 minute intervals. The monitoring system components should be enclosed in NEMA 4X weather and corrosion proof enclosures.

7.6 Electrical Point of Connection

This DFSP Tampa facility is serviced by 13.2 medium voltage distribution system. (b) (7)(F) [redacted] The photo below shows the existing circuit feeding into the facility at the transformer.

There is an existing breaker panel adjacent to the transformer that has spares that can be used for the solar system connection as shown below.

The existing main electrical switchgear will not require upgrading for the Phase 1 solar system. We recommend installing a reverse power relay(s) at the existing transformer. The inverter output over-current protection is via circuit breakers at the PV unit subsystem. These breakers will be lockable and serve as the owner's isolating disconnecting means. The utility isolating disconnect will be at the new PV unit subsystem and be separate and lockable.

The main electric switchgear and transformer will require upgrading to handle the capacity of the Phase 2 solar system.

8.0 FINANCIAL ANALYSIS

One of the determining factors for the feasibility of an energy conservation project is economics. The measure must provide sufficient annual savings to justify the initial capital investment. Energy savings will depend on the amount of power the solar system produces and the cost of energy. The capital cost depends on the system size, the quantity of equipment that must be installed, and the solar irradiance available. Higher energy costs tend to improve the economics of the project.

Life cycle cost analysis (LCCA) is the basis of determining whether the project is economically feasible. LCCA is a method of project evaluation in which all costs arising from owning, operating, maintaining and disposing of a project are considered to be potentially important to that decision. The first capital costs can be high but the reduced energy costs and maintenance costs may make a project economically feasible. LCCA provides a better assessment of the long-term effectiveness of a project than alternative economic methods that focus only on first costs or on operating related costs in the short run. The National Institute of Standards and Technology Handbook 135, Life-Cycle Costing Manual was used as a basis of conducting the LCCA.

8.1 Methodology

The Building Life-Cycle Cost (BLCC) program was used to calculate the LCCA. The National Institute of Standards and Technology (NIST) developed the BLCC Program to provide computational support for the analysis of capital investments. The following methodology was used to conduct the LCCA:

1. Annual energy consumption for the facility was calculated
2. Detailed cost for the system was estimated
3. Solar system modeling software was used to estimate the potential power production.
4. Life cycle cost analysis (LCCA) was computed using Building Life-Cycle Cost (BLCC) software.

8.2 Cost Analysis

Cost estimates were prepared for each phase. Each cost estimate is included in **Appendix G.** The BLCC software was used to compute the LCC data. LCC data is also included in **Appendix G.** A breakdown of the economics for the project is provided below.

Phase	Installation Costs	Annual Savings	Simple Payback (yrs)	SIR	Annual GHG (MT CO_2)
Phase 1	$1,274,292	$66,836	20	1.0	436
Phase 2	$3,105,925	$179,299	18	1.13	1,172
Total	**$4,380,217**	**$246,135**	**19**	**1.1**	**1,608**

Currently, there is a federal tax credit of 30% through 2016 for solar PV installations. However a federal agency is not allowed to take the credit. Instead the credit may be assigned to the installer. The financial implications if the 30% tax credit is available are shown below.

Phase	Installation Costs (USD)	Annual Savings	Simple Payback (yrs)	SIR	Annual GHG (MT CO_2)
Phase 1	$876,355	$66,836	14	1.46	436
Phase 2	$2,174,147	$179,299	13	1.57	1,172
Total	**$3,050,503**	**$246,135**	**13.5**	**1.52**	**1,608**

9.0 DESIGN CONSIDERATIONS

In designing a PV solar system, many factors must be taken into account. In general some critical factors associated with the PV design include:

- Solar power site conditions related to grading and site preparations
- Site shading
- Review of the PV modules and inverters reliability and performance
- Data acquisition system
- Infrastructure underground conduit works for power and communication per DLA building specifications including concrete reinforced ductbanks.
- Equipment platforms for combiner boxes, inverters, communication equipment, site utilities, and transformers
- Grounding and lightning protection
- Site utility electrical system
- Equipment platforms and shading structures
- Soil conditions, civil and structural engineering, drainage, ground conditioning options
- Design concrete foundations for all equipment. Foundations will be designed per the applicable building code
- Material specification and procurement
- System Maintenance
- Site preparation, material storage
- Vehicular transport and site disturbance issue
- Electrical AC and utility intertie engineering design component
- Testing, commissioning and acceptance entity
- Personnel training documentation, type of training materials

The design submittal typically will include the following information and drawings:

- Electrical design calculations
- Structural design/wind and seismic load calculations
- PV module, combiner box, AC and DC disconnect, and overcurrent protection data sheets
- Inverter data sheets
- Monitoring system data sheets

Typical List of Design Drawings

- Title sheet
- Existing site plan
- PV Array layout
- Electrical one-line diagram sheet
- Equipment location plan
- Equipment specifications
- DC wiring schematic
- AC wiring schematic
- Conduit and wire schedule
- DC combiner layout

The submittals should include one-line diagrams of the power system to support the system evaluation and analysis. The one-line diagram shows the identification and ratings of electrical equipment such as: transformers, cables, circuit breakers, protective relays, fuses, switches, current transformers, potential transformers, surge arresters, etc.

10.0 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

This section discusses some construction considerations for the installation of the PV system.

Site Work

The site will require grading and installation of a solid base for the solar panel structures. The Contractor should investigate the soil characteristics of the area to determine whether the soil requires compaction prior to the placing of a stone base for the panel structures.

If any potentially contaminated soil was observed or suspected during installation of the PV arrays, this material would be segregated and placed on plastic sheeting. Work would be halted and facility personnel would be informed. Proper precautions would be taken in accordance with the facility's or contractor's Health and Safety Plan (HASP). Any suspect soil would be sampled for characterization, and, if determined to be contaminated, would be properly managed, transported offsite, and disposed of at a properly permitted facility in accordance with state and federal regulations.

Electrical

The Contractor would inspect the existing electrical switchgear and confirm the point of connection. The Contractor would be responsible for obtaining all permits and applying to the Utility for an interconnection permit. The Utility will provide connection requirements once the permit is provided.

Lightning Protection

The area is subject to lightning storms. The solar system should be grounded for lightning protection.

Grass and Weed Control

Weed inhibitors should be used to limit grass growth. According to facility personnel, grass growth is an issue at the facility.

10.1 Maintenance

Fixed solar systems require little maintenance. The system should be inspected annually to determine whether panels need to be tightened, etc. Typical maintenance includes weed removal and module washing if needed. Typically rain events keep the modules free of dust and dirt. If solar panels require cleaning then light water spraying using a water hose can be used to remove pollen, dust or dirt. Routine system maintenance will take approximately 10 hours per month and can be performed by facility personnel.

However more maintenance is required for tracking system since there are mechanical parts that require regular maintenance. Since this maintenance is specialized, an outside contractor would be required.

11.0 UTILITY CONNECTION REQUIREMENTS

All design and construction will have to comply with the Tampa Electric Company (TECO) and current MacDill design and construction guidelines and all applicable air force regulations. All design phases/submittals are typically reviewed by base civil engineering.

The solar energy generation system will be grid synchronized and connected to the primary switchgear. The solar energy generation system will have the ability to export power to the electric grid. Export of power to the utility in this case TECO will only occur if generated power is in excess of facility loads. It is unlikely the power generated from the solar system would be exported back to the main grid but instead would be used by MacDill.

In any case, since TECO supplies electric power to MacDill, TECO would require an interconnection agreement to ensure the solar system meets TECO's construction and connection standards. A Tier 3 interconnection agreement is required for systems rated 100 kW to 2 MW (AC). A copy of the interconnection agreement is attached in **Appendix H.**

The electric utility will require that the installed solar energy systems meet all performance standards established by the National Electric Code, Institute of Electrical and Electronic Engineers, and National Electrical Safety Codes. To prevent a net metering customer from back-feeding a de-energized line, the utility will require the facility to install necessary disconnect switch with lock out capability.

The Tier 3 interconnection agreement process includes the following:

- Application fee: $500.
- Proof of insurance not less than $2,000,000 general liability
- Provide a copy the manufacturer's installation, operation and maintenance instructions for the system's inverter.
- A manual disconnect switch of visible load break type must be installed adjacent to meter, prior to inspection.
- Proof of inspection and approval by local code authority.
- May require interconnection study at a cost of $3,000 (The interconnection study could take up to three months for the utility complete).

12.0 NEPA EVALUATION

The National Environmental Protection Act (NEPA) requires federal government agencies to determine and report on the environmental impacts of their activities in what are called Environmental Impact Statements (EISs) and Environmental Assessments (EAs). In many cases, activities are known empirically to have no significant environmental impacts and are granted an exclusion from reporting requirements. These activities are known as Categorical Exclusions.

NEPA requirements were reviewed to determine whether the proposed solar system project could receive a categorical exclusion. Categorical exclusion means a category of actions which do not individually or cumulatively have a significant effect on the human environment and neither an environmental assessment nor an environmental impact statement is required.

Also, categorical exclusions are actions which meet the definition contained in 40 CFR 1508.4, and do not involve significant environmental impacts. These actions: do not induce significant impacts to planned growth or land use for the area, do not require the relocation of significant numbers of people; do not have a significant impact on any natural, cultural, recreational, historic or other resource; do not involve significant air, noise, or water quality impacts; do not have significant impacts on travel patterns; and do not otherwise, either individually or cumulatively, have any significant environmental impacts.

Any action which normally would be classified as a categorical exclusion but could involve unusual circumstances will require the Administration, in cooperation with the applicant, to conduct appropriate environmental studies to determine if the categorical exclusion classification is proper. Such unusual circumstances include:

1. Significant environmental impacts;
2. Substantial controversy on environmental grounds;
3. Significant impact on properties protected by Section 4(f) of the DOT Act or section 106 of the National Historic Preservation Act; or
4. Inconsistencies with any Federal, State, or local law, requirement or administrative determination relating to the environmental aspects of the action.

Typically the installation of a solar PV system does not raise any concern by the public because the risk of environmental impacts is low. Based on our review of the categorical exclusion checklist, it is our opinion that an environmental assessment would not be required for a solar project at the facility.

However, the project is subject to review by the MacDill Air Force Base Civil Engineering Office. They would determine whether an environmental assessment is required. The environmental assessment is a concise public document that serves to briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact. The assessment will evaluate potential direct, indirect, and cumulative impacts on environmental and land use resources.

It is likely that an environmental assessment would conclude that a finding of no significant impact (FONSI) would be achieved.

It is recommended that the appropriate personnel of the MacDill Air Force Base be provided a copy of this study to determine whether an environmental assessment is required.

13.0 INCENTIVES AND RENEWABLE ENERGY CERTIFICATES

Solar PV projects are eligible for 30% federal income tax credit for the cost of a new System. Energy Saving Performance Contractors (ESCOs) are common third party entities who provide energy related construction services and are paid by the savings incurred by these services for a term of usually 20-30 years.

Another incentive that is available is Modified Accelerated Cost Recovery (MACRS) Depreciation. The ESCO, or other third party, can depreciate the asset on their corporate income taxes and claim tax savings. The unsubsidized portion, after the federal income tax credit, can be totally depreciated in the span of 5 years.

The utility provider does not offer rebates for renewable solar energy projects for commercial systems. The project must be approved by the utility prior to implementation. Also renewable energy certificates are applicable to electric generation projects that the DLA can use.

14.0 POTENTIAL ENVIRONMENTAL ISSUES

This section discusses potential environmental issues and possible resolutions for the solar installation. During the site visit, it was noted that two outstanding environmental issues exist at the site in the former Tank # 4 and #7 areas.

In the former area of Tank #4, there were historical releases to groundwater. HydroGeoLogic, Inc. (HGL), the remediation contractor, is currently addressing the groundwater issues in this area. According to HGL, the area requiring remediation is approximately 142,000 square feet which is located on the eastern portion of Tank #4. The groundwater contaminants of concern are benzene and vinyl chloride. HGL hopes to complete the work in this area by 2018.

In the former area of Tank #7, there were also historical releases to groundwater. The area was remediated and groundwater monitoring is currently being conducted. The completion of the monitoring program is not currently known.

15.0 FEDERAL, STATE AND LOCAL REGULATIONS AND PERMITS

Federal, state and local regulations were reviewed for applicability to the installation and operation of the PV solar system. The MacDill Air Force Base would have oversight jurisdiction over the project. AF Form 332 would need to be submitted to the Base Civil Engineer to determine the construction requirements at the facility. It is recommended that the appropriate personnel of the MacDill Air Force Base be provided a copy of this study to determine required construction requirements at the site such as applicable wind loads.

16.0 SAFETY CONSIDERATIONS

Safety during construction should be a top priority. A health and safety plan (HASP) should be prepared prior to site construction activities. The intent of the HASP is to provide general information on known or suspected safety hazards as well as general information about potential or suspected hazardous and toxic substances on a site.

Site-specific hazardous materials may include:

- Petroleum products or hydraulic fluids from equipment
- Injuries including noise, dust or trip.
- Ladder safety

The HASP summarizes the project organization and responsibilities; establishes procedures for preventing accidents, injuries and illnesses; identifies hazards; discusses the personal protective equipment that may be used at the site; identifies personnel health and safety training requirements; summarizes the monitoring techniques to be used; establishes emergency procedures; describes the medical surveillance program; identifies that appropriate first aid equipment is available; provides for accident record keeping; and establishes a schedule for safety inspections.

17.0 FINANCING ALTERNATIVES

Federal agencies are eligible to use utility incentive programs to procure financing for comprehensive energy projects. These programs range from simple rebate programs to full, turnkey project implementation programs that include financing, project management, and performance assurance. The financing options evaluated for the project are listed below:

- Energy Savings Performance Contract (ESPC)
- Utility Energy Services Contract (UESC)
- Enhanced Use Lease (EUL)
- Direct Funding

Energy savings performance contracts

Energy savings performance contracts (ESPCs) allow Federal agencies to conduct energy projects with no upfront capital costs, thus minimizing the need for Congressional appropriations. An ESPC is a partnership between a Federal agency and an energy service company (ESCO). The ESCO designs, constructs, and obtains the necessary financing for an energy savings project.

The agency makes payments over time to the contractor from the savings reduction in the utility bills, which are paid by the agency's appropriated funds. After the contract ends, all additional cost savings accrue to the agency. Contract terms of up to 25 years are allowed. From the perspective of an ESCO, the energy savings are not as attractive to warrant financing the project. For larger solar projects, simple payback periods are about 15 to 20 years, and NPVs are positive. A larger solar PV project may be attractive to an ESCO since the project economics are feasible.

Utility Energy Services Contracts

Utility Energy Services Contracts (UESCs) allow Federal agencies to enter into contract with serving utilities to implement energy and water related improvements at their facilities. The agency may fund the project with appropriations, or the utility may arrange for financing to cover the capital cost of the project, which is repaid over the contract term from cost savings generated by the energy efficiency measures. By using UESCs, agencies can partner with utilities to implement energy improvements with no initial capital investments, minimal net cost to the agencies, and savings of time and resources.

In a UESC, a serving or franchised utility company agrees to provide a Federal agency with services or products (or both) designed to make that agency's facilities more energy efficient. Federal facilities can also obtain project financing from a utility company through a UESC. During the contract period, the agency pays for the cost of the UESC from the "avoided-costs-savings" resulting from the energy efficiency improvements. Experienced agency-utility teams use "excess avoided-costs-savings" to cover the costs of a feasibility study for follow-on UESCs at their facilities. After the term of the contract, the energy efficiency improvements continue to realize the avoided cost-savings for the life of the improvements and the savings can be used to do more projects.

Enhanced Use Lease

Enhanced Use Lease (EUL) is a method for funding construction or renovations on federal property by allowing a private developer to lease underutilized property, with rent paid by the developer in the form of cash in-kind services. Currently, EULs are used by the Department of Defense. EUL authority is derived from Congress and is specific to each agency (e.g. 10 USC 2667 for the DoD).

Granted a lease, the developer is able to make improvements to the property which can be leased at market rents to any interested tenants. Under EUL, federal control over the leased property is ceded to private developers, though the federal agency retains limited rights over the developers' actions.

Since the agency can issue enhanced use leases only on land that is excess to their needs, the improvements must not be directly tied to any programmatic requirements of the installation. The advantages to the developer include prime secure convenient locations on military installations, and the opportunity to provide sole-source services and products in lieu of rent for the ground lease.

The advantages to the federal agency include the possibility of fast-tracking alterations, repairs or new construction so that the improved space becomes available for lease. Engineering, maintenance, or construction services are provided by the developer in lieu of rent, thus decreasing the federal payroll. For this project, an UL is not feasible since the DLA does not own the land. It is unlikely that an EUL would be practical.

Direct Financing

Obtaining financing from the US Congress is the preferred method when faced with low return investments. The financing cost of US Treasury bills are historically the lowest yielding borrowing costs for project financing. Since the US Congress is not a for-profit entity, the rate of return need only be greater than the interest rate of Treasury bills to justify the spending. The internal rate of return for Phase 1 is 2.7%. The 30 year Treasury Bills yield is currently at 2.7% so the Phase 1 project is justifiable.

17.1 Financing Alternatives

The financing options evaluated for the project are listed below:

- Energy Savings Performance Contract (ESPC)
- Utility Energy Services Contract (UESC)
- Enhanced Use Lease (EUL)

Energy Savings Performance Contract (ESPC)
ESPC is a partnership between a Federal agency and an Energy Service Company (ESCO). ESCO arranges the necessary financing for funding the PV Plant and guarantees the estimated energy cost savings to DLA as a result of project implementation. Energy payments are made to ESCO from DLA for the electricity supplied from the PV plant as per the contract between DLA and ESCO. The Energy Service Company operates the PV plant and is assumed to receive an operator fee per annum. The actual cash flow sharing will depend on the contract entered into with the Energy Service Company. The analysis assumes a target IRR of 10% for the ESCO on its overall cash flows which include profits from the project company and the operator fee.

Based on our analysis, the ESCO would have to charge the facility $0.09 per kWh to receive the target IRR. Since the facility is currently being charged $0.10 per kWh, it is unlikely an ESCO would be interested in this type of an arrangement. However if the target IRR is lower to 6% then the ESCO would need to charge the facility $0.06 per kWh.

Therefore depending on the ESCO's target IRR, they may be interested in the project. We recommend exploring the solar project with a federal ESCO to gauge interest in the project.

Utility Energy Services Contract (UESC)
In this arrangement, the DLA enters into partnership with the Utility to implement the solar project at their facility. The Utility arranges financing to cover the capital costs of the project and is repaid by the DLA over the contract term and in turn provides cost savings to the DLA. The actual cash flow sharing will depend on the contract entered into with the Utility.

Since DLA leases the land and pays MacDill a flat electric rate, it is unlikely the Utility will be interested in the Phase 1 solar project. They may be interested in the larger projects but the Utility would have to deal directly with MacDill.

Enhanced Use Lease (EUL)
EUL program refers to legislative authority that allows DLA to lease underutilized land and improvements to a selected developer (Lessee) for a term of up to 75 years. In exchange for the EUL, the developer would be required to provide DLA with "fair consideration" (i.e., cash and/or "in-kind" consideration) as determined by the DLA. It is unlikely that this option is feasible for the DLA since the DLA does not own the land at the facility.

18.0 SUMMARY AND CONCLUSIONS

The purpose of the study is to determine whether the installation of a solar PV system at the DFSP Tampa is both technically and economically viable. The contract required gathering information from the site, analyzing and providing insight into the operating profile of the facilities and determine the consequent suitability for a solar system.

The method and approach conducted to accomplish the project objectives are summarized as follows:

- A site visit was conducted to gather facility information.
- A proposed location for the system was identified and a shading analysis was conducted.
- Information on the existing electrical system was reviewed.
- A technical analysis was conducted.
- An economic analysis was conducted.

Based on the results of the feasibility evaluation, a solar PV system is recommended for this facility. The system is technically and financially feasible. The facility can achieve net-zero energy status by constructing the solar PV system.

19.0 REFERENCES

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Means, R.S., ***Mechanical Cost Data, 33rd Annual Edition***, R.S. Means Company Inc., Kingston MA, 2013.

National Institute of Standards and Technology, ***Life Cycle Costing Manual for the Federal Energy Management Program***, February 1996.

York, D.A. and Cappiello, C.C., **DOE-2 Engineers Manual (Version 2.1A),** Lawrence Berkeley Laboratory and Los Alamos National Laboratory.

National Renewable Energy Laboratory (NREL) PV Watts Calculator, http://pvwatts.nrel.gov/

Federal Energy Management Program, Building Life Cycle Cost (BLCC) Program, Version 5.3-14.

Appendix A
Suneye Results

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

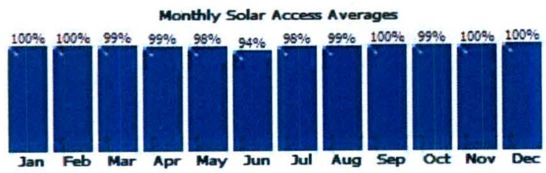
Session Properties

Name	MD 1
Creation Date	1/27/2015 10:28
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky03

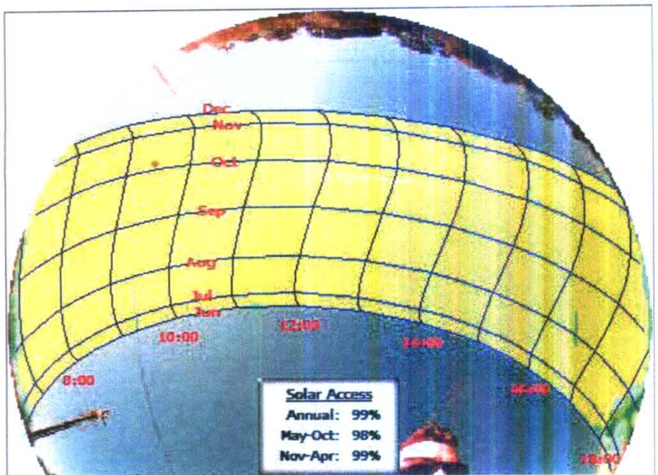
Annual	May-Oct	Nov-Apr
99%	98%	99%



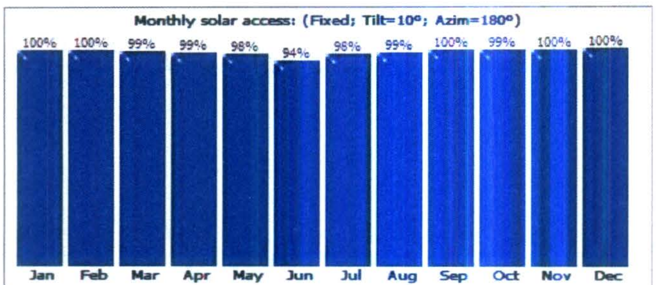
TSRF for the skyline in this session: 94%

Sky03 – 1/27/2015 10:33 – (no skyline note)

Panel Orientation: T t=10° – Az muth=180° – **Skyline Heading=175°**
Solar Access: Annua : 99% – Summer (May-Oct): 98% – W nter (Nov-Apr): 99%
TSRF: 94% – **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

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5313 N. Boundary Blvd.
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By:

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Measurements made by **Solmetric SunEye™** – www.so metr c.com

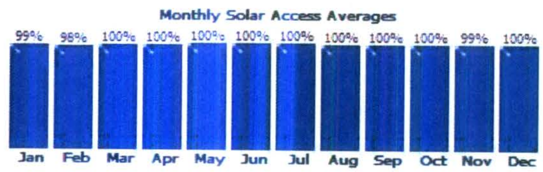
Session Properties

Name	MD 10
Creation Date	1/27/2015 10:56
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

Annual	May-Oct	Nov-Apr
100%	100%	99%



TSRF for the skyline in this session: 95%

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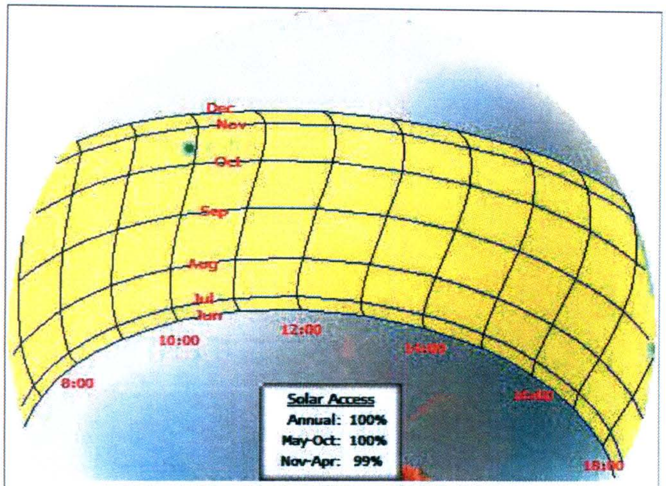
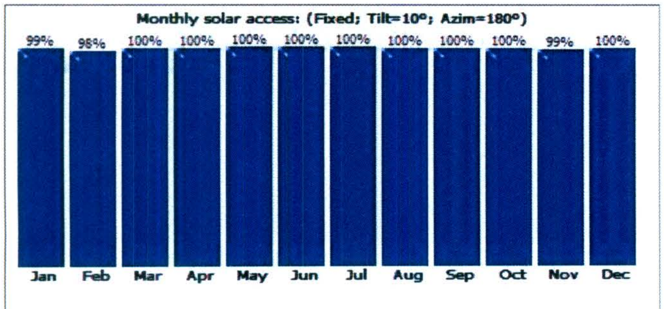
Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 100% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 99%
TSRF: 95% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
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Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

Session Properties

Name	MD 11
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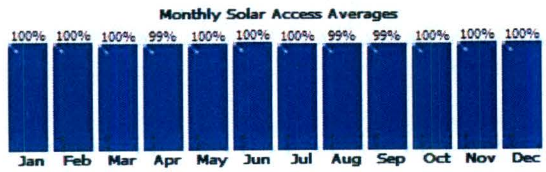
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

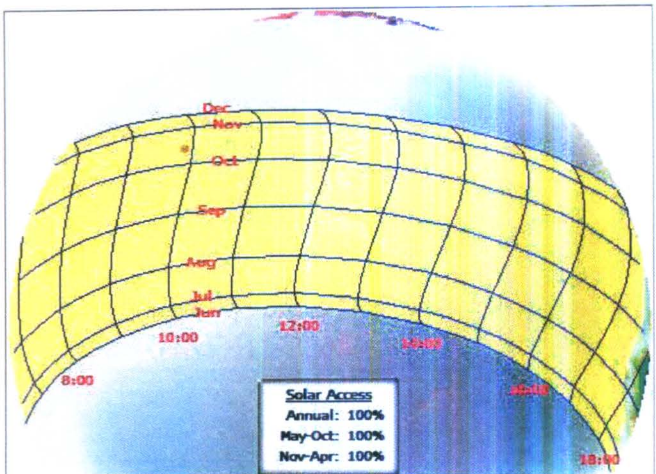
Annual	May-Oct	Nov-Apr
100%	100%	100%



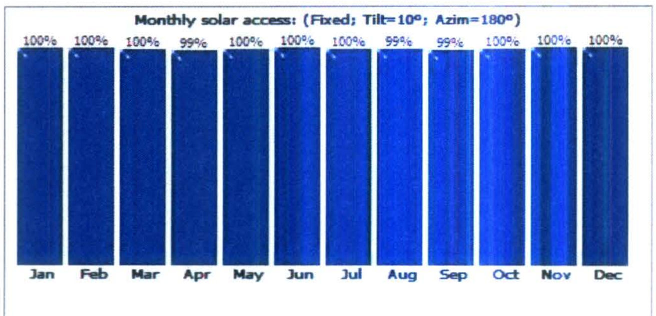
TSRF for the skyline in this session: 95%

Sky01 -- 1/27/2015 10:59 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 100% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 100%
TSRF: 95% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

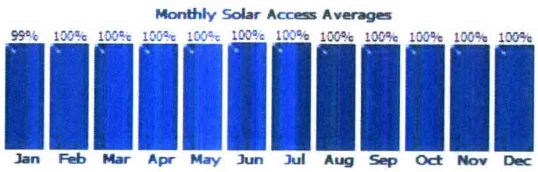
Session Properties

Name	MD 12
Creation Date	1/27/2015 11:01
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

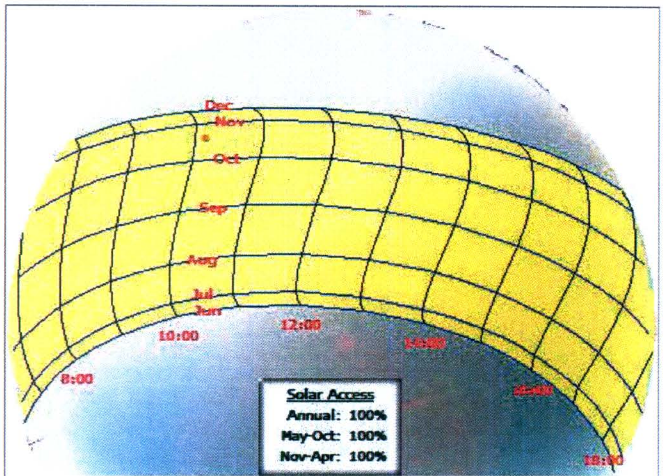
Annual	May-Oct	Nov-Apr
100%	100%	100%



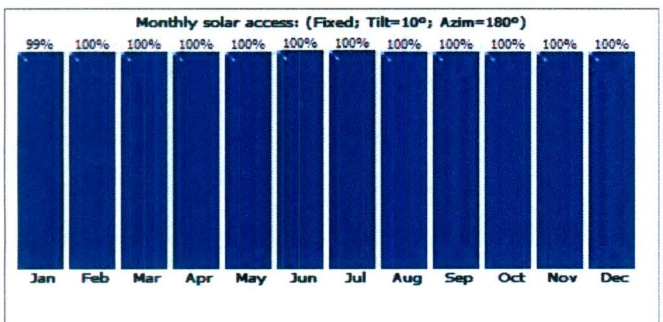
TSRF for the skyline in this session: 95%

Sky01 -- 1/27/2015 11:01 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 100% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 100%
TSRF: 95% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

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5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

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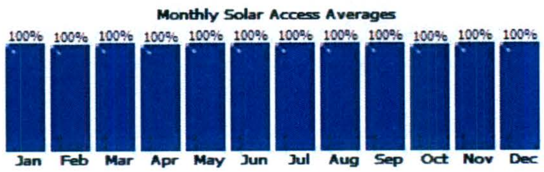
Session Properties

Name	MD 13
Creation Date	1/27/2015 11:02
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

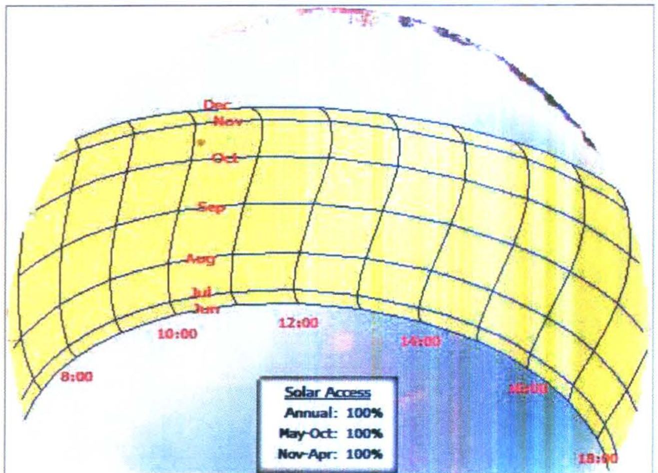
Annual	May-Oct	Nov-Apr
100%	100%	100%



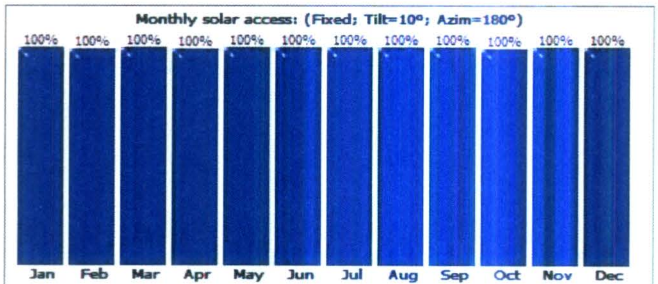
TSRF for the skyline in this session: 95%

Sky01 -- 1/27/2015 11:02 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 100% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 100%
TSRF: 95% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

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5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

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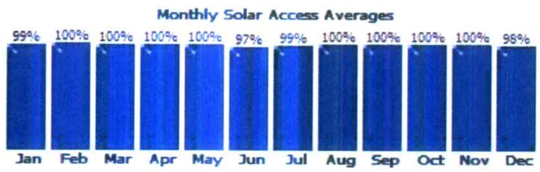
Session Properties

Name	MD 2
Creation Date	1/27/2015 10:35
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky03

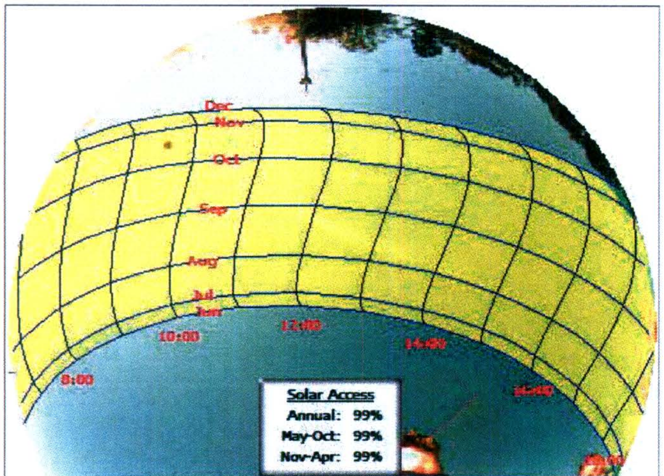
Annual	May-Oct	Nov-Apr
99%	99%	99%



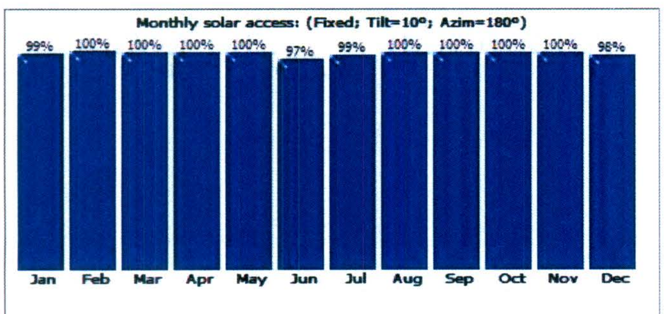
TSRF for the skyline in this session: 95%

Sky03 -- 1/27/2015 10:37 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 99% -- Summer (May-Oct): 99% -- W nter (Nov-Apr): 99%
TSRF: 95% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

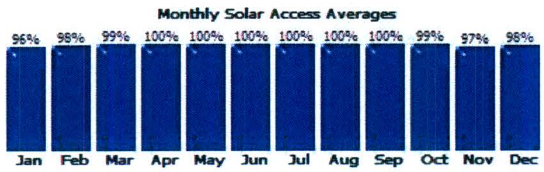
Session Properties

Name	MD 3
Creation Date	1/27/2015 10:40
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

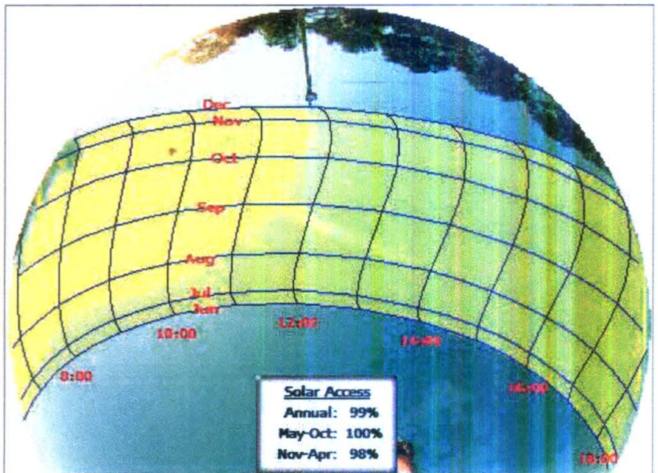
Annual	May-Oct	Nov-Apr
99%	100%	98%



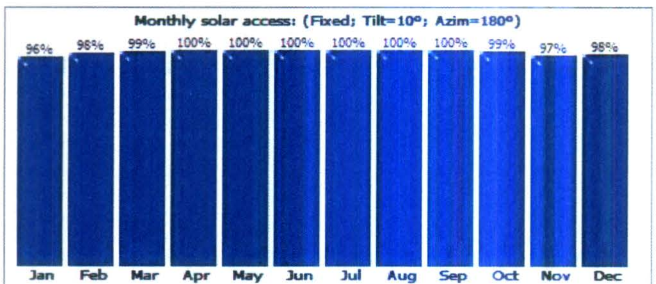
TSRF for the skyline in this session: 94%

Sky01 -- 1/27/2015 10:40 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 99% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 98%
TSRF: 94% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

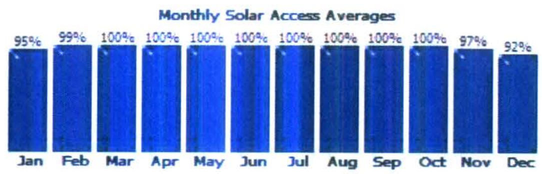
Session Properties

Name	MD 4
Creation Date	1/27/2015 10:42
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky02

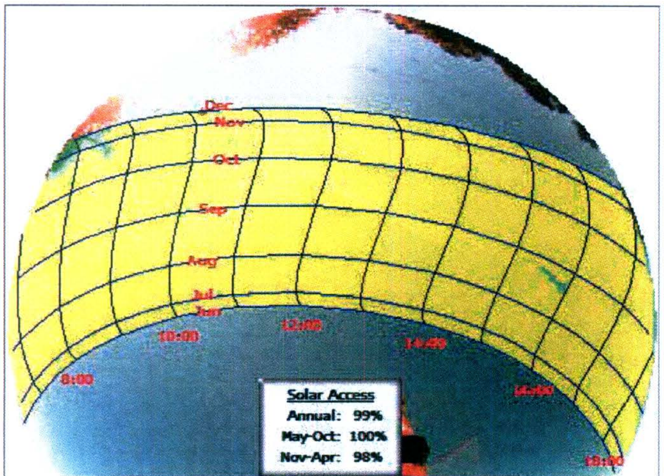
Annual	May-Oct	Nov-Apr
99%	100%	98%



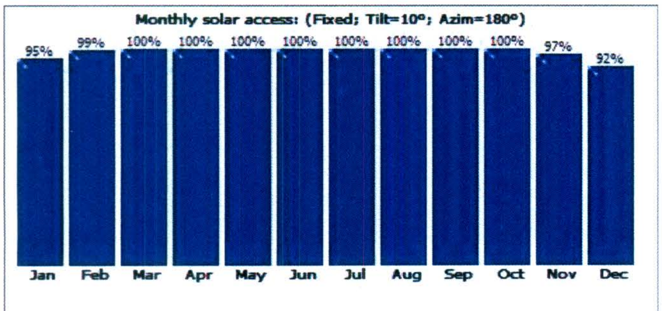
TSRF for the skyline in this session: 94%

Sky02 -- 1/27/2015 10:43 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 99% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 98%
TSRF: 94% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
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Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

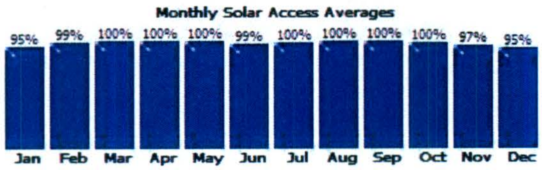
Session Properties

Name	MD 5
Creation Date	1/27/2015 10:44
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

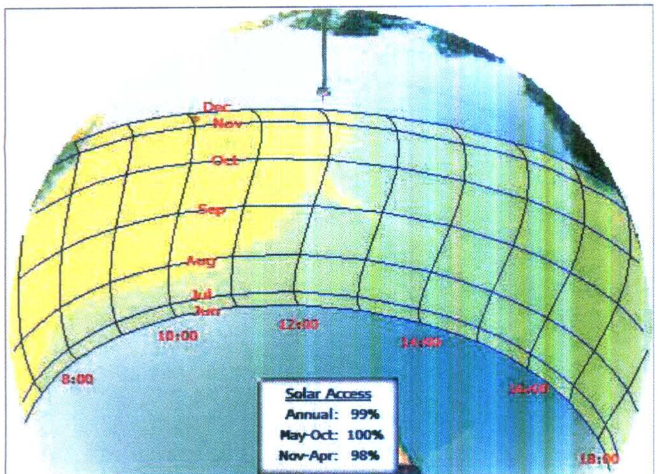
Annual	May-Oct	Nov-Apr
99%	100%	98%



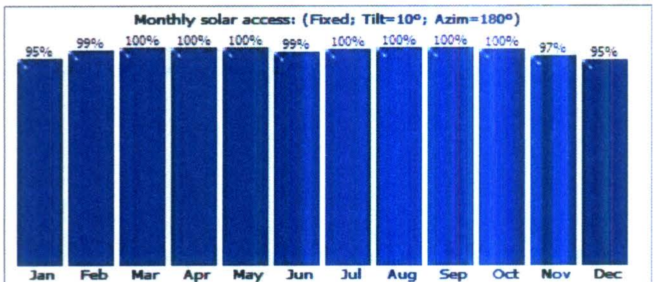
TSRF for the skyline in this session: 94%

Sky01 -- 1/27/2015 10:44 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 99% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 98%
TSRF: 94% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
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Quincy, MA 02171
(610) 597-6001

Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

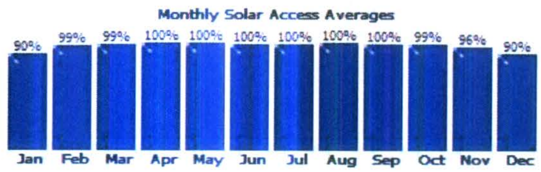
Session Properties

Name	MD 6
Creation Date	1/27/2015 10:45
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

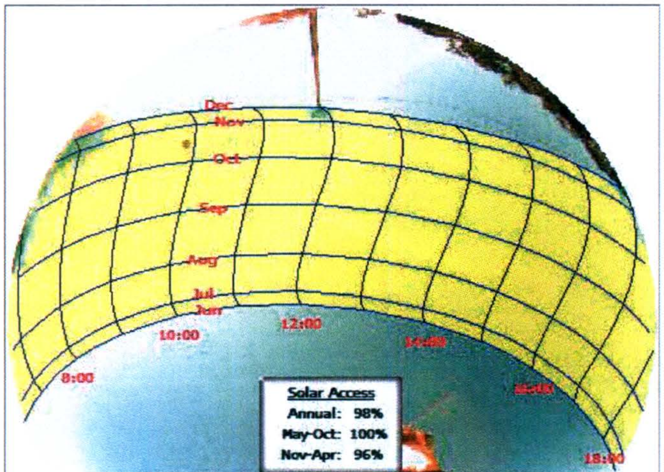
Annual	May-Oct	Nov-Apr
98%	100%	96%



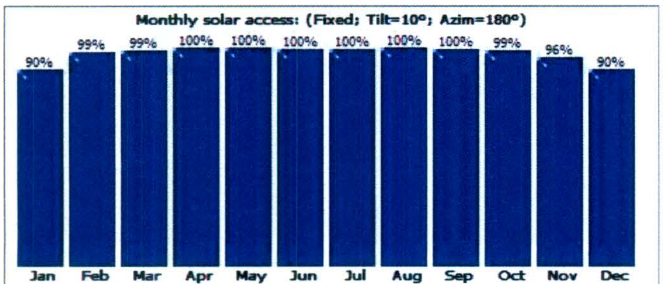
TSRF for the skyline in this session: 93%

Sky01 -- 1/27/2015 10:46 -- (no skyline note)

Panel Orientation: T t=10° -- Az muth=180° -- **Skyline Heading=175°**
Solar Access: Annua : 98% -- Summer (May-Oct): 100% -- W nter (Nov-Apr): 96%
TSRF: 93% -- **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

For:

DLA MacDill AFB
5313 N. Boundary Blvd.
MacDill AFB, FL 33621
(813) 840-1251

By:

The Dean of Solar
9A Ash Street
Quincy, MA 02171
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Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

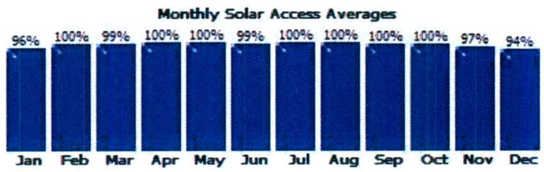
Session Properties

Name	MD 7
Creation Date	1/27/2015 10:47
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

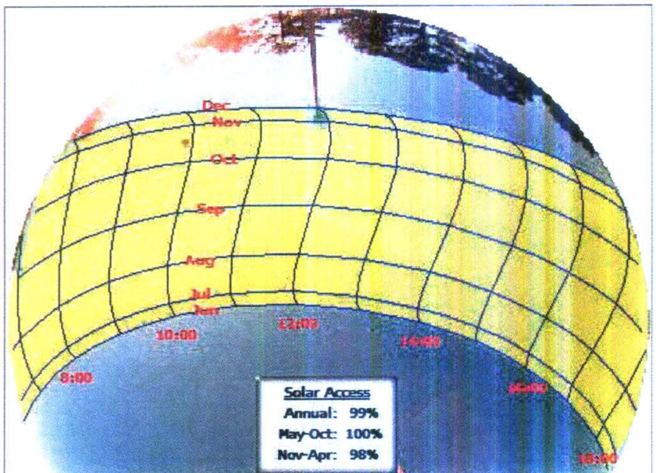
Annual	May-Oct	Nov-Apr
99%	100%	98%



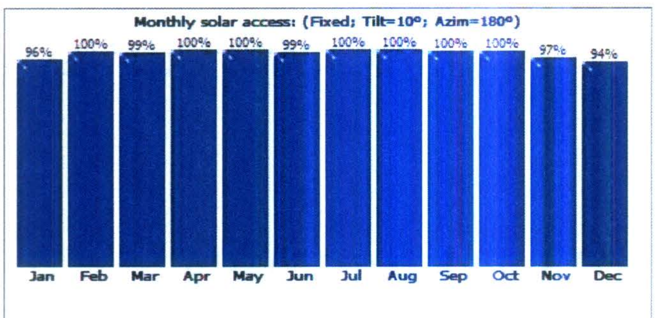
TSRF for the skyline in this session: 94%

Sky01 – 1/27/2015 10:47 – (no skyline note)

Panel Orientation: T t=10° – Az muth=180° – **Skyline Heading=175°**
Solar Access: Annua : 99% – Summer (May-Oct): 100% – W nter (Nov-Apr): 98%
TSRF: 94% – **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

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MacDill AFB, FL 33621
(813) 840-1251

By:

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Measurements made by **Solmetric SunEye™** – www.so metr c.com

Solmetric

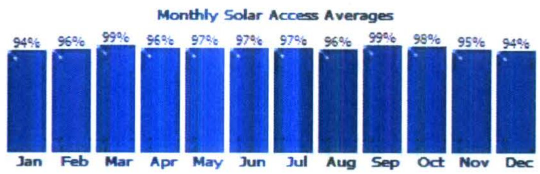
Session Properties

Name	MD 8
Creation Date	1/27/2015 10:49
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

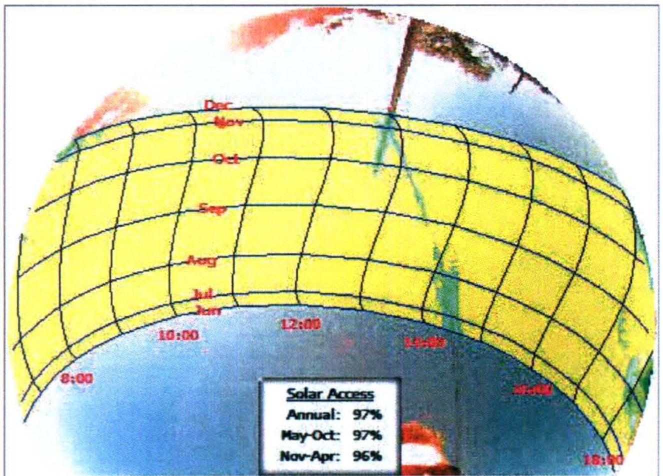
Annual	May-Oct	Nov-Apr
97%	97%	96%



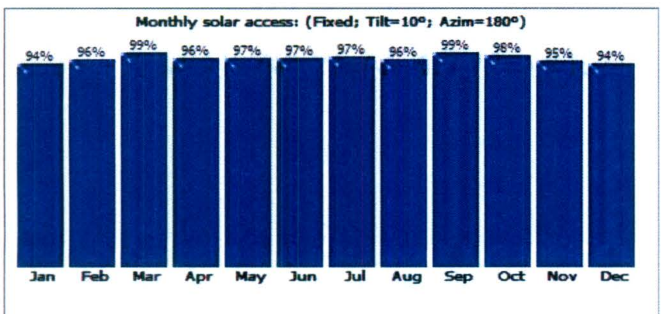
TSRF for the skyline in this session: 92%

Sky01 – 1/27/2015 10:49 – (no skyline note)

Panel Orientation: T t=10° – Az muth=180° – **Skyline Heading=175°**
Solar Access: Annua : 97% – Summer (May-Oct): 97% – W nter (Nov-Apr): 96%
TSRF: 92% – **TOF:** 95%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com

Solar Access and Shade Report

4/8/2015

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Measurements made by **Solmetric SunEye™** – www.solmetric.com

Solmetric

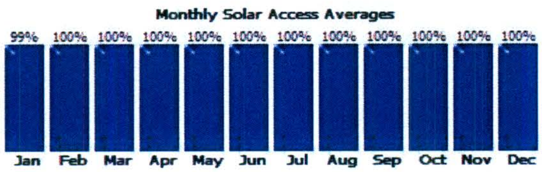
Session Properties

Name	MD 9
Creation Date	1/27/2015 10:51
Note	(none)
Location	27.9°N, 82.5°W Mag Dec: 5.3°W T me Zone: GMT-05:00

Solar access averages of 1 skyline in this session

Skylines Averaged: Sky01

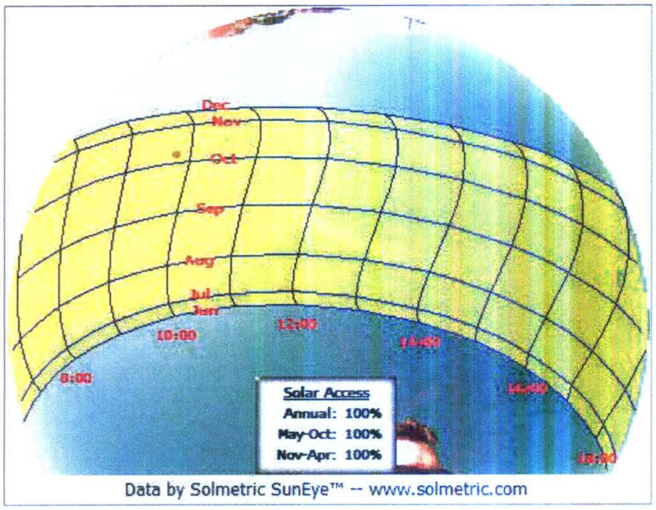
Annual	May-Oct	Nov-Apr
100%	100%	100%

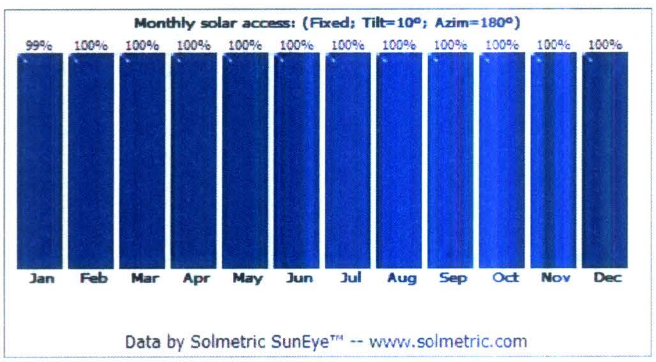


TSRF for the skyline in this session: 95%

Sky01 – 1/27/2015 10:52 – (no skyline note)

Panel Orientation: T t=10° – Az muth=180° – **Skyline Heading=175°**
Solar Access: Annua : 100% – Summer (May-Oct): 100% -- W nter (Nov-Apr): 100%
TSRF: 95% – **TOF:** 95%





Appendix B
SolarWorld Solar Glare Technical Bulletin

Technical bulletin

December 1, 2010 | Issue: 1006

Reflectivity of SolarWorld Sunmodule plus photovoltaic modules

Photovoltaic (PV) modules normally do not produce significant reflection or 'glare', as they are manufactured with glass that is specifically designed as "non-reflective." Solar glass is intended to minimize reflected light and instead allow light to pass through to the cells and be converted to useful electrical power in the module.

The spectrum of light which is visible to the human eye and can be seen as reflection is in the range of 350 nm – 700 nm wavelengths. Below is a scale of the amount of reflection produced by common items, including PV modules.

Percentage of Reflection:

80%	70%	60%	50%	40%	30%	20%	10%	0%
Snow			Vegetation		Soil			PV Module

Common Item:

Source: FAA Airport Solar Guide

For certain installations, reflection or 'glare' may be of high importance. One example, are installations near airports where reflection may need to be considered in the design of the PV system.

SolarWorld Sunmodules reflect on average 4% of the applied light as determined by ISO 9050. This reflected value was determined for the following conditions:

- 400 nm and 500 nm
- AM 1.5
- Apparatus: λ 1050

The amount of light reflected off of an installed PV module depends on the amount of sunlight hitting the surface as well as the surface reflectivity. The amount of sunlight interacting with the PV module will vary based on geographic location, time of year, cloud cover, and module orientation. The reflectivity value provided in this bulletin can be used in conjunction with these site specific factors in the FAA approval process as outlined in the "Airport Solar Guide" and in 14 CFR Part 77 "Safe, Efficient Use and Preservation of the Navigable Airspace." These documents can be found at www.faa.gov.

America's Authority on Solar

P 800-947-6521 | **P** 800-94-SOLAR | solarworld.com

SOLARWORLD

Appendix C
Solar Glare Hazard Analysis Tool Reports

Solar Glare Hazard Analysis Flight Path Report

Generated April 5, 2015, 9:45 a.m.

Flight path: 1

No glare found

g Print

Analysis & PV array parameters

Analysis name	DFSP Tampa
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	10.0
Rated power (kW)	465.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	4.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	40.6
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	27.8528231836	-82.5335879805	2.7	10.0	12.7
2	27.8528611272	-82.5323717598	4.0	10.0	14.0
3	27.8528548665	-82.5323578121	4.34	10.0	14.34
4	27.8523299153	-82.5323861361	3.59	10.0	13.59
5	27.8523299153	-82.5335592273	3.56	10.0	13.56

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	27.8344903099	-82.5356775281	6.13	50.0	No
1/4 mi	27.8317464982	-82.5383400656	0.0	125.3	No
1/2 mi	27.8290026864	-82.5410026032	0.0	194.49	No
3/4 mi	27.8262588746	-82.5436651407	0.0	263.66	No
1 mi	27.8235150628	-82.5463276783	0.0	332.83	No
1 1/4 mi	27.820771251	-82.5489902158	0.0	402.02	No
1 1/2 mi	27.8180274392	-82.5516527534	0.0	471.19	No
1 3/4 mi	27.8152836275	-82.5543152909	0.0	540.38	No
2 mi	27.8125398157	-82.5569778285	0.0	609.56	No

No glare found.

Solar Glare Hazard Analysis Flight Path Report

Generated April 5, 2015, 9:52 a.m.

Flight path: 2

No glare found

g Print

Analysis & PV array parameters

Analysis name	DFSP Tampa
PV array axis tracking	none
Orientation of array (deg)	180.0
Tilt of solar panels (deg)	10.0
Rated power (kW)	465.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	4.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	222.71
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	27.8528231836	-82.5335879805	2.7	10.0	12.7
2	27.8528611272	-82.5323717598	4.0	10.0	14.0
3	27.8528548665	-82.5323578121	4.34	10.0	14.34
4	27.8523299153	-82.5323861361	3.59	10.0	13.59
5	27.8523299153	-82.5335592273	3.56	10.0	13.56

Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	27.8636821078	-82.5079525053	11.0	50.0	No
1/4 mi	27.8663374729	-82.5051766527	10.61	119.56	No
1/2 mi	27.868992838	-82.5024008001	9.87	189.5	No
3/4 mi	27.8716482031	-82.4996249476	10.23	258.3	No
1 mi	27.8743035682	-82.496849095	6.92	330.79	No
1 1/4 mi	27.8769589333	-82.4940732425	9.32	397.57	No
1 1/2 mi	27.8796142984	-82.4912973899	6.54	469.53	No
1 3/4 mi	27.8822696635	-82.4885215373	7.7	537.56	No
2 mi	27.8849250286	-82.4857456848	8.21	606.22	No

No glare found.

Appendix D
PV Watts Results

NREL

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)
January	3.82	43,739	4,466
February	4.60	46,948	4,793
March	5.43	60,563	6,183
April	6.59	69,168	7,062
May	6.33	68,401	6,984
June	6.07	62,864	6,418
July	5.87	62,604	6,392
August	5.87	62,890	6,421
September	5.17	53,886	5,502
October	4.88	53,229	5,435
November	4.11	44,296	4,523
December	3.49	39,773	4,061
Annual	5.19	668,361	$ 68,240

Location and Station Identification

Requested Location	macdill afb tampa fl
Weather Data Source	(TMY2) TAMPA, FL 81 mi
Latitude	27.97° N
Longitude	82.53° W

PV System Specifications *(Commercial)*

DC System Size	465 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	10°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.10 $/kWh
Initial Cost	3.00 $/Wdc
Cost of Electricity Generated by System	0.13 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)
January	3.82	117,338	11,980
February	4.60	125,945	12,859
March	5.43	162,470	16,588
April	6.59	185,554	18,945
May	6.33	183,498	18,735
June	6.07	168,642	17,218
July	5.87	167,944	17,147
August	5.87	168,712	17,225
September	5.17	144,559	14,760
October	4.88	142,797	14,580
November	4.11	118,833	12,133
December	3.49	106,699	10,894
Annual	5.19	1,792,991	$ 183,064

Location and Station Identification

Requested Location	macdill afb tampa fl
Weather Data Source	(TMY2) TAMPA, FL 81 mi
Latitude	27.97° N
Longitude	82.53° W

PV System Specifications *(Commercial)*

DC System Size	1247.44 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	10°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.10 $/kWh
Initial Cost	3.00 $/Wdc
Cost of Electricity Generated by System	0.13 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

Appendix E
Electric One-Line Diagrams

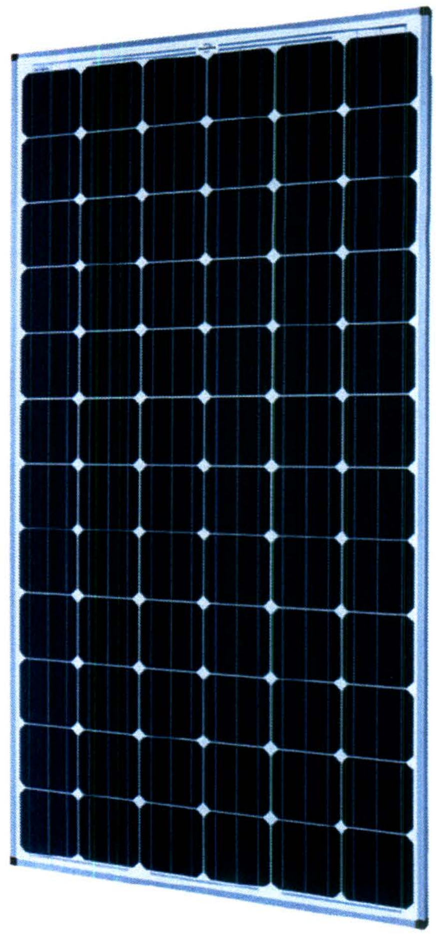
[redacted]

[redacted]

Appendix F
System Components

Sunmodule® Pro-Series XL
SW 310-315 MONO

SOLARWORLD
REAL VALUE



TUV Power controlled:
Lowest measuring tolerance in industry

Every component is tested to meet
3 times IEC requirements

Designed to withstand heavy
accumulations of snow and ice

Sunmodule Plus:
Positive performance tolerance

25-year linear performance warranty
and 10-year product warranty

World-class quality
Fully-automated production lines and seamless monitoring of the process and material ensure the quality that the company sets as its benchmark for its sites worldwide.

SolarWorld Plus-Sorting
Plus-Sorting guarantees highest system efficiency. SolarWorld only delivers modules that have greater than or equal to the nameplate rated power.

25-year linear performance guarantee and extension of product warranty to 10 years
SolarWorld guarantees a maximum performance digression of 0.7% p.a. in the course of 25 years, a significant added value compared to the two-phase warranties common in the industry, along with our industry-first 10-year product warranty.*

*in accordance with the applicable SolarWorld Limited Warranty at purchase.
www.solarworld.com/warranty

Sunmodule® Pro-Series XL
SW 310-315 MONO

SOLARWORLD REAL VALUE

PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

		SW 310	SW315
Maximum power	P_{max}	310 Wp	315 Wp
Open circuit voltage	V_{oc}	45.8 V	45.9 V
Maximum power point voltage	V_{mpp}	36.6 V	36.8 V
Short circuit current	I_{sc}	9.09 A	9.16 A
Maximum power point current	I_{mpp}	8.56 A	8.63 A
Module efficiency	η_m	15.77 %	16.03 %

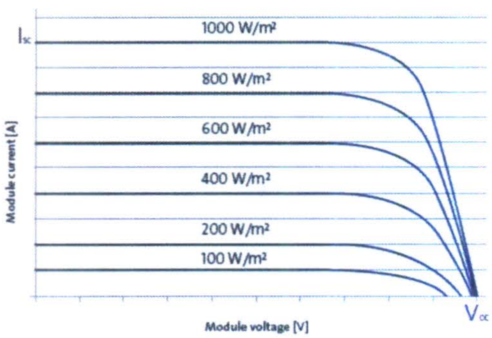
Measuring tolerance (P_{max}) traceable to TUV Rheinland: +/-2% (TUV Power controlled)

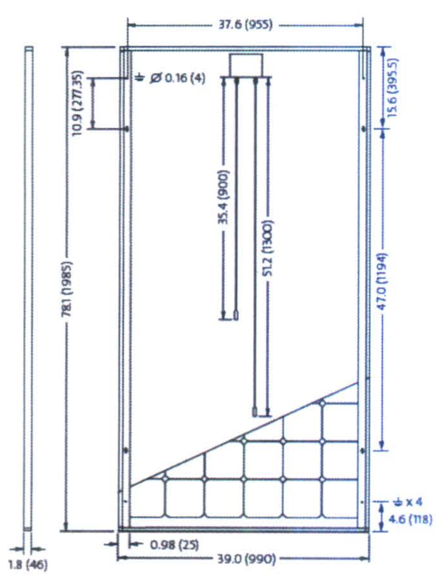
*STC: 1000W/m², 25°C, AM 1.5

PERFORMANCE AT 800 W/M², NOCT, AM 1.5

		SW 310	SW315
Maximum power	P_{max}	234 Wp	237 Wp
Open circuit voltage	V_{oc}	42.3 V	42.4 V
Maximum power point voltage	V_{mpp}	33.8 V	34.0 V
Short circuit current	I_{sc}	7.41 A	7.46 A
Maximum power point current	I_{mpp}	6.92 A	6.97 A

Minor reduction in efficiency under partial load conditions at 25° C: at 200 W/m², 100% (+/-2%) of the STC efficiency (1000 W/m²) is achieved.





DIMENSIONS

Length	78.15 in (1985 mm)
Width	38.98 in (990 mm)
Height	1.81 in (46 mm)
Frame	Clear anodized aluminum
Weight	49.6 lbs (22.5 kg)

COMPONENT MATERIALS

Cells per module	72
Cell type	Mono crystalline
Cell dimensions	156 mm x 156 mm
Front	3.2 mm Tempered glass (EN 12150)

THERMAL CHARACTERISTICS

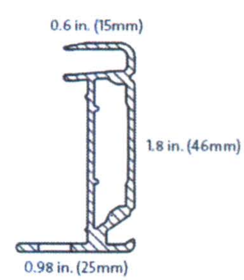
NOCT	46°C
TCI_{sc}	0.042 %/K
TCV_{oc}	-0.304 %/K
TCP_{mpp}	-0.43 %/K

ADDITIONAL DATA

Power sorting	-0 Wp/+5 Wp
J-Box	IP65
Connector	KSK4
Module fire performance	(UL 1703) Type 1

PARAMETERS FOR OPTIMAL SYSTEM INTEGRATION

Maximum system voltage SC II / NEC	1000 V
Maximum reverse current	25 A
Load / dynamic load	113/64 psf (5.4/2.4 kN/m²)
Number of bypass diodes	3
Operating range	-40° C to +85° C



All units provided are imperial. SI units provided in parentheses.
SolarWorld AG reserves the right to make specification changes without notice.

SW-01-6053US 10-2014

Appendix G
Financial Analysis Information

DFSP Tampa
Solar PV System Cost Estimate
System size: 465 KW

Direct Costs

Materials	**Quantity**	**Unit Price**	**Unit**		**Total**
Modules	1500	$260.00	Module		$390,000
Racking	1500	$75.00	Module		$112,500
Inverters	1	$110,000.00	inverter		$110,000
Data Acquistion	1	$4,500.00			$4,500
Balance of System	1	$175,000.00	Each		$175,000
			Subtotal		**$792,000**
Labor					
Installation Labor	465000	$0.30	per watt		$139,500
Overhead and Profit				20%	$186,300
		Total Direct Costs			**$1,117,800**

Indirect Costs

		% of Direct Costs	
Engineering		10	$111,780
Environmental Studies		4	$44,712
Commissioning		5	$55,890
	Total Indirect Costs		**$156,492**
	Total Installed Costs		**$1,274,292**
	Costs per Watt		**$2.74**

DFSP Tampa
Solar PV System Cost Estimate
System size: 1,247 KW

Direct Costs

Materials	**Quantity**	**Unit Price**	**Unit**	**Total**
Modules	4024	$260.00	Module	$1,046,240
Racking	4024	$75.00	Module	$301,800
Inverters	1	$275,000.00	inverter	$275,000
Data Acquistion	1	$4,500.00		$4,500
Balance of System	1	$375,000.00	Each	$375,000
			Subtotal	**$2,002,540**
Labor				
Installation Labor	1247440	$0.25	per watt	$311,860
Overhead and Profit			22%	$509,168
		Total Direct Costs		**$2,823,568**

Indirect Costs

	% of Direct Costs	
Engineering	8	$225,885
Environmental Studies	2	$56,471
Commissioning	2	$56,471
	Total Indirect Costs	**$282,357**
	Total Installed Costs	**$3,105,925**
	Costs per Watt	**$2.49**

O&M Costs

Task	**Quantity**	**Unit Price**	**Unit**	**Total**
O&M	1247	$7.00	KW	$8,729

NIST BLCC 5.3-13: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case Existing Electric Costs

Alternative Solar System

General Information

File Name:	C:\Users\dmaggioli\Desktop\don folder\projects\DLA solar feasibility\BLCC\465 kw.xml
Date of Study:	Thu Apr 09 19:47:15 EDT 2015
Project Name:	Phase 1 - 465 kW
Project Location:	Florida
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Alares
Base Date:	April 1, 2015
Service Date:	April 1, 2015
Study Period:	25 years 0 months(April 1, 2015 through March 31, 2040)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$1,274,292	-$1,274,292
Future Costs:			
Energy Consumption Costs	$1,234,931	$0	$1,234,931
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$80,975	-$80,975
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	-$121,724	$121,724
Subtotal (for Future Cost Items)	$1,234,931	-$40,749	$1,275,680
Total PV Life-Cycle Cost	$1,234,931	$1,233,543	$1,388

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$1,153,956
- Increased Total Investment	$1,152,568
Net Savings	$1,388

Savings-to-Investment Ratio (SIR)

SIR = 1.00

Adjusted Internal Rate of Return

AIRR = 3.00%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 20

Discounted Payback occurs in year 25

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	Base Case	Alternative	Savings	Savings
Electricity	668,361.0 kWh	0.0 kWh	668,361.0 kWh	16,708,567.5 kWh

Energy Savings Summary (in MBtu)

Energy	-----Average	Annual	Consumption-----	Life-Cycle
Type	Base Case	Alternative	Savings	Savings
Electricity	2,280.5 MBtu	0.0 MBtu	2,280.5 MBtu	57,012.0 MBtu

Emissions Reduction Summary

Energy	-----Average	Annual	Emissions-----	Life-Cycle
Type	Base Case	Alternative	Reduction	Reduction
Electricity				
CO_2	436,923.56 kg	0.00 kg	436,923.56 kg	10,922,789.90 kg
SO_2	2,201.64 kg	0.00 kg	2,201.64 kg	55,039.53 kg
NO_x	652.07 kg	0.00 kg	652.07 kg	16,301.32 kg
Total:				
CO_2	436,923.56 kg	0.00 kg	436,923.56 kg	10,922,789.90 kg
SO_2	2,201.64 kg	0.00 kg	2,201.64 kg	55,039.53 kg
NO_x	652.07 kg	0.00 kg	652.07 kg	16,301.32 kg

NIST BLCC 5.3-13: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case Existing Electric Costs

Alternative Solar System

General Information

File Name:	C:\Users\dmaggioli\Desktop\don folder\projects\DLA solar feasibility\BLCC\1247 kw.xml
Date of Study:	Thu Apr 09 19:52:38 EDT 2015
Project Name:	Phase 2 - 1247 kW
Project Location:	Florida
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Alares
Base Date:	April 1, 2015
Service Date:	April 1, 2015
Study Period:	25 years 0 months(April 1, 2015 through March 31, 2040)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$3,105,925	-$3,105,925
Future Costs:			
Energy Consumption Costs	$3,312,910	$0	$3,312,910
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$152,007	-$152,007
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	-$296,687	$296,687
Subtotal (for Future Cost Items)	$3,312,910	-$144,680	$3,457,591
Total PV Life-Cycle Cost	$3,312,910	$2,961,245	$351,666

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$3,160,903
- Increased Total Investment	$2,809,238
Net Savings	$351,666

Savings-to-Investment Ratio (SIR)

SIR = 1.13

Adjusted Internal Rate of Return

AIRR = 3.49%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 18

Discounted Payback occurs in year 25

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	1,792,991.0 kWh	0.0 kWh	1,792,991.0 kWh	44,823,547.9 kWh

Energy Savings Summary (in MBtu)

Energy Type	-----Average Base Case	Annual Alternative	Consumption----- Savings	Life-Cycle Savings
Electricity	6,117.9 MBtu	0.0 MBtu	6,117.9 MBtu	152,944.3 MBtu

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Electricity				
CO_2	1,172,121.07 kg	0.00 kg	1,172,121.07 kg	29,302,224.37 kg
SO_2	5,906.27 kg	0.00 kg	5,906.27 kg	147,652.81 kg
NO_x	1,749.29 kg	0.00 kg	1,749.29 kg	43,731.05 kg
Total:				
CO_2	1,172,121.07 kg	0.00 kg	1,172,121.07 kg	29,302,224.37 kg
SO_2	5,906.27 kg	0.00 kg	5,906.27 kg	147,652.81 kg
NO_x	1,749.29 kg	0.00 kg	1,749.29 kg	43,731.05 kg

Appendix H
Sample Interconnection Agreement