Sustainable Systems at Poblaki

Exploring the Designer-User Relationship and Developing a Business Model Rooted in Community Co-operation

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December 2008

ABSTRACT

During a site visit in early October 2008, staff members from the Meribah Ram Pump company and the Border Green Energy Team (BGET) identified technical and non-technical issues with the current ram pump system at Poblaki that prohibit system sustainability. In response, this report proposes a three-element solution that addresses the following: (1) understanding the community context for introducing the ram pump system, (2) developing a business and education model to encourage system health, and (3) implementing solutions for immediate and anticipated technical issues.

OVERVIEW OF ISSUES AT POBLAKI

Technicians and volunteers from BGET recently accompanied two representatives from the Meribah Ram Pump company to inspect a pump system failure at Poblaki village. In January 2008, Meribah donated an advanced prototype of their product to the village as part of a system to deliver water from a nearby stream to the local school. BGET aided Meribah with the system installation. When the system failed, a village member called Meribah and BGET to request help.

Upon arrival at the village, the BGET and Meribah teams walked to the water collection site just upstream of the ram pump. Here, a shallow, concrete-lined basin collects water diverted from a nearby stream. A 4" diameter PVC pipe carries this water to the catchment tank that supplies the drive pipe to the ram pump. The original intent of this preliminary upstream collection basin was to allow sediment carried by the inlet stream to settle to the bottom of the basin. Unfortunately, due to recent heavy rainfall, characteristic of the rainy season in this part of Thailand, mud and other debris had filled the basin almost to capacity. Only about one inch of water stood in the basin and flowed into the 4" PVC pipe to the catchment tank. Team members hand-dug the basin free of mud, and once the basin filled with water, the flow to the pipe increased dramatically.

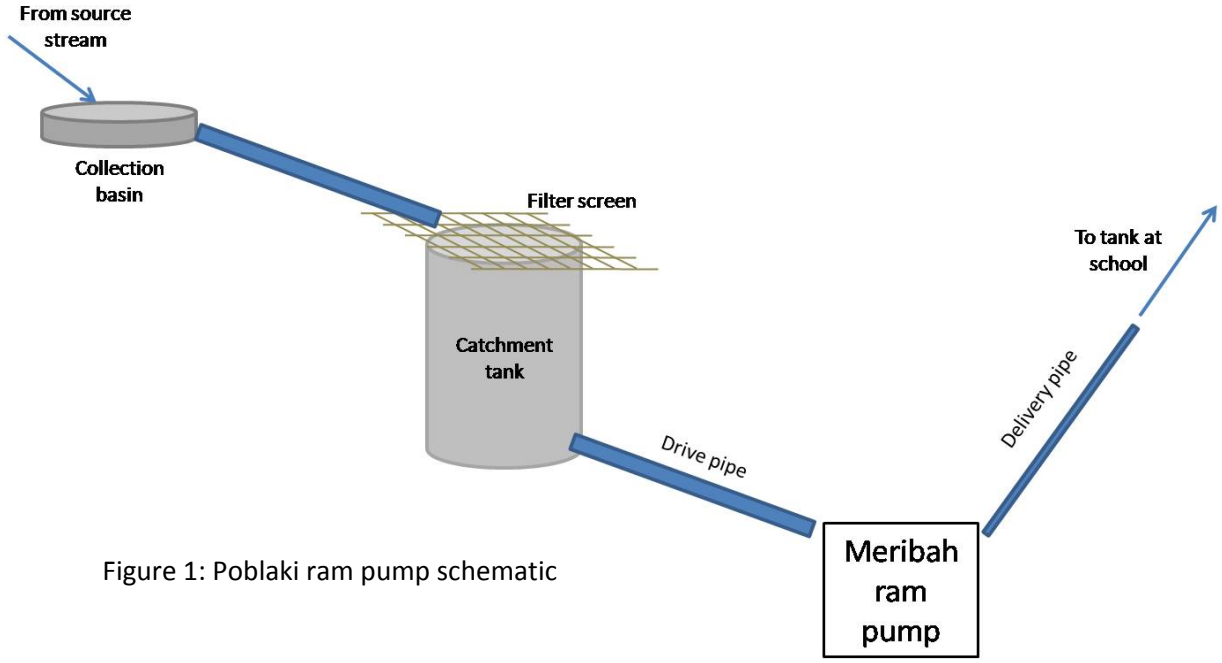


Figure 1: Poblaki ram pump schematic

The team then moved downstream to the catchment tank and ram pump. Due to the prior low flow condition from the upstream settling basin, the catchment tank was only half full. Since the ram pump automatic starter will not trigger the ram pump unless the tank is full, the teams waited a few minutes for the increased flow from the settling basin to fill the catchment tank. The Meribah team experimented with the automatic starter counterweight, and soon the ram pump system was continuously pumping water. Cheered by the relatively simple solution, the teams returned to the village for dinner.

Later in the evening, after another intense but brief rainstorm, the teams received news that water was not being delivered to the tank at the school. BGET team members volunteered to inspect the system the next morning.

Again, the upstream settling basin was nearly filled with mud deposited from nearby streams during the previous evening's heavy rainfall. BGET members again removed the mud by hand until water flowed easily into the pipe. A brief check to the ram pump site showed that the catchment basin quickly refilled and that the automatic starter kicked off the ram pump. BGET members then returned to the village by following the delivery pipe, stopping every few steps to touch the pipe and feel the vibrations form the water hammer to indicate that the pump was incrementally pushing water up the hill.

At the village road just before the delivery pipe enters the school grounds, BGET members discovered the delivery pipe had broken where it entered the road. The pipe had been buried in the road at some depth, but had snapped where it was not covered with dirt.

Figure 2: BGET technician Em lifts the broken end of the delivery pipe from the muddy road. Water flows from the break.

Unfortunately, the team was not prepared to fix a broken pipe and had to leave Poblaki without a water pumping system. BGET hopes to address the pump issues when the team returns in early 2009 to install a small photovoltaic system at the school.

In addition to the technical issues mentioned above, the Meribah and BGET teams discussed the project's long-term operation and maintenance sustainability in the community. Other than initially calling Meribah and BGET for help and hosting the teams during the short trip, there was no community involvement in seeking a solution to the broken pump system. Meribah admitted that the ram pump was given to the community at no cost and installed with little input from the villagers. Both teams recognize a need for more communication with Poblaki citizens about the value of a water pumping system and about the technical issues.

The proposal that follows presents three aspects of a solution to encourage long-term sustainability for the Poblaki pump system. The first element investigates the needs, desires, and habits of Poblaki citizens, with an eye towards understanding the village's point of view and refining the problem to be solved. In the end, a ram pump water delivery system may or may not be appropriate. This seems like taking a step backwards, but it is a critical step. Without insight into the community's point of view – including social organization, values, needs, and wants – it is impossible to design a system that meshes with village life. If the system does not fit well with the people who use it, then when any component fails, the entire project will fail.

The second and third elements assume that the ram pump system is appropriate and desired by Poblaki. The business model of the water pumping system, including a value scheme to commoditize the pumped water and plans to buy replacement parts and support local technicians, and other ideas to encourage community involvement once the system is completed satisfy the second element. The third element describes the solutions to the technical challenges outlined above and proposes a process for handling any future problems.

THE THREE-ELEMENT SOLUTION

ELEMENT ONE: COMMUNITY INTERVIEW FOR APPROPRIATE SYSTEM DESIGN

The best solutions are inspired from intimate knowledge of and empathy with the user for whom they are designed. In this case, BGET should commit several hours over a period of several days to ask questions, listen, and learn about life in Poblaki, state of water use and needs before the arrival of the ram pump, and the state of water use and needs since the installation of the pump. Thai, Karen, and English speaking members of BGET will be vital in this process. Interviews can be conducted on an individual or family basis, or BGET team members can invite interested villagers to meet in the school (or other public place) to participate in a town hall-type gathering. The following is an outline of example questions that will help build a context in which to start designing a system:

1. Current state of the village:
    a. How is the community organized?
        i. Who are the leaders?
        ii. How are decisions made that impact whole community?
    b. What is the local economy like?
        i. What type of jobs do people have?
        ii. Who works? (i.e. teenagers? Old men and women? Children?)
        iii. What is the highest/lowest valued job?
        iv. What is the economy based on? Cash? Rice?
        v. How are resources shared (or not)?
    c. What is the village work ethic?
        i. What do people consider their daily responsibilities?
        ii. How do people spend their free time?
        iii. What would people like to do if they had more free time?
    d. What is the role of the school in the village?
        i. Who goes to school?
            1. Open to all children?
            2. Age groups?
        ii. Who runs the school?
        iii. What services does the school provide?
            1. i.e. space for adult classes, meeting space, etc?
        iv. Do parents have to pay some fee to send kids to school?
    e. What else about the culture do we need to understand?
2. Water in the village before Meribah pump
    a. How did people access water?
        i. How much time does it take in the day?
    b. What did people like and not like about that method?
    c. Who used the water?
    d. What is the water used for?
    e. Did/how did use behavior change with seasonal variations?
    f. Does anyone do rainwater harvesting?
3. Water in the village after Meribah pump
    a. Who uses the water?
    b. What do ppl like and not like about the new system?
    c. What happens when the system fails and water is not delivered to the tank at the school?
    d. How was use behavior changed since the ram pump was installed?
        i. Do people use the water for new purposes?
        ii. Do people use more water?
    e. DOES THE VILLAGE WANT TO KEEP THE RAM PUMP SYSTEM?

The above questions are a launching pad for conversations with the citizens of Poblaki. Ideally, these interviews will reveal more than simply the answers to the questions, but will also reveal key insights to village culture that will shape the design, installation, and life of the water system. If the interviews show that members of the village would like to keep the ram pump, BGET should call another meeting in accordance with the village decision-making structure to begin the design process. This meeting should discuss financial, educational, and technical schemes to support the system, as outlined in the following description of Element Two.

The remainder of this report assumes that the user interviews conducted during Element One indicate that the villagers identify *water delivery* as the central issue. The best solution will provide the service of water delivery in a way that respects all villagers' lives.

ELEMENT TWO: BUSINESS MODEL AND EDUCATION FOR SYSTEM SUSTAINABILITY

In this section of the report, we recommend that the Poblaki Ram Pump System include a structure to commoditize the service of water delivery from the stream to the tank at the school, such that the structure provides financial support for the system's operation and maintenance to ensure its sustainability.

Identifying the Role of the Ram Pump

The most successful NGO efforts to bring advanced energy technology into the developing world have been those that do not simply donate equipment, install with foreign volunteer labor, and walk away. These attempts, while directed with good intentions, do not consider the lifetime of the system and the role of the system in the context of the village culture. In addition, case studies of development projects show that people take better care of and are more engaged in systems for which they had to contribute money or labor (please refer to the Appendix for brief synopses of some case studies). The same principle holds for most people around the world, the haves and the have-nots alike; a person will be more careful with a product she has bought or made herself than with one an anonymous donor has given to her for free. In the developing world, not only do donated products fail because of the lack of user buy-in, but because the act of donation itself condescends. Alternatively, treating all people as potential consumers who will pay for a service or good allows the individual a sense of pride in the exchange of her hard-earned money for the product. The questions of how much the fee is and what it is truly paying for are best worked out by the community itself.

Water is an essential resource, and access to clean water is a basic human right. Since water is so valuable as to be priceless, is it ethically responsible to, as we are suggesting, put a price tag on the system that improves villagers' access to water? What would a water system that operates without a price tag look like? What kind of socio-economic stratification do we impose on the community with the introduction of a commoditized water delivery service?

The key distinction that enables us to consider any degree of commidification is that we are proposing that the price tag go on the ***water delivery service*** and not on the resource itself. The

ram pump system does not increase or decrease the amount of water available; it merely changes the avenue by which villagers obtain the water. Charging some fee for this new service does not deny anyone the basic right to water. Those who cannot afford the fee or choose to opt out can continue to retrieve water in the traditional method.

The traditional method – walking to and from the stream and carrying water a few gallons at a time in plastic containers—is certainly an example of a system without a monetary price tag. It works, in the sense that it provides the service of water delivery from source to point of use, but at what physical and psychological cost to the person hauling the water? Before the recent pipe failure, the ram pump system did not charge a monetary fee and may have saved villagers whatever physical and psychological cost they may have felt under the traditional method; this also represents a price tag-less system, but only until the point at which the ram pump system requires maintenance. Then the price tag appears for the villagers, who must revert to the traditional method and pay the physical and psychological costs, and an even larger price tag for the engineering teams at BGET and Meribah, who must travel to Poblaki with replacement parts. So, neither the traditional method nor the previous ram pump system is a price tag-less system.

Developing the Fee Model

A system that combines the physical and psychological cost-saving benefits of the ram pump with a village-based operation and maintenance schedule that precludes need for BGET and Meribah engineering teams would remove the price tags mentioned above. This is the system that we propose in this report, but it also is not without some costs at the village level. We believe these costs are appropriate for the following reasons:

1. they indicate the value added by the water delivery service
2. together they form a bank from which to fund replacement parts and basic salary for a trained village technician.

Now that we have defended the utility of a fee-based water delivery service, the question remains how that fee will be shaped. As mentioned previously, ideally the villagers will collaborate to develop the rate structure, with talks mediated by BGET. The following list outlines some discussion topics that should be raised during these talks:

1. Who pays? Who wants to benefit from the water delivery service?
2. How much is the fee? Should it be monthly/annual/other fee?
3. How to regulate?
    a. Charge a rate based on metered consumption similar to electricity rate structures
        i. How to meter? Buy a flow meter for the tank at the school?
    b. Charge per family/per person?
    c. Charge per trip to the tank?
4. Change fees throughout the year to reflect seasonal availability of water?

5. Is the fee monetary or based on something else of value (labor, time, barter, etc. as ascertained by the conversations with people as suggested in Element One)?
6. Who is responsible for collecting and saving the fees?
7. Funds for technician salary, spare parts for system maintenance
    a. Perhaps set up a fund to sponsor education, electrification, agriculture, etc. efforts within the village. Who will determine which proposed projects receive funds?

Education for System Sustainability

As is consistent with BGET's practice in other projects for which it is the primary organizer, BGET and Meribah should schedule a general training session to inform a representative from each family participating in the ram pump water delivery service how the system works. This training should be general enough so that people without technical interests can follow along, but detailed enough so that anyone could identify maintenance issues when water stops flowing to the tank at the school. BGET can also help devise a plan of action that anyone can take upon noticing a system malfunction, which might include a diagnostic flowchart or checklist of potential solutions for common failures. In addition, BGET and Meribah should offer more detailed technicians' training sessions to those citizens who are especially interested. This training builds jobs in the village and provides local maintenance support. BGET should also emphasize the importance of community technician (CT) roll-over, so that as trained members move out, they pass along their knowledge to others who can care for the system. Villagers may also be interested in supplementary classes in water safety, health, and hygiene, which BGET allies such as Aide Médicale Internationale (AMI) may teach.

Other community responsibilities that will support the system's long-term sustainability include regular village-wide meetings to discuss system health, pricing, resource sharing, and funds allocation to deserving projects from fees collected for the ram pump water delivery service.

ELEMENT THREE: PROBLEM SOLVING FOR TECHNICAL ISSUES

In this section of the report, we recommend easily implementable solutions to the two immediate technical problems – (1) the persistent pipe blockage from mud washed into the basin from seasonal storms, and (2) the broken pipe at the road near the school—and propose methods for addressing future technical issues.

Pump System Design Review – Pipe Blockage

As BGET and Meribah observed, even a brief afternoon rainstorm can wash enough sediment from the surrounding hillside to nearly fill the small collection basin to capacity.

Figure 3: BGET technicians Thai (left) and Sunti (right) stand in the shallow basin and use their hands to remove sediment deposited by run-off from previous rainstorms.

During the wet season, two streams feed the collection basin; during the dry season, one stream dries to a trickle and only one stream contributes to the basin. The ram pump system was designed to handle only the flow from the year-round stream. Installation team members had placed a section of bamboo in the year-round stream to divert some flow to the basin. After the storm that occurred on the first day of BGET's recent visit, some sand partially filled the bamboo "pipe" and restricted flow. Also during installation, the team had built a short, basic wall of rocks and dirt to isolate the collection basin from the wet season-only stream. Storm run-off from the wet season-only stream has since destroyed the short wall so that sediment-laden flow contributes to the collection basin.

Figure 4: Bamboo "pipe" diverts water from the year-round stream to collection basin.

During the BGET's recent visit, it was observed that although the bamboo "pipe" did accumulate some sand, the water flowing to the collection basin was relatively free of sediment compared to the flow from the wet season-only stream, which was murky brown with silt-sized particles. To keep the collection basin and intake pipe unclogged, BGET should ***reinforce the isolation wall*** between the collection basin and the wet season-only stream by building a concrete

wall instead of the current wall of rocks and dirt. This will prevent the bulk of the sediment from entering the collection basin, reduce time spent emptying the basin of accumulated sediment, and significantly improve the ram pump system operation. Isolating the collection basin to the year-round stream will not completely eliminate sedimentation effects; manual sediment removal must be considered in a maintenance schedule and as a potential solution in a trouble-shooting guide.

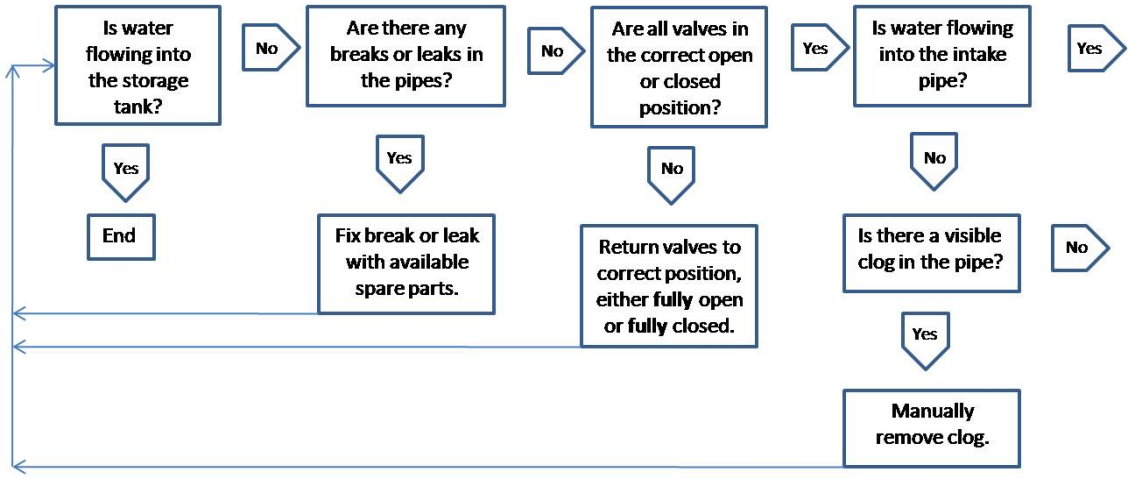
Pump System Design Review – Broken Pipe

To restore water flow from the stream to the tank at the school, the broken delivery pipe must be replaced (see Figure 2). Upon inspecting the break, BGET team members hypothesized that seasonal storms washed away enough overlying dirt to expose the pipe to damage from human or animal foot traffic. To reach the water storage tank at the school, the delivery pipe must somehow cross a three meter-wide dirt road. Running the pipe overhead would introduce unnecessary head loss in the system. Running the pipe under the road requires appropriate protection for the pipe against the weight of the dirt road and all traffic on the road. BGET may consider protecting the pipe with the following solutions: 1) bury the replacement pipe section deeper under the road surface, 2) cover with a flat plank or surround in a larger diameter pipe or bamboo and then bury at the same depth as before. No other section along the delivery pipe path is exposed to as high risk for damage as the section under the road. Community members responsible for ram pump system maintenance should keep extra lengths of pipe available to quickly fix future breaks.

Systematize Troubleshooting and Maintenance

BGET is already familiar with including troubleshooting and maintenance in the training curriculum for PV and microhydro power systems; Meribah engineers can provide information and guidance to help BGET craft similar lessons for the ram pump system training. In addition to the training classes, BGET also has experience writing multilingual manuals (English, Thai, Burmese) with comprehensible illustrations, and can use Meribah's help to create similar documents for the ram pump system.

To assist the community's trained technicians (CTs) identify a problem's source when water stops flowing to the school tank, BGET and Meribah should work together to create a flowchart (or other method of organizing and presenting information) similar to the one shown below as an example:



In addition to the flowchart that CTs can use to take action when a problem arises, BGET and Meribah should develop a list describing common or expected failures in the system. As with the manual, the flowchart and list should be available in many languages. BGET can also suggest that the CTs record system status and maintenance histories in a logbook for future reference.

To support the CTs, the village should also maintain a stockpile of replacement parts, such as extra lengths of PVC pipe, and tools so that any issues can be addressed as soon as they are identified. Meribah and BGET may need to buy the first cycle of parts for the village on a loan to be repaid through the water delivery service fee; future replacement parts can be paid for directly from the fees.

In the case that CTs cannot identify or address a problem in the system, Meribah and BGET should be called. The CTs will be able to provide detailed knowledge about the system's operational history and maintenance schedule that may be helpful in determining the issue and solution, and they will expand their own knowledge of the system by helping Meribah and BGET.

CONCLUDING REMARKS

The current sustainability issues with the ram pump water delivery system at Poblaki present BGET unique opportunities to test the effectiveness of the community cooperation model for development projects and to work with a community to develop a pricing scheme for water instead of kilowatt-hours. The lessons learned from this project will guide Meribah in future ram pump system installations and may widen BGET's scope to include more water delivery service projects.

A.1: Solar Electrification in Bhutan and Nigeria

Website: http://www.self.org

The Solar Electric Light Fund (SELF) is a non-governmental, not-for-profit organization that designs and installs photovoltaic systems to provide power for fluorescent lighting, computer, internet and satellite connection, and equipment for homes, medical clinics, research stations, and micro-enterprises in developing nations around the world. Scope of the project varies with local needs at each project site.

In Bhutan, SELF provided capital funding for all the solar electric system costs and a loan mechanism for 151 families in Phobjikha. Systems ranged from US$475 for 75 W units to US$365 for 50 W units. The loan plan required families to pay one quarter of the install cost at the time of installation, with monthly payments at an interest rate of 7% for the following three years. In addition to providing electrification and an appropriate loan mechanism, SELF taught locals – including a pair of teenage women – solar technology concepts, installation procedure, and maintenance.

SELF followed the same model for the project in Jiagawa State in northern Nigeria. Here, the US Agency for International Development, the US Department of Energy, and the Jigawa Alternative Energy Fund (JAEF) with the Jiagawa state government financially supported the project's capital costs. SELF and JAEF's goals were to use solar energy to electrify many aspects of village life, including water pumping/irrigation, homes, entrepreneurial businesses, primary schools, medical clinics , and night lighting for safe streets. JAEF manages the operation and maintenance of the system, collects fees, and trains and deploys technicians. Electricity consumption is metered, and people pay a community-determined price per kilowatt-hour. The monthly cost of the electricity simply replaces the nearly equivalent to the monthly cost of fuel residents used to burn for lighting and other energy services (a water delivery service fee is not replacing any existing cost). These fees contribute to system maintenance costs and technicians' salaries. Since the villages' electrification, residents have taken initiative to launch businesses with micro-financing, develop evening adult education classes at the schools, and kick-off social events in public areas. Residents and local government officials have been so satisfied with the results that the Jigawa state governor is partnering with JAEF to expand the project to thirty more villages.

(Photo credits: http://www.self.org)

A.2: Bikes Not Bombs Village Bicycle Project

Website: http://www.bikesnotbombs.org

Bikes Not Bombs (BNB) is a non-governmental, not-for-profit organization based in Boston, Massachusetts, USA. The mission statement proclaims:

Lasting peace and social justice require equitable and sustainable use of resources. BNB provides community-based education and assists development projects with recycled bicycles, related technologies and technical assistance, as concrete alternatives to the militarism, over-consumption & inequality that breed war and environmental destruction. Our organization is part of a worldwide movement for peace and responsible stewardship of the earth.

This organization relies heavily on enthusiastic volunteers to support its domestic and international missions. Domestically, BNB operates a bike retail shop and bike mechanics training courses for youth and adults. BNB's Earn-A-Bike program encourages youth ages 12 to 18 to pick their own bike from the donated stock. The students then "pay" for the bike by learning to build it up and repair it themselves through bike mechanic classes taught by staffers and volunteers (including graduates of the same program). The students also work out a number of hours they will volunteer in the bike shop to contribute to their "payment" for the bike. The Earn-A-Bike program gives students practical training that qualifies them to pursue further training as bike technicians if they choose, develops appreciation for environmental awareness, and engenders a sense of community through organized bike rides in and around Boston.

Bikes Not Bombs also runs an international version of their domestic programs, called the Village Bicycle Project. To date, BNB has shipped over 33,000 donated bikes to communities in Central America, the Caribbean, and Africa. For example, at the program's leg in Ghana, BNB works with Ghanaian import groups to distribute and sell the donated bikes to communities and micro-enterprises. BNB has also worked to set up Earn-A-Bike and other technical training programs. In addition, BNB has helped expand the market for spare bicycle parts, which supports the growing bike repair businesses.

The success of BNB's Earn-a-Bike programs in Boston and in communities throughout Ghana demonstrates the effectiveness of a business model for customers with minimal financial capital. This model acknowledges that a purely charitable scheme of bike donation has only one tier of benefit – supplying an alternate form of transportation. In contrast, by treating all people, regardless of access to financial capital, as customers with purchasing power in the form of valuable labor, BNB provides multiple tiers of benefit – alternate transport, job training, spare parts market development, and community strengthening.

To apply the Earn-A-Bike method of trading labor for product (bike) or service (bike mechanics training or repair) to the Poblaki water delivery system would require families who take advantage of the water delivery to contribute labor in system operations and maintenance. Unfortunately, a bike is a quantized element with a single purchase time, and the path of responsibility is easy to trace. You want the bike, you must work *X* hours to earn it. In the case of a water delivery service, there are many consumers using a varying amount of water over an undetermined time period; monitoring water consumption would require a flow meter, which is expensive.

(Photo credit: http://www.bikesnotbombs.org)

A.3: Thai Government's Solar Home Systems

This case study demonstrates the failure of the "install-and-run" model of projects with donated components.

Three to four years ago, some members of the Thai government made a promise to families who voted for their party's candidate – if elected, the government would give those families a Solar Home System, which includes one 120W solar photovoltaic panel, one 125 Ah deep-cycle lead acid battery, two 10W fluorescent lights, one outlet, and a combined inverter and charge controller panel. BGET's experience in border villages around Mae Sot has taught that while the recipients of this government gift appreciate and value the electricity, they have no knowledge of system operation and maintenance, and therefore, no recourse when the lights fail to turn on one evening.

BGET staff and volunteers have observed several instances of dirty and dusty panels, as well as partly to fully shaded panels from foliage overgrowth. In one case, BGET was asked to look at a family's failed system while BGET was visiting the village for a microhydro site survey. The family reported that the lights would not turn on, even when they expected power from previous days of sunshine. BGET's technicians used a multimeter to determine that the charge controller/inverter unit was malfunctioning and took it back to Mae Sot to ship to the company for a replacement.

What happens to families in villages all over Thailand who experience similar failures but have no access to trained technicians and no knowledge of the system? They must cope without electricity—after three to four years of enjoying its benefits—or travel to the nearest town to find someone who could help. This model undervalues people's intelligence, keeps them dependent on the government, and is fundamentally unsustainable.
(Photo credit: Author)