SRC Solar PV Project: Integrating Renewable Energy into UAF’s Campus

Jessie Huff
The SRC Solar PV Project (Integrating Renewable Energy into UAF’s Campus)

Figure 1: Created by Jessie Huff as a concept design

“We hold the following values to be the cornerstone of our identity as an academic community: Student success, Vitality and creativity of new discoveries and scholarship, Access to comprehensive higher education and lifelong learning, Sharing assets and resources with Alaska communities through active engagement, Independence of thought and action in the pursuit of knowledge, Diversity of our students and employees, Accountable for and efficient use of university resources, Promoting sustainable living in the North.” _UAF Master Plan

Abstract

The Student Recreation Center (SRC) Solar PV Project is a student run and financially supported initiative to install a 15kW system on its southwest exterior wall. In developing this project undergraduate students worked with faculty and staff from many departments and disciplines. Not only will it be the first large scale solar array on campus, but it will also create a model and set a precedence for future renewable energy integration. In order to receive the 30% federal tax credit on solar installations the students are seeking a public/privet partnership with a local investor. The students recognize that energy efficiency is the first step in greening campus, because energy not needed is better than energy supplied by renewable technologies. To increase awareness of energy conservation and efficiency, a touch screen monitor will be placed in the lobby of the SRC and a web-site will track real time energy consumption and production as well as overall performance throughout the systems life (funded through previously approved grants). As the SRC is continually upgraded for efficiency, we will continually educate the population about solar power in Alaska and energy savings through efficiency techniques.
Sustainable Thinking and Initiative

UAF has an obligation and opportunity to foster sustainability in the north. Alaska is rich in renewable energy potential and is poised to grow our local economies by utilizing these resources (REAP). This is particularly true in rural Alaska where the high cost of fuel (mostly diesel and gasoline) creates a greater economical incentive, compared to populated grid-tied areas. Thus, rural communities are in the unique position to lead the world in small scale, integrated renewable energy systems, and UAF has the opportunity to exemplify this potential and to help Alaska emerge with leading experts and exporters of advanced renewable energy knowledge and technique. Through renewable energy integration and a holistic approach to sustainable community planning we can empower northern communities and thus increase self-reliance. Each successful efficiency upgrade, weatherization, and renewable energy project helps secure our community from the volatility of the fossil fuel market. The many projects and initiatives supported by the Office of Sustainability and the RISE Board are strategic steps in fostering a cultural change and demonstrating an institutionalized commitment to energy awareness, sustainable thinking and local economic development on the UAF campus and connected northern communities (Anderson, 1999). The many unobstructed south facing walls of campus are ideal for solar capture. Being able to assess and understand a sites solar potential is critical for sustainability in northern climates, whether through solar PV, solar thermal, or passive solar design. Taking advantage of this solar resource is demonstrative of how sustainable thinking can attract investment, boost local economy and knowledge, lessen or dependence on fossil fuels, and create reliably priced energy.

The University of Alaska Fairbanks is witnessing a rapid increase in efforts to measure, monitor, and foster sustainability on campus. With the top down support of the chancellor Brian Rogers, sustainability is becoming part of UAF’s culture and curriculum.

The following timeline represents key moments and milestones in the rapid growth of sustainable efforts in and around UAF:

- **2001 – Currently** Resilience and Adaptation Program (RAP) was created at UAF and funded by the National Science Foundation. The program accepted its first students in 2002. Masters and PhD students focus on issues related to sustainability for Alaska and the Circumpolar North through the exploration of global-local interactions, up- and down-scale effects, important feedbacks, adaptive capacity, and critical thresholds of social-ecological change. Go to [http://www.uaf.edu/rap/](http://www.uaf.edu/rap/) for more information.

- **2003-2005** – Sustainable Campus Initiative and Steering Committee created a document outlining the state of campus and recommending areas in which sustainable solutions should be applied.

- **2004 – Currently** Sustainable Campus Task Force (SCTF) organizes first Annual Sustainable Living Conference, and becomes the campus sponsor of Earth Day events.

- **2006 – Currently** The Cold Climate Housing Research Center (CCHRC) opened, on land leased from UAF, allowing staff to work closely with students, faculty, and researchers at the university. It is an industry-based, nonprofit corporation created to facilitate the development, use, and testing of energy-efficient, durable, healthy, and cost-effective building technologies for people living in circumpolar regions around the globe.

- **Spring 2008** – Students in NRM 430 class under the leadership of Susan Todd prepare a first draft of a UAF campus sustainability plan.

- **July 2008** – Chancellor’s Sustainability Transition Team develops recommendations for UAF Campus Sustainability, based on 9 categories: Energy, Transportation, Purchasing, Waste Management, Built
Environment, Food, Education and Curriculum, Social Sustainability and Institutions. Energy is listed as the number one issue and recommends that UAF strive to become a leader in sustainable energy use and generation in the north.

(see http://www.uaf.edu/sustainability/rise/currentproposals/faqs/SustainabilityReportSummary.pdf for the mission and vision of these nine areas)

- **Spring 2009** – Students vote in favor of a $20 per semester fee titled Student Initiative for Renewable Energy Now (SIREN). It is intended to help pay for programs and initiatives to make UAF a more sustainable and energy efficient campus. It will raise approximately $5 million over the next ten years, with Chancellor Brian Rogers pledged match.

- **Spring 2009** – UAF’s Really Free Market in partnership with Interior Alaska GreenStar is a success.

- **Fall 2009** – Review of Infrastructure, Sustainability and Energy (RISE) Board created to review and administer the SIREN Funds for student-initiated sustainable projects and programs. Preference is given to reducing UAF’s consumption of non-renewable resources.

- **Spring 2010** – Student Initiative for Renewable Energy Now (SIREN) fee up and running, known to the students as the *sustainability fee*.

- **Spring 2010** – The Campus Master Plan incorporated sustainability into the current challenges facing UAF.

- **Fall 2010** – The Office of Sustainability is established and Michele Hébert becomes the Sustainability Director.

- **Fall 2010** – First recycled art show.

- **Spring 2011** – Recycling is incorporated into UAF’s master plan, a free bike rental program is established for UAF students, and the chancellor awards the first Green Carpet Awards on earth Day.

- **Summer 2011** – A carbon footprint analysis of campus is completed (link coming soon). An interactive online metering of 20 campus buildings real-time energy use begins (link coming soon). A team of 10 students worked together to complete UAF’s first STARS® report. The Sustainability Tracking, Assessment & Rating System™ (STARS®) is a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. STARS® was developed by the Association for the Advancement of Sustainability in Higher Education (AASHE). Student vegetable gardens sell produce at UAF’s own farmers market and supply the cafeteria.

Sustainability appears to be the global challenge of the 21st century, and universities around the world are creating curricula and strategies to prepare students for and lead society into a more desirable future (Greenberg, 2011 & Meyer, 2010, & Roca, 2007). UAF’s campus is no different, and after many years of talking about the changes which need to transpire, increased top-down and community support, in combination with the students commitment to the SIREN fee and subsequent fund has given UAF the power to act in new and powerful ways.

The SRC Solar PV project will also create a new precedent for solar PV investment partnerships, it will demonstrate that solar technology is not just installed for research (such as on the Cold Climate Housing Research Center) but that it is also viable option for Alaskans, and it will begin to diversify and thus secure UAF’s energy future.
Justification: site specific renewable energy concept

When analyzing the potential for integrating renewable energy systems into the current UAF power system, wind and hydro-capacity are negligible on campus. Although we do have plans to measure wind speeds on buildings and near ventilation systems for possible future wind integration. Geothermal heat is not available and the potential for geothermal heat pump technology is not often discussed because of the incompatible relationship with permafrost and the difficulty of integrating it into existing infrastructures. The UAF campus is, however, perfectly positioned to capture solar radiance. It has many unobstructed south facing buildings which can be utilized. In general, solar-thermal-heating (through closed loop glycol heating or through passive solar) is the most efficient way to capture solar radiance in Alaska; due to the low solar density at our northern latitude. Areas near the poles receive a lower solar density because the sun is lower on the horizon and must filter through more atmospheres to reach the Earth’s surface. However, because of our Combined Heat and Power plant (CHP) this technology is redundant (discussed in more detail on page 7).

Justification: solar PV information

Solar (PV) photovoltaic can and should be utilized at UAF. The community of Fairbanks, the AK Railroad, the Department of Transportation, and off grid residence have already begun to integrate solar. The 2011 The Alaska Solar Tour, funded by the Alaska Center for Appropriate Technology in conjunction with the American Solar Energy Society had 43 residence open their homes and businesses to the public in order to share and educate about our communities renewable energy potential. Please take a look at the pdf on line to learn more about what AK residence are doing, http://www.alaskasolartour.org/Sites/AlaskaSolarTourStatewide.pdf. While many off grid homes are utilizing solar PV, GVEA has begun a power purchasing agreement for grid tied homes.

“Launched in 2005, the Sustainable Natural Alternative Power program - SNAP - now has 39 local renewable energy producers. SNAP output topped 129,100 kilowatt-hours in 2009 - enough to power almost 15 average Interior residences for a year. That’s 9,128 gallons of refined oil GVEA didn’t have to burn. In 2009, nearly 500 members contributed to SNAP, raising a total of approximately $41,000 to pay SNAP producers.”
http://www.gvea.com/about/history.php/

A technique for looking at solar PV and determining suitability is through an energy-pay-back-time (EPBT) calculation or an embodied energy calculation. Figure 2, explains the EPBT for different solar PV technologies, and with color variation to clarify the energy intensity associated with each phase of production.

Embodied energy - can be defined as, the total amount of energy per panel expended in mining and gathering the material + The total energy used per panel to produce the item + the total energy per panel to ship and install the panel in the usable location.

EPBT - is a commonly used calculation for renewable energy devices and is defined as the time required for any energy producing system or device to produce as much energy as was required for its manufacture (Sanchez, 2008). Sometimes the energy used in transportation is excluded in EPBT calculations.

Each part of a PV system takes energy to both produce and
transport. Out of these components the modules require the most energy to manufacture because of the heat required to create molten silicon (Sanchez, 2008). As with most complex economics-related calculations, some assumptions are required. Once the EPBT value is established, the payback period is dependent on proper installation of the panel in order to capture the full solar insolation (about 1700 kWh/m2/yr average for southern Europe, about 1800 kWh/m2/yr average for the United States and about 1000 kWh/m2/yr in Fairbanks Alaska).

In Fairbanks, depending on the quality of the location (shading decreases performance), the amount of snow mitigation (also decreases performance), and the amount of solar reflection from snow (increases performance) we can expect approximately 1000 kWh/m2/yr.

PVWATTS, an online solar PV resource created by the National Renewable Energy Laboratory (NREL) was used to calculate the solar insolation of a fixed vertical wall mounted system like the one being developed for the SRC and output a value of 944 kWh/m2/yr. It is important to note that this calculation does not account for the added insolation documented in Fairbanks from our spring solar reflection off of snow. Also, the standard derate factor they use is .77, which may not be exact (see appendix page 2).

**Solar PV has advanced over the years in many ways, here are some of the main points to consider:**

1) It is more efficient to make PV panels today than it was just a few years ago. This is important because it lowers the embodied energy or EPBT of the panel.

2) By calculating Fairbanks solar insolation and adjusting the calculations from figure 2 we can expect an EPBT of about 3.5 - 4 years and a total embodied energy payback of about 4.5-5.5 years for polycrystalline solar PV panels. (Sanchez, 2008, & Bankier & Gale, 2006.)

3) It is important to note that most rural villages in Alaska experience a much higher cost of energy than the UAF campus. The monetary payback gets shorter as we compare the price of solar to the higher cost of energy in villages. Remember the EPBT has nothing to do with price only energy used vs. the amount of energy produced. EPBT might increase as the transportation to a village is added, while monetary payback will become quicker.

4) Solar energy systems are also known for their low maintenance costs. As long as you position the panels in such a way as to discourage snow build up, there is little upkeep involved and no moving parts to replace. Inverters are generally warranted for 10 to 15 years and they also very rarely need maintaining over that time period.

5) Panels are typically warranted for 20 to 25 years.

**Justification: Current power sources, existing solar PV**

The Nenana bus shelter’s three solar PV panels total 510 watts. This small array was installed in August of 2007 and was meant to be a pilot project for a larger system (on the SRC). Installation was initiated through the efforts of the UAF Power plant and UAF Design and Construction. They UAF power plant monitors the data from the small system (see figure 4).
Figure 4: Provided by UAF Power Plant, output from Nenana Bus Shelter since its instillation in August of 2007 (shown in light blue).

Justification: Current power sources, UAF Power Plant

UAF currently operates a combined heat and power plant (CHP). This means that the heat generated by burning coal is used to produce steam which having turned the turbines to produce electricity; steam is captured as a condensate and used to heat the buildings and water on campus. It does this very efficiently and because campus continually needs power, we continually have heat. In fact, UAF has a total summer electrical load that is almost as large as its winter load, due to the fact that we are not burning coal for heat in the winter. When coal, or any material, is burned to produce electricity only about 30% of the energy potential in that material is captured in the production of electricity. The rest of the potential energy literally “goes up in smoke” or steam in this case. Many power plants in the U.S. are not CHP plants, and very few U.S. CHP plants achieve efficiency to the extent which UAF’s power plant has. The current CHP plant and infrastructure makes the use of solar thermal technology redundant on UAF’s campus. However UAF is in need of electricity and solar PV technology can supply that.

The plant was built in 1964 and is constantly receiving small upgrades to improve and maintain its efficiency. It is, however, in need of major upgrading. The campus has also outgrown the power plant; today campus demands more electricity than it is capable of producing. A typical yearly profile of energy input for all of campus is: coal 86%, fuel oil 10%, natural gas 1%, and purchased power from GREA 3% (see figure 5). Because campus is continually expanding and if all other variables remain constant, UAF will need to buy more power from Golden Valley Electrical Association (GVEA) in the future. This is our highest expenditure for power (see figure 6).
For reference, the 3% of purchased power is bought from GVEA. In 2006 GVEA’s power profile was: 41% Natural Gas, 26% Oil, 30% coal, and 3% Hydro. The average amount UAF pays for purchased energy is $.20 per kW-h. This is in comparison to an average $.03 per kW-h of Healy coal utilized by the UAF CHP plant.

The SRC Solar PV Project will displace this higher-cost energy which we buy from GVEA.

**Justification: Campus grid and building efficiency**

As part of UAF’s commitment to sustainability, each building on campus will soon be metered and charged for actual energy used. This incentivizes energy awareness and encourages energy conservation. These upgrades also require digital monitoring, and a real-time, public display of energy information. The Office of Sustainability has simultaneously planned the introduction of an interactive energy dashboard which allows for on-line monitoring of 20 buildings real-time energy use, allowing us to have campus wide competitions. The Lucid Dashboard will go online in the fall semester of 2011. Lucid system will also track solar PV’s production in real-time and we will have the ability to see graphs representing the overall performance of the system throughout its life. As the SRC is continually upgraded for efficiency, we will be continually educating the population about solar power in Alaska and energy saving through efficiency upgrades. In June of 2011 the SRC Solar PV Project received $5,000 for the purchase of three touch screen monitors which can display the Lucid software, one monitor for the SRC, the Woods Center, and a third location yet to be determined.

The SRC is a student funded building and any power produced by the PV system will lower the student’s costs when the campus wide metering project reaches fruition. The UAF power plant has agreed to pay for the solar electricity generated at GVEA prices. This money will either go to the SIREN Fund or to the SRC depending on the stage of the metering project. It could be viewed that the UAF Power Plant is incentivizing solar energy on campus by agreeing to pay the higher cost of energy to the students.

The proposed Solar PV System would never supply the SRC with all of its power. The proposed system of 15.6kW would replace 2.25% of the 2009 yearly load. Therefore, there is no need for batteries, since all the power the solar panels produce will be utilized at all times and immediately by the SRC. If for some reason it is not used by the SRC, the electricity will automatically flow into the university grid system. With only a 2.25% effect on the current SRC’s yearly electrical load, the students and staff at UAF will have an opportunity to improve the efficiency of this building and increase this percentage (see figure 7).
Looking at energy loads per building, there are many roofs and walls on campus which receive full unobstructed southern exposure, and are ideal for mounting solar PV arrays. Thermally, many buildings on campus benefit from the sun (south facing windows) in the winter months, but in the summer become some of the highest users of electricity in order to cool them (mostly achieved by the use of fans to circulate outdoor air, not through actual refrigeration units). Likewise, some buildings use more heat in the winter because they do not have south facing windows. We can also tie electricity use to the amount of natural lighting provided by windows. Over the years many organization such as the CCHRC and the Alaska Center for Appropriate Technology (ACAT) have achieved very efficient buildings though smart designs specific for our northern climate. These utilize south facing windows with smart lighting designs coupled with proper insulation and ventilation.

The SRC was targeted as the first of many possible solar PV arrays for the following reasons:

- Its energy profile shows more demand in the summer months (when UAF purchases more power from GVEA at a higher cost, but we have no use for the waste heat) which is when solar PV is available.
- It has an unobstructed south-facing wall and roof, both capable of holding a solar PV array.
- It has grid tie in capabilities.
- The SRC has been targeted for energy efficiency upgrades and has been listed to receive grant money for this. It is UAF’s hope that through the attention gained from the Solar PV array we can draw attention to the usefulness and potential of conducting efficiency changes to buildings. Often efficiency upgrades go unnoticed, in actuality, they are one of the most sustainable and cost effective tools we have to decreasing our dependence on fossil fuels.
- It is a student-funded building and at the point when the campus departments begin paying their own energy bill, any cost savings from the PV array will directly benefit the students’ cost of running the SRC.
- The Beluga Field and recreation area is often the center of community wide events. Being a highly visible and public building a solar PV array will be noticed there, helping to start the conversation about sustainability in northern communities.
- It is shown that students seeking a higher education are concerned about environmental issues and look for universities which are in line with their ideals. “Green means eco-friendly, and 69% of college applicants this year say having information about a college’s commitment to environmental issues would contribute to their decision to apply to or attend the school, according to a survey of 8,200 students by The Princeton Review. That’s up from 64% in 2008” (Marklein, 2011).
This project’s intent is to use the SIREN fund for renewable energy on campus, (true to SIREN’s name), and for a project that directly benefits the students in the long run. It is also meant to draw attention to the University’s newly formed Office of Sustainability and the UA and UAF system-wide commitment to combating climate change and carbon emissions. This will be the first large renewable energy project for UAF and will bring a goal and vision of the university, and the student body into realization. We hope this commitment to and the development of renewable energy will positively affect UAF’s image, the community of Fairbanks, the interior, and the long term impact on the perspective of present and future students.

SRC Solar Panel Review Committee: 10/22/10 – 11/19/10

Student and community opinion

In October 2010, the SRC Solar Panel Review Committee was created by the RISE Board and charged with informing the student body of the project and collecting their opinion. The committee met twice to organize the information before distributing it to the student body on November 1st 2010. A display was posted in the SRC, West ridge Café, and the Woods Center. The display consisted of 2 artist sketches, (see figure 1 & 8) depicting mounting options, the web address where the original justification could be found (see appendix pages 3-6), and a link to the SRC Solar PV Survey. See appendix page 7-12 for the results of the survey or online at http://www.uaf.edu/sustainability/rise/projects/solar/srcresults/.

The survey results are overwhelmingly in support of the project and a continued sustainability effort.

Funding Options: UAF based funding

2 grants have been awarded to the project through the RISE Board: a total of $38,000, as of 08/09/11

On December 10th 2010 the RISE Board awarded the SRC solar PV project $23,000 in order to develop the prescriptive specifications. UAF’s Design and Construction hired Design Alaska to produce them and Design Alaska consulted Remote Power. On February 11th all parties involved met at the SRC to do a walk through.

UAF’s Design and Construction gifted the solar PV Project funds to buy an interactive screen for viewing the Lucid software, connected buildings, and the solar arrays real-time power profiles: a total of $5,000
Funding Options: Help from the community, public private partnerships

The SRC Solar PV Project is currently in a pre-solicitation phase (8/9/2011). We are advertising the project with hopes of developing public interest. We are looking for vendors, contractors, investors, or individuals whom wish to become involved with the project. Technical edits are being coordinated through the input of several University departments. Our hope is that a private partnership will allow for the use of the federal governments 30 percent Business Energy Investment Tax Credit (ITC).

The Bid Proposal Idea
The investor will install the system and own the system for the agreed upon term. The investor can receive the 30% tax credit on the total cost of the system in the year of construction (approx. $60,000). The electricity generated, will be used in the SRC building and the exterior south facing wall space will be used by the investor. The investor can capture depreciation on the system however they see fit. The RISE Board will pay a monthly or annual fee to the investor for leasing of the solar PV system, as part of the agreement. At the end of the contract term, the system will be donated to the University and the ownership will transfer to UAF. The third party may be eligible to take advantage of a second tax credit based on the donated value of the system. We assume the Solar PV System will take on a negotiated name, involving advertisement for the third-party as an incentive for investing.
References


CCHRC – Cold Climate Housing Research Center - http://www.cchrc.org/


