Solar Feasibility Report
Michael E. DeBakey VA Medical Center & Houston VA Regional Offices

Purchase Order Number: VA-701-10-RQ-0198

Prepared for:
The Department of Veterans Affairs

June 2, 2011

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BPA Contract Number: VA776-BP-0018
GSA Contract Number: GS-10F-0089S

TABLE OF CONTENTS

Introduction

Gabel Associates (Gabel) was contracted by the Department of Veterans Affairs (VA) to provide a feasibility study for solar photovoltaic (PV) and solar thermal energy projects at the Michael E. DeBakey VA Medical Center and the Houston Regional Offfices located in Houston, Texas and to recommend next steps for project development.

This study takes into consideration information collected during on-site visits, data provided by the Contracting Officer's Technical Representative (COTR), and other technical and economic considerations specific to the site and the Texas energy and incentive marketplace. The report provides technical and financial analysis regarding the feasibility of a solar system. This report will recommend whether a solution appears feasible for the site, will assess the potential for alternative financing approaches and will recommend "next steps" in project development, if appropriate.

Specifically, the report contains the following sections:

1. Summary of Findings and Recommendations

2. Technical and Site Review
   a) Overview of Photovoltaic (PV) Systems and Solar Thermal Systems
   b) Types of PV Systems and Solar Thermal Systems
   c) Site Visit Review
   d) Panel Location and Structural Roof Analysis
   e) Solar PV System Sizing
   f) Solar Thermal System Sizing
   g) Electrical System and Interconnect Point
   h) Calculation of Solar Production
   i) Data Collection

3. Financial Analysis
   a) Economic Feasibility
   b) Economic Benefits Overview
   c) Summary of Financial Results
   d) Calculation of Annual Energy Savings
   e) Estimated Project Costs

4. Financing Options for Solar Projects

5. Design and Construction Requirements
   a) Logistical, Site Related and Environmental Issues
   b) Preliminary Project Timeline
   c) Site Work and Preparation

6. Environmental Benefits

7. Conclusion

1. Summary of Findings and Recommendations

Gabel evaluated the Department of Veterans Affairs (VA) site at the Michael E. DeBakey VAMC and Houston Regional Offices, 6900 Almeda Rd., Houston, Texas 71101.

In order to determine the feasibility of a PV system and a solar thermal system, Gabel conducted a site inspection of the buildings and its operations, including interviews with facility personnel and undertook detailed technical and financial analysis. The results of this review include the following key findings:

- A conceptual design and layout of the proposed PV system consists of roof-mounted PV arrays only. Pursuant to direction from VA personnel, no parking areas were considered at this stage. The structures considered include Buildings 100 (Main Building), 103 (Engineering Shops), 104 (Chiller Building), 108 (Rec Center/Gym), 110 (Substance Abuse) and VA Regional Offices. The entire system will have approximately 4,399 panels totaling 1,033 kW and an estimated 1,521,316 kWh of annual production.

- A conceptual design of a thermal solar system to heat water for a therapeutic pool was considered. The system would consist of 81 collectors mounted on the roof of building 100 to substitute some of the steam currently used for pool heating. The proposed system could save approximately 1143 MMBtu's of natural gas annually.

- An economic analysis, inclusive of estimates of savings and capital and operating costs, as well as additional funding of $4,000,000 was developed for a VAMC-owned PV solar and solar thermal system. The results of the analysis indicate net present value savings of $1,200,964 over the life of the project and an internal rate of return of 6%. The analysis includes conservative estimates of project installation and maintenance costs, electric production, electric rates, and rebates.

- Solar is a positive investment for the property only with sufficient support from additional funding. In the absence of such funding, the project is not economically feasible;

- With adequate additional funding, VA should pursue a "self-own" structure in which VA owns the system and captures its benefits. If the VA cannot self fund, or desires to transfer operation, maintenance and market risk to a third party, an alternative to consider, if permissible, is a power purchase agreement/lease approach; and,

- If adequate additional financing can be arranged, VA should move to procurement for the purpose of selecting a vendor.

The chart below summarizes the key elements of the roof mounted solar and carport canopy project, with project economics based on receipt of sufficient additional funding.

Metric	Value
System Description	1,033.77 (PV); 81 panels (thermal)
Total Installation Cost	$5,522,575
Nominal Electric Cost Savings Over 20 yr	$3,028,231
NPV Electric Cost Savings Over 20 yr	$2,018,653
Nominal Thermal Savings Over 20 yr	$261,575
NPV Thermal Savings Over 20 yr	$174,368
Internal Rate of Return	6%
Nominal Life Cycle Costs	$1,200,964
NPV Life Cycle Costs	$288,601
Electric Generation Estimate Year 1	1,521,316 kWh
Electric Generation Estimate Total (20 Years)	29,023,521 kWh
Thermal Generation Estimate Year 1	1,144 MMBTU
Thermal Generation Estimate Total (20 Years)	21,820 MMBTU
Financing Method	Combination of self and additional funding
Amount of Funding	Additional Funding=$4,000,000

2. Technical and Site Review

a) Overview of Photovoltaic (PV) and Solar Hot Water Systems

Photovoltaic Overview

PV cells convert energy from sunlight directly into electrical energy through the use of semi conductors, diodes and collection grids. PV cells are then linked together in a single frame, or module, to become a solar panel. This conversion occurs without any moving parts and without generating any noise or pollution.

Rooftops, carports and ground-mounted arrays are common mounting locations for solar PV projects. To be effective, solar panels must be mounted in a non-shaded location. The angle of inclination of the PV panels, the amount of sunlight available, the orientation of the panels, the amount of physical space available and the efficiency of the individual panels are all factors affecting the amount of electricity that is generated.

Under full sun, each panel produces direct current (dc) electricity at about 12% to 18% efficiency, although this efficiency depends on the type of collector, the tilt and azimuth of the collector, the temperature and the level of sunlight. An inverter then converts the dc to alternating current (ac) at the desired voltage and phasing compatible with building and the utility power systems. The balance of the system consists of conductors/conduit, switches, disconnects and fuses.

PV system installation typically includes the installation of a remote web-based monitoring system that will display real-time data such as instantaneous kWh generation, cumulative kWh generation, dollars saved, on-going environmental savings associated with the system and current weather data. In addition to web access, this information can also be displayed on a flat panel monitor that can be installed at a location selected by the VA.

The most common type of solar panels are crystalline panels, which are generally 39 inches high and 65 inches wide. They are linked in strings, and are covered by a protective glass panel. A new emerging technology is that of "thin film" solar panels, which are lightweight and durable as compared to crystalline panels. Per square foot, thin film panels are less efficient than their crystalline counterpart, while also being fairly more expensive as a product of their age and development. The advantage to crystalline panels is found in their light-weight, easy to install design and the productivity on large scale installations.

Solar Thermal Overview

Unlike PV systems, solar thermal systems utilize solar collectors and a storage tank. A pump is used to circulate heat-transfer fluid (water or glycol) to and from the panels to extract heat which can be used in the building for space heating, pool heating or domestic hot water heating.

Solar thermal systems can be 46% to 74% efficient which is much higher than that of PV systems. The downside of a solar thermal system is that the only time that the system is effective is when the heat is actually being used unless large storage tanks are installed, whereas a PV system will generate electricity which can be net-metered effectively storing the savings for later use. However, applications such as swimming and rehabilitation pools do not require large storage tanks, as they immediately use the extracted energy to compensate for heat loss.

b) Types of PV and Solar Thermal Systems

i. Roof mounted PV

The most common roof mounted system is referred to as a "fixed tilt" system typically mounted to a metal rack that is fixed at a specific angle (tilt). The tilt is determined by considering the geographic location, total targeted kWh production, seasonal electricity requirements and weather conditions such as wind and snow. Experience with many installations has shown that roof-mounted PV systems are typically installed at a tilt of 10 degrees or lower, thus minimizing issues with wind while maximizing total system size. The azimuth (or orientation of the panels) illustrates the direction in which the panels will be facing (180-degrees is due south). The type of PV panels and equipment used to mount the system are determined based on wind conditions and structural integrity of the roof, determined during the design phase of the project. In general, penetration/tie-down systems, non-penetrating ballasted type systems, or a combination of the two can be considered.

ii. Canopy System PV

In order to mount PV panels over parking spaces, a "carport" type construction using steel support members is needed. Experience has shown that the supporting structures do not interfere with the flow of traffic or with snow plowing or de-icing operations. Each parking space typically accommodates four to six PV panels. The type of PV panels, equipment used to support the system, and any alterations or additions to the parking lot lighting are determined during the design phase of the project.

iii. Ground Mounted PV

Ground mounted systems are designed to stack three or more panels together in a rack and position them with a 25-degree tilt. Spacing between racks is approximately 10 feet. Ground mount designs typically require concrete and steel support posts or "screw-type" helical anchors to withstand wind loads and other factors. Finished installations result in racks over 5 feet in height at the tallest point.

iv. Solar Thermal Systems

The two main types of Solar Thermal systems are evacuated tube and flat plate. Typically flat plate collectors are more efficient at 61% to 74% while evacuated tube collectors are 46% to 57% efficient. Evacuated tube collectors can produce higher temperature water than flat plate collectors and may be necessary depending on the application. These systems can be set up with either drain back systems or an anti-freeze solution to prevent damage to the system from freezing. Both systems require a storage tank to hold the heat absorbed by the system. Typically solar thermal systems are mounted on roofs.

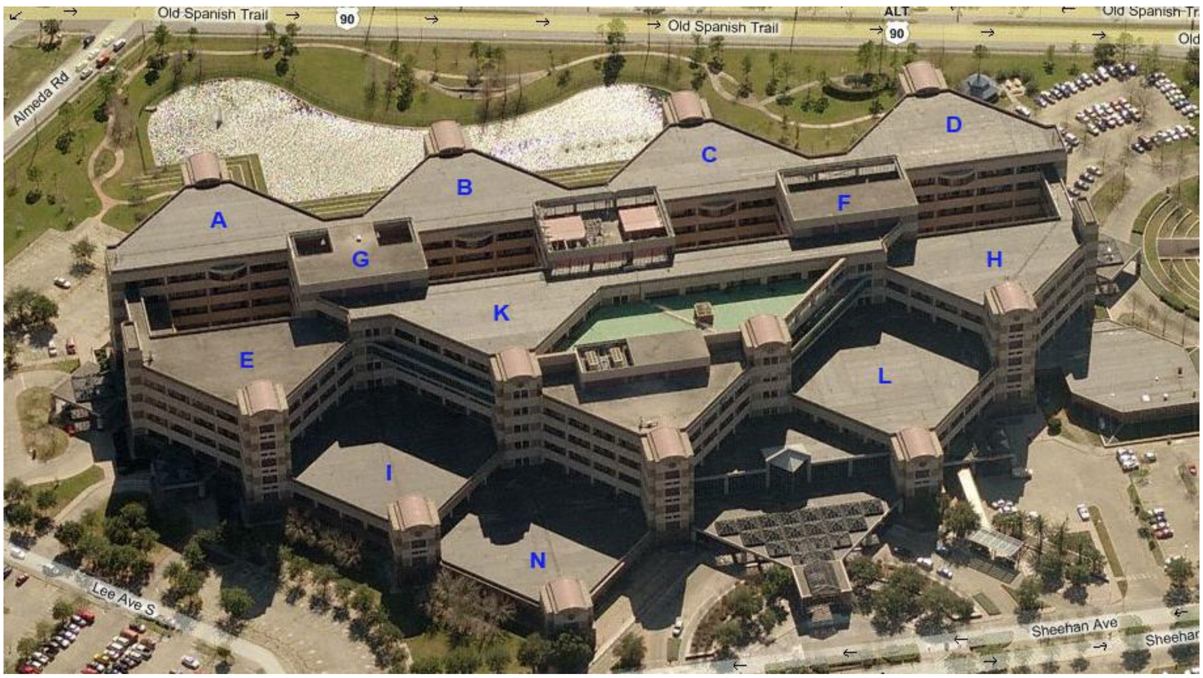
c) Site Visit Review

Gabel conducted a site walkthrough of the facilities on April 12, 2011. The purpose of the site walkthrough was to assess roof availability and orientation, potential carport canopy locations, access to electrical interconnection points, access to mechanical rooms that have domestic hot water units, and positioning of the solar panels relative to the movement and track of the sun. The walkthrough consisted of an inspection of the site's overall electrical and hot water systems, along with an inspection of the electrical installations throughout the campus. Additionally, Gabel reviewed the roof of Buildings 100, 103, 104, 108, 110 and VA Regional Offices for potential to accommodate solar PV electric systems and solar thermal systems. Additionally, parking lots were visually inspected; however, VA personnel asked that they not be included in the feasibility study.

d) Panel Location and Structural Roof Analysis

The roofs of buildings 100, 102, 103, 104, 108, 110 and VA Regional Offices were visually inspected and evaluated for PV system installation. Other areas such as building 105 (boiler room) and 109 (Research) were excluded due to the presence of large number of obstructions such as exhaust stacks, exhaust fans, pipes, or HVAC equipment. A more detailed explanation of each roof is provided below.

The roof of Building 100 consists of numerous incongruent roof surfaces of varying construction, size, and height. The built-up tar roof is about 1 year old, in very good condition, surrounded by a 30” parapet wall and is mostly free from obstructions such as HVAC equipment, vents, and drains. The architecture of the building causes shading on lower roof surfaces; therefore, only higher elevation surfaces can be fully utilized for solar. These areas are labeled as A, B, C, D, F, and G (see picture below). Areas labeled as E, H, K and L may be partially utilized, while all other areas were excluded from the analysis due to significant shading concerns.



According to VA personnel, building maintenance (window cleaning) requires that an area of approximately 6-8 feet from the parapet wall be free from solar panels or other electrical equipment. Based on all these considerations, the total size of a PV system that could be installed on this building is estimated at 716 kW.

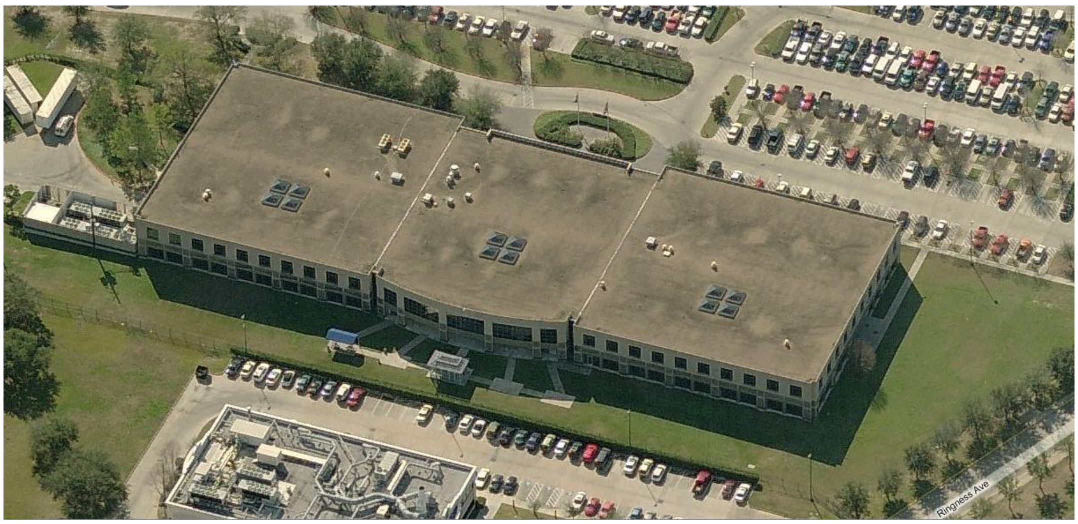
The engineering complex is located in the south-west area of this property and consists of several buildings (101-105), a waste disposal area, two large water storage tanks and other mechanical and electrical equipment. The roofs are approximately 1 year old and in very good condition. Buildings considered for a PV installation include buildings 102, 103 and 104. Buildings 102 and 103 are surrounded with a parapet wall, while all of the building roofs have a number of exhaust fans and ventilation pipes. The system size of these buildings was reduced in order to accommodate maintenance on exhaust fans. In addition to roof areas, it is also recommended to utilize areas above road pass-through’s located in between buildings 102, 103 and 104. This can be achieved by adding a light roof construction to support the panels, similar to those used for parking canopies or garages. The total size of a PV system installed on all of these areas is estimated at 193.4 kW.

The roof of Buildings 108 is a two-level, flat roof that is approximately 10-11 years into a 25 year warrantee. According to VA personnel, only the upper section can be used for PV solar installation as the lower section may be affected by an addition scheduled to be built in the near future. Gabel typically does not recommend installing solar panels if the existing roofs are older than 10 years, however, in this case the roof appears to be in good condition and VA may elect to install a PV system on the existing surface. Solar panels are warranted for 25 years, and often can operate 30 years and beyond. The total size of a PV system that could be installed on building 108 is estimated to be 59.5 kW.

Building 110 consists of four interconnected structures. Roofs of only two of these structures were considered in our analysis as other areas were covered by HVAC equipment, exhaust fans and vent pipes. The roofs are 11 years old (installed in 2000) and in similar condition to building 108. The total size of a PV system that can be installed here is estimated at 64.6 kW.

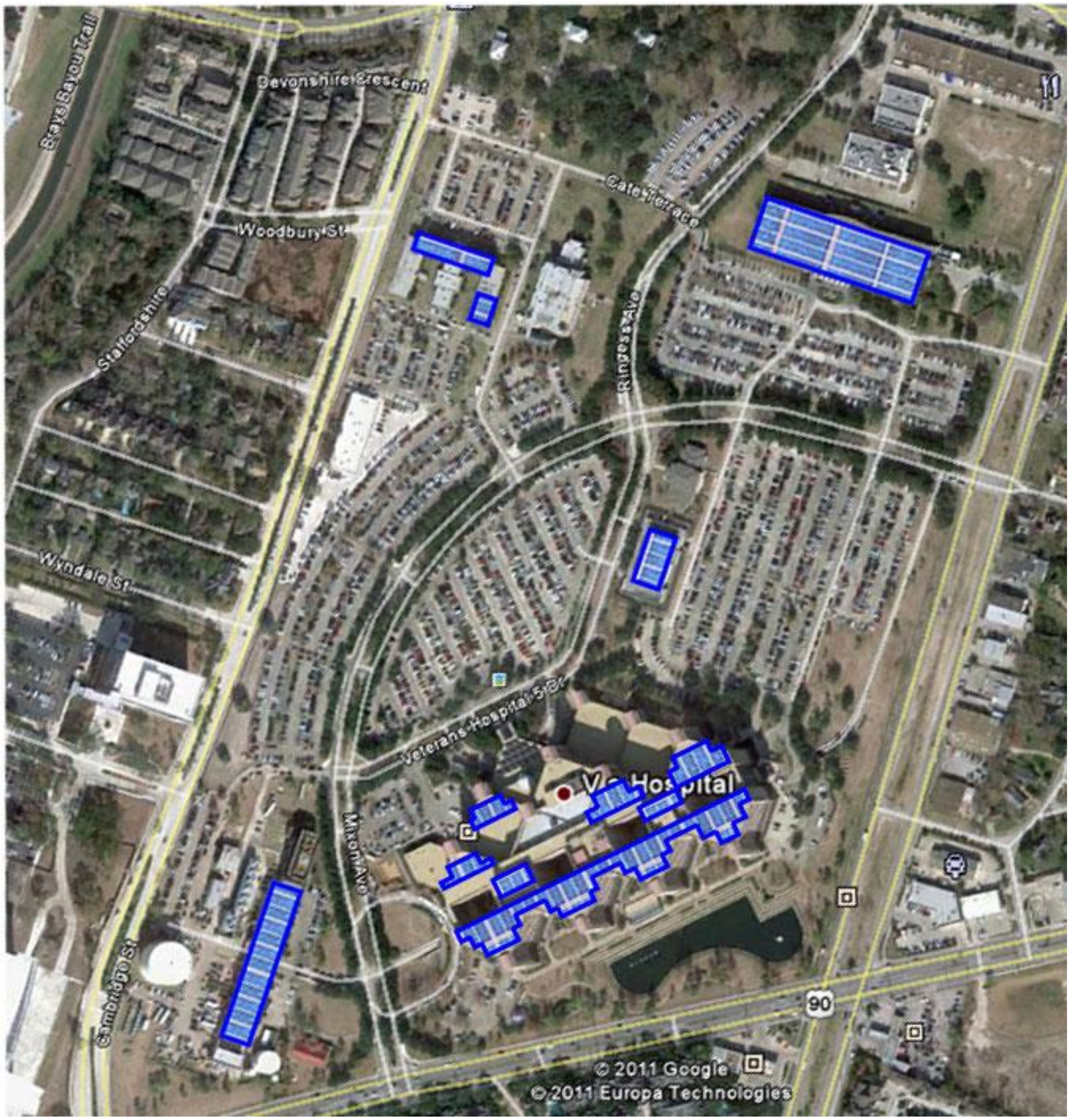
Finally, the roof of the VA Regional offices building was also considered for a PV system installation; however it could not be surveyed during our site visit due to access limitations. Based on the information obtained from VA personnel, the roof is original to the building and about 14 years old (installed in 1997). Review of satellite images revealed that the roof is mostly free from obstructions except for 12 skylights, several HVAC units and a number of exhaust fans. Due to the age of the roof of the VA Regional Offices, a PV Solar system is not recommended at this time. Should the VA elect to replace the roof of the Regional office, the total potential PV system size installed on this roof is estimated to be 396 kW.

Gabel has found it to be good practice in the solar market not to construct solar systems on roofs over 10 years of age. While a roof might last another 15-20 years, solar panels are warranted for 25 years, and often can operate 30 years and beyond. Should the roof have to be replaced at any point while the solar system is active, it will have to be removed, resulting in significant damage to the long-term economics of the project.



The below table summarizes the potential system sizes of each of the facilities recommended in this report:

Location	**Estimated PV system size (kW dc)**
Building 100	716.3
Engineering Complex (Buildings 102, 103 and 104)	193.4
Building 108	59.5
Building 110	64.6
Total	**1033.8**



Please note that system location and sizing is preliminary in nature and subject to change. Actual sizing and placement will be determined during the design phase.

The sizing and feasibility of the solar systems are also subject to conducting final due diligence on roof condition, wind load testing and structural stability.

e) Solar PV System Sizing

Gabel investigated the installation of a south facing, non-tracking, fixed tilt system for roof-mounted systems. The calculations were based on a poly-crystalline panel such as the SharpNU-235 (rated at 230 watts dc) utilizing a 5-degree tilt. The azimuth varies based on building orientation. For systems located on Building 100 the azimuth used was 155 degrees and for all other locations an azimuth of 198 degrees was assumed.

The preliminary analysis shows that a total of 1,033.8 kW (dc) PV array consisting of approximately 4,399 panels can be installed. Factors taken into consideration include proximity to the potential electrical interconnection points, roof obstructions, and potential shading of the PV panels. The previous page provides a preliminary overlay of the areas identified for placement of solar panels.

f) Solar Thermal System Sizing

Gabel investigated the installation of a solar thermal system on Building 100 that can be used to heat water in two 25,000-gallon therapeutic pools. According to interviews with VA personnel, the pools are currently heated by steam supplied by VAMC boilers via a steam-to-hot water heat exchanger. Pool water temperature is kept constant throughout the year at 92 degrees Fahrenheit and the ambient air in the room is at approximately 80-deg F.

In order to supplement this system with thermal solar, solar collectors and a large storage tank with integral heat exchanger coils would have to be installed. The collectors would be placed on the building roof, while the storage tank would be installed in the mechanical room located below the pool area. A closed-loop piping system would run between the collectors and the hot water storage tank, where pool water would be pre-heated. The pre-heated water would be supplied to the steam heat exchanger and temperature controls would be installed to reduce steam flow based on the temperature of the solar hot water supply tank. Based on the potential for winter temperatures to drop below freezing, it is possible that an anti-freeze agent or a drain back system would be required as part of the solar hot water system and it is recommended that this be considered during final design of the system.

Based on the pool dimensions and temperature requirements, Gabel estimated the current energy required to heat the pools with steam at approximately 1,830 million Btu per year. However, it is assumed that only about 50% of this energy (915 MMBtu) could be theoretically served by a solar system.

To meet this demand, Gabel considered installation of a number of 4’ by 8’ flat plate collectors, such as the SolarHot S-SC-126P32. Based on an average heat gain of 31,000 Btu/day/panel, an array of 80 flat-plate collectors would be required to supply 915 MMBtu, offsetting the consumption of steam.

Please not that system location and sizing is preliminary in nature and subject to change. Actual sizing and placement will be determined during design phase.

The sizing and feasibility of the solar systems are also subject to conducting final due diligence on roof condition, wind load testing and structural stability.

g) Electrical System and Interconnect Point

The facility is purchasing primary power from the utility company at 12,470 volts. The primary voltage is distributed underground throughout the campus to the various buildings and stepped down to 480/277 volts through customer-owned transformers. Metering is performed on the primary side of the switchgear.

During the field survey, it was found that there is adequate electrical service at the buildings to support the proposed PV systems. In Building 100, there are 14 substations as listed in the following table:

Location / Area	Transformer 12470 V – 480/277 V	Substation amperage
USS-Laundry	500 kVA	800 A
USS – 2 Area "D"	1000 kVA	1600 A
USS – 3 Area "C"	750 kVA	1200 A
USS – 4 Area "G"	1500 kVA	2500 A
USS – 5 Area "F"	2000 kVA	3000 A
USS – 6 Area "B"	750 kVA	1200 A
USS – 7 Area "A"	1000 kVA	1600 A
USS – 8 Area "I"	750 kVA	1200 A
USS – 9 Area "H"	1500 kVA	2500 A
USS – 10 Area "L"	1500 kVA	2500 A
USS – 11 Area "K"	1500 kVA	2500 A
USS – 12 Area "N"	300 kVA	600 A
USS – 13 Area "J"	300 kVA	600 A
USS – 14 Area "E"	750 kVA	1200 A

Based on a total size of the PV system estimated at 716 kW, a load side connection would be permitted at this building under National Electric Code (NEC) rules. The connection would have to be made to multiple points so none of the substations are overloaded. The final number of the interconnection points will depend on the total PV system size, and type and size of the solar inverters.

Building 104 has a 15 kV service that is then stepped down to either 4160 volts (chillers) or 480/277 V (boiler room, pump motors and general electrical load). There are multiple points where the proposed PV system (193.4 kW) can be tied to the grid and they may include the main 12470/480V transformer low voltage side, a 250-amp distribution panel in building 103; a 200-amp distribution panel for building 104 or one of the pad-mounted transformers located outside of the building.

Building 108 electrical service consists of a 480V feed that is first stepped down to 208/120 V service using a 225-kVA transformer and then distributed to the building. The distribution panel is rated at 800A at 208/120V. As per NEC rules, the maximum size of a PV system that can be connected at this panel (load side connection) is estimated at approximately 33 kW. Since the size of the proposed system for this building is 59.5 kW, a line side connection would have to be made, possibly at the high side voltage of the 480/208 V transformer. A similar connection is also anticipated for the building 110 since the electrical service is similar to building 108 and the total size of the PV system is estimated at 64.6 kW dc.

h) Calculation of System Production

An industry accepted software package, the National Renewable Energy Laboratory's (NREL) PVWatts v1, was used to calculate projected annual electrical production of the crystalline silicon PV system in its first year at this location. The following table outlines the parameters used in the calculations:

Table 1: PV Watts parameters

Location	Tilt (deg)	Azimuth (deg)	De-rate Factor
Building 100	5	155	.77
Building 102	5	198	.77
Building 103	5	198	.77
Building 104	5	198	.77
Building 108	5	198	.77
Building 110	5	198	.77

Table 1 analyzes the roof-mounted solar system based on the assumptions above in order to display combined monthly electrical outputs of all roof systems. Table 2 analyzes the solar thermal system that could be installed on the roof of building 100 and displays its estimated monthly energy savings.

Table 1: Roof-Mounted PV System Output Calculations – Year 1 (1,033.77 kW dc)

Month	Solar Radiation (kWh/m2/day)	AC Energy (kWh)
1	2.9	85,890
2	3.51	93,926
3	4.41	129,070
4	4.99	139,628
5	5.63	159,466

6	6.1	164,382
7	5.9	162,224
8	5.58	154,784
9	5.04	136,876
10	4.43	125,746
11	3.4	94,106
12	2.59	75,220
Year	4.54	1,521,316

Table 2: Roof-Mounted Solar Thermal System Output Calculations – Year 1 (81 Panels)

Month	BTU Output (MMBTU)
1	64.57
2	70.26
3	96.07
4	103.41
5	117.51
6	120.53
7	118.35
8	112.36
9	98.86
10	90.37
11	67.29
12	53.52
Year	1113.09

i) Data Collection

Site personnel provided a full year of historical electrical usage data. Total site electrical consumption is 50,254,970 kWh. A chart of monthly electrical usage data and cost is provided below:

Year	Month	Consumption kWh	Cost $	$/kWh
2010	**Mar**	3,661,411	$ 407,887.38	0.111
2010	**Apr**	4,308,291	$ 368,178.67	0.085
2010	**May**	3,774,701	$ 446,991.82	0.118
2010	**Jun**	4,746,846	$ 494,759.03	0.104
2010	**Jul**	5,366,826	$ 490,150.13	0.091
2010	**Aug**	5,461,380	$ 509,494.00	0.093
2010	**Sep**	3,923,431	$ 487,145.46	0.124
2010	**Oct**	2,508,451	$ 406,095.01	0.162
2010	**Nov**	4,254,867	$ 411,646.75	0.097
2010	**Dec**	4,381,176	$ 415,190.58	0.095
2011	**Jan**	3,799,646	$ 366,577.05	0.096
2011	**Feb**	4,067,945	$ 392,917.90	0.097
	Total	50,254,970	$ 5,197,033.78	0.103

Gabel is using a conservative 2% electricity escalation rate to determine the electricity benefits of this project. This rate was determined using the Annual Energy Outlook published by the U.S. Energy Information Administration. We also find it to be conservative based on the standard VA electricity escalation rate of 3%.

Site personnel provided a full year of historical gas usage data. Total site gas consumption is dekatherms. A chart of monthly gas usage data and cost is provided below:

Fiscal Year	Month	Usage DekaTherms	Cost $	$/Dtherm
2010	**October**	18,000	$167,714.00	9.32
2010	**November**	19,034	$167,736.00	8.81
2010	**December**	25,191	$223,229.00	8.86
2010	**January**	26,142	$234,801.00	8.98
2010	**February**	26,005	$231,881.00	8.92
2010	**March**	24,347	$207,378.00	8.52
2010	**April**	17,655	$156,243.00	8.85
2010	**May**	17,094	$154,262.00	9.02
2010	**June**	14,179	$140,572.00	9.91
2009	**July**	12,522	$135,359.00	10.81
2009	**August**	12,395	$136,425.00	11.01
2009	**September**	14,071	$141,224.00	10.04
	total	226,635	$2,096,824.00	9.25

Gabel is using a conservative 2% natural gas escalation rate to determine the electricity benefits of this project. This rate was determined using U.S. Energy Information Administration past and future prices.

Site personnel also provided detailed maps of the site along with one-line electrical drawings.

Gabel has been instructed to assume that no insurance costs would be incurred to support the installation of a solar system.

3. Financial Analysis

a) Economic Feasibility

This section will provide an analysis of the overall economic feasibility of the project. In summary, economic feasibility is determined by the fixed and maintenance cost of the project as weighed against project benefits. Project benefits are comprised of:

1) Electric value, i.e. the benefit of avoiding the cost of local utility delivered energy; and,
2) Hot water generated from solar thermal, which reduces the purchase of natural gas or oil;
3) Tax benefits if the project is owned by a private vendor instead of the VA.

The analysis presented utilizes these values to determine internal rate of return, adjusted internal rate of return, net present value and other financial metrics.

b) Economic Benefits Overview

Economic Value of Solar Projects

As a result of state and national energy policy, solar projects in Texas can yield economic benefits based on the following stream of benefits:

Electric Generation

The most obvious direct benefit of solar systems is that they generate electricity on site and result in reduced utility purchases. Benefits are detailed by forecasted utility rates. Our rate forecast is described on page 15.

State regulations provide that the utility company allow a PV system interconnection on its distribution system (through the building's electrical system) for net metering purposes. Net metering is a process that occurs when the solar panels are producing more electricity than the building is using. This is not a typical occurrence, but it could happen during off-peak periods such when electrical demand is lower such as on weekends and holidays. When net metering occurs, the electric meter actually runs "backwards" reducing electricity usage from the meter. Net metering in Texas pays the solar project owner an amount determined by their specific electricity provider for the electricity produced, which is often more than the wholesale value which is usually obtained. Net metering is permitted after the PV system passes local electrical inspection (National Electric Code), passes the BPU inspection, meets all utility safety requirements and the customer has entered into an Interconnect Agreement with the utility. In order to accomplish net metering, the utility will install a new meter that has the capability of running in reverse.

Hot water Generation

Solar thermal systems heat water to be used for domestic hot water use throughout a facility. Solar thermal decreases the need to use natural gas or oil to heat water, thus, saving money by offsetting its purchase.

Tax Benefits (For Private Sector Ownership Only)

Private developers constructing solar renewable energy projects (including both solar PV systems) on public property can, under the federal tax code, take advantage of 5 year MACRS accelerated depreciation and a 30% tax credit which add significant value to a project. Additionally, in 2011, the 30% tax credit can be taken as a Department of Treasury Grant 60 days after commercial operation. As a result of these provisions, all things being equal, projects owned by private developers create substantially more value than projects owned by public entities.

c) Summary of Financial Results

Based on conservative assumptions and VA ownership of the system, the solar system recommended for this site has the following financial metrics assuming sufficient additional funding:

Metric	Value
Annual Cash Flow Yr 1	$121,336
Life Cycle Costs Over 20 yr	$1,200,964
NPV Life Cycle Costs Over 20 yr	$288,601
Savings-to-Investment Ratio*	1.13
Internal Rate of Return	6.0%
Adjusted Internal Rate of Return*	4.4%

If no additional funding is provided for the project, the project is negative on an NPV and internal rate of return basis as summarized below.

Metric	Value
Annual Cash Flow Yr 1	$121,336
Life Cycle Costs Over 20 yr	-$2,799,036
NPV Life Cycle Costs Over 20 yr	-$3,557,553
Savings-to-Investment Ratio*	0.45
Internal Rate of Return	-5.8%
Adjusted Internal Rate of Return*	-2.1%

*Savings Investment Ratio (SIR) assumes 10% residual value. Adjusted Internal Rate of Return assumes a 4% reinvestment rate.

Discussion of the underlying analysis that led to these results is provided in the following sections.

d) Calculation of Annual Energy Savings

As discussed earlier in this report the total system has a capacity of 1,033 kW dc. The total estimated annual production is equal to 1,521,316kWh. The first year avoided retail electric cost savings generated by the installation of approximately 1,033 kW dc of PV power is estimated to be $131,087.

Monthly solar output and monthly electric tariff analysis were both used in the savings calculations. This properly accounts for the higher proportional value of energy savings from PV due to higher output during summer peaks periods when electricity prices are higher.

In calculating energy cost savings for the VA, Gabel prepared a rate analysis of the local utility tariff. The analysis of the local utility tariff rate is the result of a detailed review of the tariff, by component, over the life of the solar system. Specifically, the analysis takes into account the components of the utility tariff rate that are not avoided as a result of the solar installation. For example, the customer charge and the major portion of the demand charges are not avoided by the use of solar energy generated by a solar system.

The base forecasts for electricity is shown below in Figure 1. These serve as the basis for estimating savings. Gabel is using a conservative 2% electricity escalation rate to determine the electricity benefits of this project. This rate was determined using the Annual Energy Outlook published by the U.S. Energy Information Administration. We also find it to be conservative based on the standard VA electricity escalation rate of 3%. To the extent prices increase faster than the forecast greater savings will be realized.

The base forecast for gas is shown below in Figure 2. These serve as the basis for estimating savings. Gabel is using a conservative 2% natural gas escalation rate to determine the hot water benefits of this project. This rate was determined using U.S. Energy Information Administration historic and future Natural Gas data. To the extent prices increase faster than the forecast greater savings will be realized.

Figure 1: Electric Rate Forecast

Year	Avg. Electric Costs ($/kWh)	% Increase
2011	$0.086	0.0%
2012	$0.088	2.0%
2013	$0.090	2.0%
2014	$0.091	2.0%
2015	$0.093	2.0%
2016	$0.095	2.0%
2017	$0.097	2.0%
2018	$0.099	2.0%
2019	$0.101	2.0%
2020	$0.103	2.0%
2021	$0.105	2.0%
2022	$0.107	2.0%
2023	$0.109	2.0%
2024	$0.111	2.0%
2025	$0.114	2.0%
2026	$0.116	2.0%
2027	$0.118	2.0%
2028	$0.121	2.0%
2029	$0.123	2.0%
2030	$0.126	2.0%

Figure 2: Natural Gas Rate Forecast

Year	Avg. Costs Natural Gas ($/MMBTU)	% Increase
2011	$9.900	0.0%
2012	$10.098	2.0%
2013	$10.300	2.0%
2014	$10.506	2.0%
2015	$10.716	2.0%
2016	$10.930	2.0%
2017	$11.149	2.0%
2018	$11.372	2.0%
2019	$11.599	2.0%
2020	$11.831	2.0%
2021	$12.068	2.0%
2022	$12.309	2.0%
2023	$12.556	2.0%
2024	$12.807	2.0%
2025	$13.063	2.0%
2026	$13.324	2.0%

2027	$13.591	2.0%
2028	$13.862	2.0%
2029	$14.140	2.0%
2030	$14.422	2.0%

e) Estimated Project Costs

The estimated installation cost for a 1,033 kW PV solar installation is $5,168,825. The estimated installation cost for an 81 panel solar thermal installation is $353,750. The estimated total cost of installing both the 1,033 kW PV solar system and the 81 panel solar thermal system is $5,522,575.

The total cost for the installation of a 1,196 kW dc roof mounted PV crystalline panel solar system is estimated at a conservative $5.00 per watt. The total cost of the installation of 81 roof mounted solar thermal panels is estimated at a conservative $4,367 per panel.

A typical PV solar installation can vary in cost from $4.00 to $8.00 per watt depending on size, complexity of the system, mounting system, labor rates, etc. Approximately 60-70% of that amount is material costs, while the balance is labor, engineering, environmental and permitting. A normal roof mounted solar system will cost around $5.00 per watt, followed by a ground mount at approximately $5.50 while a carport canopy system will cost around $6.00 per watt because of additional material costs to construct the canopy.

Like any installation, certain conditions can affect a price upward or downward. The budget costs presented in this report reflect the total material and labor cost required to provide a working system as described herein, including mounting (racking) systems and electrical interconnection work. The estimate does not include structural improvements (if necessary) to the roofs.

Solar systems do not require much ongoing maintenance. For this project, maintenance is estimated to be $21,074per year, escalating at 3% annually. All major components will be protected by warranties. Solar PV modules typically carry a 10 year/90%, and 25 year/80% performance warranty. In the event that a solar panel fails to produce 90% of its rated output (during years 1-10) or 80% of its rated output (years 11-25), VA will be entitled to receive replacement panels at no cost. Panel re-installation labor costs will be borne by the VA.

Although in general terms ongoing maintenance is minimal, to add an additional level of security and protection to the VA, Gabel has assumed two cost components associated with maintenance; on-going maintenance and replacement costs.

On-going maintenance costs are calculated based on an estimate of the number of man hours required on a monthly and annual basis to provide two functions; review production data to identify any irregularities and to conduct periodic inspections of the various system components.

Replacement costs are based on establishing a maintenance reserve fund and are calculated on an estimate of the total costs associated with replacement of the inverters for the system once over the 25 year solar panel manufacturer warranty of the system. Inverters have a standard 5 or 10-year warranty depending on the manufacturer, and may have an option to extend it for additional 5 or 10 years. Combiner boxes, conduits, disconnect switches, fuses, and circuit breakers are furnished with warranties provided by their respective manufacturers.

Contractors performing installation typically warrant their workmanship for five years.

4. Financing Projects for Solar Projects

There are several alternative approaches to financing solar projects. These alternatives can be viewed as two separate categories: "self owned" in which the VA purchases the solar system, and "vendor owned" which includes the Purchase Power Agreement (PPA) approach, Energy Savings Performance Contract (ESPC), Utility Energy Services Contract (UESC), and Enhanced Use Leased (EUL) contracts. A key factor is that under a self-owned structure the VA cannot realize federal tax benefits; but does control the facility and captures more economic benefits.

1. **Direct Purchase by VA**– under this model, VA would fund the project directly, and build, own, operate and maintain the PV system. Under a direct purchase VA receives all of the financial benefits of a PV system directly.

2. **Power Purchase Agreement (PPA)** – under this approach, a third party invests all of the capital necessary to build, own, operate, and maintain the PV systems. Under this approach the third party claims all of the financial benefits of the project, including federal tax incentives and accelerated depreciation benefits. VA would enter into a 15 to 25 year agreement to purchase the generated power from the PV system at a rate less than the cost of power from the utility. It should be noted that most PPA providers require a minimum total system size of approximately 300 kW.

3. **Energy Savings Performance Contracts (ESPC)** provide energy service companies (ESCO) the opportunity to construct and finance energy saving projects for federal agencies. The ESPC stipulates that after performing an energy audit, the ESCO will recommend improvements within the federal agency to save energy, and save money. These suggestions can be realized because of the ESPCs willingness to pay for the initial costs of these projects upfront. The ESCO is reimbursed throughout the life of the contract by the federal agency from the energy cost savings stemming from the recommended energy saving endeavors.

4. **Utility Energy Services Contracts (UESC)** are agreements between federal agencies and utilities in which the utility covers the capital costs of a green energy project for the agency. Since the federal agency only faces minimal costs, it is able to repay the utility through savings generated from the energy project.

   There are three typical types of UESCs that are available to federal agencies and utilities.

   1. Area Wide Contracts (AWC) are infinite-delivery, infinite-quantity (IDIQ) contracts for public utility services. The agreement outlines all details of the projects and allows for any agency to complete delivery for orders identified in the contract.

2. Basic Ordering Agreements (BOA) set obligations for future contracts between parties but are not necessarily binding.

3. Model Agreements are the most in-depth and intricate of all UESCs. They can stand alone, or be complemented by AWCs or BOAs. The agreement represents an outline for agencies to create UESCs or master agreements with an AWC.

5. **Enhanced Use Leased (EUL)** agreements offer innovative avenues in which agencies can agree to develop solar projects on their property with private developers. EULs can be extremely long-term agreements (up to 75 years) and allow federal agencies the ability to maximize the output of unused land. Upon agreeing to a EUL with a private developer, the developer would become a pseudo owner of the property, obligated to all legal, business, and financial risks associated with the property. The developer is required to pay the agency a fair price, but has the option to pay either cash, or in-kind considerations.

Gabel recommends the VA should utilize a "self own" approach utilizing its own funds, state, and additional funds as available. Should additional funding not be available, Gabel does not recommend proceeding with a solar energy project at this time. Based on the local price of electricity and the size of the project, none of these "vendor owned" approaches would likely be applicable to this project without adequate additional funding. For a vendor to invest in a solar project, it must be able to provide a price lower than the cost of utility delivered power for pricing to be attractive.

A transfer of additional funding, if permissible, to a vendor could result in appropriate pricing from a PPA approach and could be considered an alternative financing approach, instead of the self-funding approach. In this scenario, the vendor would finance, own, install and maintain the project, and would transfer some of the project benefits to the VA through a PPA, a lease, or other financial arrangement.

The Solar Thermal marketplace is not nearly as robust as that of Solar PV, and does not offer PPA projects to interested customers. Savings from Solar Thermal would create a challenge for a third-party to capitalize on, and therefore no PPA approach would be viable to install a Solar Thermal system.

5. Design and Construction Requirements

The project consists of a 1,033 kW roof mounted PV solar system and an 81 panel solar thermal system. Both types of systems are designed to withstand local wind conditions following in strict accordance with County, State, local and NEC Code requirements.

The roof mounted system is based on standard design and installation protocol.

The solar thermal system will need to be fully attached to the roof structure. The flat plate collectors would be mechanically fastened to steel dunnage racking, which, in turn, will be fully attached to the roof structure. A tilt angle of approximately 35 degrees is desirable for maximum heating efficiency at this geographic location. The tilt angle will necessitate spacing between rows of collectors to prevent the array from shading itself. Additional equipment includes, but is not limited to piping, possible drainback tank, system controls, a storage tank with integral heat exchange coils, temperature controls, and additional pumps. There should be sufficient space in the building basement and mechanical areas for the additional equipment. Final design will determine the exact equipment and construction requirements.

System location and sizing is preliminary in nature and subject to change. Actual sizing, placement, geotechnical studies and structural review will be determined during the design phase.

a) Logistical, Site Related and Environmental Issues

Based on our site visit and discussions with site personnel the facility has no obvious environmental, cultural, or historical barriers (i.e. wetlands, brownfields, and historical significance) which would be problematic to this project.

b) Preliminary Project Timeline

The total project should be completed within 10 months from the procurement process through commercial operation. Some variables which may impact scheduling include but are not limited to panel selection and lead time of panel delivery, permitting processes, weather and security. The following is an estimated timeline of events:

Event	Month
Procurement Developed and Issued	1
Procurement Process	2
Contract Award and Contract Execution	3
Design Completed and Approved	5
Construction Start	5
Construction End	9
System Inspection and Commissioning	10

c) Site Work and Preparation

Contractors will most likely be required to have full security background checks. Once a project is approved, bid, and awarded, a pre-construction meeting will take place to discuss these items as well as a variety of other construction related issues including but not limited to array design, construction scheduling, staging and number of dumpsters.

6. Environmental Benefits

In accord with Environmental Protection Agency metrics, below is a summary of the Greenhouse Gas Equivalency of the project. The Greenhouse Gas Equivalency Calculator offers a conversion of emissions data into comprehensible everyday metrics. The environmental benefit of the recommended project would be a reduction in carbon dioxide or CO_2 equivalent of 1,106 metric tons (MT) which is equivalent to:

- Annual greenhouse gas emissions from 217 passenger vehicles;
- CO_2 emissions from 124,013 gallons of gasoline consumed;
- CO_2 emissions from 2,573 barrels of oil consumed;
- CO_2 emissions from the electricity use of 134 homes for one year; or,
- Carbon Sequestered annually by 11 acres of forests preserved from deforestation.

7. Conclusion

Based on a conservatively calculated internal rate of return of **6.0%**, supported by additional funding if available, Gabel believes that a solar project is viable at the site.

Gabel has no specific knowledge of additional funding appropriations to the VA, but is providing the impact of additional funding on project economics, specifically the estimated amount needed to provide positive investment metrics. In the event adequate funding is not received, the project would have negative cash flow and internal rate of return.

Should additional funding be acquired, a "self own" approach is recommended. Should adequate additional funding not be available, Gabel does not recommend proceeding with a solar project at this time.

An alternative approach to consider is a "vendor owned" project through the transfer of additional funding to a vendor, if permissible, who would finance, own, install and maintain the project, and transfer some of the project benefits to the VA through a PPA, a lease, or other financial arrangement. The project is unlikely to attract a private developer without additional funding.

Accordingly, Gabel recommends the following steps:

- Discussion with VA with respect to this report and its implications to project development;
- Review of funds available from additional sources to assist in the purchase of the solar system; and,
- If adequate funding is available, undertake a procurement process to select a vendor.

Economic Assumptions:

Attachment A: Page 1

On the first page of the spreadsheet analysis, the economic assumptions that are used throughout the analysis are shown in the table on the left side of the page. We have included estimated total project costs. This total project cost reflects both the carport canopy solar system installation costs and the roof mounted solar system installation costs, which includes the design, acquisition and installation of the solar system and electrical modification costs where appropriate.

Below are the key economic assumptions as described in detail above that can impact the financial viability of the project and the conservative assumptions we are using for the base case:

Installed cost per watt of the solar project – We have assumed $5.00 per watt for the roof mounted system using crystalline panels. Should the installed cost of the winning installer/developer be less than that assumed, the economics of the project will improve.

Installed cost per panel of solar thermal – We have assumed $4,367.28 per panel for the solar thermal system. Should the installed cost of the winning installer/developer be less than that assumed, the economics of the project will improve.

Electrical modification costs – Until a system is selected and a detailed engineering analysis can be made the economic feasibility study incorporates a conservative estimate of the cost of modifications to the facility's electrical system as well as the utility interconnection.

Cost of money – We have assumed the federal cost of money is 4% to calculate the net present value of project costs and benefits. If the VA is interested in evaluating the economics of a PPA (a privately owned project selling power to the VA under a longer term power purchase agreement) we would use a higher cost of capital.

Retail electric rate – The most obvious direct benefit of solar systems is that they generate electricity and thermal energy on site and result in reduced utility purchases. We have assumed an average retail electric rate of $0.041 per kWh for the site for 2011. This $0.041/kWh value is based on recent energy contracts held by the VA and a detailed tariff rate analysis.

Retail natural gas rate – We have assumed an average retail natural gas rate of $9.90/MMBtu for the site for 2011. This value is based on recent gas contracts help by the VA.

As discussed in Section 3(d), Gabel is using a conservative 2% electricity escalation rate to determine the electricity benefits of this project. The mounting social and political pressure to reduce greenhouse gas emissions, improve energy efficiency, and increase reliance on renewable energy could be expected to put upward pressure on electric rates.

In addition, the current design of solar panels can result in gradual decline of output efficiency. Although many systems show negligible decline after years of operation, this financial analysis assumes a 0.5% annual degradation in electric output.

The Table in Sections 2(i) and 3(d) of this report shows the resulting solar production-weighted average annual prices and resulting annual escalation rates used in this analysis.

Attachment A: Pages 2 through 3– Solar Project Economics Summary

Pages 2 and 3 provide the summary economic analysis to determine whether the solar project is economically viable. The model includes an internal rate of return calculation taking into consideration all project revenues applied against all project costs to determine the return on investment. Page 2 provides an economic analysis based on sufficient additional funding. Page 3 provides an economic analysis without any additional funding.

Attachment A: Page 4

Page 4 of the spreadsheet analysis develops information on retail electricity revenues, which support information shown on Page 2 of the attachment.

Attachment A: Page 5

The final page of the spreadsheet analysis develops information on natural gas savings revenues, which support information shown on Page 2 of the attachment.

Attachment A: Page 6

Includes a site overview of panel locations and the overall size of the system.

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Assumptions
May 9, 2011

System size and Output	
DC KWatts (kW-DC)	1,033.8
First Year kWh	1,521,316
Annual kWh degredation	0.50%
Number of Solar Thermal Panels	81
First Year MMBTU	1143.75
Annual degredation	0.50%

Economic Variables	
Solar PV Installation Cost	$5,168,825
Solar Thermal Installation Cost	$353,750
Total Solar Installation Cost	**$5,522,575**
Total Costs	
Avg PV Installation Cost ($ per W-DC)	$5.00
Avg Thermal Installation Cost ($ per Panel)	$4,367.28
2011 Forecast Electricity Avg Value ($/kWh) [1]	$0.086
Electricity escalation (%) Avg Compound rate	2.0%
2011 Forecast Natural Gas Avg Value ($/MMBTI	$9.900
Natural Gas escalation(%) Avg Compound rate	2.0%
Capital Recovery Period	15
Project Life (Years)	20
Federal Tax Rate	35%
Replacement O&M Costs ($/kW-yr) [2]	$17.00
Ongoing O&M Costs ($/yr) [2]	$3,500
Est Insurance Costs ($1,500/$million solar)	$0
Insurance De-escalation (%)	0.0%
O&M Escalation (%)	3.0%
Discount Rate / Cost of Capital (VA)	4.0%

Economic Incentives

[1]

Estimate of displaced retail electric costs based on historical electric pricing and detailed analysis of current tariff

[2]

O&M Costs are broken into ongoing and replacement cost components for PV systems. Replacement costs include (1) inverter replacement over the life of the system. Ongoing costs for PV include periodic system inspection twice per year and monthly data oversight. Ongong costs for SHW include periodic system inspection, preventative maintenance and calibration of temperature controls and pumps.

REC Values ($ per MWh)

Year	N/A to Analysis because of REC Rentention and Retirement [3]
2011	$0
2012	$0
2013	$0
2014	$0
2015	$0
2016	$0
2017	$0
2018	$0
2019	$0
2020	$0
2021	$0
2022	$0
2023	$0
2024	$0
2025	$0

Definitions

REC - Renewable Energy Credit. A tradable certificate used to satisfy compliance with solar energy portfolio requirements.

[3]

VA will not be selling RECs; their retention and retirement is required to meet renewable energy requirements for federal agencies.

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Project Economics with ARRA funding
May 9, 2011

		COSTS			BENEFITS					
	Year	Capital Investment	Insurance Costs	O&M Costs	Additional Funding		Retail Electric Savings	Hot Water Savings	Net Cashflow	Cumulative Cashflow
0	2010	$5,522,575			$4,000,000				-$1,522,575	-$1,522,575
1	2011	$0	$0	$21,074			$131,087	$11,323	$121,336	-$1,401,239
2	2012	$0	$0	$21,706			$133,040	$11,492	$122,826	-$1,278,413
3	2013	$0	$0	$22,357			$135,023	$11,663	$124,328	-$1,154,085
4	2014	$0	$0	$23,028			$137,034	$11,837	$125,843	-$1,028,242
5	2015	$0	$0	$23,719			$139,076	$12,013	$127,370	-$900,871
6	2016	$0	$0	$24,431			$141,148	$12,192	$128,910	-$771,961
7	2017	$0	$0	$25,163			$143,252	$12,374	$130,462	-$641,499
8	2018	$0	$0	$25,918			$145,386	$12,558	$132,026	-$509,473
9	2019	$0	$0	$26,696			$147,552	$12,745	$133,602	-$375,871
10	2020	$0	$0	$27,497			$149,751	$12,935	$135,189	-$240,682
11	2021	$0	$0	$28,322			$151,982	$13,128	$136,788	-$103,894
12	2022	$0	$0	$29,171			$154,247	$13,324	$138,399	$34,505
13	2023	$0	$0	$30,046			$156,545	$13,522	$140,021	$174,526
14	2024	$0	$0	$30,948			$158,877	$13,724	$141,653	$316,179
15	2025	$0	$0	$31,876			$161,245	$13,928	$143,296	$459,476
16	2026	$0	$0	$32,833			$163,647	$14,136	$144,950	$604,426
17	2027	$0	$0	$33,818			$166,086	$14,346	$146,614	$751,040
18	2028	$0	$0	$34,832			$168,560	$14,560	$148,288	$899,328
19	2029	$0	$0	$35,877			$171,072	$14,777	$149,972	$1,049,300
20	2030	$0	$0	$36,953			$173,621	$14,997	$151,665	$1,200,964
	TOTAL	$5,522,575	$0	$566,266	$4,000,000	$0	$3,028,231	$261,575	$1,200,964	
	NPV	$5,310,168	$0	$370,301	$3,846,154	$0	$2,018,653	$174,368	$288,601	

IRR	**6.0%**
AIRR	**4.4%**
SIR	**1.13**

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Project Economics without ARRA funding
May 9, 2011

		COSTS			BENEFITS				
	Year	Capital Investment	Insurance Costs	O&M Costs	Additional Funding	Retail Electric Savings	Hot Water Savings	Net Cashflow	Cumulative Cashflow
0	2010	$5,522,575			$0			-$5,522,575	-$5,522,575
1	2011	$0	$0	$21,074		$131,087	$11,323	$121,336	-$5,401,239
2	2012	$0	$0	$21,706		$133,040	$11,492	$122,826	-$5,278,413
3	2013	$0	$0	$22,357		$135,023	$11,663	$124,328	-$5,154,085
4	2014	$0	$0	$23,028		$137,034	$11,837	$125,843	-$5,028,242
5	2015	$0	$0	$23,719		$139,076	$12,013	$127,370	-$4,900,871
6	2016	$0	$0	$24,431		$141,148	$12,192	$128,910	-$4,771,961
7	2017	$0	$0	$25,163		$143,252	$12,374	$130,462	-$4,641,499
8	2018	$0	$0	$25,918		$145,386	$12,558	$132,026	-$4,509,473
9	2019	$0	$0	$26,696		$147,552	$12,745	$133,602	-$4,375,871
10	2020	$0	$0	$27,497		$149,751	$12,935	$135,189	-$4,240,682
11	2021	$0	$0	$28,322		$151,982	$13,128	$136,788	-$4,103,894
12	2022	$0	$0	$29,171		$154,247	$13,324	$138,399	-$3,965,495
13	2023	$0	$0	$30,046		$156,545	$13,522	$140,021	-$3,825,474
14	2024	$0	$0	$30,948		$158,877	$13,724	$141,653	-$3,683,821
15	2025	$0	$0	$31,876		$161,245	$13,928	$143,296	-$3,540,524
16	2026	$0	$0	$32,833		$163,647	$14,136	$144,950	-$3,395,574
17	2027	$0	$0	$33,818		$166,086	$14,346	$146,614	-$3,248,960
18	2028	$0	$0	$34,832		$168,560	$14,560	$148,288	-$3,100,672
19	2029	$0	$0	$35,877		$171,072	$14,777	$149,972	-$2,950,700
20	2030	$0	$0	$36,953		$173,621	$14,997	$151,665	-$2,799,036
	TOTAL	$5,522,575	$0	$566,266	$0	$3,028,231	$261,575	-$2,799,036	
	NPV	$5,310,168	$0	$370,301	$0	$2,018,653	$174,368	-$3,557,553	

IRR	**-5.8%**
AIRR	**-2.1%**
SIR	**0.45**

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Retail Electricity Value from Solar
May 9, 2011

	Year	Retail Value $ per KWH	Solar Generation KWH	Value of Solar Retail
1	2011	$0.086	1,521,316	$131,087
2	2012	$0.088	1,513,709	$133,040
3	2013	$0.090	1,506,141	$135,023
4	2014	$0.091	1,498,610	$137,034
5	2015	$0.093	1,491,117	$139,076
6	2016	$0.095	1,483,662	$141,148
7	2017	$0.097	1,476,243	$143,252
8	2018	$0.099	1,468,862	$145,386
9	2019	$0.101	1,461,518	$147,552
10	2020	$0.103	1,454,210	$149,751
11	2021	$0.105	1,446,939	$151,982
12	2022	$0.107	1,439,704	$154,247
13	2023	$0.109	1,432,506	$156,545
14	2024	$0.111	1,425,343	$158,877
15	2025	$0.114	1,418,217	$161,245
16	2026	$0.116	1,411,126	$163,647
17	2027	$0.118	1,404,070	$166,086
18	2028	$0.121	1,397,050	$168,560
19	2029	$0.123	1,390,064	$171,072
20	2030	$0.126	1,383,114	$173,621
	Total		**29,023,521**	**$3,028,231**
	NPV		**N/A**	**$2,018,653**

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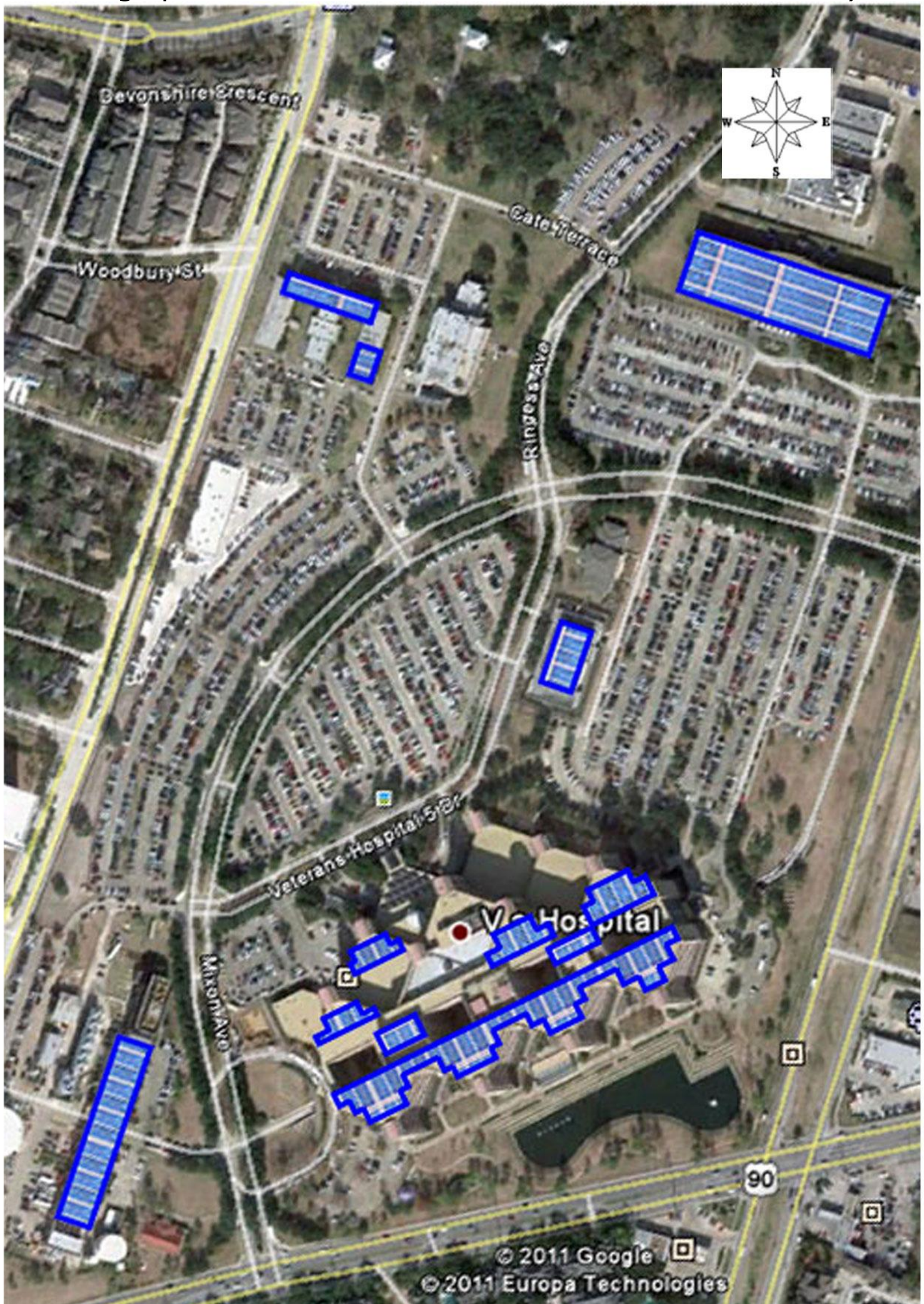
Solar Thermal Energy Savings
May 9, 2011

	Year	Cost of Gas Per MMBTU	Energy Saver MMBTU	Value of Solar Thermal
1	2011	$9.900	1,144	$11,323
2	2012	$10.098	1,138	$11,492
3	2013	$10.300	1,132	$11,663
4	2014	$10.506	1,127	$11,837
5	2015	$10.716	1,121	$12,013
6	2016	$10.930	1,115	$12,192
7	2017	$11.149	1,110	$12,374
8	2018	$11.372	1,104	$12,558
9	2019	$11.599	1,099	$12,745
10	2020	$11.831	1,093	$12,935
11	2021	$12.068	1,088	$13,128
12	2022	$12.309	1,082	$13,324
13	2023	$12.556	1,077	$13,522
14	2024	$12.807	1,072	$13,724
15	2025	$13.063	1,066	$13,928
16	2026	$13.324	1,061	$14,136
17	2027	$13.591	1,056	$14,346
18	2028	$13.862	1,050	$14,560
19	2029	$14.140	1,045	$14,777
20	2030	$14.422	1,040	$14,997
	Total		**21,820**	**$261,575**
	NPV		**N/A**	**$174,368**

Aerial Photograph of Potential Houston VA Site with Noted Solar Systems:



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		Location	6900 Almeda Road Houston, Texas 77030
UNAUTHORIZED REPRODUCTION OF THIS MATERIAL IS STRICTLY PROHIBITED. PLEASE CONTACT GABEL ASSOCIATES FOR PERMISSION TO REPRODUCE OR DISTRIBUTE THIS MATERIAL.		Notes	Preliminary conceptual design for solar array.