

The Co-Design of Culturally-Inspired, Sustainable Housing with the Pinoleville Pomo Nation

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Abstract

The notion of developing sustainable communities is generally accepted as a way to reduce the negative environmental impacts associated with human activities, increase the health of citizens, and increase the economic vitality of communities within a country. In order to further the development of sustainable communities, federal and local governments have placed significant attention upon designing sustainability and renewable energy technologies, such as photovoltaic (solar) and grey water recycling systems to reduce (1) fossil fuel based energy consumption, (2) water consumption, and (3) climate-changing greenhouse gas (GHG) emissions associated with anthropogenic activities. The Pinoleville Pomo Nation (PPN) of Ukiah, CA, is an example of a Native American government and community that has embarked upon an infrastructure development program to design and develop culturally appropriate, sustainable housing for its members. In 2008, the Pinoleville Pomo Nation formed a partnership and the Community Assessment of Renewable Energy and Sustainability (CARES) to co-design sustainable housing that utilized sustainability best practices and renewable energy technology as well as reflecting the long-standing culture and traditions of the PPN. We present the Pomo-inspired housing design created by this partnership and illustrate how Native American nations can partner with universities and other academic organizations to utilize engineering expertise to co-design solutions that address the needs of the tribes. As a result of this partnership, the Pomo-inspired house design was utilized to secure federal funding to create centralized housing that will aid the PPN in their tribal sovereignty, economic self-sufficiency, and environmental harmony goals.

The Pinoleville Pomo Nation

The Pinoleville Pomo Nation (PPN) is a self-governing Native American tribe located in Northern California's Mendocino County on the outskirts of the city of Ukiah; it is dedicated to ensuring that its "members enjoy safe, healthy, and environmentally benign environments, both natural and built" (Edmunds n. d.). The PPN has several hundred members scattered throughout Northern California, and most of these members are seeking to return to their ancestral lands and traditional community. In order to meet the growing demand of people seeking to return to PPN lands, the PPN has undertaken two land purchasing and housing development ventures. One is a large parcel, zoned semi-agricultural, located in Ukiah, and the other is a much smaller housing subdivision located in Lakeport, CA. Rising energy costs associated with heating and cooling the current houses funded by the US Department of Housing and Urban Development (HUD) is placing an increased burden on residents. Furthermore, the drought conditions within and around the PPN are also taxing the resources of the residents and the local government. As a result, the PPN is seeking to implement sustainable technology and best practices that will increase their self sufficiency and meet their housing, energy, and water conversation needs.

Some of the sustainable technology and best practices being considered to address the aforementioned concerns are solar photovoltaic systems, wind turbine systems, passive and active solar water heaters, grey water systems, and passive building design strategies such as passive solar gain and sun shading. The solar photovoltaic and wind turbine systems are currently being evaluated for power generation capabilities, while the solar water heaters are being evaluated for water storage and heating capabilities. The grey water systems are being considered for their water conservation capabilities, and the passive building design strategies are being considered for their impact on overall household energy usage. The PPN, however, neither has the technical expertise, nor adequate funding, to develop and implement the designs outlined above. In the spring of 2008, the PPN contacted UC Berkeley and CARES in the hope of creating a partnership that would help them achieve their goals.

Community Assessment of Renewable Energy and Sustainability (CARES)

The Community Assessment of Renewable Energy and Sustainability (CARES) is a sustainability assessment and engineering organization that is led by engineering and architectural graduate and undergraduate students at the University of California, Berkeley (NCIIA 2008). CARES was founded in 2007 to address the disconnect between the creation of sustainability technological innovations by engineers and the needs of end users. The mission of CARES is to enable end users to make informed decisions about sustainability and renewable energy technologies by giving them agency during the design, development, and implementation of renewable energy technologies. In 2008, CARES received an Advanced E-Team grant from the National Collegiate Inventors and Innovators Alliance (NCIIA) to create an online sustainability hub and assessment tool that will facilitate collaboration among consumers, communities, academics, and manufacturers to assess problems and find solutions to reduce their environmental impact. The sustainability hub and assessment tools provide a platform where users can (1) assess their current level of sustainability, (2) receive advice on appropriate sustainability and energy solutions, (3) connect with vendors and customers with similar interests to help implement the sustainability and energy solutions, and (4) measure the improvement in their personal level of sustainability and environmental impact.

Under the CARES umbrella, students at University of California, Berkeley have been able to work on projects that allowed students to provide services to local communities and further developed their

communication and professional skills. In the case of the Pinoleville Pomo Nation-CARES partnership, UC Berkeley undergraduate students in the Human-Centered Sustainable Product Design module of the Engineering 10: Introduction to Engineering Design and Analysis course were able to work with members of the Pinoleville Pomo Nation on an energy and housing design project. [0]

Related Work: Tribal Governments and Sustainability

Native American tribal governments throughout the United States of America have placed great importance upon achieving environmental harmony within their lands. These tribal governments have begun discussing ways to reduce their tribes' environmental impacts and improve their overall personal level of sustainability. Native American tribes that are considered to be "federally recognized tribes" or sovereign nations by the United States government have the right to create treaties and have a direct government-to-government relationship with the US government and other local governments. This effectively means that no decisions about the lands and people of a sovereign Native American tribe can be made without the consent of the respective tribal governments. Currently, the Bureau of Indian Affairs (BIA) has a granted 562 Native American tribes as "federally recognized tribes" (2009).

The Navajo Nation Council, for example, has developed a policy "to promote harmony and balance between the natural environment and people of the Navajo Nation, and to restore that harmony and balance as necessary" (n. d.). To implement this policy, the Navajo Tribal Utility Authority (NTUA) has been pursuing renewable energy power generation from wind power to provide electricity to 18,000 Navajo homes that currently are not electrified. These homes account for approximately 75% of tribal homes in the United States that have not been electrified (Battiest 2008). The Navajo Nation has also cultivated a partnership with Sandia National Laboratories to address the issues of water and soil contamination by uranium processing (2005). Engineers and scientists from Sandia National Laboratories went into several Navajo communities and met with the people in order to determine which technologies were culturally appropriate and could be transferred to the Navajo Nation to clean up the communities exposed to contamination by uranium and processing chemicals. The Navajo Nation was able to take the lead in defining the scope of the projects and prioritizing the objectives of the projects. This partnership has lead to an improvement of the health of the members of the Navajo Nation and has also lead to increased discussion about developing the renewable energy potential of the Navajo Nation's lands.

Pinoleville Pomo Nation (PPN) and University of California at Berkeley

On April 13, 2008, residents of the PPN in northern California, members from the University of California, Berkeley (UCB), and CARES participated in an innovation workshop to understand the sustainability and environmental needs of the PPN community and to provide recommendations for housing designs for the community. The underlining principle of the innovation workshop is that the residents of the PPN community are experts on their needs and therefore should co-design solutions with designers and engineers.

The innovation workshop began with an ice-breaker session in small groups of three to five people. The listening session was then followed by a large group round-robin session on good and bad technology in order to increase the comfort level of discussing technology and to learn the impact of different technologies on various members of the community. In order to increase the comfort level of all participants, no titles were used during the innovation workshop. Next, the participants were divided into three groups (Elders, Adults, and Youth) and the participants described and/or illustrated specific needs related to sustainability in their current environment. The participants then voted on the top needs identified by the three groups using Post-it notes and markers. Finally, the participants were divided into five groups (Traditional Building Techniques, Energy Generation and Conservation, Exercise and

Recreation, Privacy, and Heating, Cooling, and Lighting) to brainstorm about conceptual design solutions based on the needs generated by the Elders, Adults, and Youth groups. Figures 1 and 2 show images and results from the innovation workshop.



Figure 1. Privacy Group Figure



Figure 2. Heating, Cooling, Lighting Group

| Split Group User Needs Assessments | | | |
|---|--|---------------------|----------------------|
| Elders Group | Adults Group | Youth Group | |
| Opportunities to Work | Privacy in Home | Cooling | Shooting |
| Exercise and Improve | Activity Space (Sleeping, Playing) | Heating | Lighting |
| Fresh Air | Lower Electricity Bills | Privacy | Fun |
| Less Overcrowding | Clean Road (No Dirt when Dry /Mud in Rain) | Individuality | Sleeping |
| Host Visitors for Extended Time | Save Electricity | Swimming | Eating |
| Accessibility within House | Larger Cooking Space | Space | Surviving |
| Build Your Own Things with Resources You Have | Larger Working Area | Convenient | Resisting |
| Be Able to Grow Your Own Foods (Vegetables and Herbs) | Openness in Homes | Storage | Driving |
| Opportunities to Socialize within Community (Unplanned and Planned) | Protection from Strangers | Comfort | Power Generation |
| Youth to Get Excited and to Build Hands On | Privacy among Homes | Safety | Shelter |
| Learn and Use Traditional Techniques | Protection from Animals | Community | Showering |
| Buy Equipment to Teach Young Ones Skills | Storage Space | Exercise | Happiness |
| Traditional Pomo Housing: Circular | | Personal Connection | Transportation |
| | | Attractiveness | Cultural Integration |

Table 1. Needs Expressed During Split Group User Needs Assessment Sessions

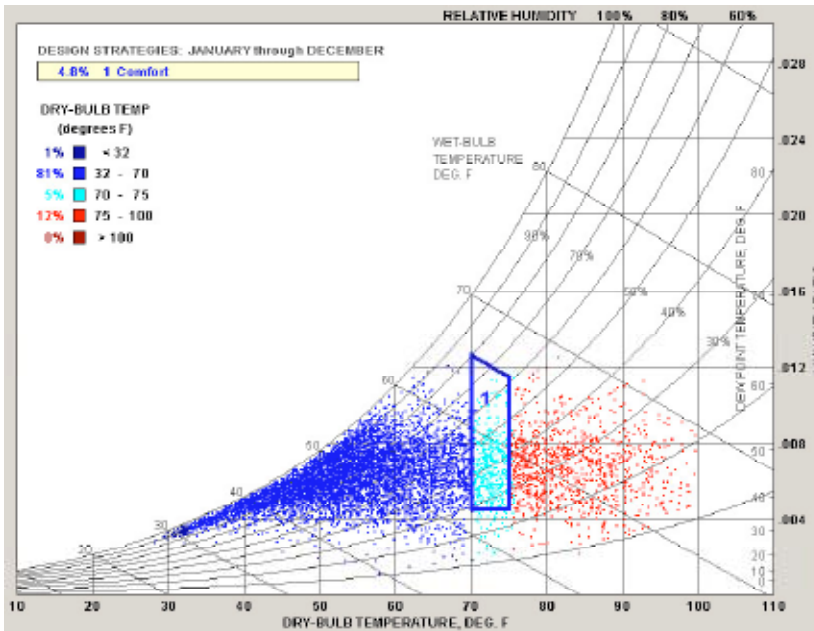


Figure 5. Full-Year Psychrometric Map of California Climate Zone 2

Twelve percent of the time, the temperature range is above the comfort zone (75-100°F), while most of the time (81%) the temperature is too cold, ranging between 32-70°F and sometimes getting even cooler than that. This means that this climate suffers both from cold and hot weather and will need climate solutions for both situations to make living more comfortable. During the winter months the climate is usually too cold, while during the summer months, the temperature ranges from being very hot during the day to too cold during the night (Figure 6, 7). The low range of humidity during the summer months makes the heat easier to overcome with passive cooling solutions. Building with high thermal mass will reduce the heat load and will move 17.5% of the hours into the comfort zone (marked #3 in Figure 8). The addition of night ventilation to this strategy will help quickly cool down the thermal mass, moving 3.2% more hours into the comfort zone (marked as #4 in Figure 8).

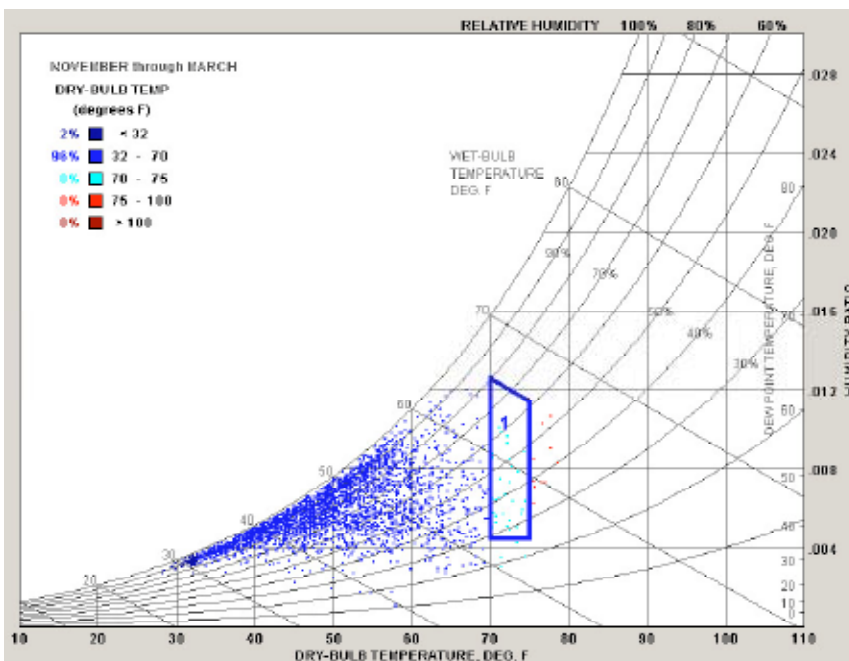


Figure 6. November-March Psychrometric Map of California Climate Zone 2

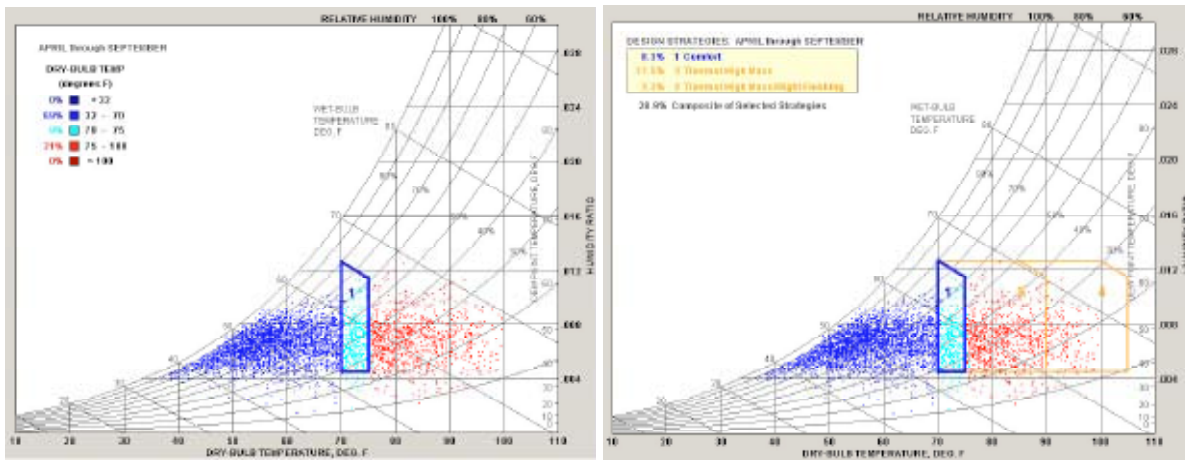


Figure 7. April-September Psychrometric Map Figure 8: Potential of Design Strategies for Reducing Heat Load

These two strategies will take care of nearly all the over-heated hours and could completely eliminate the need for active cooling systems like air conditioning. The cold weather is more difficult to overcome in this climate, as it is spread all throughout the year and occurs during both day and nighttime hours. Nevertheless, adding direct internal heat gain through southern windows (marked as #7 in Figure 15) as well as passive direct solar gain through high mass (i.e., heavy wall absorbing direct radiation and radiating it back as heat into the house), marked as #9 in Figure 15, can cover 32% more of the cold hours through the year. These potential strategies bring us to a total of 68% of time which will not require active, energy-consuming solutions for gaining thermal comfort at home. However, an efficient heating strategy combined with well-insulated walls and energy efficient technology can take care of the remaining time with minimal energy use.

Co-Designed Pomo-Inspired Housing Design

Based on the needs and the conceptual home designs generated from the innovation workshop and follow-up interviews with members of the PPN, a new Pomo-inspired housing design shown in Figure 3 and Figure 4 was generated. The main structure of the design includes a large decagon with five hexagon shaped attachments and a dome shaped roof. We chose to incorporate one large central living space and then additional smaller private spaces attached to address the needs of community living and openness, but also the need for privacy. In our floor plan, you'll see that we allotted the main living area as a split living room and kitchen and the attachments as private bedrooms or storage. Please see Figure 9 for the final prototype.

The design also takes into account cultural and traditional respect for the four directions of north, south, west, and east in addition to Father Earth (down) and Mother Sky (up). We incorporated this into our design with five attachments and one main central unit, making six areas in total. Overall, we wanted our design to resemble the yurt structure as best as we could while also making accommodations for larger families, including space for extended family to stay. In the Pomo Indian culture, the elder family members never move to nursing homes but live with their children when they are no longer able to care for themselves. Therefore, our design allows for "granny units" by using attachments for additional living space. The roof is dome shaped but flattens out at the top to increase available space for "living roofs," which we have placed on all roof surfaces.

The living roofs not only have insulating qualities, but also provide space for traditional plants to be grown, addressing needs of optimizing space, energy conservation, and cultural integration. We included

lots of windows in our design to take advantage of natural lighting. There are windows above each of the attachments to allow for roof access, large windows in the east and west, and a large circular window in the center of the roof. The opening in the attic allows light to be carried all the way to the lower floor of the house. The window directly on the face of the roof acts as both a skylight and provides access to the roof.



Figure 9. Prototype of Pomo-Inspired Housing Figure 10. Prototype of Pomo-Inspired Housing

Outcome of Partnership

As a result of the work with CARES, the Pinoleville Pomo Nation has become empowered to make more informed decisions about renewable energy options and sustainability best practices for their community. The Pinoleville Pomo Nation has used the Pomo-inspired home design to apply for and receive federal funding to build culturally inspired sustainable homes and buildings and perform renewable energy feasible studies of wind, solar, and biogas technologies. [0] Some qualitative comments from members of the PPN and students also provide more information about the success of the collaboration:

Personally, I really enjoyed working with all of the UCB and CARES students over the one-year project. To see this project go from an original model all the way through to the completed prototype was amazing. The students worked very hard to create this project. They asked a lot of questions and seemed to take genuine interest in our needs, such as: our energy bills and gray water usage, and to keep this project as green as possible. We had several meetings with the UCB and CARES students and from these meetings they were able to accurately assess and meet our “green” ideas and traditional needs. Because of this project, I have become very interested in sustainable environments and architecture. I look forward to working with CARES members Ryan and Tobias on future energy feasibility studies and other projects.

Another member from the PPN spoke about how this collaboration gave her agency in the design process: I feel an important part of the collaboration for me, is my voice is finally being heard. We don’t have to settle for living in a “box” HUD house. At the conclusion of the planning sessions with Pinoleville Pomo Nation and UC Berkeley, we will have a prototype house that represents Culturally Informed Sustainable Housing, the product of our collaboration. There are many cultural and historical barriers that have appeared during this process. I personally had to take a step back and look deep inside of myself and decide what is best for our next generations. It was difficult to rethink what was taught to me as a child in order to make the best decision for the future of the Pinoleville Pomo Nation. I am satisfied with the outcome of the collaboration and I look forward to more projects in the future.

One male, Asian-American student wrote in his design journal:

Today was essentially the kick-off for our human-centered sustainable design project. To be honest, I’m rather excited about it. I was assigned to my first choice project - solar electricity generation for the Pinoleville Pomo Indian tribe. I’ve been interested in alternate forms of energy for a long time, and am eager to learn more about it, not to mention have the chance to work on my first genuine engineering project.

Today, we had our innovation workshop at the PPN reservation in Ukiah. Man-where to begin! Overall, I'd have to say the experience was a positive one. I mean yes, it was a bit of a hassle getting there and it was certainly a very long day, but I feel that the knowledge gained about the PPN people and their needs . . . It was a productive/ informative day, and I look forward to beginning the design process with my team mates.

Conclusions

In the partnership with Pinoleville Pomo Nation, we have found that the approach of considering the end user as an expert on their own needs and co-designing with members of the community leads to the development of the best solutions and high adoption rates of these solutions. One of the biggest lessons learned from this partnership with the Pinoleville Pomo Nation was that there is no one standard for sustainability, merely frameworks. During the innovation workshop, the members from CARES and UCB were able to learn that the PPN framed sustainability in terms of Tribal Sovereignty, Economic Independence, and Environmental Harmony.

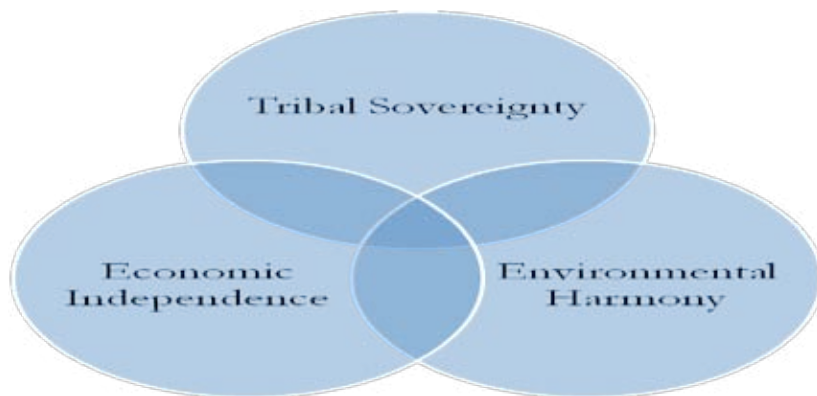


Figure 11. Framing Sustainability

This co-design approach typically involves spending a significant amount of time working with members in a community to build trust and understand the needs of a community in order to design solutions to meet those needs. We have found that the concept of sustainability is personal and it must be defined by the end user(s). The co-design approach utilized by CARES changes the power dynamic to the extent that everyone involved in the design process is considered to have expertise in certain domains, and the participants' collective intelligence can be harnessed to produce solutions that meet the needs and requirements of the end user.

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