

Chapter 5: Opportunities for Solar Installations

5.1 New and Retrofit Structure Opportunities for Solar Technology

New construction projects provide the easiest outlet for installing solar technology by avoiding the headaches often associated with retrofit projects. Throughout the Claremont Colleges there are several major construction projects planned that present opportunities for integrating solar energy generation into the design. Some of the colleges are already creating plans for the installation of photovoltaic systems in one or more of their construction projects. Additionally, there are many existing buildings that could be retrofitted with an array. Following are summaries of construction projects at various stages of completion accompanied with possible areas for solar expansion.

5.1.1 Claremont Graduate University

Although CGU has no upcoming construction projects and a very limited availability of accommodating roof space, the fact that 15-25% of CGU's electricity comes directly from SCE rather than through CUC means that there is a much greater incentive for solar energy in certain buildings. If CGU is paying the direct SCE price of 21.5 or 25¢/kWh for electricity for a building rather than the CUC rate of about 11 ¢/kWh, payback periods for solar arrays are greatly reduced. However, even if CGU stands to save a large amount of money in a short length of time with a solar energy project, they have recognized the need to update aging mechanical systems, which would save them more money and natural gas on their investment through efficiency savings.

CGU Student Apartments

Five new apartment buildings for CGU students located between the Claremont School of Theology and the CUC-owned Claremont Golf Course will be opening in August 2008 and will be occupied year-round from then on. Photovoltaic panels were originally included in the design, but were eliminated when construction costs rose. There is now an opportunity to install a solar energy system into the completed buildings. By rough estimate, there is approximately 5,000-6,000 ft² of available roof space per building, or 30,000-35,000 ft² in total. There are also 143 parking spaces in the apartment complex that could be covered with PV arrays. The CGU apartments buy their electricity from SCE at market rate, making self-generation an attractive option.

CGU Office-Houses

Many of CGU's offices and academic departments are located in residential houses bought and lightly remodeled by the college. Most of these houses buy their electricity directly from SCE at almost twice the price that other buildings on campus pay. In the course of re-roofing projects on the houses, CGU may be interested in installing solar roofing tiles on the houses. This opportunity may be limited, however, since there is generally a significant amount of shading around the houses, which are all one- or two-

stories tall. The aesthetic opinions of the neighbors are an additional concern, as any complaints from residents can halt a project.

Burkle Building

The Burkle Building is the newest building at CGU (built 1998) except for the new residence halls. It has a large flat roof on which there may be enough room for a solar thermal installation. The roof is quite cluttered, leaving relatively small areas of space for solar thermal arrays. The Burkle Building pays the reduced rate for electricity through the Consortium, which is why a solar thermal installation may be more appropriate.

5.1.2 Claremont McKenna College

Claremont McKenna College is in the process of updating their campus with a range of construction projects. If the financial and sustainable incentives of solar energy are convincing enough, it is quite possible that solar arrays could be included in some of their projects. Unfortunately, there is currently a lack of space at CMC for solar energy systems given the terrace style architecture and prevalence of ceramic roofing tiles. However, there may be several opportunities available on campus that have not yet been identified.

East Campus Construction (see also Pitzer's East Campus construction project)

Claremont McKenna and Pitzer are constructing new athletic facilities to the east of the colleges across Claremont Blvd., in what is currently a large dirt-filled quarry, descriptively known as the "Pit." Pitzer will build on the northwestern portion of the Pit, while CMC will develop the southern area. CMC's sports complex will be almost entirely playing fields and parking lots, with small support buildings. Pitzer and CMC are considering covering their parking lots with solar car ports through a power purchase agreement that would send electricity back across Claremont Blvd. into the CUC grid. The two colleges are planning to do this in collaboration with each other. The soil around the Pit is unstable fill and will need to be compacted before it can support the weight of a solar array. Pitzer and CMC claim that they are willing to pay for the cost of soil compaction, in CMC's case a \$400,000 project. Construction of the array may still be somewhat more expensive due to the soil limitations, and it will be difficult for the PPA provider to match the Consortium's low electricity rate. The soil stability issues apply only to the parking lots along Claremont Blvd.; CMC will be placing a parking lot in the middle of the Pit area, behind the baseball field, that will be built on imported dirt and will not need special compaction. CMC has plans to cover this parking lot with a PV array as well.

West Campus Construction

A new building to replace Pitzer Hall at the west end of the CMC Quad has been designed and will soon be built. With any new construction, there is the option of utilizing any unused rooftop space for a solar array. However, there is not enough roof

space currently in the design, which features a terraced roof, for any solar energy system.

Ducey Gymnasium

Ducey Gym will either be reconstructed or heavily renovated. CMC is currently in the contract phase with the architect, and the presentation on the chosen design is to be in September 2008. Demolition may begin as early as November 2008, but probably later. Solar energy could easily be worked into the design, especially with the large, flat, open roofs typical of gymnasiums. In the renovation there is a possibility for a tri-generation system, using hot water for the nearby swimming pool (as well as showers), air conditioning for the building, and additional electricity for other purposes.

Campus Center

A new campus center will be built on the CMC campus. Although this project is roughly five years away, there is the possibility of integrating solar energy into the campus center during the design process.

5.1.3 Claremont University Consortium

CUC has three large infrastructure projects that could possibly involve solar energy systems. The opportunities for simple retrofitting projects to add solar energy generation to existing buildings are quite limited, given that the majority of the available roof space will be the subject of renovation projects. Perhaps the only suitable and available roof space is Huntley Bookstore, which is relatively small and shaded.

Central Facilities Services Building Renovation

The current CUC Central Facilities Services building on Mills Street, south of First Street, is to be gutted and renovated, with the new building housing a conference center for the colleges, and offices for Campus Safety, Central Facilities Service, and all departments now in the Pendleton Building. As part of the renovation, the parking lot will be expanded into a vacant gravel lot bordering the east side of the current lot. Currently, the renovation is in the design phase, with the floor plan just completed as of June 2008. The chance for drawing solar energy into the design will be this summer. According to Bruce Spena, Director of Central Facilities Services, there is a 50/50 chance that a solar energy system will be in the design for the CFS building. Although extensive daylighting is planned for the building, there will still be enough roof space remaining for a solar array. A particular area of opportunity is the parking area for CUC's 45 electric carts. This corner of the larger building parking lot could have a small car port array that would generate electricity for the carts. CUC is also aware of the possibility of a power purchase agreement for the large parking lot surrounding the CFS building. There will be approximately 8,000 m² (80,000 ft²) of available parking lot space to the east of the building, with more space available in the parking spaces surrounding the building on all sides. However, the aesthetic concerns of the southern neighbors are an important consideration in the decision to install a solar carport, or other type of system. Any

designs for the renovated building may need to be compatible with Pomona's plan to purchase the land in the future.

Library Warehouse Construction

CUC will be constructing a new library storage facility that will house 60% of the books currently in the Honnold-Mudd library. These are the books in the library that have not been checked out in over 20 years. These books will be moved off site to the warehouse where they will be available upon request. The warehouse construction project has recently been approved in concept by the college presidents, although the timeline for the project is not yet known. Construction may begin in a year or two, although this depends on the selection of a location for the building. As of now, no site has been found. When the warehouse is designed and constructed, there will likely be a large amount of open roof space on which a solar energy system can be installed. The progress of this project depends upon finding an appropriate location for the warehouse.

Honnold-Mudd Renovation

The Honnold-Mudd library will undergo a radical renovation to update its facilities and services. During the renovation, all library books will be moved to the new library warehouse, while personnel will work from Pendleton, which will have been emptied by the shift to the renovated CFS building. The project cannot begin until after the completion of the warehouse. As of now there are no funds for the library renovation. During the renovation, a solar energy system could be installed on the library roof. This project is not likely to gain momentum for a number of years.

5.1.4 Harvey Mudd College

Harvey Mudd will not begin its planned infrastructure projects for a few years. However, the college has numerous buildings that present ample opportunities for solar retrofitting. Mudd buildings that have been identified as available locations for solar installations are the Linde Activities Center and Kingston Hall, and North, South, East, West, and Sontag Residence Halls. We have estimated that there is a total of 100,000 ft² of available roof space on the Harvey Mudd campus. Linde Activities Center (~ 11,000 ft²) and Atwood Residence Hall (~ 13,000 ft²) present the largest amounts of available roof space. Platt Campus Center will be undergoing a renovation project and is thus not an ideal location for any retrofitting project. Sontag, East and West dorms all have numerous small heat pumps as their HVAC systems, such that heating and cooling in the dorms are electrically driven and could be powered by PV systems. See Chapter 6 for proposed installations of PV arrays and solar thermal systems on East and West Dorms, North and South Dorms, and Sontag Residence Hall. With cheaper and higher efficiency solar PV panels, or low-tech solar thermal systems, it is hoped that the payback period can be reduced to an acceptable length of time (~ 10 years).

Thomas-Garrett Hall Replacement

It is likely that the academic building Thomas-Garrett Hall will be demolished and

replaced with a new and more effective building. Construction will begin in roughly five years. There will be many chances during the planning phase for the new building design to include renewable energy features, especially with advances in solar technology that may come on the market between now and the project start date.

Platt Campus Center Renovation

The Campus Center will be extensively remodeled so that it can more ably fulfill its purpose as a student center. Construction will begin in roughly five years. During the renovation process there will be opportunities to incorporate solar energy systems into the roof of Platt.

New Dorm Construction Project

Harvey Mudd will be building a new dorm to the east of Sontag dorm, with construction beginning in roughly five years. A solar energy system could easily be put into the design for the new dorm.

New science building construction project

Harvey Mudd may be building a new science building with classrooms, offices and labs to the north of Olin Science Center. If this project goes forward, renewable energy could be incorporated into the design for the new building.

5.1.5 Scripps College

Although the architecture of most buildings on Scripps precludes the easy placement of any kind of solar array, Steele Hall and the Lang Art Building have flat roofs that may accommodate solar panels. Additionally, the buildings share the same boiler, and the plumbing necessary to access the boiler is also located on the roof.

The Scripps swimming pool would benefit from solar heating if an aesthetic placement of solar thermal panels can be designed.

5.1.6 Pitzer College

Phase II of New Dorm construction

Pitzer College is creating new residence halls to replace all the old student housing. Phase I was completed in the fall of 2007 and has one 17 kW solar PV array installed on one of the three LEED Gold certified buildings. Phase II will involve the construction of two new dormitories to the north of Phase I. There will be a final Phase III that will see the final residence halls erected. Planning will begin in the fall of 2008. Construction may begin the year after that. The dorms will be built to achieve LEED Gold certification, and thus there will be added incentive for Pitzer to gain LEED points by installing renewable energy generation capacity in them.

East Campus construction (see also CMC's East Campus construction project)

As noted in Section 5.1.2, Pitzer and Claremont McKenna are constructing new athletic facilities to the east of the colleges across Claremont Blvd., in what is currently a large dirt-filled quarry, descriptively known as the “Pit.” Pitzer and CMC are considering covering parking lots in the Pit with solar car ports through a power purchase agreement that would send electricity back across Claremont Blvd. into the CUC grid. Pitzer may be able to host a 100-200 kW system on its parking lot.

East Mesa Parking Lot

Pitzer may enter into a power purchase agreement for the 208-space East Mesa Parking Lot. This system would be installed in conjunction with the Pit systems if all go forward. It is not known if a PPA provider will agree to build the system given the Consortium's interruptible electricity rates – far below standard electricity rates.

5.1.7 Pomona College

Pomona College has not discussed the possibility of solar energy in any recent planning meetings and has not identified any potential locations for installing new systems outside of already-planned infrastructure projects.

North and South Campus Parking Structures

Two new underground parking structures will be built as part of the extension of Columbia Avenue to create a north-south corridor through Pomona's campus. The south parking garage will have an artificial turf athletic field over it, while the north parking garage will have a natural turf athletic field and two dorms on top of it. The design phase is just beginning and construction on the parking structures is expected to begin between January and April 2009. The dorms will be LEED Gold certified, thus encouraging the inclusion of renewable energy. Solar hot water systems are a possibility for the dorms.

5.1.8 Joint Science

The planned new Joint Science building on the east side of Mills Street, just north of Ninth Street, offers an excellent opportunity for solar technology.

5.2 Available Rooftop Spaces at Harvey Mudd College

The following estimates for total and available roof space on the Harvey Mudd campus are calculated through physical measurements with a tape measure along with the aid of the “ruler tool” in the publicly available program Google Earth™. Total roof area is the cumulative sum of the estimated total roof space. Total roof dimensions for each building are the sizes of rectangular areas on the building roofs corresponding to estimates from measurements and aerial photographs. This value is obtained by taking

note of both trees and rooftop mechanical equipment that would shade or otherwise make unusable certain areas of the roof for the purpose of a solar installation. Estimated available roof space is the total area of the roof that appears available for installation of solar panels.

If any other college is seriously considering retrofitting any of its existing buildings with solar technology, our team highly recommends a similar study of the other campuses. Knowing how much roof space is available is extremely helpful in planning any solar system.

Harvey Mudd College Roof Areas:

*Values marked with an asterisk were obtained through estimates from aerial images rather than in-person measurements.

Building	Total Roof Area (ft²)	Available Roof Dimensions (ft)	Estimated Available Roof Area (ft²)
Atwood Residence Hall	14,000*	2x (45 x 26) 35 x 65 110 x 15 20 x 35 26 x 45 110 x 35 26 x 70 19 x 15	12,920
Case Residence Hall	14,700*	20 x 13 20 x 20 30 x 20 80 x 20 50 x 10 85 x 20 30 x 20 40 x 20 90 x 20	8,300
East Dorm (Mildred E. Mudd Hall)	12,130	27 x 100 105 x 40	6,820
F.W. Olin Science Center 49 x 70	10,800*	66 x 23* 30 x 30* 66 x 14*	3,300*
Kingston Hall	7,500*	75 x 15* 20 x 40*	2,000*

Hoch-Shanahan Dining Hall	28,000*	20 x 45 75 x x10 10 x 70 30 x 30 70 x 25 20 x 30 2x (15 x 15)	6,000
Jacobs Science Center/ Keck Laboratories	18,900*	27 x 22* 20 x 20*	1,000*
Linde Activities Center	19,600*	85 x 115 25 x 55	11,100
Linde Residence Hall	16,400*	2x (63 x 43) 2 x (28 x 13) 25 x 51 8 x 72 18 x 36	8,350
North Residence Hall	12,200*	65 x 65	4,200
Parsons Engineering Building	19,800*	19 x 119* 36 x 28* 34 x 34* 32 x 28*	5,300*
Platt Campus Center	18,400*	116 x 67* 40 x 30*	9,000*
Sontag Residence Hall	14,200*	50 x 20 2x (35 x 50)	4,500
South Residence Hall (Marks Hall)	12,200*	30 x 130 30 x 50	5,400
Sprague Memorial Library	7,900*	55 x 19* 42 x 7* 85 x 15*	2,500*
Thomas-Garrett Hall	7,100*	35 x 78* 35 x 45* 48 x 35*	6,000*
West Residence Hall	12,130	27 x 55 78 x 52 27 x 105	8,120
Covered walkways around courtyard of Jacobs Science Center, Keck, and Parsons	7,400*	20 x 50 20 x 100 20 x 50	4,000
Total			108,810

5.3 Parking Lot Survey

Parking lots often provide the largest open area ideal for a solar photovoltaic installation. Campuses such as California State University at Fresno and Dominguez Hills have adopted such installations with the aid of a power purchase agreement. The 520 kW solar parking lot at CSU Dominguez Hills has about 249 parking spaces. The array covers an area approximately equal to the parking area, plus a small amount of covering on meridian strips and borders. In addition to the possible carport mentioned above in the Pit across Claremont Blvd., there are many excellent parking lots across the Claremont Colleges.

The following table lists a representative sampling of the largest parking lots on the Claremont Colleges campuses. We assume a parking space size of 8.92ft x 16.7ft (2.72m x 5.08m), and we assume full coverage of the individual parking space areas only – not the access lanes.

Institution	Lot	Parking Spaces	Available Area - ft ² (m ²)	Physical Characteristics
CUC	Central Facilities Service Semi-Contiguous Lots	Total: 284	<u>42,000</u> (3900)	<i>East:</i> highly exposed, roughly square lot with two center double rows; expected to be doubled in size by CFS building renovation
	East of Mills Ave.	118	17,000 (1600)	<i>West:</i> highly exposed triangular lot with most spaces along edge of building or wall abutting railroad tracks; all but 24 spaces in single rows
	West of Mills Ave.	166	25,000 (2300)	
CGU	Grad Housing Lot - North of 11 th St., West of Dartmouth Ave.	99	15,000 (1400)	Rectangular lot with long center double row, some peripheral shading
CMC	Ninth St. Semi-Contiguous Lots	Total: 214	32,000 (3000)	Two rectangular lots with peripheral shading separated by tree populated
		50		

	East of Bauer Hall		7400 (690)	meridian strip; eastern lot has large amount of exposed central space
	Farther East of Bauer Hall	164	25,000 (2300)	
CMC	Mills Ave. & Sixth St.	157	24,000 (2200)	Rectangular lot with peripheral shading, 80 spaces in center double rows
CMC	Office of Development	72	11,000 (990)	Highly exposed square lot; main lot on south side of building with some separated spaces on north included in count
HMC	Foothill Blvd. Semi-Contiguous Lots	Total: 310	46,000 (4300)	A series of thin rectangular lots (except for the Sontag east & south lots) that run along Foothill Blvd., separated by small roads; frequently heavy southern shading, Sontag and Linde lots are exposed
	North of Platt	17	2500 (230)	
	North of South, North, & LAC	108	16,000 (1500)	
	North of Sontag	52	7800 (720)	
	North of Linde	83	12,000 (1100)	
	Sontag East Lots	31	4600 (430)	
	Sontag South Lots	19	2800 (260)	
HMC	Foothill Blvd. North of Parsons	79	12,000	Two contiguous lots, one with southern

			(1100)	shading from buildings and trees and the larger mostly exposed
PZ	East Mesa	208	31,000 (2900)	Exposed square lot; Pitzer is considering a power purchase agreement for solar panels on this lot
PO	East Court	163	24,000 (2200)	Exposed L-shaped lot with the great majority of parking spaces in double rows
PO	Big Bridges	116	17,000 (1600)	L-shaped lot with Big Bridges giving southern or western shade to the lot; all of the parking spaces are in single rows
PO	Kenyon House/South Dorms	124	18,000 (1700)	Square lot with some southern shading from trees
PO	Seaver Theater	113	17,000 (1600)	Square lot with some general shading from surrounding trees
SC	South of Revelle House	85	13,000 (1200)	Rectangular lot with northern shading and some western shading from trees; shielded from street view by wall
Total			302,000 (28,000)	