A glimpse into community and institutional biogas plants in Nepal

Dr.-Ing. Arquitecta Joana Forte – Nepal 2011

A glimpse into community and institutional biogas plants in Nepal

Dr.-Ing. Arquitecta Joana Forte – Nepal 2011

1 Introduction

A reliable and sustainable supply of energy is necessary for every country. In Nepal this is one of the major challenges. Among many other problems and risks, there is: a) a very weak and unstable supply of electricity; b) an expensive and uncertain availability of fuel and c) the risk of substantial deforestation around the country. Therefore, the use of renewable energy resources is essential. Biogas presents itself as one of the most promising alternatives. Besides its energy gains, biogas also reduces municipal solid waste, improves the health and sanitation situation of the population, and promotes cleaner living environments.

1.1 Background of the study

Biogas plants have a long and successfully history in Nepal. They provide energy for cooking and light dark rooms in a country where energy is a scarce and valuable resource. Consequently, biogas plants have been one of the main sources of green and renewable energy. Biogas can improve people's lives and alleviate poverty, as well as contributing to a sustainable future. At the same time, biogas plants, because they are an on-site technology, have been able to avoid the difficulty of posed by the lack of good infrastructure on a national level.

The energy consumption of Nepalese people is very low (402 GJ per year for the entire country, which is equivalent to 9.3 million litres of oil) (Water and Energy Commission Secretariat, 2010). Some of this energy is supplied by the electricity grid. Fossil fuels aren't available everywhere; they are contaminators and becoming more and more expensive. Although scarce, fuelwood constitutes 77.7% of the total energy consumption (WECS, 2010) and its use is decimating the forests. Smoke generated by the burning of fuelwood makes people ill. The solution is the development of cleaner, green energies. Biogas doesn't use and destroy the country resources; it transforms the problem of inadequate sanitation into energy. It is a 'closing the loop' answer.

The Biogas Support Programme (BSP) was initiated in July 1992. It aimed to install biogas plants at the household level all over the country. Almost 20 years later there are approximately, according to AEPC, 250,000 plants distributed across the 75 districts. The programme is organised by the Alternative Energy Promotion Centre (AEPC) under the Ministry of Environment.

Due to the success of household size biogas plants in the rural areas of Nepal, the interest in biogas plants at both the community and institutional level has grown in urban areas. These plants are placed in urban communities where different households contribute, benefit and share the system. Larger biogas plants can also be found in institutional buildings like schools, hospitals, jails and monasteries.

However, at this stage there is still no national policy on biogas, or even an overview of the sector. A National Support Programme is currently in the process of being drafted.

1.2 Objectives

At this stage it is important to look at the situation of community and institutional biogas plants in Nepal. This is the main subject of this research, conducted by Dr.-Ing. Arquitecta Joana Forte. The aim of this research is to visit and analyse several case studies of community and institutional biogas plants in urban areas of Nepal. Many key actors were interviewed as part of the research to build a sketch of how this sector is developing in Nepal. To achieve this objective, the following research components were undertaken: a) an overview of biogas technology research; b) an overview of community and institutional biogas plants; c) a detailed survey and analysis of case studies; and d) an evaluation and conclusions.

1.3 Research questions

In order to guide this assessment, the following research questions were developed:

–How is the sector working?

–Which case studies should be chosen from community and institutional biogas plants?

–How are these plants working? (This analysis encompassed technical details, operational parameters, functional status, maintenance, gas production, composition and usage, technical knowledge and information of the users, subsidies and promoters, users' motivations and awareness, users' evaluation). Fieldwork was undertaken for this research question.

–What are the impacts of biogas in Nepal?

–Can this be improved? (This includes conclusions and recommendations and an overview of best practices and lessons learnt).

1.4 Scope and limitations

Many of the community and institutional biogas plants in Nepal are in remote areas and scattered around the country. It was, therefore, necessary to limit the study to the Kathmandu valley. Due to the timeframe of this assessment, not all the biogas plants in Kathmandu were visited and evaluated. Case studies were selected and used as examples.

Another limitation in this research is the fact that the biogas plants were visited once and for a limited time only.

There have been many studies of household scale biogas plants in Nepal, but only a few of community and institutional biogas plants. Therefore, the data on community and institutional biogas plants is very limited. There is also no agency responsible for monitoring community and institutional biogas plants in Nepal.

2 Background information

2.1 Current energy and renewable energy in Nepal

Nepal has one of the lowest energy demands in the world: around 885 MW during peak demand. (In 2008/09 the demand for energy was met from the following sources: agricultural residue 3.7%, animal dung 5.7%, fuelwood 77.7%, petroleum 8.2%, coal 1.9%, electricity 2.0%, biogas 0.6%, micro hydropower 0.0% and solar 0.0%) (WECS, 2010). Nevertheless, energy supply does not meet demand in Nepal. Furthermore, an important part of the energy utilised comes from non-sustainable sources such as fuelwood, petroleum products, natural gas and imported coal. These forms of energy have high economic and ecological costs.

Large-scale hydropower energy is the main source of electricity in Nepal. However, it does not provide sufficient energy. Furthermore, the energy produced is often difficult to distribute due to the poor national grid infrastructure. So there is a need for more investment in sustainable and renewable energy. Sustainable and renewable energy systems are decentralised, and are, therefore, better suited to the scattered population. They use the local potential and provide feasible and environmentally friendly energy. The most important renewable energy technologies in Nepal are:

–Micro hydropower

–Solar photovoltaic (PV) systems (used as solar home systems), solar PV water pumping, solar battery charging

–Solar thermal energy (used in solar water heaters, solar dryers, solar cookers)

–Biomass green energy (in the form of briquettes, gasifiers, improved cooking stoves)

–Biogas (the topic of this research, and one of the most important forms of renewable energy technology in Nepal)

Politicians in Nepal have recognised the important role of alternative and renewable energies. From 1992 to 1997 the need for a coordinating agency was acknowledged. The Alternative Energy Promotion Centre (AEPC) was subsequently created. Initially, the goals of AEPC were to reduce firewood consumption and dependence on fossil fuels. Topics, including poverty reduction, health hazard reduction, income generation, among others, were added to its targets later.

Micro hydropower provides electricity for small and localised areas. Solar PV systems provide lighting for many houses in Nepal. These also provide power for various electrical devices and irrigation for fields. Biogas can be used for cooking and lighting. At the same time, sanitised slurry is generated, which assists ecological sanitation. This slurry can be used as a fertilizer and contains all minerals needed for plant growth.

The Nepal Electricity Authority (NEA) foresees a growth in energy demand of about 8.3% per year over the next 17 years. Already, there is a general scarcity of energy at the moment reflected in the daily power cuts. In April 2011, Kathmandu was supplied with electricity for only eight hours daily. Based on this, it is easy to predict the problems that will arise in the next few years. Alternative and renewable energies are one of the answers. Around 43% of the energy demand in Nepal is from households. The biggest demand is in urban areas, according to AEPC. Therefore, community and institutional biogas plants can play an important role in the supply of energy in Nepal.

AEPC is promoting the use of renewable energy in Nepal. But AEPC needs more partners, coordination, investment and development. Because Nepal has a long way to go in resolving its energy problems. This research is but a small step in formulating recommendations and identifying best practices and lessons learnt from studying biogas community and institutional plants in Nepal.

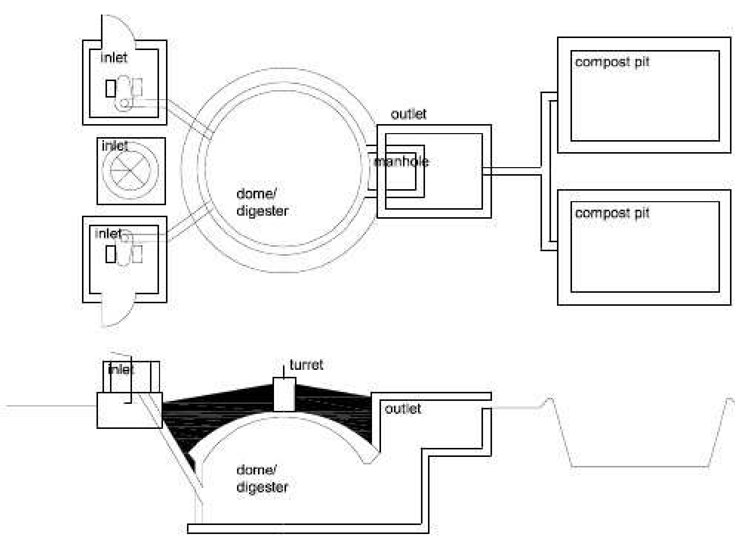
2.2 Biogas in Nepal

According to the literature, the first biogas plant installed in Nepal was in Kathmandu in 1955. It was a test model and was successful. From then on several organisations became involved in promoting and spreading the technology. The first official biogas programme started in 1974. Until 1985, between 100 and 300 biogas plants were installed annually in Nepali households. From 1955 until 1990, these plants were subsidised and the number of biogas plants installed increased to 800 systems per year. These first years of the use of biogas in Nepal proved the potential of this technology. In July 1992, an important partnership was established between the Government of Nepal and the Netherlands Development Organisation (SNV). The Biogas Support Programme (BSP) was launched. It aimed to install household size biogas plants all over the country. Now there are 250,000 plants installed. BSP, coordinated by AEPC, which is under the Ministry of Environment, has promoted and subsidised these plants.

Biogas plants in Nepal are an important tool for improving livelihoods through the supply of more energy and by encouraging a better sanitation system. This is, without doubt, an effective renewable energy strategy.

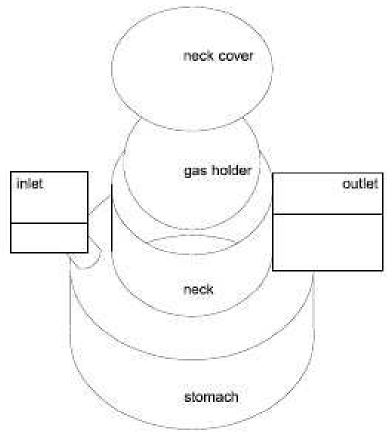
Nepal's household size biogas plants produce 6 tons of fertilizer annually, which can be used for farming. Together, these biogas plants save 239,386 tons of fuelwood per year and 3,830,000 litres of kerosene (Centre for Rural Technology Nepal, 2005). This means that the biogas plants provide a total of 520,370 kW, an average of 7.59 kW hours per plant, or 2.75 hours of stove usage daily (BSP, 2009).

The biogas plant model used by BSP is the fixed dome type GGC 2047. It is a modification of the Chinese and Indian fixed dome models. The size ranges from 4 to 20 cubic metres. This model is considered a reliable, well functioning, simple, low maintenance and durable technology, and has been reproduced all over the country in many different contexts.



Household Biogas plant design model GGC 2047

There are many other types of biogas plants used in Nepal; however, their numbers are limited. It is important to refer to the TED and the PUXIN type biogas plants.



Biogas plant design model PUXIN

The potential of biogas in Nepal is still large and at an early stage. BSP has estimated a potential for 1.9 million household scale biogas plants in Nepal (BSP, 2009). Many more possibilities exist if community and institutional biogas plants are also promoted.

Due to the success of household size biogas plants in the rural areas of Nepal, the interest in biogas plants at both community and institutional level has grown. These have great potential and value, especially in urban areas.

2.3 Biogas and sanitation

In Nepal, the majority of the implementation strategies and actors involved in the biogas sector see it as a major energy tool. However, it is important to highlight its qualities as an ecological sanitation solution.

Reliable sanitation ensures safe conditions for people and their communities. Sanitation conditions in Nepal are inadequate. Only two of 75 districts presently consider themselves to be free of open defecation. This leads to the contamination of soil and water, with dangerous repercussions for health.

Besides being a reliable sanitation system, waste can be transformed into biogas for cooking and lighting and the fertilizer generated contains all of the minerals needed for plant growth. Biogas is a sanitation solution and its promotion is, therefore, a sustainable approach.

The advantages of ecological sanitation systems compared to conventional sewer-based sanitation include lower costs and a more flexible and decentralised approach, hence, it is easier to involve the community. These decentralised systems treat sewerage from individual homes, smaller communities and institutional buildings. This approach prevents pollution, recycles nutrients, solves waste problems and creates energy at the same time.

Biogas is also a decentralised technology, in a country where grid infrastructures are difficult to implement. It is a local solution and easy to implement.

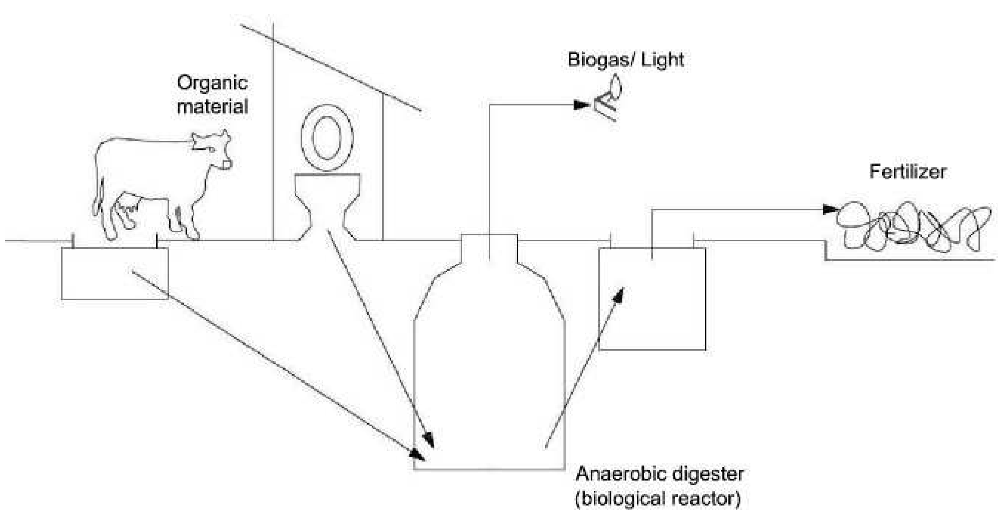
In Nepal, these sanitation issues have been taken into consideration for a long time. Biogas is a sustainable and clean sanitation solution, which can ensure basic sanitation for all. The Rural Water Supply and National Sanitation Strategy (established in 2004) intends to achieve this goal by 2017. Their last survey revealed that around 48% of the population have sanitation systems in their houses. Many projects have contributed to these results, in particular the School Led Total Sanitation (SLTS) programme by UNICEF and the Household Centred Environmental Sanitation (HCES) programme by UNHabitat Water as part of the Asian Cities programme.

Biogas can be widely used as an important tool in many of these programmes and for sustainable sanitation in Nepal.

3 An overview of biogas technology

3.1 Biogas: An anaerobic digestion technology

Biogas is a technology that allows the population to take care of their waste in more efficient ways, while at the same time producing energy and fertilizer. People need energy for cooking and for lighting, and in many parts of the world this is achieved in expensive and unsustainable ways. So, biogas is a sustainable, 'closed loop' system that converts waste into useful products:



Biogas plants graphic chart

For biogas systems to work, digestible organic materials are necessary as fuel. The organic matter is broken down into smaller components, which are digested. This process is ‘anaerobic’, which means that it happens without oxygen. The digestion of organic matter is done by simple organisms. These organisms produce carbon dioxide and combustible gas by fermenting the organic matter. For this to happen the following conditions are necessary: 1) a stable temperate; 2) enough water or liquid; 3) an oxygen free dome and 4) the presence of all necessary nutrients.

Any biodegradable organic matter is suitable for feeding a biogas plant. Therefore, household, community and institutional waste is normally adequate, because this kind of waste normally has the necessary micro-organisms.

The anaerobic bacteria breakdown the organic materials into CO^2 (carbon dioxide) and CH^4 (methane). A combustible mixture of CH^4 (50 to 75%) and CO^2 (25 to 50%) – the biogas – is created in the digester dome. Digested slurry is also created in the process.

The temperature is an important factor for digestion. If the temperature changes drastically, the digester must be insulated or built underground. The temperature shouldn't get below 3° Celsius. The higher the temperature, the faster the process of digestion and gas production. The second element that is necessary for a successful biogas plant is water or another liquid. The third element is the absence of oxygen. For this, the dome construction is critical. One of the most common designs all over the world is the Chinese fixed dome, from which the GGC Nepali biogas plant model is derived. The main advantages of this system are the low initial cost, the simple operation and maintenance, and the durability as well as the low technical skills required by constructors and users. In this model, organic materials are fed in equal proportions of solid and liquid. Sometimes it is necessary to increase the amount of liquid. This mixture is the raw material for the anaerobic dome where micro-organisms decompose the waste into methane gas and slurry. Due to the hydraulic pressure of continuous feeding, this material continues to move. Then gas rises through the scum layer filling the upper part of the fixed dome. The pressure increases. The liquid materials in the digester rise and then are pressed down and expelled through the outlet in the form of slurry. The gas is produced and goes out through the pipe on the top of the dome. When this happens the liquid rises again. The slurry produced through this process is only partially sanitised and can be used as a strong fertilizer, which is rich in nitrogen and phosphorus. Further processes should be used for cleaning before agriculture usage.

As a rule of thumb, it can be said that for each kilogram of organic solid waste added to the digester somewhere between 0.38 and 0.42 Nm3 of biogas is produced.

Biogas plants are a very simple technology. For example, there are easy ways to check if the digester is working properly, namely, no odour, no foaming or no gas. If the biogas plant is not working it can easily be checked if there is enough water, if the dome is anaerobic and there are no leaks, if the temperature hasn't dropped too much, or if ash needs to be added. Desludging is only rarely necessary.

3.2 Community and institutional biogas plant technology

Biogas plants need the right amount of feeding materials in order to work properly. Often, household scale biogas plants only work if there are animals belonging to the family and if manure is added manually to the plant. Therefore, the right characteristics are present at the community and institutional level for biogas plants to be successful, due to the available quantities of waste. In Nepal there is no financial support or national programme in place for these kinds of biogas plants, despite the great potential for their use. However, many examples of these plants in operation can be found all over the country.

The technology applied for this scale of plant is basically the same as for household size plants, namely, a dome digester with an inlet, an outlet for slurry and a gas exit on the top of the dome. The main difference is in the size of the plant. As a rule of thumb, it can be said that these biogas plants should have between 30 and 60 cubic metres of inside dome space. Of course, this depends on the kind of plant, usage and amount of waste available.

4 Methodology

4.1 Case studies

This research is an empirical study based on several research questions. It uses qualitative methods, case studies and fieldwork to assess some of the community and institutional biogas community plants in Kathmandu, Nepal. Due to the scope and timeframe of the work, only a few case studies were selected. These were chosen following interviews with experts in this field and literature analysis.

This assessment takes into account different community and institutional biogas plants using different technologies, ages, types of waste and users. The results are analysed and used as a reference in order to give an overview of community and institutional biogas plants in Nepal. The fieldwork was performed in association with the case studies and an analysis of their impact made in order to formulate conclusions and make recommendations. The following plants were selected as case studies:

At the community level:

–**Sunga Waste Water Treatment, Thimi (institutional usage)**

–**Community Biogas Plant, Shrikhandapur (community usage)**

In institutions:

–**Mirabel Hotel, Dhulikhel (hotel)**

–**University Science Department, Kirtipur (university)**

–**Ama Ghar, Godawari (hostel)**

–**Bir hospital, Kathmandu (hospital)**

A total of six case studies were undertaken. After the data collection was made, an analysis was performed. The case studies are presented, explained and interpreted in order to introduce them as examples of community and institutional biogas plants in Nepal.

4.2 Data collection

A questionnaire (see annex) and assessment guidelines were prepared and used with key actors at each of the biogas plants.

The main aspects taken into consideration were:

–Technical details: model, size, date and constructions plans

–Operational parameters: feeding material and quantities

–Functional status of the plant: working or not, and if not, why?

–Maintenance: by whom, when and how?

–Gas and slurry production: composition and use

–Technical knowledge and information of the users and key persons

–Subsidies and implementation agency

–Users' motivations and awareness of biogas technology and advantages

–Users' evaluation and impact on their lives and economic, environmental and social impacts

–Additional information: key persons, initial objectives and motivations, project history, lessons learnt

5 Community and institutional biogas plants in Nepal

AEPC and BSP are the organisations that support, implement and monitor household size biogas plants in Nepal. Because a framework for such biogas plants is still not in place and there are no proper records kept on the number of community and institutional biogas plants, it is difficult to know how many plants there are and where they are located.

According to the last AEPC database (2008), there are about 200 community and institutional biogas plants in Nepal. These were installed by several organisations and actors without governmental subsidies. These plants range from 6 to 75 cubic metres. Normally they are fed from kitchen waste, toilet waste and livestock manure.

Through secondary data, it was assessed that there are approximately 90 institutional biogas plants in the Kathmandu Valley alone. There are also 12 community plants. This means that, even without accurate numbers, it is clear that the sector is progressing. This seems to be the general opinion of many of the key interviewees.

During this research, several interviews were conducted with key actors in the community and institutional biogas plants sector of Nepal. Mr. Samir Thapa from AEPC is one of the most involved and active promoters. Dr. Indira Shakya is a main actor in the BSP project. Professor Jagan Nath Shrestha from the Centre for Energy Studies from Tribhuvan University also expressed his opinion. In the next few lines, resumes and excerpts from the interviews are presented. These interviews reveal the views of some of the main promoters and active stakeholders in the sector.

*** Interview with Mr. Samir Thapa, Senior Energy Officer for Biogas Promotion, AEPC**

The Biogas Programme was the first alternative energy programme to be installed in Nepal. It started in 1992 with the support of SNV. In 1996, at the initiation of AEPC, it became their responsibility. They started promoting small-scale biogas plants, up to 8 cubic metres, and medium size biogas plants, up to 20 cubic metres. Only later, did they start to promote larger plants as the concept was growing and becoming more popular. AEPC has promoted some community and institutional biogas plants. These were primarily used as demonstrations of the technical advantages and possibilities in order to show the plants' potential. Schools, hospitals, municipalities or vegetable markets were the targets.

Slowly, AEPC is promoting more and more community and institutional biogas plants. In 2011 they will promote 20 community and 20 institutional plants. AEPC will launch a public competition defining criteria for choice and construction. The chosen plants will be examples and trialled. Because there were many applications, more than expected, the authorities are trying to allocate and request more funds. “The sector is growing and there are many demands”, says Mr. Thapa. These new biogas plants will be around 50 cubic metres for communities and all sizes for institutions. They will choose the cases, provide the funds and then give the construction to one of the companies accredited for the construction of small-scale biogas plants. They will try to adapt the design and characteristics to suit each case. Therefore, there will be a lot of technical investigations.

These examples could help to develop the national programme for community and institutional biogas plants, which is being written at the moment.

Many of the existing community and institutional biogas plants in Nepal were financed privately or by NGOs and agencies working in the country, because governmental subsidies don’t exist. Normally, the communities and institutions contact donors directly or collect money and hire a construction company. Normally these are the same companies that are pre-qualified by AEPC and BSP for the construction of household scale plants.

There has not been any assessment of the sector since 2008. But, according to Mr. Thapa, “there are at the moment between 500 and 1000 community and institutional biogas plants in Nepal”. It is a sector that is growing so much that AEPC doesn't have accurate numbers any more.

“It is essential for the country to invest, promote and construct many more community and institutional biogas plants”, says Mr. Thapa.

*** Interview with Dr. Indira Shakya, Senior Energy and Sanitation Expert, BSP**

The opinion of BSP is that there is still a low level of information about the potential of community and institutional biogas plants, although there have been several examples operating in the country for many years. The knowledge is spreading, but it is a slow process. The main problems, according to BSP, are:

–Difficulties in management at the community level due to lack of ownership

–The technology is too expensive and needs to be more cost effective

–The technology is not compatible with all organic materials, but this has improved in recent years

–The plants are big and land is expensive. Community and institutional biogas plants can only be built where public land is available, otherwise the government needs to support them

–The government hasn't given many subsidies for this technology

–Biogas use should be promoted, not only as an energy tool, but also as an income generator for communities and institutions. It will be, therefore, be easier to advertise their potential. Possibilities are: to sell slurry and fertilizer, to develop a kind of tariff system for the usage of the gas instead of distributing it free, or to use the gas to promote other economic activities for the community and institutions

Dr. Indira Shakya says that the sector is definitely growing and that it can be made sustainable "if connected to income generating possibilities".

BSP is conducting feasibility studies for possible biogas plants. The communities need to be engaged and give land, labour and some money or construction materials. In this way they choose the place and design the plant and also supervise the critical phases of construction.

*** Interview with Professor Jagan Nath Shrestha, Centre for Energy Studies, IOE, Tribhuvan University**

Professor Jagan Nath Shrestha is one of the most important and active promoters of biogas in Nepal. His Centre for Energy Studies has conducted several studies supporting and investigating this technology. In his words: "When Nepal fully understands the economical potential of biogas through its energy and sanitation qualities, the Government will really promote this technology and Nepal will become much more sustainable in terms of its energy dependency and ecological situation and conditions".

6 Case studies, six detailed surveys of community and institutional biogas plants in Kathmandu valley

A total of six detailed case studies of community and institutional biogas plants were made. All the case studies are in the Kathmandu Valley. These were visited by the researcher and a detailed survey was made comprising an interview and questionnaire, a land survey and a photo documentation. Secondary sources, such as the construction company or the donor agency, were also taken into account and served as sources of information. Conclusions and recommendations were then drafted.

The case studies are located in the following places:

- Sunga Waste Water Treatment, Thimi
- Community Biogas Plant, Shrikhandapur
- Mirabel Hotel, Dhulikhel
- Tribvuhan University Science Department, Kirtipur
- Bir Hospital, Kathmandu
- Ama Ghar, Godawari

6.1 Sunga Waste Water Treatment, Thimi

Sunga was the first case study to be investigated. The plant was visited on September, 30 2011. Krishna Shrestha, the caretaker, hosted the visit.

Sunga is a small community in the municipality of Bhaktapur in the Kathmandu Valley. It is an established community of mostly Newars.

The project was funded by the Asian Development Bank (ADB) and UNHabitat, and was implemented by the NGO ENPHO (waste water plant, wetlands) and BSP Nepal (biogas plant). Initially, the project was planned to be constructed in another small community in the vicinity. This other community rejected the project, which was later embraced by Sunga. After initial discussions the community was encouraged to visit similar projects and participated in information sessions. The first part of the launch of the project was a waste water treatment plant installed by ENPHO. A constructed wetland was built and is currently working properly. It is giving the community the possibility of enjoying an appropriate and sustainable sanitation system. The second part of the project was the installation of a biogas plant. This was implemented with a grant from UNHabitat and constructed under the supervision of BSP Nepal.

The chosen GGC plant is 35 cubic metres and was built in 2005. The cost was 314,166.66 NPR. The community did not finance any part of the project.

Approximately 80 households are linked to this biogas plant and nearly 470 people are participating in the project. All toilets are connected to the system. Initially, the kitchens were intended to be part of the system, but due to technical problems this did not happen. The fed material is equivalent to toilet waste of 142 kilograms per day. The community does not have many animals so dung is not added manually.

Summarising, the biogas plant is linked to most bathrooms of the community, which is relatively large number. There seem to be all the components for success. However, this is not the case. The biogas plant has never worked properly and there is virtually no production of gas. None of the participating households benefits from the biogas project and only the local primary school receives gas. This is often insufficient for food preparation for the students, and there is only a maximum of 2 hours of gas production per day.

Apparently there were several technical problems after construction causing poor performance and leading to leakage and cracks in the digester chamber. The ground collapsed and several repairs had to be done later. To date, the problem is still not resolved.

During the plant visit, instead of sludge, only water was flowing into the biogas plant. If all would go as planned, liquid should go directly to the wetland and sludge should go to the biogas plant, but this does not happen. There is more sludge in the morning and, at this point, it should be fed into the biogas plant. At other times of the day, when practically only water runs, the connection to the biogas plant should be closed. In this way the correct amount of sludge and water would be inside of the chamber. Probably more sources of waste could be added to the plant to produce more gas.

Two main steps are needed for the Sunga project to work properly. It is necessary to repair the biogas plant. The community still seems to be committed to the project, however, a stronger level of engagement is needed. In fact, the caretaker, an old man, is the only one that tries to manage the project. The caretaker and the community need more training in how to manage the project, especially how to maintain the biogas plant properly. There is a lack of communication between the community and entrepreneurial agencies, and the problems are apparently not reported or addressed.

The population is happy with the project, but only with the sanitation part, which solved a problem for the village. They are still waiting to receive gas from the plant and benefit from it. If the existing problems could be solved, the project would have a great chance of success.

6.2 Community Biogas Plant, Shrikhandapur

The Community biogas plant in Shrikhandapur (Dhulikhel Municipality) was visited on October 12, 2011. It was implemented through a partnership between ADB and UNHabitat. It was also built by the NGO ENPHO. Charya Purna, chairman of the Community Association, was the guide during the project visit. When the project started he was the chairman of Dhulikhel Municipality ward nine and he fought for a sanitation system in the community, because the entire sewer was going directly into the river. The Municipality had no money, so they contacted UNHabitat, which agreed to support the project on the condition that a biogas plant was added. The first step was the establishment of a community association to manage the project. This association has since conducted and administrated everything.

The project is waste water treatment associated with a biogas plant. There are two biogas reactors, each 75 cubic metres. These were added in the second phase of construction without a significant increase in costs.

Construction began in December 2007 and ended in August 2008. The total cost of the construction was 7,400,000 NPR. Of this, 1,700,000 NPR was paid by Dhulikhel Municipality. The community paid 300,000 NPR. The rest was financed by UNHabitat. The participating households are connected by underground pipes to the plant site, which is very well maintained by the caretaker. The pipes are directly connected to the biogas plants. From the outlet of these plants, the remains are directed to the wetland and from there clean water runs into the river.

One hundred of the 200 existing households in Shrikhandapur are linked to the project. The community still aims to connect all houses. All sewers from the connected houses are linked to the biogas plants, including toilets, bathrooms and grey water from outside. The community does not have cattle, so dung is not used. No water needs to be added to be system. Sometimes there is a blockage, which can be repaired by community members. There are no other serious problems.

All seems to run well. However, not enough biogas is being produced and only five houses get biogas. These five households are the nearest to the biogas plant and use the gas only for cooking. Apparently this was the plan from the beginning. But the community doesn't seem very satisfied with this and would like more houses to benefit from the project. The fact that 100 households are participating and only 5 are getting gas is also not justified. Further tests must be conducted to establish why more gas is not being produced. There could be leakages in the system, construction problems in the biogas plant or not enough solid sludge for the system to work properly, as the caretaker says. More houses could be connected, sludge and water divisions should be made, and other sources of waste added.

The local committee manages the project, but does not have enough money and is not able to allocate more funds to the project. Their budget is only sufficient to pay 200 NPR per month to the caretaker. From time to time ENPHO checks the plant, but does not assist in solving problems that arise with the project. According to their calculation, they would need 200,000 NPR more to successfully complete the project. The Municipality doesn't give them the money because the project doesn't generate income, as it could if there was enough material for compost.

The project seems to have all the key factors necessary for success, especially an interested community, and it only needs some aspects of the construction have to be rectified. With a little more funds and community training, Shrikhandapur believes that their biogas plant would be a good example for others to follow. The sanitation system is working very well. The river is clean and the community is very happy. The biogas plant is not working as well, but it is on the right path. In the interview with Charya Purna he said that he recommends a sanitation system to all communities in Nepal because “it made such a beautiful, sustainable and clean village and a biogas plant will help them very much as soon as it works better”.

6.3 Mirabel Hotel, Dhulikhel

Mirabel hotel biogas plant in Dhulikhel was the first institutional plant to be visited. In October 12, 2011 the manager of the hotel guided the tour and answered the questions. The Mirabel biogas plant belongs to Shyam Moham Shrestha, the owner of the hotel. It is a PUXIN model with 10 cubic meters. It was installed by NSES and was financed, among others, by United Nations Development Programme and UNHabitat. It works mainly on agricultural and kitchen waste. Other biodegradable waste is also fed when available. It was constructed in August 2008, and is expected to work for 25 years. The project started because the hotel was visited by NSES staff promoting biogas technology. The owner of the hotel got interested and decided to try it. The biogas plant cost 200,000 NPR.

The plant works with manual feeding. The kitchen staff are responsible for the garbage selection and division. The gardeners, who in fact manage the plant, select the kitchen waste and add it to their garden waste. After that, all is fed into the plant. The feeding inlet has a ramp that allows smashing and pre-treatment before feeding. If the waste is too solid they insert it into the biogas plant with the help of bamboo sticks. At this time they also add water.

The gas produced is used in the staff kitchen. The plant produces enough gas to cook all the meals for all the staff every day. Because the plant isn't of the continuous feeding type they can add more or less waste as needed. This can be checked through the outlet chamber. The sludge is discharged to the sewage through the outlet chamber, visible in the front. Every five years the plant needs to be cleaned and emptied. The plant doesn't have any major problems. There were initially some leakages but these were easily repaired. Mirabel can call NSES and someone comes to make the necessary repairs. There are also seasonal changes because of the number of guests and the waste added to the plant, which results in the production of very different quantities of gas. In the winter due to the colder temperatures there is also less production of gas. However there is an average of 3 to 4 hours of gas per day during the summer and 2 to 3 hours during the winter. That is 0.7 cubic metres per day, on average.

The plant is very well maintained and very successful. The staff haven't received training, but they seem to have understood how the system works and operate and manage it very well. The hotel is very satisfied with the technology, which allows them to save gas and deal well with shortages; it also enables them to use much of their waste in a sanitary and sustainable way. The hotel is now cleaner and they save around 4,500 NPR per month in garbage disposal.

There is clear ownership of the plant, which has resulted in a successful project.

6.4 Tribvuhan University Science Department, Kirtipur

The biogas plant at the University science department in Kirtipur was visited on October 24, 2011. Assistant Jagan Nath Ariel was the guide. It is a PUXIN model with a six cubic meters capacity. It is owned and operated by the science department. It was constructed in 2007 and it took six months to be finalised.

The plant is part of a project from Professor Jagan Nath Shrestha from the Centre for energy studies at Tribhuvan University. His department installed three institutional plants in the Kathmandu Valley in different sites. One was in the Mirabel hotel, one in a vegetable market in Kalimati and this one in Kirtipur University campus. The aim was to study and investigate PUXIN biogas plants in different contexts. For this project he got the support of UNDP, UNHabitat and others.

This plant is fed once a year with small batches of a mixture of shrubs available on the campus, animal dung that the gardeners collect, and water. The gas is used for making tea in the staff kitchen. The plant is located at the back of the building. It has two inlets and one outlet and a gas pipe that connects to the kitchen stove.


However, there is not enough gas being produced. This happens because of bad management by the university due to internal issues. There is a lack of ownership and difficult decision processes about who is responsible. However, many of the professors and assistants seem to be fighting for the project.


The Department would like to be totally sustainable and independent from external sources in terms of energy. Therefore, they have requested more funds from AEPC and more support. The department has received several solar panels and is at the moment trying to get going with the plant update. Besides the kitchen usage, they would like to use the biogas for their laboratories to replace the LPG. But to do that they need equipment to measure pressure and gas quality and other sources of feeding in order to have more gas production. The Department plans to have a research centre and a demonstration site for alternative energies in collaboration with AEPC.

For two years the plant was not operating. Three months ago it was fed again and since then there is gas coming continuously. There were no major repairs to make. If there are technical problems, the caretakers call the staff of Professor Jagan Nath. It they feed the biogas regularly it seems that it could work well. And it could provide gas for the staff and the laboratory and could be a study site.

6.5 Bir Hospital, Kathmandu

On November 2, 2011 the biogas plant of Bir Hospital was visited. Mahesh Nakarmi, the director, and Nimesh Dhakal, the programme officer of the operating NGO, facilitated the visit. The plant is part of a major project in hospital waste treatment. The NGO Health care foundation is responsible for its design and implementation.

The project consists of the separation of all the waste produced in all hospital wards through a system of different colours and bins installed in corridors, rooms and medical trolleys. Thus the garbage is separated directly at the origin. At present, the project is installed in 20 of 26 wards of the hospital. It has been so successful in solving the garbage problem, that now all the hospital wings are planning to join the project. The environment is now cleaner, safer and more sustainable. The staff is not afraid of catching diseases and contaminating the patients.

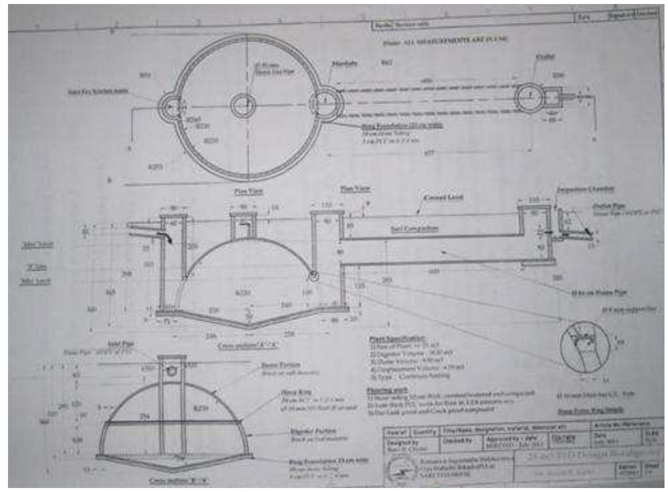
Bins and information boards are placed throughout the hospital. Staff of the Health care foundation is responsible for collecting the separated waste. All waste is then taken to the NGO facilities. Originally all the waste was collected by municipality staff who came and took all the garbage bins. The waste was mixed and dumped in landfills, thus endangering the entire population. Now all the waste is recycled, sold or transformed. For each type of waste there is a use, .e.g., paper, plastic and glass are sold; medical contaminated material is sterilised and then disposed properly.

One of the garbage divisions is the organic waste, and to manage this kind of trash the NGO decided to build a biogas plant. The plant uses and treats the organic garbage and at the same time produces energy that is added value. As soon as compost is produced it is sold and reused.

The biogas plant is a TED model with 25 cubic meters. It has been running for about two months. Organic waste collected daily, such as fruit and residues of snacks that patients and staff consume, is feed to the plant for a total of about 45 kg per day. At present there is no cafeteria in the hospital. The plant is still in its initial stage but already produces enough gas to prepare the lunch and tea for the NGO staff.

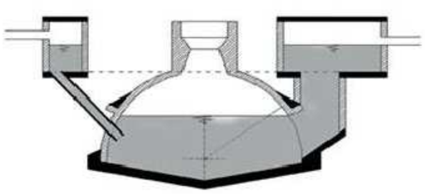
The NGO knew of the biogas technology, but before using it they investigated the best models, possibilities and applications. The plant was designed and built by a consulting company that still provides help and technical support when needed. The total price was about 500,000 NPR.

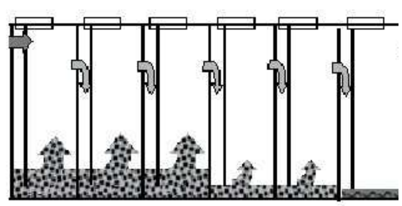
The waste treatment project is not funded consistently, but it gets subsidies here and there. It works with volunteers and wants to establish itself as a pilot project so that similar plants can be installed in other hospitals in Nepal, thereby solving the problem of medical waste disposal. For this purpose, biogas technology is an important tool. It uses waste and at the same time produces energy that can be used in the facilities. In Bir Hospital, the project is very well managed and maintained. The NGO is constantly looking for new solutions to the garbage disposal problem. Research and innovation make the Health care foundation project very valuable. With the income from the transformation and sale of waste they invest in new solutions and in a sustainable process. Furthermore, the project deals with simple, local solutions that can be replicated and used without major problems. The NGO is also constantly trying to make their best practices known in order to be used by others. Biogas is one of their newest and most successful tools.

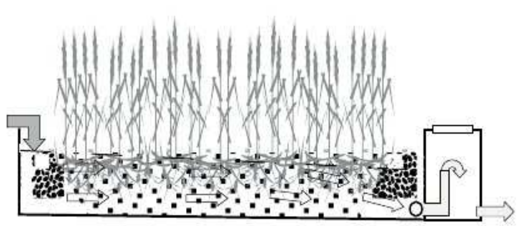


6.6 Ama Ghar, Godawari

Ama Ghar is a home for underprivileged children in Godawari. It has been operating for one year and the aim is to have a traditional architectural building based on sustainable principles and technologies. It is managed and funded by a US NGO. The facilities include solar panels, improved cooking stoves, recycling and compost to be used as fertilizer, UDDT toilets transforming urine into fertilizer and a wastewater treatment system, of which biogas is a part. It was visited on November 3, 2011.







The wastewater treatment has three stages: the biogas reactor, an anaerobic baffle reactor and a horizontal wetland. The black water from the toilets, through a circuit of manholes, is sent directly to the biogas reactor, along with the soft organic solid waste from the kitchen and garden. Hard kitchen waste is used for compost directly. The biogas plant is fed every day; no water is added. Grey water is sent directly to the anaerobic reactor. The water is then led from the biogas plant and from the anaerobic reactor into the horizontal wetland for further treatment. The treated water is collected in a pond and utilised for irrigation.

The biogas plant is a TED model of 17 cubic meters. It is designed for 100 children. At present, they have 46 students plus the staff in the house. It was constructed by the NGO ENPHO. It took about 7 months to build and has operated since February 2011. The total cost was 150,000 NPR. At the moment, it produces enough gas for tea, rice and hot water for everyone. There are no major problems. The NGO, ENPHO, has provided one day training for the staff, and is responsible for the operation and maintenance of the plant. Supervision and monitoring is done by ENPHO when required. Ama Ghar is very satisfied with the biogas plant; it is one more step towards their aim of a sustainable project. There is still not enough gas being produced, but they are searching for more feeding options.

7 Conclusions and recommendations, best practices and lessons learnt

This research is a glimpse into community and institutional biogas plants in Nepal. The objective was to present an overview of the sector and analyse several case studies in order to draw conclusions and make recommendations. The aim was also to highlight best practices and lessons learnt. The study builds a sketch of the sector based on the investigated examples. The study does not claim to arrive at final conclusions about all community and institutional biogas plants in Nepal. However, it presents a general overview based on several case studies.

The following is a summary of conclusions and recommendations, best practices and lessons learnt about community and institutional biogas plants in Nepal:

● A biogas plant works if there is ownership of the project and responsibilities are clearly defined. Ownership and dedication are essential. Based on this conclusion, it is clear that institutional biogas plants are more successful than community plants. The community biogas plants studied all need stronger ownership and the roles of everyone participating need to be better defined, otherwise the plants deteriorate and are not properly maintained. There needs to be better training of responsible staff and a clear definition of responsibilities. The advantages of biogas systems for the communities need to be better emphasised. Strategies for income generating possibilities needed to be researched and added. This would stimulate dedication and engagement.

● Many biogas plants seem to have technical problems. Sometimes these are not solved, even after years of operation. The solution to this problem requires two things:

–It is essential for community and institutional plants to have a better technical knowledge as many are much bigger than the widely used household plants. More studies need to be conducted and more technicians need to be taught how to service and maintain the plants.

–Good after sales service is essential, and if the plant was financed by a donor, covering the costs of after sales service should be part of the contribution. Technical problems often severely limit the effectiveness of the biogas plant. A very harmful example of such problems is leakages; if the biogas plant is not well built or maintained it can release methane into the atmosphere. Which is harmful to health.

● In all of the plants visited in the study the amount of gas produced is too low. The following questions need to be asked: Are there leakages? Is the feeding properly done? Is the retention time in the digester chamber sufficient? Has the plant the right dimensions? For these questions to be answered, better technical knowledge is needed and further tests and research need to be conducted.

● The choice of appropriate biogas technology is also essential. The choice of alternative technologies (CCG, TED, PUXIN or others) should be made according to the needs of the users and their behaviour in waste production. For example, the CCG model is best used with animal manure, which is often not available in urban communities and institutions. The TED model is more appropriated for kitchen waste. It is recommended that more technical investigation needs to be performed prior to the installation of a biogas plant.

● In Nepal, the advantages of biogas technology are not well understood. Biogas plants are normally presented as an energy tool. Often it seems that the other advantages are forgotten – for example, their potential as a sustainable sanitation solution. However, in the investigated case studies the sanitation advantages, for the users, the communities and institutions, seem to be more important than biogas production. Biogas, as a sanitation solution, supports sustainable ecological development. Therefore, it is recommended that biogas technology be promoted as a sanitation and energy production system. The potential of energy for rural areas and sanitation for the urban areas could also be emphasised. There seems to be a greater energy supply deficit in the rural areas of Nepal, whereas, in the cities, the main problem is with sanitation. Community and institutional biogas plants are normally more frequently in urban areas.

● Based on the last conclusion, it is proposed that if the community is weak in organisation and dedication, simpler technological solutions than biogas plants could be more cost effective in solving sanitation problems, even though they don't generate income and reduce expenses as a functioning biogas plant can. Wetlands were found to be better suited for biogas plants in many of the case studies. Ecosan technologies should also be supported and enhanced in Nepal due to their simple, on-site technology.

● In conclusion, it is recommended that further investigation of existing plants and their operation is necessary in order to develop a successful programme to promote community and institutional biogas plants in Nepal. Such a programme should cover the needs of the users to save fossil and other fuels, resolve sanitation issues, and contribute to the environment and climate protection. This programme should endeavour to answer the question of how community and institutional biogas plants can play a more important and decisive role in the sustainability of Nepal.

For better, longer and wider results more research needs to be conducted.

8 Bibliography

- AEPC (2009): Renewable energy data book. Ministry of Environment, Nepal.

- Bajgain, Sundar; Shakya, Indira (2005): The Nepal Biogas support program: a successful model of public private partnership for rural household energy supply. BSP.

- BSP (2009): BSP year book. BSP.

- Centre for Rural Technology Nepal (2005): National Energy Situation Survey Report Nepal -Focus on Renewable Energy & Poverty Reduction. International Network for Sustainable Energy.

- Devkota, Govinda (2008): Policy development modality for promotion of Institutional or Community Biogas plants in Nepal. BSP.

- ENPHO: Community based Waste Water treatment plant at Thimi Municipality. UNHabitat, WaterAid.

- ENPHO: DEWATS for Ama-Ghar. ENPHO.

- ENPHO: DEWATS for Srikhandapur community . ENPHO.

- GTZ: Grid extension in countries of power shortages, experience from energising development (EnDev),Nepal. GTZ.

- Heeb, J.; Jenssen, P.; Gnanakan, K. and K. Conradin (2007): Ecosan curriculum 2.0. Norwegian University of Life Sciences, ACTS Bangalore, Swiss Agency for Development and Cooperation, German Agency for Technical Cooperation and the International Ecological Engineering Society.

- Kishore K.C. et al. (1998): A study on the effective demand for Biogas in Nepal. BSP.

- Müllegger, Elke; Langergraber, Günter and Lechner, Markus (2011): Biogas systems. EcoSan club, Sustainable Sanitation Alliance.

- Müller, Christian (2007): Anaerobic Digestion of Biodegradable Solid Waste in Low- and Middle-Income Countries. Eawag.

- Snater, Fenna (2009): CLOSE OUT REPORT UN Volunteer Mission UN Habitat Nepal. UN Habitat Nepal.

- Tchobanoglous, G.; Burton, F.L. And Stensel, H.D. (2003): Wastewater Engineering, Treatment and Reuse. McGraw- Hill.

- WaterAid: Sunga constructed wetland for wastewater management A case study in community based water resource management. WaterAid.

- Water and Energy Commission Secretariat (2010): Energy Sector Synopsis Report. Water and Energy Commission Secretariat.

- Zhang Wudi et al. (2001): Comprehensive utilization of human and animal wastes. Proceedings of the First International Conference on Ecological Sanitation, EcoSanRes.

9 Attachment: Biogas assessment guidelines and questionnaire programme

General information		
Case study number		
Date		
Name of the Biogas Community or Institution		
Contact person		
Contact telephone		
Location		
GPS coordinates		
Technical details		
Model		
Size		
Date of construction		
Community or Institutional		
Construction plans		
How many people participate		
How many persons benefit		
Operational parameters		
Feeding material		
Toilet waste	Yes	No
	Number of persons:	
Kitchen waste	Yes	No
	Number of persons:	
Animal manure	Yes	No
	Number of animals:	
Others:		
Feeding amount per day (kg)		
Need of water addition	Yes	No
	Amount of water added:	
Functional status		

Working	Yes	No
If no, Problems:		
Leaks	Yes	No
Broken parts	Yes	No
Blockages	Yes	No
Stove	Yes	No
Stop of Biogas production	Yes	No
Seasonal changes	Yes	No
Flies or mosquitoes	Yes	No
Bad odour	Yes	No
Other problems	Yes	No
	Which:	
Maintenance		
Maintenance	Yes	No
How often		
What		
By who		
Costs		
Repairs	Yes	No
How often		
By who		
Costs		
Gas and slurry production, composition and use		
Gas production	Yes	No
Gas usages		
Cook	Yes	No
Light	Yes	No
Compost	Yes	No
Gas production quantities per day		
Hours for cooking		
Hours of light		
Produced of gas is enough	Yes	No
Gas composition (if tested)		
Slurry production	Yes	No
Slurry usages		

Fertilizer	Yes	No
Waste management	Yes	No
Slurry production quantities		
Better agriculture?	Yes	No
Technical knowledge and information		
How did you listen about the project		
Training about Biogas	Yes	No
Self Biogas plant operation	Yes	No
Subsidies and implementation agency		
Constructor		
Cost of construction		
Subsidies	Yes	No
Implementation agency		
Plant manage by		
Users motivations and awareness		
Why did you install the Biogas		
What are the advantages		
Users evaluation and impacts		
Are you satisfied	Yes	No
Why not		
Would you recommend it	Yes	No
Does it work well	Yes	No
Enough gas	Yes	No
	How more much still needed:	
Enough electricity	Yes	No
	How more much still needed:	
Enough slurry	Yes	No
	How more much still needed:	
Economical impacts		
Saves money in fuel	Yes	No
Saves money in slurry	Yes	No
Saves money in waste collection	Yes	No

Income generator	Yes	No
Others:		
Environmental impacts		
Less other fuels	Yes	No
Less waste	Yes	No
Better sanitation	Yes	No
Others:		
Social impacts		
Less health problems	Yes	No
More free time	Yes	No
Others:		
Users commentaries:		
Additional information (provided by implementation agency):		
1. Initial objectives and motivations		
2. Location and conditions		
3. Project history		
4. Practical experiences		
5. Lessons leaned		

I would like to thank to UNHabitat Nepal for helping me developing this research.

A glimpse into community and institutional biogas plants in Nepal

Dr.-Ing. Arquitecta Joana Forte – Nepal 2011