



CASE STUDY

Green Growth Initiative in Bhutan: Bhutan Biogas Project

Bhutan, the land of Gross National Happiness, is creating renewable energy from animal waste, while reducing air pollution and increasing agricultural outputs, as it also reduces the labor necessary to power rural homes.

Background Information

Bhutan is a landlocked country that's perched between India and China within the Himalayan mountains. It's one of the smallest countries by land mass and population, but it's also one of the fastest-growing economies, partially thanks to its bountiful hydropower resources which are being harnessed for energy exports.

In recent years, Bhutan has gained notoriety for its focus on the idea of Gross National Happiness (GNH). GNH is a concept that was developed in Bhutan which places happiness as the ultimate desire of every individual. Springing from this idea, the responsibility and purpose of the state is to foster happiness for its citizens. Bhutan's Gross National Happiness rests on four pillars: (1) Equitable and equal socio-economic development, (2) Preservation and promotion of cultural and spiritual heritage, (3), Conservation of the environment, and (4) Good governance.

In Bhutan, nearly all electricity comes from hydroelectric sources. The fertile resource currently exceeds demand annually, but seasonal supply swings (energy production is lower in the dry season), and rising demand (as of 2013, internal had been growing by 17% annually over the prior five years) have led to occasional shortages. Diversifying the supply will help dampen the effects of the dry season, while also helping to mitigate the risk of relying so heavily on a source that may be impacted by climate change.

The country is also South Asia's only net exporter of energy. Staying ahead of demand will allow the country to continue to use the income from energy production to continue its development efforts. Additionally, through a December 2009 Declaration of the Kingdom of Bhutan, the country has committed to keeping the country absorbing more carbon than it emits—to continue being a net sink for Green House Gases (GHG). Fuel wood is still predominantly used for cooking by rural households; liquefied petroleum gas (LPG), kerosene and electricity are widely used for cooking by urban households (90%). Fuel wood consumption contributes to deforestation, greenhouse gas emissions, and smokes with adverse health effects on households. All the fossil fuels including LPG and kerosene are imported as Bhutan does not have any known fossil fuel resources.



Approach, Delivery, & Challenges

Bhutan's Biogas Project is the evolution of a project that started in the late 1980s, when fifty biogas plants were installed in Lhamoidzingkha. The relatively large, centralized production approach was not successful at that time, but interest remained in the technology. In 2011, the government of Bhutan committed to reintroduce the concept with a new formulation. The new project was launched in four of Bhutan's twenty districts that were deemed to be most likely to have success. Rather than create large scale biogas installations, this time the Bhutanese government chose family-sized equipment and aimed to deploy 3,600 of these units by the end of 2017. (3,176 units were installed in seventeen districts by late March 2017.) The program aims at bringing significant benefits to the areas of energy and agricultural production, family health and sanitation, employment generation, and environmental protection.

The family-sized biogas units that are being rolled out in Bhutan are expected on average to serve four people's energy needs, so the full rollout of the project is expected to benefit more than 15,000 people directly. The units that have already been installed are collectively producing around 5,000 m³ of biogas/day (the equivalent of nearly 60,000 cylinders of LPG/year). The savings from fuel replacement was recently estimated at Nu. 31.4 million/year (roughly \$500,000 USD). The systems have also reduced firewood use by around 10,000 tons per year. And Bhutan has no known fossil fuel reserves, so every unit avoided is also one that does not have to be imported, further reducing fossil fuel use and mitigating the related climate change effects.

The Bhutan Biogas Project seeks to provide several direct and indirect benefits with its implementation. Primary among the direct benefits are: (1) increased access to modern household cooking and heating, (2) reduced greenhouse gas emissions, and (3) reduced deforestation. Indirect benefits include: (1) a reduction in adverse health effects from indoor air pollution resulting from firewood smokes, (2) a reduction in time spent collecting firewood, and (3) an improvement of crop yields thanks to the use of the organic by-product from the biogas plants. The project aims to provide a sustainable energy source in a country where 57.7% of the energy use was estimated to have come from firewood as recently as 2007. It also aims to improve indoor air quality and reduce related health concerns that stem from the use of firewood. "We used to have lots of respiratory problems in the rural areas because the kitchen is entirely dependent on fuel wood," says Sonam Tschering, the secretary of the Ministry of Economic Affairs, in discussing Bhutan's efforts to shift its energy sources. One additional aim is poverty reduction through reduced costs (for those replacing fossil fuels), or increased income (via the potential sale of the fertilizer created by the system), thereby reducing hunger while limiting the environmental impacts of firewood use in a growing population.

The project budget of \$3.3 Million USD supports the project in several ways. It provides partial subsidies for the equipment (Nu. 11,700/plant), as well as a range of services including:

- Support for credit via local banks
- Technical support
- Routine visits to assess usage
- Repairs and maintenance
- Equipment guarantee and quality enforcement of after-sale-services
- Research and development
- Quality control (of under-construction biodigesters, completed biodigesters, and after-sale-services)
- Training and capacity building (including biodigester training, creation and provision of instruction booklets, and bio-slurry utilization).



The Bhutan Biogas Project is managed and implemented by the Department of Livestock (DoL), with technical assistance from the SNV Netherlands Development Organization. Subsidies and credits are being handled by the Bhutan Development Bank (BDBL) and other national and local stakeholders. The program was funded by the Asian Development Bank (ADB) under the framework of the Energy for All Partnership Program, and the Ministry of Economic Affairs' Department of Renewable Energy (DRE) is the executing agency.

The current program was developed with a number of assumptions. Among those were assumptions around fuel costs and usage, including: (1) the unit cost of a 4M3 unit is Nu. 26,000, (2) the target clientele are dairy farmers, and (3) the benefits are the cost savings from displacement of firewood, liquefied petroleum gas (LPG) and electricity, as well as the agricultural gains or income from the fertilizer the system produces (A by-product of the biogas plants used in this project is bio-slurry, an organic fertilizer that can be sold at Nu. 11/kg, and a plant would produce about 55 kg annually).

Energy use was also a necessary component of the system's design. Target users were estimated to have daily consumption of 12 kilograms (kg) of firewood, 0.22 kg of LPG, and 4.1 kWh of electricity. It was also assumed that biogas would reduce firewood use and electricity consumption for cooking by 75% and LPG use by 50%. Firewood was assumed to be free as it is mostly freely collected (although there is the cost of time and effort in collection), the cost of LPG was set at Nu. 400 per 14 kg cylinder, and Nu. 1.12/kWh for electricity.

Benefits & Lessons Learned

Several factors helped make the Bhutan Biogas Project feasible. Among those, the largely rural, less-developed nature of the implementation sites, the size of nuclear families and the variety of supports provided by the program all helped provide a context in which the rollout is working. Any effort to implement this project in another context would require feasibility studies and more in-depth research to determine whether similar units might work, as well as what parts of the program to keep and what changes might be necessary.

Opportunities & Next Steps

Here are a few of the important findings from the Bhutan Biogas Project:

- Along with producing energy for use in the home, the fertilizer the bio-digesters produce can represent a non-trivial income source for those living at or near the poverty line.
- The Bhutan Biogas project was a significant adaptation from the early attempt which featured fifty plants of larger size, that were all located in the same district. The current program rests on the affordability of family-size units that need the waste from a minimum of two cows to run properly.
- Technological advances, and other evolving circumstances (like infrastructure upgrades) continually alter the realm of what's possible in terms of financially viable projects. Therefore, projects that were once deemed infeasible due to specific constraints, may later become viable.
- Adoption of the practice depended on familiarity. Biogas units became common in the south of Bhutan, making adoption simpler in that region, whereas local government agencies provided incentives late in the project in the East as adoption lagged.
- The current incarnation of the biogas project focuses on animal wastes. Future efforts may look to integrate human waste, agricultural waste, or both. Either of these materials would add a layer of complexity to the biogas systems, while tapping into an available resource that's currently going to waste.



As the project is coming to an end, there is a need to determine whether it makes sense to extend the project and increase the number of installations.

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Website

Bhutan Biogas Project - <http://www.bbp.gov.bt/>

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