

UCB CAMPUS SOLAR PROJECT

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1. INTRODUCTION

1.1 University of California Green Buildings & Clean Energy Project

On July 17, 2003, the University of California Regents expressed their support for a Presidential policy to promote "...the principles of energy efficiency and sustainability in the planning, financing, design, construction, renewal, maintenance, operation, space management, facilities utilization, and decommissioning of facilities and infrastructure to the fullest extent possible, consistent with budgetary constraints and regulatory and programmatic requirements." Following this announcement, the Office of the President committed the University to the attainment of Green Building Design and Clean Energy Standards.

Under the Clean Energy Standards, the University is to implement a systemwide portfolio approach to reduce the consumption of non-renewable energy across the University of California system. This approach includes a combination of energy efficiency projects, local renewable power measures, and renewable power purchases from the State's electrical grid. This approach allows each campus to adopt measures commensurate with local technological and economic factors.

On-site Renewable Generation

The University will supply up to 10 megawatts of its own electricity demand through on-site generation by 2014. To achieve this goal, the University will maximize use of available subsidies, negotiate price reductions in the marketplace, and develop funding sources for asset acquisition. On-site generation will include demonstration projects for photovoltaic (PV) systems and other renewables sources, including biomass and geothermal energy.

Grid Purchases of Renewable Energy

The University will purchase grid-provided renewable energy commensurate with the State's Renewable Portfolio Standard. The University is committed to procuring 10 percent of its electricity needs from renewable sources by 2004, 20 percent by 2017.

Energy Efficiency Measures

The University will develop a strategic plan for implementing energy efficiency projects for existing buildings and infrastructure with a goal of reducing systemwide non-renewable energy consumption. The initial goal of energy efficiency retrofit projects is to reduce systemwide growth-adjusted energy consumption by 10 percent or more by 2014 from the 2000 base consumption level.

1.2 University of California, Berkeley Campus Solar Project

The UC Berkeley Campus Solar Project will move the University towards the goal of supplying 10 megawatts of electricity from on-site renewable generation. Specifically, our objective is to assess solar energy generation potential and financial viability for a large scale photovoltaic (PV) installation at the University of California, Berkeley. Increased solar generation will help the campus to stabilize long-term cash flow and improve future energy purchase flexibility.

This project focuses on three areas that will lay the foundation for a large scale solar installation.

(1) Solar Feasibility Assessment – The first assessment develops a working map of the real estate assets onto which PV panels could be placed. This survey reflects industry considerations such as shading, AC line access, roof support, and also UCB-specific issues, most notably, roof refurbishment and seismic retrofitting schedules.

(2) Solar Assest Assessment – The second assessment contains technical information important to the siting and operational efficiency of installed photovoltaic systems. This assessment discussess technical considerations such as the selection of PV types (crystalline, thin-film etc), the orientation and tilt angle of installed cells, solar radiation at UCB’s lattitude and altitude, use of batteries to store electricity, and life-time operational considerations.

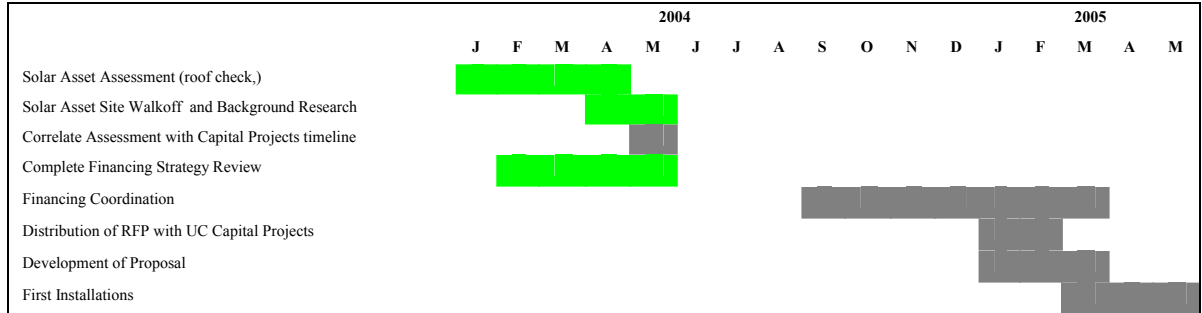
(3) Funding Strategies – The third assessment identifies potential funding strategies for PV purchases. After several conversations with energy consultants, our project team has identified three funding strategies and calculated return on investment (including social considerations) for the UCB Green Energy Project.

1.3 Project Timing & Approval

Our team completed project planning and upfront research, including a solar asset assessment, site walkoffs, and financing strategy review, over the course of the spring 2004 semester. Elements of implementation and project financing coordination will continue through May of 2005. After May, 2005 we plan to transfer operational management duties for the solar assets to an appropriate representative who will oversee implementation of the project schedule. Physical Plant Services department will assume maintenance for the useful life of the solar assets.

The approximate project timeline is shown below. Light shaded cells indicate completed activities; dark shaded cells indicate continuing or planned activities.

Figure 1: Project Timeline



2. CAMPUS SOLAR ASSESSMENT

Assessment of solar potential took place in two phases. The first evaluation consisted of a remote surface scan to generate a first cut of buildings with solar potential. The second evaluation, which aimed to narrow and prioritize our initial list, entailed gathering information (i.e., individual building plans) and completing individual walkoffs of a short-list of campus rooftops. A more detailed description of these evaluations is outlined below in Sections 2.1 and 2.2 below. Section 2.3 describes our methodology for estimating solar potential.

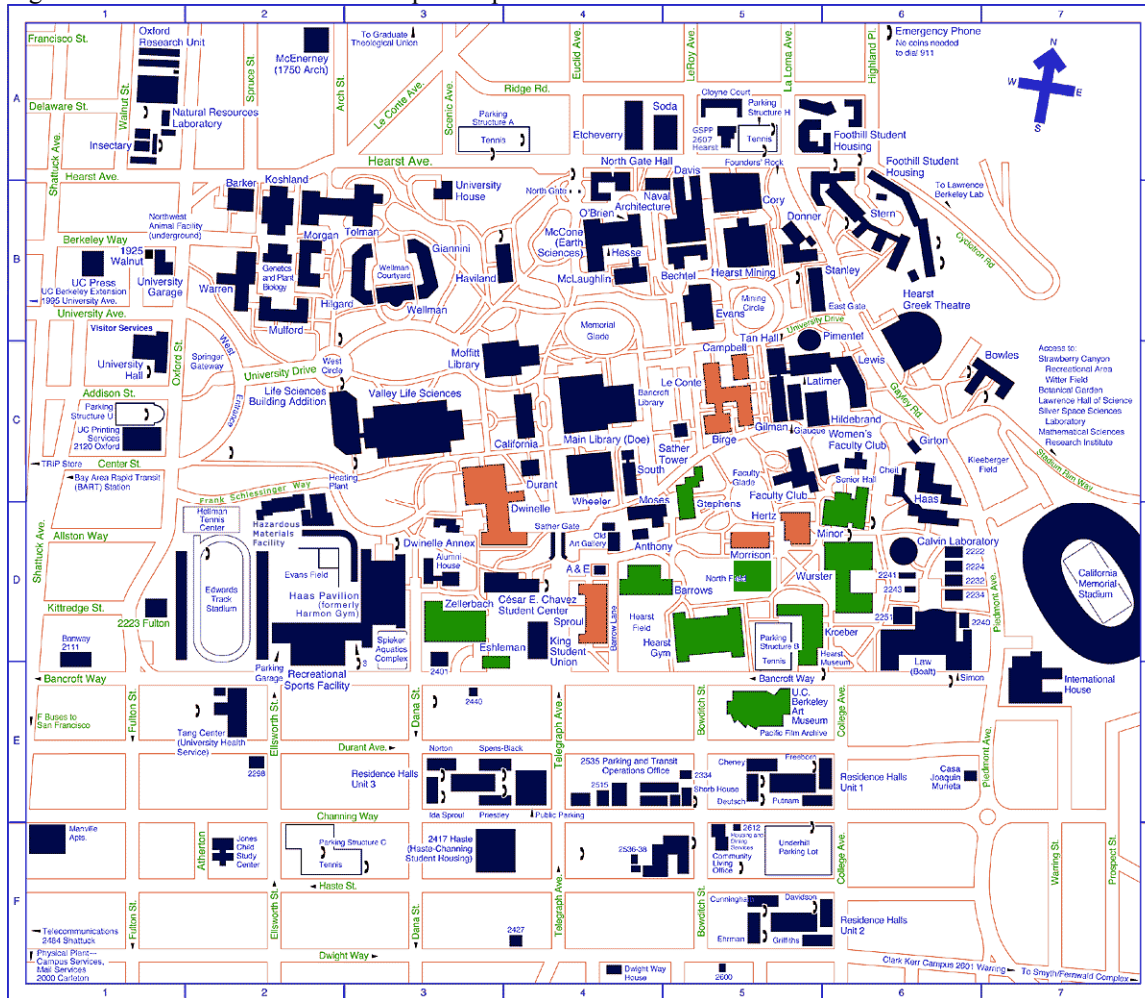
2.1 Remote Surface Scan

We performed remote surface scans of approximately 60% of the 150 campus roof structures to determine optimal sites for the solar installation. These scans identified buildings with a high potential for solar installation. We assessed the following factors during the remote surface scan:

- Minimal obstructive building appurtenances (i.e., extensive HVAC)
- Minimal shading
- Flat design
- Polar orientation/ southern exposure is favorable for optimal summer generation
- Available surface area

Based on this assessment, we generated a campus map identifying structures that had significant solar capability (See Figure 2 below. Buildings marked in green are viable for solar assets). A listing of campus buildings assessed during the remote scan is included in Appendix 1 of this report.

Figure 2: Remote Surface Scan: Campus Map



2.2 Individual Building Assessments

We met with Paul Black, head of the UC Energy & Utilities group, to refine and narrow our initial list of building structures with solar potential. We gathered information such as roof age and construction, energy consumption data, and the expected building life span. This information allowed us to narrow and prioritize our initial list. We also discussed solar potential of UC buildings located off-site.

After narrowing our focus, we visited the following top five building rooftops to visually assess feasibility:

- Barrows Hall
- Evans Hall
- Latimer Hall
- Tolman Hall

Architectural blueprints for these buildings are contained in Attachment 2 of this report. Relevant considerations during the walk-off assessment included:

- Total potential surface area
- Desirable alternating current connection/inverter location
- Conduit connection length
- Roof load / structural design considerations (i.e., grid connection)
- Roof construction (Can roof sustain additional weight? Is the roof due for upgrade?)

Based on the site walk-offs and information analysis, our top choices for solar siting include the 6701 San Pablo Avenue Facility (also called the “Marchant Building”) and Tolman Hall.

2.3 Baseline Solar Estimates

Based on available surface area for solar siting, 6701 San Pablo Avenue Marchant Building and Tolman Hall combined have enough surface area to install roughly 560 kW of photovoltaics.

Figure 3:	6701 San Pablo Ave.	Tolman Hall	Total
Approximate roof surface area	40,000 sq. ft.	30,000 sq. ft.	70,000 sq. ft.
Total kW capacity using crystalline technology (~125 sq.ft/kW)	320 kW	240 kW	560 kW
Total annual energy production Assumptions (also see Section 3.1): 1) 1552 hrs/kW = annual average production factor for San Francisco 2) Flat installation yields 89% efficiency)	442,010 kW/hr	331,507 kW/hr	773517 kW/hr

A more detailed explanation of these calculations, as well as financial analysis for these installations is included in Section 5 of this report. Pollution avoidance estimates (Social Return on Investment data) are also included in Section 6.

2.3 Correlate Solar Implementation with Retrofit Schedule

To develop an accurate timeline for developing UCB solar installation sites, we must also bear in mind a number of other considerations. Namely, expected repair schedules and seismic retrofit dates will need to be coordinated with solar asset installation. This coordination will require firm commitment and review by the UC Capital Projects Team, namely Crystal Barriscale and Billi Romaine.

3. TECHNICAL CONSIDERATIONS

PV cells convert sunlight into electricity by using a semiconductor material that, in the presence of light, produces an electric current. A PV module's conversion of sunlight to electricity varies depending upon technical variables, only some of which are controllable. This section discusses efficiency considerations that follow decisions about the installation and maintenance of PV modules.

3.1 Efficiency Considerations and Installation Options

The efficiency with which PV modules convert sunlight into electricity varies based on the type of semiconductor material used. Efficiency also depends on a number of factors that are largely related to the siting of PV modules.

Photovoltaic Types

Two major types of photovoltaic material are presently in use: polycrystalline and amorphous silicon. Polycrystalline types are more expensive (\$6.25 – \$7.00 per Watt) but also more efficient. Using this technology, between 100 and 150 square feet of surface area are needed to generate a kilowatt of electricity. The useful life of polycrystalline solar panels is 20-25 years. The second major type, amorphous silicon, or thin film modules, require approximately 170 to 250 square feet of surface area to generate a comparable flow of electricity. Amorphous silicon modules are less expensive by comparison (\$5.75-\$6.50 per Watt) but last only ~10 years.

Under a third-party financing model, the selection of PV material for the project may be determined by the third-party financier. For this reason, we have considered both of these technologies separately within our financial analysis in Sections 4 and 5; however, we presently favor crystalline modules for this solar project.¹

Tilt and Orientation of Installed PV Panels

To achieve maximum efficiency PV arrays must be optimally exposed to the sun. However, solar exposure depends on time of day, hemisphere, latitude, and local conditions. These factors, as well as the physical orientation of a building, must be considered in siting PV modules.

Tilt angle is typically adjusted to match the sun's arc in traversing the afternoon sky. Optimum tilt angle varies as seasons change and the sun crosses either higher or lower in the afternoon sky. Orientation, by contrast, refers to adjustments to the easterly or

¹ Solar technology is progressing rapidly. We are monitoring industry progress in development of higher efficiency, lower cost panels.

westerly face of a PV module. Orientation is varied to take advantage of either morning or afternoon sun, depending on local shading and fog conditions.

Given aesthetic concerns, PV modules at UCB would likely be installed flat to the surface of campus facilities. Assuming no shading of the installed panels, PV arrays installed in this manner will generate electricity at about 89 percent of their maximum efficiency.¹ In other words, about 10% of maximum electricity generation will be lost due to this placement.

Incident Solar Radiation (Insolation)

Incident solar radiation is a term that denotes the amount of solar radiation, of all wavelengths (direct, diffuse, and reflected), that strikes the earth. In essence, insolation is a measure of the average amount of sunlight that is available to PV modules for conversion into electricity. Incident radiation varies with latitude, local climate, and altitude.

Incident solar radiation is used to calculate “energy production factors,” which are estimations of the annual electricity generation kilowatt hour of alternative current (kWh AC) that is likely to be produced from an installed 1 kW DC array. Altitude, latitude, and local climate are conditions outside of campus control. Thus, there are no measures that can be taken to alter the “energy production factor.” For San Francisco, the estimated range of output is 1379 kWh to 1724kWh.² We have used the midpoint of this figure, 1552 kWh in our financial calculations (see Section 5).

3.2 Operational Concerns

Other technical considerations, such as grid interconnection and PV maintenance, also impact the optimum configuration and ongoing efficiency of installed PV modules.

Electricity Metering and Procurement

UC Berkeley is provided with electricity by two sources: power generated at the campus cogeneration plant, and power furnished to the Hill Area Substation by Pacific Gas & Electric. Electricity is currently obtained under a direct access contract with Arizona Public Service, and delivered to the campus through transmission lines owned by PG&E. Electricity is transported via underground wiring to a switching station on the Campus Park and then distributed to various buildings on the Campus Park.

¹ Source: California Energy Commission, “A Guide to Photovoltaic (PV) System Design and Installation,” June 2001.

² Source: California Energy Commission, “A Guide to Photovoltaic (PV) System Design and Installation,” June 2001.

Under the Arizona Public Service contract, the University is charged a fixed, per unit charge for electricity. Including transmission charges, taxes, and public goods charges, the per unit fee is approximately 10 cents per kilowatt hour (kWh). Presently, this rate does not vary according to time of use; the 10 cent rate is charged for both peak and non-peak usage.

As you will see in Section 5, this flat rate pricing reduces the amount of cost savings that PV provides. Electricity demand peaks on summer afternoon summer days; exactly the time when solar panels generate the most electricity. If the University's energy rates were priced according to market demand (peak/non-peak rates) the cost advantages of these assets could be greatly enhanced. Our understanding is that the University renegotiates energy procurement rates biannually. The next rate negotiation will take place this summer.

Batteries to Store Electricity

There are two basic types of grid-connected PV systems. The first is direct grid-tied, the second is PV with battery backup. Direct grid-tied PV systems immediately convert the DC electricity into AC and feed it into the building's electrical supply. PV generated electricity is used to offset the building's electrical demand, allowing reduced grid purchases. Theoretically, a PV system could produce more electricity than a building demands. In this case, excess electricity would run the electrical meter backwards. In essence, electricity, under this scenario, is being sold back into the grid. No electrical backup is provided in this configuration because there is no storage device. With a PV system with battery backup, an uninterruptible power supply is attached to the system. This allows power flow to the building even in case of a blackout.

Presently, it does not appear that UCB would be benefitted by the extra expense of a battery backup system. There are no buildings upon which enough PV modules could be installed to over-supply building electrical needs; rather, the installations will offset the grid energy consumption, particularly during peak use periods. Thus, electricity meters on campus buildings will neither run backwards nor be in a position to charge a battery backup system.

Life-time Operational Considerations: Maintenance, Project Oversight, Etc

PV panels typically require very low maintenance. Thus, we did not consider maintenance as part of our financial analysis, as these costs are negligible compared to the capital outlay. The following factors are the primary, controllable variables that reduce system output, along with the efficiency reduction associated with each:¹

- Temperature (11% loss)
- Dirt & Dust (7% loss)
- Mismatch & Wiring Losses (5% loss)
- DC to AC Conversion Losses (10% loss)

4. PROJECT FINANCING ALTERNATIVES

Financing of the solar assets is the greatest barrier to implementation of this program. University policy necessitates that capital projects have a better than 7 year return on investment. Donations, grants, subsidies, or low/no interest loans, are necessary to meet this payback requirement. Furthermore, 26% of all donations to the University are allocated to the general UC-fund, which makes the prospect of fund raising through this channel more challenging. To maximize donations and avoid the 26% deduction of donated funds, we are considering three financing options. The first two options entail creation of a profit or not-for-profit corporation. The third option would entail financing via a combination of grants, and an interest free loan from the UC Green Campus Initiative. A more detailed description of each of these options is included below:

4.1 Non-Profit Solution

Under the non-profit scenario, the solar assets would be in-kind donations to the University. As such, we would establish a corporation which would purchase solar assets with donated funds and subsequently gift these assets to the University. Under this option, we would have access to grant funds for renewable energy, and tax benefits due to the non-profit status. In addition, we would circumvent the 26% UC general fund deduction; while still enabling donors to receive credit for their gift to the University. Fund raising efforts would be a key component of this alternative. Under this option, the project team would dedicate significant time and energy toward fundraising activities in Fall of 2004.

¹ Source: California Energy Commission, "A Guide to Photovoltaic (PV) System Design and Installation," June 2001.

4.2 For-Profit Solution

Under the for-profit alternative, individuals or third party financing would be used to purchase solar assets. These assets would then be leased to the University for a period of years after which point the assets would be sold to the University.

Two types of leasing options are being considered under this scenario: an operating lease or a capital lease. In an operating lease the owner, or lessor, enjoys the rewards and bears most of the risks of ownership. The lease will require the University to make fixed periodic payments. At the end of the lease period, the solar assets would be sold to the University at fair market price. Based on discussions with Geoff Sharples, a solar financing expert, we understand that by utilizing an operating lease, the for profit corporation could take advantage of renewable energy federal tax credits (a tax credit of 10% is available until 2012). On the other hand, if a capital lease is utilized, the lessee enjoys the rewards and bears most of the risk of ownership. If the periodic rental payments vary with changes in the interest rate, the University would bear the interest rate risk. The lease payments under this scenario must equal or exceed 90% of the fair market value of the asset at the time the University signs the lease: this restriction could make capital lease financing difficult if the lease cost exceeds University budget constraints. It is our understanding that the for-profit would not be able to claim the 10% renewable energy federal tax credit in a capital lease scenario. Finally, a for-profit corporation may be eligible for additional state tax advantages (currently 7.5% tax rebate).

4.3 The Harvard Model

The University of California Office of the President has expressed interest in pursuing a financing option similar to the model that Harvard used in a recently completed solar project. This option entails financing the solar project via a combination of grants, and an interest free loan from the UC Green Campus Initiative. Third party financing may also be explored. Matthew St. Clair is currently exploring this financing option to determine the UC level of commitment, and potential timeframe for this financing option.

5. RETURN ON INVESTMENT

The financial benefit of the UCB Solar Energy Project is captured through avoided grid-purchased electricity costs. In this section, we determine the estimated solar capacity, installation costs, project return on investment (payback), and pollution avoidance that are likely to follow PV installations at two key campus sites, 6701 San Pablo and Tolman Hall. Together, these two sites could provide over 500kW of generation capacity. The textual description below provides an explanation of the spreadsheet that follows Section 5. The spreadsheet is organized by building and shows the estimated generation capacity and financial analysis for both crystalline and thin-film. Italicized terms refer to line item titles in the spreadsheet.

5.1 Estimating Solar Capacity

Based on information obtained during the campus walk-offs, and from roof architectural diagrams, we estimated available roof area (in sq ft.) for solar panel installation at Tolman Hall and the 6701 San Pablo Building. With the estimate of available roof area we were able to determine the estimated solar capacity on each of these roofs based on which PV type was installed (crystalline or thin-film). Using crystalline technology, 1kW of electricity can be generated for every 125 sq ft of solar paneling; whereas using thin-film technology 1 kW of electricity is generated for every 200 sq. ft. of solar surface area. Accordingly, we estimate that 6701 San Pablo has an estimated solar capacity of 320 kW using crystalline technology, or 200 kW using thin-film paneling. Tolman Hall has an estimated capacity of 240 or 150 kW using crystalline or thin-film respectively. These figures are represented as *maximum generation capacity* in the attached spreadsheet.

5.2 Project Costs

Total Installation Cost

Estimated installation cost is calculated using an industry average price of \$6.50 per installed watt (\$6,500 per kW) for crystalline technology, and \$6.00 per watt for thin-film (\$6,000 per kW). These assumptions can be altered based on actual vendor bids received later in the project. *Total cost* of installation was determined by multiplying the, *maximum generation capacity* by the per-unit cost (\$6,500 for crystalline and \$6,000 for thin-film). The total cost figure does not include rebates or tax break advantages.

Rebates

The California Energy Commission (CEC) and Pacific Gas & Electric (PG&E) both offer rebate programs for purchasers of PV systems. It is unlikely that UCB would

qualify for the CEC rebate due to the large size of the campus installation. It appears, however, that UCB would qualify for the PG&E rebate, subject to continued funding availability.

California Energy Commission: The CEC rebate is available for PV installations of 30 kW or less. As such it is unlikely that even small campus installations would qualify for this rebate. The present rebate amount is \$3.20 per watt installed, however, the rebate is being reduced in \$0.20 increments as CEC rebate funds are depleted. The rebate is scheduled to continue through 2006. Although, it is likely that the fund will be exhausted sooner.

Pacific Gas & Electric: The PG&E rebate is available for PV installations of greater than 30kW but less than 1,500kW. This rebate is more suitable for U.C. Berkeley's solar installation as installed campus solar capacity will likely be within this range. The rebate amount is presently \$4.50 per watt installed, or up to half the system cost, whichever is less. Typically, the rebate works out to half the installed cost. This rebate is authorized to continue through December 31, 2007. Presently, this rebate is oversubscribed and subject to a waiting list. Rebate forms may be submitted in advance to reserve funding. If a rebate form is accepted from the waiting list, project proponents have 90 days to move forward.

Tax Benefits

Depending on the financing model chosen for the project, a federal income tax credit of 10% may apply. We are currently exploring these potential tax benefits to determine how these credits will apply in various financing situations. State tax breaks are also available under certain circumstances. We intend to update our spreadsheet as we learn more about the specific applicability of these tax advantages given UC Berkeley's tax status, or given our various financing alternatives.

5.3 Annual Energy Savings

Annual Energy Savings

Future avoided electricity purchases are calculated by multiplying the *maximum generation capacity* by the *orientation tilt factor* (.89) and the *energy production factor* (1552 kWh/kW).¹ (See Section 3.1 for additional description of orientation tilt factor and the energy production factor calculations.) Total avoided electricity purchases per year are reflected in the *total produced* figure. Multiplying this figure by UC's contract rate of \$0.10 kWh provides an estimation of annual future avoided electricity costs. This figure is stated as *annual savings*. The cumulative amount of energy savings depends on the life of the solar assets. Accordingly, cumulative energy savings using crystalline solar technology exceeds the energy savings available using thin-film technology.

¹ See section 3.1 for an explanation of these figures.

5.4 Payback Analysis

Payback Analysis

In order to assess the financial viability of this project, we calculated payback periods using different scenarios: Scenario 1 assumes no discount factor; Scenario 2 assumes 3.5% growth rate in electricity costs, and an opportunity cost (or discount factor of 8%). Scenario 3 assumes a 3.5% growth rate and a 6% loan, where energy savings are used toward loan repayment. Each of these options is described in detail below:

Scenario 1- No discount factor: Scenario 1 assumes no growth rate in energy costs, and no discount factor. Essentially, this scenario ignores the time value of money. Under this scenario, the payback period for crystalline assets without the PG&E rebate is ~47 years; with the PG&E rebate, the payback period is 22 years. These figures indicate that this project may pay for itself over the life of the solar assets. However, as you will see in Scenario's 2 and 3, the accounting for the time value of money significantly affects the payback analysis.

Scenario 2 - Discount factor: Scenario 2 assumes that energy costs will increase by 3.5% per year, and that the opportunity cost of alternative use of this money is 8% (discount rate). Under these assumptions, the payback period is significantly extended. For crystalline technology, payback of the capital outlay will take over 100 years, which far exceeds the useful life of the asset. With the PG&E rebate, the payback period is 34 years; roughly 10 years greater than the useful asset life. This signals that we will need to pursue donations, grant funding, or other cost savings in order to increase the financial viability of the project. Interestingly, however, the discount factor applied in the payback calculations significantly alters the attractiveness of this project. For example, by increasing the discount rate to 10%, the payback period of the *adjusted cost* (with rebate) increases to more than 60 years. In contrast, if energy prices significantly increased, this would significantly alter our calculations.

Scenario 3 - 6% loan: Scenario 3 explores the financial attractiveness of the project given financing using a 6% loan, and loan repayment using the money saved on grid energy procurement. In this scenario, the net present value (NPV) of the energy savings is calculated (using a 25 year annuity for crystalline technology, and 10 year annuity for thin-film technology). This NPV calculation is compared to the *adjusted project cost*. If the NPV of the cash flows exceeds the adjusted project cost, the project pays for itself. As shown in the spreadsheet, using crystalline technology, the cumulative energy savings exceeds the project cost over the life of the assets. In contrast, because of the short lifespan of thin-film technology, the energy savings do not cover the project costs. If the University procures an interest free loan (as in the Harvard model), the project becomes significantly more attractive. The spreadsheet design allows us to alter various assumptions to assess such alternative payback alternatives.

6. ENVIRONMENTAL CONSIDERATIONS

6.1 Pollution Avoidance

In addition to the financial calculations, we performed an analysis of avoided pollution costs for this solar installation. These calculations were generated using publicly available pollution data from the EPA website. This data provides average pollutant figures for grid generation given California's current energy generation portfolio. Major constituents of concern included in our analysis include mercury (a neurotoxin), nitrous oxide (acid rain contributor), CO₂ (greenhouse gas), and sulfur oxides (acid rain contributor). As these pollutant figures are given based on kWh produced, we scaled these costs based our projected kWh production. For CO₂, the amount of pollution avoided was translated into equivalent amount of car emissions avoided, and how many trees the CO₂ savings offset.

6.2 Other Social Benefits

In addition to the environmental and financial benefits, there are other benefits from this project that are not easily quantifiable and are not included in Section 5 above. First, this project promotes the use of renewable energy. By supporting solar technology, this project will help the solar industry realize economies of scale. Furthermore, increased use of renewable energy on campus will increase awareness and support for renewable generation both on campus and in the community. Second, solar installation will reduce the campus' exposure to volatility of energy spot prices.

Ultimately, it is in society's long-term interest to create efficient means of harnessing the sun's energy; we feel that it is important to begin taking steps toward that goal. Finally, because solar provides energy primarily during peak usage periods, this project will reduce campus energy usage when demand on electricity is highest. This will help avoid future energy crises such as the 'brown outs' experienced in the summer of 2001.

6.3 Draft Environmental Impact Report & 2020 Long Range Development Plan

The University of California's Draft Environmental Impact Report (EIR) and 2020 Long Range Development Plan (2020 LRDP) was issued on 15 April 2004. The EIR provides a

program-level assessment of the potential environmental consequences of adoption and implementation of the proposed 2020 Long Range Development Plan for the campus. This assessment informs UC Berkeley decision-makers, other responsible agencies, and the public-at-large about the nature of the 2020 LRDP and its effect on the environment. The U.C. Berkeley Campus Solar Project is fully consistent with the 202 LRDP and accompanying EIR.

In addition to the policies of the U.C. Regents and Office of the President, the U.C. Berkeley Campus Solar Project is also fully consistent with state regulations. Buildings built in California after June 30, 1977 must comply with standards set forth in Title 24 of the California Administrative Code. Title 24 requires the inclusion of state-of-the-art energy conservation features in building design and construction including: incorporation of specific energy conserving design features, use of renewable energy resources, or a demonstration that the proposed new buildings would comply with a designated energy budget.

In addition to this mandate, the Regents of the University of California are also encouraged to comply with Executive Order D-16-00, issued August 2, 2000. This Executive Order establishes the Governor's sustainable building goal: "to site, design, deconstruct, construct, renovate, operate, and maintain State buildings that are models of energy, water and materials efficiency; while providing healthy, productive and comfortable indoor environment and long-term benefits to Californians."

Appendix 1: Contacts

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Appendix 2: Building Energy Consumption Data

12/9/2003 **Building Electrical Demand Estimates**
 1999-2000 Energy Consumption Data

0.65 Load Factor
 [1.5 times the average d
 EST. Max EST. Max
 Demand Campus Demand
 kW kWmain system

BLDGNAME	Data	
	Annual Use, kWh	kW actual
2120 OXFORD	1,344,618	
2222 PIEDMONT	14,486	
2224 PIEDMONT	55,494	
2232 PIEDMONT	54,437	
2234 PIEDMONT	21,962	
2401 BANCROFT	27,749	
2401 BOWDITCH	189,832	
2547 CHANNING	28,598	
ABRS	200,000	
ALUMNI HOUSE	71,760	
ANTHONY	19,301	
BARKER	1,963,517	
BARROWS	2,933,473	
BECHTEL	521,214	
BIRGE	2,315,721	350
BOTANICAL GAR	100,000	
BOWLES	20,167	
CALIFORNIA	438,032	90
CALVIN	1,391,802	
CAMPBELL	656,419	125
CORY	8,752,027	1,134
DAVIS	1,910,418	265
DOE	882,906	
DOE ADDITION	2,361,169	422
DONNER	1,008,205	100
DURANT	102,281	
DWINELLE	1,656,608	214
EDWARDS TRACK	94,850	
ESHLEMAN	355,241	
ETCHEVERRY	4,392,742	560
EVANS	4,692,293	650
FOOTHILL	2,223,196	
GIANNINI	2,898,448	

EST. Max Demand kW	EST. Max Campus Demand kWmain	EST. Max Demand system
236	236	main
3	3	main
10	10	main
10	10	main
4	4	main
5	5	main
33	33	main
5	5	main
35	35	main
13	13	main
3	3	main
345	345	main
515	515	main
92	92	main
407	407	main
18	18	main
4	4	main
77	77	main
244	244	main
115	115	main
1,537	1,537	main
336	336	main
155	155	main
415	415	main
177	177	main
18	18	main
291	291	main
17	17	main
62	62	main
771	771	main
824	824	main
390	390	main
509	509	main

HAAS BUSINESS	3,201,118	552	562	562	main
HAAS CLBHOUSE	441,777		78	78	main
HAAS PAVILION	2,400,000		421	421	main
HAVILAND	38,942	90	7	7	main
HEARST ANNEX	22,100		4	4	main
HEARST GYM	99,605		17	17	main
HEARST MINING	3,493,218	640	613	613	main
HEATING PLANT	128,281		23	23	main
HERTZ	271,114	65	48	48	main
HESSE	122,313	75	21	21	main
HESSE ANNEX	404,012		71	71	main
HILDEBRAND	4,760,565		836	836	main
HILGARD	1,036,649		182	182	main
I-HOUSE	1,553,423		273	273	main
KLEEBURGER	82,113		14	14	main
KOSHLAND	9,992,172	1,320	1,755	1,755	main
KROEBER	725,669		127	127	main
LATIMER	5,879,032		1,032	1,032	main
LAW	2,851,313		501	501	main
LECONTE	1,243,884	200	218	218	main
LEWIS	966,686		170	170	main
LHS	1,650,973	259	290	290	main
LSA	5,661,203	1,600	994	994	main
LSB	11,953,828	1,750	2,099	2,099	main
MATH SCIENCE	266,448	43	47	47	main
MCCONE	5,462,301	260	959	959	main
MCLAUGHLIN	300,000	100	53	53	main
MEMORIAL STD	203,782		36	36	main
MENS FAC CLUB	426,712		75	75	main
MINOR	330,128		58	58	main
MOFFITT	1,930,188	310	339	339	main
MORGAN	1,060,092		186	186	main
MORRISON	289,781	38	51	51	main
MOSES	134,280		24	24	main
MULFORD	592,015	83	104	104	main
NAVAL ARCH	20,731		4	4	main
NORTH GATE	230,000	50	40	40	main
NW ANIMAL	2,065,191		363	363	main
OBRIEN	409,068	75	72	72	main
OXFORD TRACT	2,965,786		521	521	main
PARKING A	152,440		27	27	main
PARKING B	58,658		10	10	main
PARKING D	230,922		41	41	main
PARKING H	260,541		46	46	main
PARKING STDM	100		0	0	main
PSL	421,863		74	74	main
REC SPORT FAC	1,571,542		276	276	main
RES HALL I	1,930,696		339	339	main
RES HALL II	1,914,272		336	336	main
RES HALL III	1,927,919		339	339	main
RUGBY FLD HSE	9,307		2	2	main

SERVICES	892,609		157		off
SILVER	1,095,145	92	192	192	main
SILVER EXPAN	1,525,894	248	268	268	main
SODA	4,315,731	510	758	758	main
SOUTH	238,982		42	42	main
SPROUL	1,200,000		211	211	main
STANLEY	1,782,960		313	313	main
STEPHENS	519,082		91	91	main
STERN	403,170		71	71	main
STRAW RESCH	51,705		9	9	main
STRAW SOFTBALL	16,564		3	3	main
STRAWBERRY	30,519		5	5	main
TAN	3,148,954		553	553	main
TANG HEALTH	1,375,780		242		off
TOLMAN	1,739,011	316	305	305	main
UNION	2,300,394		404	404	main
UNIV ART CTR	2,145,619		377	377	main
UNIVERSITY	1,932,572		339	339	main
WARREN	1,426,189		250	250	main
WELLMAN	627,865		110	110	main
WELLMAN CTYD	150,000		26	26	main
WHEELER	745,762		131	131	main
WOMEN FAC CLB	123,658		22	22	main
WURSTER	1,384,940		243	243	main
ZELLERBACH	1,377,934	163	242	242	main
Grand Total	163,047,376	13,063	28,635	28,222	

kW Total kW Total
Main Campus

Off-Campus Structures

2000 Carleton St.	750,000	160
6701 San Pablo	3,500,000	450

**Attachment 1: UC Draft Presidential Policy for Green Building Design
and Clean Energy Standards**

Attachment 2: Roof Plans

Attachment 3: Walk-Off Checklist