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Students in Pursuit of Sustainability Since 1978

HEIF RFP Fall 2008 Cover Page

Proposal Title: Solar Thermal Project Fall 2008

Applicants: Laura Hughes and Jeff Steuben

Primary Contact: Laura Hughes, CCAT Grant writer, Student
Anticipated date of graduation: Spring 2010
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826-3551

Secondary Contact: Jeff Steuben, Student
Anticipated date of graduation: Spring 2009
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Abstract / Brief Description: The Solar Thermal Project seeks to install two evacuated tube panels on the roof of the Campus Center for Appropriate Technology, as well as a monitoring and data-collection system, and interpretive display. The project will showcase solar technologies and offer a unique set of educational opportunities for students and the public to learn about appropriate technologies, while providing heat and hot water to the CCAT building and reducing CCAT's environmental impact of energy usage.

Budget Request: HSU Implemented & Awardee Implemented
Total cost not to exceed: $14,951

Starting Date: (9/09) Completion Date: (5/10)

Partners: Lonny Grafman, Environmental Resources Engineer Lecturer
lonny@humboldt.edu
826-3649

Solar Thermal Project Fall 2008

1. Project Description

The Campus Center for Appropriate Technology (CCAT) is a student funded, student staffed and student directed organization dedicated to sustainability and seeking to help others live likewise. Our mission is to demonstrate appropriate technology in a residential setting, to provide hands-on experiential learning opportunities to HSU and the surrounding community, and to collect and disseminate information about appropriate technology locally and worldwide. For 30 years, the Center has served as a living laboratory for experiential learning opportunities by designing, creating, and testing numerous appropriate technologies, green building designs, and sustainable living techniques, including such projects as a photovoltaic system, a grey water marsh, water catchment system, natural buildings, permaculture design, organic gardening, and pedal power machines.

In this spirit, we seek to implement a new Solar Thermal Project at CCAT by installing two evacuated tube solar thermal panels on the roof of the house, as well as a monitoring and data-collection system, and interpretive display. The solar energy captured by the proposed evacuated tube solar thermal panels will be stored in our existing solar-specific hot water heater system, the Phoenix, which is co-fired by natural gas as a backup. The Solar Thermal Project will not only provide hot water and heat for the facility, but also a unique set of educational experiences to HSU students and the community through the installation workshop, the interpretive display sign, and integration of the project into curriculum of a variety of classes at HSU and CCAT, furthering our aim to demonstrate appropriate technologies to the public (please see connection to University curriculum and student learning outcomes below).

The bottom story of CCAT's Buck House is already equipped with a radiant floor heating system, a series of tubes in the sub-floor through which hot water flows. The heat from the water rises upward to heat the house. Hot water is also utilized in the sinks and shower. Future plans at CCAT include incorporating hydronic heating in the top floor of the building as well, but more investment will be necessary. Although CCAT is equipped with radiant floor heating and a specialized water heater, the system lacks the essential component—the solar panels that provide clean and renewable thermal energy. Without them, we are dependent on natural gas to heat our water. Unfortunately, due to the expense of moving, CCAT has depleted its building funds a cannot purchase these panels on its own.

The Solar Thermal Project includes both HSU and Awardee implemented portions. The HSU portion includes funds for the installation of two solar thermal panels and associated monitoring equipment. The Awardee implemented portion includes funds for the production of a student created interpretive display intended as a marketing and educational tool to explain solar thermal panel function, and to highlight the involvement of HEIF. We request an amount not to exceed $14,951 for the implementation of the Solar Thermal Project at CCAT. This includes the purchase of two evacuated tube panels, a metering system, materials and installation, and a permanent interpretive display. The cost of installation may be less than anticipated depending on the details of implementation. The contractor time involved in the project is estimated to take 45 hours[1] which totals $2,925 at the rate of $65/hour. We have identified Steve Bohner of Alchemy Construction as a preferred potential contractor because of his experience with CCAT installing the Phoenix water heater and the rest of the radiant floor heating. His intimate knowledge of the current installation would aid the task of installing the solar portion of the hot

[1] Source: Ben Scurfield of Scurfield Solar

water system. Bohner and his company have shown time and time again their willingness to help out in-kind and provide quality services at a discounted rate.

One of CCAT's long-term goals is increased scientific quantification of our projects. A design for the solar thermal system monitoring and data collection was chosen based on recommendations from graduate student Peter Johnstone to produce data with low uncertainty. Additionally, the data logging system is scaled to provide future opportunities to measure other systems at CCAT. The monitoring and data collection system will include:

1. Campbell Scientific Data Logger, CR1000
2. EME Systems Pyranometer, Li-Cor200 & signal amplifier, (UTA)
3. McMillan flow meter, U706
4. Three temperature sensors: ambient, entering panels, and exiting panels.

With this system, we will record the total energy captured by the panels, and allow for tracking their efficiency. To jumpstart this process, we are including funding to pay an engineer from the Schatz Energy Research Center to help train CCAT's student engineering technician and webmaster in data downloading and processing.

HEIF is a relatively new program at HSU, helping the university expand its programs for energy independence. CCAT has a strong history of working toward this end as a demonstration home and public educational tool for effectively integrated appropriate technologies, interfacing with thousands of visitors each year in both residential and commercial capacities. Our work promotes the accessibility and applicability of appropriate technologies for energy independence in everyday living and in supporting this solar thermal project, HEIF could benefit from our visibility and reputation for forward-thinking design and experience in showcasing appropriate technologies to the public.

2. Need Statement

The Solar Thermal Project addresses HEIF's mission in the following ways:

The Solar Thermal Project uses innovative technologies to lower the environmental impact of energy usage at HSU. Sources[2] claim that converting from natural gas heating to solar thermal heating can lower a home's energy consumption by one-half to three-quarters. Based on current usage data calculations (see supporting materials page 10), we should expect to save about 100 therms per year. This number is small for a number of reasons. We already have installed the Phoenix, a boiler/hot water heater hybrid with an efficiency of 94%, which vastly reduces our consumption in comparison to a traditional tank water heater. Additionally, CCAT is a residence, and therefore does not use large quantities of hot water.

Apart from the physical installation of the panels, the solar thermal project is entirely student-driven. This grant proposal is authored by Jeff Steuben and Laura Hughes, with contributions from Jocelyn Orr, Nathan Chase and Danielle Ladimir, all students. CCAT Co-Directors and External Affairs staff will organize publicity for the workshop during the installation of the panels, while the Engineering Technician will maintain and operate the system once installed. The project's success will be monitored and published by students.

The Solar Thermal Project meets each of HEIF's goals in the following ways:

- **Student Involvement** – Students are involved in every step of the Solar Thermal Project from planning the logistics to applying for the grant, from hosting the installation workshop to monitoring its progress (please see Needs Statement above).

[2] EERE (Office of Energy Efficiency & Renewable Energy)

- **Accountability** – As mentioned in our project description, a long-term goal of CCAT is increased quantification of our projects and we will thus be recording ongoing data to assess the long-term effectiveness of our solar thermal system.
- **Connection to University Curriculum** – CCAT is already part of the university curriculum, offering a variety of classes on appropriate technology. The solar thermal project affords hands-on learning experience through data collection, monitoring and analysis. Data generated from the project can be used in efficiency models of the house, future greenhouse and photovoltaic system, measuring the effectiveness of installed technology and solar thermal hot water in our climate. Data will also be integrated into courses such as ENGR 114 – Whole Earth Engineering, ENGR305 – Appropriate Technology, ENGR 308 – Technology and the Environment, and ENGR 477 – Solar Thermal Engineering, lending itself to system design, solar thermal design, economic analysis, technological comparisons and examination of appropriate technologies. Through the NRPI department, students will also be involved in the creation of an interpretive educational display (see student learning outcomes and letters of support).
- **Public Outreach and Educational Activities** – We will disseminate information about the Solar Thermal Project and information generated by it through a number of outlets. In addition to traditional press releases, details about the project will be given in our AT Transfer, a bi-annual CCAT publication as well as posted on our website. Hundreds of visitors per year will be directed toward an educational interpretive display sign explaining the project. Finally, the primary educational component surrounding this project is the free public workshop planned around the installation of the panels. Students and the wider community will be invited to join CCAT while the panels are put in place to engage with the project, learn the benefits of solar thermal heat generation, and how solar thermal panels can be installed at home.
- **Media Outreach** – If CCAT were awarded a grant, we would issue an initial press release to traditional outlets as well as local organizational and community newsletters announcing the project and the role of HEIF it making it possible, as well as a final release upon project completion outlining project details and the involvement of HEIF with CCAT. Preference for this task would be given to a student intern in HSU's Marketing & Communication department, or a member of the CCAT student staff.

3. Outcomes

Tangible results and benefits

At the end of this project we will have a functional, energy-efficient heating system and the classroom and workshop space will be heated using solar energy instead of fossil fuels. Additionally, we will have a method to track the effectiveness of the system over time. Overall, the solar thermal project will be an outlet to publicly showcase applied appropriate technology within the community.

Student learning outcomes

Primary learning opportunities for students include the solar thermal panel installation workshop as well as through the development of the in-house interpretive display. Through the installation workshop, students and community members will learn the process of solar thermal absorption from panels and how that energy is transformed in the Phoenix water heater. They will also be made aware of the various uses of the water in the house. Through the development

and creation of the project's interpretive display at CCAT, Natural Resources Planning and Interpretation students will have an opportunity to put their skills into practice. Further learning opportunities include the data monitoring and collection system, which will be integrated into University curriculum through a number of courses. (See connection to university curriculum above.) Additionally, students and community members will be educated about HEIF and solar thermal systems on future tours of CCAT.

Environmental impact

Although there will be a reduced need for natural gas in the CCAT facility and thus some associated carbon offsetting, the reduction will be modest. At 13.4 lbs CO_2 per therm, we will save 13,700-20,000- lbs $C0_2$ per year, equivalent to two average global citizens' annual CO_2 emissions (PG&E, 2008)[3].

4. Student Involvement

Students are involved in every step of the project (please see Needs Statement and Connection to University Curriculum above.)

5. Implementation

The first step in project implementation will be a meeting of the grant authors, CCAT representative and Plant Operations staff to produce an RFP for the solar thermal panel installation and put it out to bid. Once proposals have been reviewed by Plant Operations and a contractor selected, we will meet with the contractor to ensure proper system design, as well as to set a date for installation and an appropriate time for the accompanying educational workshop. Once dates are set, CCAT Co-Directors and External Affairs staff will conduct extensive public and media outreach to ensure proper project and workshop publicity and to solicit the participation of students and community members in the educational experience. In the physical installation of the solar thermal panels, the contractor will mount the panels on the roof, connect them to the existing Phoenix system and test them to make sure they are working. Additionally, CCAT's Engineering technician and webmaster will work with the contractor and an engineer from the Schatz lab to familiarize themselves with the data logging system to ensure that data can be recorded and archived correctly. Once installation of the panels is completed, CCAT will solicit the design and development of an interpretive display sign from Natural Resources Planning & Interpretation seniors based on attached criteria and arrange for its production, as well as conducting press outreach regarding the project. CCAT would be more than happy to include the HEIF committee in the design of the sign.

Key challenges to the Solar Thermal Project involve scheduling the panel installation workshop at an available time for both the contractor and CCAT. Additionally, if the project is contracted to a company other than Alchemy Construction, there may be some compatibility issues. Lastly, the implementation of this project is dependent on CCAT having a new roof installed. Funding for the roof has been approved and Plant Operations and the roof contractor have been notified. We anticipate the completion of the roof before December.

Although funds for the Solar Thermal Project could be approved at a lower level by removing the monitoring or interpretive display components, this would strip the project of its meaning and educational value. Other options include the purchase of less expensive monitoring equipment, although this is unlikely to result in significant savings.

[3] Source: http://pge.com/myhome/environment/calculator/ accessed November 6th 2008

6. Partners

HSU Senior Jeff Steuben, CCAT Grant writer and Graduate Student Laura Hughes, other CCAT employees and affiliates, as well as current Co-Directors Jess Huyghebaert, Andrea Lanctot, and Robert Zandi are partnering to complete this project under the advisory of Lonny Grafman, Lecturer for the Environmental Resources Engineering department. We have also collaborated with graduate student Peter Johnstone and Professor Arne Jacobson on the design for the system metering. Community partners and consultants include Tim Moxon and others from Plant Operations, the contractor responsible for installing the panels and leading the informational workshop, as well as a Schatz Energy Research Center engineer responsible for training the CCAT student engineering technician and webmaster. Long-term implementation of the project will be overseen by the CCAT Co-Directors and Engineering Technician.

7. Timeline

The timeline of this project is predominantly dependent upon scheduling a contractor to do the necessary work. Once arranged, the installation and workshop will take place within a 1 to 2 week period. The interpretive display design will be solicited at the beginning of the semester following installation, when NRPI students partner with organizations to produce signs for their class. The design of the sign will be completed within a semester and produced shortly thereafter. CCAT Co-Directors and staff will be responsible for the installation of the display.

8. Sustainability

CCAT can afford to repair and update our equipment as we have an annual budget for structural maintenance. Co-Directors and the Student Engineering technician will be educated about the solar thermal system and will make repairs when necessary and staff will continue with various outreach efforts. We recognize our limitations in maintaining the integrity of data collection projects through several generations because of the frequent turnover in student employees and Co-Directors. After much consideration, we have decided to focus on the effectiveness of the panels over time, and establish appropriate standardized procedures for data collection, analysis and dissemination. Instrumental in this process is the involvement of the engineering technician, whose explicit responsibilities include the continued monitoring, analysis and publication solar thermal and other CCAT system data, involving other students in the process. At the end of the project's lifespan, most project components will be retired and displayed as demonstration models. All others will be recycled.

9. Assessment

Environmental impact and energy generation will be measured through the data monitoring system and long-term data collection. This information will tell us the number of therms per year CCAT has offset through the implementation of this project and how effective the system is over time. Data will also inform a number of research topics including solar insulation and ambient temperature, which can lend themselves to studies in building efficiency.

Student learning experiences will be measured through a number of methods including: monitoring student and community attendance at the panel installation workshop; monitoring the number of students who have access to the project through CCAT's classes and other organizational opportunities; tracking the hours of students involved with the planning and implementation of the project; consulting with professors of classes who use the project as a teaching tool; tracking student and community use of the interpretive educational display.

Index of Supporting Materials

Heat Pump Alternative Comparison Calculations:

As an alternative to our solar thermal proposal, we have considered an air-source heat pump. However, given CCAT's previously existing infrastructure (see solar thermal system diagram), as well as the increased cost of an air source heat pump, we feel the solar thermal option is most appropriate and cost effective for our purposes (see heat pump alternative comparison calculations).

Solar thermal hot water and air source heat pump were compared using data from a 2 person household in the Arcata area extrapolated for a 3 person household.

Heat Pump Costs:

$8,000	PV electricity for Heat Pump demand
$16,000	Heat pump and installation
$24,000	Total Project (100% water heating capacity)
$12,000	For 50% water heating capacity

Solar Thermal Costs:

$7,400	For 50% water heating capacity in this proposal

As shown, Solar Hot water is 40% less expensive than an air source heat pump. If we consider a 100% air source heat pump at $1.30/therm, the air source heat pump would have a payoff period without inflation of approximately 110 years. Similarly, the solar hot water will pay off in approximately 70 years without inflation. Because of the previously installed infrastructure at CCAT, as well as the increased cost of an air source heat pump, we feel the solar thermal option is most appropriate for our purposes.

Energy Savings Calculations

The amount of energy savings estimated in the Solar Thermal Project Proposal was derived from a 6-month baseline (July-Dec 2007) of natural gas usage of the Buck House during the Fall 2007 semester as seen below.

Month	**Usage** (in therms)
July	11
August	33
September	14
October	24
November	44
December	44
Total	**170**

Table 1: Natural Gas Buck House usage for July-December 2007

To estimate yearly consumption, we predicted that January through June will have a similar usage pattern as July through December. We accordingly multiplied our 6-month consumption by two to identify usage over 12 months: **170 x 2 = 340 therms per year**. If we assume 50% of that was used for the stove (see comment 2 below), we are left with 170 therms used by the heating system.

Based on claims from sources consulted for the project (see narrative), we expect the solar hot water system can reduce heating needs in the neighborhood of 50% to 75%. We thus estimate approximately 100 therms/year in energy savings.

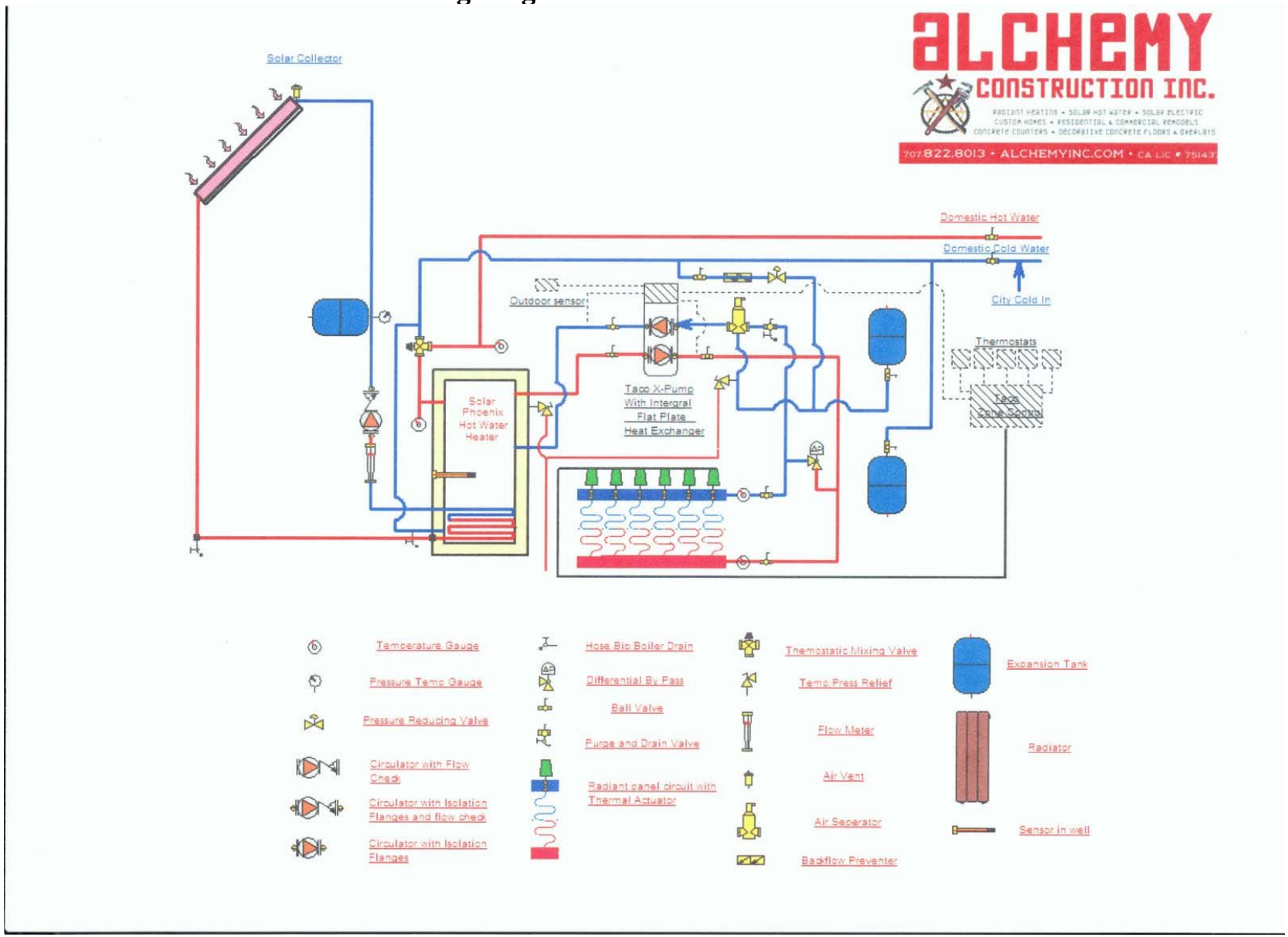
Low estimate: ½ x 170 = 85 therms saved per year
High estimate: ¾ x 170 = 128 therms saved per year

This calculation omits two pieces of information:

1. It strictly looks at natural gas usage and does not consider the electrical demand to run the system. CCAT has a 2.4 kW PV array on the roof that is planned to be operational by the time the solar thermal system would be installed. This system on the former CCAT house reportedly generated about twice as much energy as was consumed in the house. Even with significant additions to the house, we anticipate being a net-zero building in terms of electrical needs.
2. The data in Table 1 does not differentiate between how much gas was used by the Phoenix and the stove/range in the Buck House. Without sub-metering at least one of the appliances, it is impossible to know exactly how much gas is used by each. However, we would estimate that well under 50% was consumed by the range.

Finally, the projected savings (100 therms/year) does not appear to be a significant amount. This is because the Phoenix system is one of the most efficient systems of its kind on the market. First, it is rated at 94% efficiency, and second, it eliminates the need for a separate water heater and heating system. The previous arrangement at CCAT involved an On-Demand water heater with an efficiency rating of only 80-85%, and a heating system using forced air, plagued with duct and leakage problems, severely reducing system efficiency.

Solar Thermal/Radiant Floor Heating Diagram



Model SunMaxx-25
Evacuated Tube Solar Thermal Collector

Specifications:

- Weight: 244 lbs (without crating)
- Dimensions: 89" (with pipe connections) x 6.6ft
- Packaging: Ships via freight on pallet or available for local pickup (1 pallet is available for residential or commercial delivery.)
- Assembly Time: A single collector can be assembled in 1.5 hours
- Manufacturer: Silicon Solar Inc
- Warranty: 3 Year limited (extended warranty available)
- Expected Lifetime: 25-30 Years
- Fitting: 1" NPT

Includes:

- Standard Flush Mounting Face Frame
- Manifold (header)
- 25 Revolutionary SunMaxx Evacuated Tubes
- 25 Copper heat pipes
- Hardware required for collector assembly

Product Details :

- Tube Length: 70 in
- Outer Tube Diameter: 2.2 in
- Inner Tube Diameter: 2.1 in
- Tube Thickness: 0.1 in
- Tube Material: Borosilicate Glass 3.3
- Tube Coating: Graded AI-N/AI
- Thermal Expansion: 3.3 x 10-6 C
- Absorption: >92% (AM 1.5)
- Emittance: <8% (80 C)
- Vacuum: P <5 x 10-3 Pa
- Stagnation Temperature: >428 F
- Heat Loss: <0.7 W/(m2 C)
- Maximum Strength: 1.0 MPa
- Flow Rate: 3-4 G/Min
- BTU per Day at 2000 BTH/ft2 * d: 35,000

Data Monitoring Equipment List:

CR1000 Datalogger for Measurement and Control

Features

- Designed for unattended network applications
- Consists of a measurement and control module and the CR1000WP, a detachable wiring panel
- 4 MB SRAM for data storage, program storage and CPU usage
- Additional data storage using CFM100 Module with a CompactFlash® card
- Data stored in table format
- Operating system: PakBus®
- Software support offered in LoggerNet 3.x, PC400 1.2, or ShortCut 2.2
- Detachable keyboard/display, the CR1000KD, can be carried to multiple stations.

Specifications

- Analog inputs: 16 single-ended or 8 differential, individually configured
- Pulse counters: 2
- Switched voltage excitations: 3
- Control/digital ports: 8
- RS-232 port: 1
- CS I/O port: 1
- Scan rate: 100 Hz
- Burst mode: 1500 Hz
- Analog volt. resolution: to 0.33 uV
- A/D bits: 13
- Programming: CRBasic
- Data Storage: Table
- Telecommunications: PakBus

Campbell Scientific 108-L Temperature Sensor

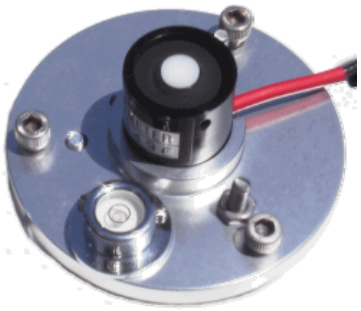
Features

- Sensor measures air, soil, or water temperature
- Incorporates a thermistor as the active element
- Recommended for -5° to +95°C temperature range
- Naturally aspirated radiation shield recommended when sensor is exposed to sunlight

Specifications

- Temperature measurement range: -5° to +95°C
- Steinhart-Hart Equation Error: <±0.01°C at the -5° to +90°C range
- Interchangeability error: Typically <±0.2°C over 0° to 70°C range increasing to ±0.3°C at 95°C

LI-COR Sensors LI-COR radiation sensors receive radiation in a photodiode, which generates a small current in direct proportion to the incident light intensity. The response to light of different wavelengths is tailored by filters inside the different models of sensor to match the response of plants, the human eye, or pyranometry. The current produced by the sensor is too small for use with many data loggers and controllers. The EME Systems UTA (Universal Transconductance Amplifier) can be used to amplify the LI-COR signals to higher levels of voltage or current for use with standard data loggers and controllers.



McMillan Model U706 UHP FLO-SENSORS These units will precisely measure flow rates of virtually any fluid as low as 15 mL/minute or as high as 50 L/minute. Repeatable results are achieved by using a patented microturbine flow sensor design. This design, unlike traditional paddlewheel designs, provides accurate flow measurement with no particle generation. PTFE, perfluoroelastomers, and sapphire wetted parts ensure compatibility with chemicals commonly found in microelectronics manufacturing processes, including deionized water, CMP slurries, acids, solvents, and photoresist.

These UHP FLO-SENSORS integrate the sensing element with advanced electronics to provide output signals proportional to flow rate. Each unit is individually calibrated before shipment, and a certificate of calibration accompanies all FLO-SENSORS. A repeatability specification of ±0.2% full scale reassures process engineers of consistent results.

The Model U706 features a straight flow path and an analog output.

Interpretive Sign Criteria

The following information identifies criteria for the interpretative sign opportunity for students from the Natural Resources Planning and Interpretation (NRPI) program. Jennifer Tarlton's Interpretive Graphics Practicum would be an excellent fit for the project, and she has tentatively agreed to participate in the project for Spring 2010. Students involved in the design of the interpretive display would be meeting NRPI 453 course objectives of gaining skills in theoretical and practical design of interpretive signs, effective graphic communication techniques, and real-world experience in graphic communications and dealing with an agency.

Budget for materials: $2,500

Sign requirements:
• Aesthetically pleasing
• Technically informative
• Accurate
• Easy to read
• Eye-catching
• Weatherproof
• Approximately 5'x 3'

Applicant requirements:
• Enrolled in HSU during semester completed
• Individual or group up to 3 students

Selection/Implementation process:
CCAT will present ideas for the interpretive sign to Jennifer Tarlton's NRPI 453 – Interpretive Graphics Practicum. CCAT has a long-standing relationship with the department and makes such presentations each semester. The individual or group who agrees to construct the sign will work with CCAT Co-Directors, staff and potentially the contractor to ensure the information is accurate. The students will submit their draft to CCAT for review. CCAT will invite HEIF committee members to aid in the review process.

Information on the sign will include:
- Benefits of solar thermal
- How CCAT's solar thermal system works
- What is HEIF and how this project was funded

Letter of Support, Lonny Grafman

HEIF Committee
Humboldt State University
Arcata, CA 95521

November 08, 2008

Dear HEIF Committee,

I am excited to be the faculty partner for the CCAT solar thermal project grant for a few reasons. One is that as a member of CCAT's steering committee, I have been impressed with the level of work and impact from this student run organization. The charter of the HEIF to support student based, energy independence initiatives seems to be a perfect fit for what CCAT has been doing for a long time. This specific solar thermal project is exciting because not only does it move HSU towards energy independence, but it also serves as a great training ground for future engineers and leaders.

The second reason for my excitement is the basis for this letter of support. As an instructor in the Environmental Resources Engineering department, I am very enthusiastic about having quantifiable, renewable energy projects on campus. I feel that projects that support scientific studies and rigorous analysis with sound and consistent data are critical to our education. Three of the courses I teach would directly benefit from a data logged solar thermal project on campus: Engineering 114, Engineering 308 and Engineering 305.

Engineering 114, Whole Earth Engineering, is a broad survey of appropriate technologies. In 114, this solar thermal project would serve as an example to inspect and discuss, both on its technological and social implementations. Engineering 308, Technology and the Environment, focuses on using spreadsheets to analyze and make decision between various technologies. These decisions are based on metrics such as buy-back time, energy use, carbon offset time, impacts on water, air and soil, etc. Good data are crucial to the success of such studies and analyses. Engineering 305, Appropriate Technology, focuses on the science and technology of how appropriate technologies are built and function. This solar thermal project would serve as a great example to study either cursorily or in-depth, giving students the chance to see how this project and its connected systems were created and function. This project would also potentially present some students a system to study before implementing an adapted system as their own project.

In each of these classes this solar thermal project at CCAT would serve as an important on campus model, while the data would allow for study, analysis and reporting. This reporting should be done by Humboldt State University students and published to share with other universities and the world.

Thank you for your careful review of this useful and exciting project,

Lonny Grafman, Lecturer
Environmental Resources Engineering

HUMBOLDT STATE UNIVERSITY

November 12, 2008
To: HEIF Committee
From : Arne Jacobson, Assistant Professor, Environmental Resources Engineering
Re: CCAT HEIF Proposal: Solar Thermal Project Fall 2008

Dear HEIF Committee,

I am pleased to write a letter in support of CCAT's proposal to install solar water heating collectors on the Buck House. The system that they propose to install, including the solar collectors as well as the associated data monitoring equipment, would provide valuable learning opportunities for students in the Solar Thermal Engineering course that I teach (ENGR 477).

The installation of evacuated tube collectors would provide students with access to this state-of-the-art technology. In addition, the inclusion of a data monitoring system would make the system particularly valuable in the context of the ENGR 477 class. I would incorporate the information collected from the system into several laboratory exercises.

The data could also prove useful for students working on projects in other classes in the Engineering and Environmental Science programs, such as ENGR 322 (Environmental Data Modeling & Analysis), ENGR 326 (Computational Methods for Environmental Engineering III), ENGR 370 (Energy, Technology, and Society), and ENGR 416 (Transport Phenomenon).

Please do not hesitate to contact me if you have questions or require further information about the inclusion of this system in courses that I teach.

Very sincerely,

Arne Jacobson, Ph.D.
Assistant Professor, Environmental Resources Engineering
Graduate Coordinator, Energy, Environment, & Society Program
Co-Director, Schatz Energy Research Center

Biographies of Key Personnel

Nathan Chase is a native of Vancouver, Canada and an HSU junior studying Environmental Resources Engineering. As CCAT's Engineering Technician and RESU member, Nathan has been involved with photovoltaic installations, the Grey Water Marsh Installation, and other small structural projects. He also has experience handling successful HEIF grants and working through the implementation process to actualize projects on the ground. He has also been heavily involved in researching the monitoring equipment for this grant proposal and as per the responsibilities of his position will be responsible for collecting, processing and disseminating data and results from the solar thermal project.

Lonny Grafman is an Instructor of Environmental Resources Engineering and Appropriate Technology at Humboldt State University; the co-founder and instructor in a summer abroad, full immersion, Spanish language and appropriate technology summer program in Parras, Mexico; and the executive editor of the International Journal for Service Learning in Engineering. In addition, he is the President of Appropedia, the site for collaborative solutions in sustainability, poverty reduction and international development. Lonny seeks ways to increase knowledge of the world through exposure and synthesis and believes that science, culture and language are inextricably linked. He seeks to highlight that connection through service-learning based education while working to improve existing conditions by leveraging local knowledge, materials, wealth and labor through transparency and stakeholder participation.

Laura Hughes is an Environment and Community Graduate student whose research interests center on Community Agriculture projects as a platform to explore urban/rural place-based attachments/identities and applications to sustainable living. A transplant from New York State's mid-Hudson Valley, Laura graduated from Oberlin College in 2004 and has worked with a variety of non-profit organizations planning and implementing public and educational programs and fundraising events, as well as collaborating on grants, strategic partnerships and managing a corps of over 100 volunteers. A passionate traveler, cook and violinist, she currently works as the grant writer/fundraiser for CCAT.

Jess Huyghebaert is a recent transplant to the West Coast, hailing from the small but sturdy state of Vermont. She started her co-directorship at CCAT in January 2008 and will be finishing up this December. Starting as an exchange student in CCAT classes, Jess was part of the volunteer crew that remodeled CCAT's Buck House and transferred to HSU to become a CCAT co-director. As co-director she has been able to hone many personal, communication and leadership skills, working with the local public, HSU community and CCAT's many employees and volunteers. Jess is hoping to study "Community Agriculture Management" as an Interdisciplinary Studies major and is looking forward to applying the great wealth of knowledge acquired via CCAT to her life and further education wherever she ends up.

Peter Johnstone is a Master's student in the Environmental Systems program, Engineering Option and also works as a research assistant at SERC. He is an active participant in the Renewable Energy Student Union, and has been involved with CCAT through the auspices of RESU, installing the solar photovoltaic system and teaching a variety of workshops on solar

energy. His course of study focuses on energy systems with an emphasis on measurement and testing of energy technology, analysis of system performance, and building energy systems.

Andrea Lanctot is an Environmental Science Appropriate Technology senior who started her one-year term as CCAT Co-Director in June of 2008. As co-director, she shares the duties of managing 17 student employees, facilitating 7 classes, working with HSU students on appropriate technology projects, and implementing new technologies on CCAT grounds. Co-directors also share upkeep of the house, maintenance of appropriate technology systems, and program development. Andrea is Budget Administrator, which makes her responsible for managing CCAT's AS Program budget for this year and developing CCAT's budget for 2009-2010. Andrea is passionate about rebuilding CCAT's technologies that were lost during the move and also designing new technologies. Her interests also lie in student outreach and developing more hands-on opportunities at CCAT.

Jeffrey Steuben is an HSU senior studying Environmental Science with a concentration in Appropriate Technology and a minor in GIS. He is also a former CCAT Co-Director (07-08) and during his tenure, focused on moving CCAT into its permanent location and re-establishing house systems and organization. He is responsible for the initial research and grant writing for the solar thermal project, and has made technical updates from version 1 to version 2. Jeffrey currently sits on CCAT's steering committee.

Robert A. Zandi is a native of San Francisco and CCAT Co-Director. He is currently developing an interdisciplinary major at HSU focusing on creating sustainable global communities through the combined studies of the Spatial Analysis Techniques, Appropriate Technology, and Social Structure modalities. In addition he teaches the Green Construction and Sustainable Technology Seminar classes at CCAT. Robert is most interested in bio-remediation, natural building and green construction, and sustainability mapping, projection and implementation. He has worked over the years at such places as the San Francisco Department of the Environment and the Golden Gate National Parks and Recreation Area, where he was introduced to habitat restoration, environmental youth program development and implementation, and community outreach/ education.

Agreement to Grant Terms

(Adapted from the Humboldt Area Foundation RFP)

By signing this application form, the applicant enters into an agreement with HSU and HEIF that would take effect should the grant be awarded. The applicant attests that:

1. **Accuracy**: The information contained in this application and in any attachments thereto is true and correct to the best of your knowledge.
2. **Use of Funds**: Understands and agrees that, where applicable, all grant funds will be applied to the project in accordance with the description and budget provided in this application as set forth in the award letter. Any significant change in the use of these funds will require prior approval by HEIF. Requests for changes must be submitted in writing. If the revisions are not accepted or funds are not expended for the purpose and ~~the manner agreed to by the~~ grantee, HEIF reserves the right to cancel the grant and any further payments and said funds must be returned to the Foundation. All funds must be spent in accordance with State financial rules and regulations.
3. **Expiration**: Understands and agrees that, where applicable, grants must be paid within one year, unless otherwise specified. Any requests for extensions of time must be submitted in writing prior to the expiration date. Grants not paid or ~~granted an extension can be cancelled~~ without notice after the expiration date.
4. **Grant Report(s)**: Understands and agrees that, where applicable, report(s) will be submitted to HEIF by the phase or date specified in the grant award letter. Report guidelines will be forthcoming.

To indicate acceptance of the foregoing terms and conditions, please sign below. Please retain a copy of this agreement for your files.

Applicants:

Primary Contact

Name Laura Hughes **Signature** Laura A Hughes **Date** 11/14/08

Name Jeff Steuben **Signature** Jeff Steuben **Date** 11/14/08

CCAT Solar Thermal Project Fall 2008

Awardee Implemented Project Budget

Category (list major items)	Unit (e.g. miles, each, etc.)	Cost per unit	Total cost	Amount requested from HEIF	Matching contribution?	Who/what is the other source?	Matching contribution confirmed?
Consumable supplies							
Interpretive Sign production cost	each	$2,500	$2,500	$2,500			
		TOTAL:	$2,500	$2,500			

HSU Implemented Project Budget

Category (list major items)	Unit (e.g. miles, each, etc.)	Cost per unit	Total cost	Amount requested from HEIF	Matching contribution?	Who/what is the other source?	Matching contribution confirmed?
Durable equipment							
Evacuated Tube Panel	each	$1,000	$2,000	$2,000			
S-5! Mounting Brackets	each	$15	$180	$180			
Campbell Scientific Data Logger CR1000	each	$1,400	$1,400	$1,400			
EME Systems Pyranometer Li-Cor200 & UT/	each	$350	$350	$350			
Campbell Scientific Temperature Sensor 108	each	$90	$270	$270			
McMillan Flow Meter U706	each	$1,769	$1,769	$1,769			
Tax & Shipping	NA	$535	$535	$535			
Consumable supplies							
Misc. piping, connections, pipe insulation	various	various	$700	$700			
Other							
Contractor Labor	hours	$65	$2,925	$2,925			
17% contractor mark up*	NA	$1,722	$1,722	$1,722			
Engineer Training	hours	$20	$600	$600			
		TOTAL:	$12,451	$12,451			

*This expense may prove to be less depending on the details of implementation.

HEIF Timeline and Outcome Template

CCAT Solar Thermal Project Fall 2008

Activity	# of weeks to complete	Expected outcome	Responsible party
Release Project RFP for bid	4	Contractor selected, Date for Installation set	Co-Director, Contractor
Publicize Workshop	4	Student Attendance at Workshop	Outreach Coordinator
Panel Installation	1	Panels Mounted to the Roof	Contractor
Additional Installation and workshop	1	Functional Solar Thermal Heating System	Contractor
Data Log Set-up	1	Accurate Data Collection	Engineering Technician
Data Logging	ongoing	Long-term Record of Energy Usage	Engineering Technician
Student Interpretive Display	16	CCAT has a quality permanent display	Co-Director, NRPI Student