Solar Energy at the Claremont Colleges: Prospects and Opportunities

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Executive Summary

The community of the Claremont Colleges has become increasingly aware of the rising levels of carbon dioxide in the earth's atmosphere and the rising average global temperature. These trends have compounded environmental concerns over the depletion of fossil fuels, the availability of clean water, threats to biodiversity, and the earth's growing human population. During the past three years, all constituencies – students, faculty, staff, alums, and trustees – have vigorously discussed appropriate paths of action to address these global issues. In the spring of 2007, the Council of Presidents of the Claremont Colleges launched a Sustainability Initiative to promote and support the search for local solutions to these problems.

During the summer of 2007, with partial support from the Sustainability Initiative, a team of 15 students and 5 faculty members performed a first-pass sustainability audit of the Claremont campuses. The audit revealed two key facts. First, consumption of electricity and natural gas accounts for 50% of our carbon footprint. Second, the cost of electricity and natural gas is increasing at an alarming rate – roughly a factor of two increase over the past ten years, accompanied by wild fluctuations during the California energy crisis.

By early 2008, the Presidents of Pitzer, Claremont McKenna, Pomona, and Harvey Mudd Colleges had signed the American College and University Presidents Climate Commitment. Their actions committed the Colleges to reducing their respective carbon footprints to zero by dates to be decided upon in the next two years, and preferably to be as soon as possible. The first and most obvious steps in this mission to combat global climate change involve energy conservation. Upgrades to more efficient lighting technology and more efficient heating, ventilation, and air conditioning systems result in significant reductions in energy consumption and pay for themselves in six months to a few years. After these first conservation steps have been taken, the Colleges will be forced to focus on energy generation technologies that promise long-term, enduring reductions in carbon release and, at the same time, avoid volatile fossil-fuel energy costs.

Solar – Renewable Energy Source of Choice Solar power is the largest and most practical single source of renewable energy that can satisfy the world's energy needs. The earth receives from the sun four-thousand times the power required for global human activity. Claremont is blessed with good solar irradiation (and poor wind potential), so it makes sense for us to take advantage of our natural asset. During the summer of 2008, with support from the Sustainability Initiative, a team of two students and two faculty members surveyed and evaluated all solar technologies that are commercially available, as well as those in mature stages of research and development. The team enjoyed the support and active collaboration of the facilities personnel from all of the Colleges. This report describes our findings and presents our recommendations for the Claremont Colleges.

Global Perspective The average rate of global energy consumption is 15 terawatts, and is expected to grow by 50% to 23 terawatts by 2020. The U.S. is responsible for 22% of current energy consumption, though its share is expected to decrease as China and India and other developing countries require more energy. Fossil fuel prices will continue to escalate as extraction becomes more difficult and expensive. On the other hand, it seems likely that we will reach dangerous levels of atmospheric carbon dioxide before we fully deplete the Earth's reserves of fossil fuels. In any case, the current volatility in fossil fuel prices makes it extremely difficult to predict energy costs beyond 18 months. Since solar energy systems have operating lifetimes of 20 to 30 years, we have found it extremely difficult to evaluate the financial performance of a particular solar system because the cost of the fossil fuels displaced is so uncertain. Chapter 1 of the report describes the global environment in which the Colleges seek a path toward renewable energy sources.

Local Solar Opportunities Chapter 2 reviews the two fundamental types of solar technology: (1) solar photovoltaic (PV) cells in which the sun's energy is converted into electricity with 10% to 20% efficiency, and (2) solar thermal panels in which the sun's energy heats water with 50% to 60% efficiency to supply domestic hot water and to provide hot water for space heating. At the present time, solar thermal systems perform slightly better financially, but PV promises more significant price reductions in the future. In Chapter 3 we describe the best practices of deploying solar systems, and emphasize the point that solar thermal replaces the combustion of natural gas, while PV generates "clean" electricity. It is important to note that Southern California Edison will be supplying a larger percentage of "clean" electricity as they increase the fraction of renewable energy sources (now at 17%) in their energy portfolio. Solar thermal panels, however, seem to be the only sensible way to generate "clean" domestic hot water.

The existing solar systems on the Claremont campuses are reviewed in Chapter 4, and the most promising opportunities for future solar installations are listed in Chapter 5. We solicited proposals and quotes from solar installers for five solar systems to be located at judicious sites on the Harvey Mudd campus. These systems are described in Chapter 6, and their potential financial performances are analyzed. Payback periods range from 10 to 20 years, though these estimates are tentative because of the uncertainty of fossil fuel prices over the next 20 years. Indeed, a very attractive consequence of solar energy systems is the independence from the increasingly volatile fossile fuel industry.

Financing Solar Technology Perhaps the greatest obstacle to climate neutrality at the Claremont Colleges is the financing of solar installations. Of course endowment funds could be used to invest in solar technology, but in these disastrous economic times, it is unlikely the Colleges will be willing to further reduce the contribution of endowment earnings to the operating budget. In many cases in the past, educational institutions have used power purchase agreements (PPAs) to bring solar technology onto their campuses. In a PPA, an independent corporation finances the installation of the solar system, and the educational institution agrees to pay a specific rate for the electricity generated by the system operating on their property. The negotiated rate for electricity can be made more favorable to the college if the independent corporation is formed by alums and friends of the college – in this case the corporation is called a "distributed generation association"

(DGA). An attractive feature of a DGA is its potential as a development tool; alums and friends of the college can be solicited for investments in the renewable energy infrastructure of the college, which can engage alums who have strong commitments to renewable energy and environmental issues but who have not been active supporters of the college. PPAs and DGAs are discussed in more detail in Chapter 6.

Final Recommendations Highlights of our final recommendations are included below, and more details are provided in Chapter 7.

- ***Formulate a Plan for Investment in Renewable Energy Infrastructure*** – Distributed Generation Associations may provide a unique blend of an investment vehicle and a development tool.

- ***Invest in Cost-Efficient Solar Thermal Systems*** – Solar thermal systems are currently the most economical to deploy (although photovoltaics are expected to become much more competitive over the next five years).

- ***Install Photovoltaic Systems on Buildings not on the CUC Distribution Grid*** – Since buildings on the CUC grid receive a discounted rate for interruptible power, structures not on the grid have a much shorter payback period for photovoltaic arrays.

- ***Install Photovoltaic Systems on Buildings with High HVAC Electricity Loads*** – Buildings with electricity-powered HVAC systems operating year-round are ideal candidates for photovoltaic arrays.

- ***Monitor Existing Solar Energy Systems*** – Currently, none of the solar installations on the Claremont campuses are monitored for their energy generation.

- ***Incorporate Solar Energy in All New Construction*** – "Zero-net-energy" buildings should be the goal for new construction – many existing office buildings and housing projects have achieved this status. Generation of clean energy via solar installations is one contributing factor in the design of zero-net-energy buildings.

- ***Establish a Renewable Energy Committee for Building Project Oversight*** – A Claremont-wide committee is needed to advise and support architects and designers in creating low energy-use or zero-net-energy buildings.