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Feasibility Study on Establishing Waste to Energy Boudhanath-Alapot Project

Final Report

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Executive Summary

The Nepalese capital Kathmandu has a population of approximately 3 million, which is growing by 6% a year . The necessary infrastructure to support this population is not in place and municipal services are largely inadequate. In addition to electricity, gas and petrol shortages, the Kathmandu inhabitants are suffering from an inadequate waste management system. The current 'production' of waste is around 1000 tons per day, of which 70% is of organic nature. Problems with current waste management are numerous, for example; poor organization of waste collection has led to prolonged accumulation of waste in countless parts of the city, resulting in significant environmental and public health issues.

To address the issue of bio-degradable discards in waste management, the number of initiatives in Nepal, as well as its success, have been insufficient. As this bio-waste is such a large component, its mismanagement currently impedes efficient solid waste management. At this stage, The World Bank asked Pragya Seeds Nepal (PGSN) - a non-governmental and non-profit organization working in the field of environmental health and justice (www.pgsi.org) - to submit a feasibility study on the Waste to Energy Boudhanath - Alapot project.

Although practiced in many countries, a Resource Recovery Facility is a relatively new concept in Nepal. In the private sector similar Resource Recovery Facilities are running, though only converting organic waste to compost. Unfortunately, their accounts are not accessible to enable a market analysis. This adds to the fact that waste flows in general are largely unaccounted for on a social, political and economic level. Therefore, there is very little reliable information available and feasible examples or models are lacking. This situation shows that a properly designed and implemented resource recovery system has great potential to improve conditions in Nepal. A targeted recovery of 50% of waste will be a great achievement in terms of solid waste management as well as resource conservation.

To achieve this, the study team strongly recommends the establishment of a Resource Recovery Facility at Boudhanath-Alapot as part of the municipal solid waste management system, incorporating CBO's, NGO's and the private sector to improve efficiency of the recovery of discarded materials.

Introduction

A recent and important paradigm shift in waste management has been the change from 'managing waste' to 'managing resources'. Any progressive waste management system is responding to threatening shortages of natural resources and the current speed with which resource life cycles come to an end. Therefore, resource conservation and/or recovery is the most important focus area. The Zero Waste movement is a well-known player in this field, combining a local, community approach with a global vision for a sustainable future through waste management. Its philosophy offers context, tools and general guidelines to start 'managing resources' in every context, including a developing country like Nepal. As in all places where Zero Waste has settled, local Resource Recovery Facilities are a central medium, as they are the key to efficient, ethical and economic resource management.

Local and decentralized efforts are the key to effective resource management. One of the examples that served our study is the City of Berkeley (C.A., USA), which has demonstrated a well-organized resource recovery facility, run by the Ecology Center of Berkeley. Segregation at source, decentralized handling and resource recovery are the key elements of their Resource Recovery Facility. Such facilities create an opportunity to link the informal sector with formal sector to guide and strengthen the flow of resources in a society. In order to bridge the gap between these two sectors, intensive planning and institution building is necessary. The role of the private sector is also very important.

This feasibility study will show that a resource recovery facility (RRF) in Boudhanath- Alapot is a reasonable, practicable option to improve waste management practices in Kathmandu. This project will serve as a pilot for the Kathmandu area, converting the capital's uncontrolled, mismanaged waste streams one local step at the time. This is the best option to come to this conglomerate of changes that we are aspiring to. After all, waste management includes supporting or creating local awareness and participation, organizational structures, economic incentives and finally, environmental, health and esthetic benefits.

In this report, we will detail the scope, methodology, results of the feasibility study, as well as the financial estimates that accompany its results. As an annex, a detailed report on the preliminary training and awareness campaigns in Boudhanath is included (Annex I), as well as detailed information on the biogas plant (Annex II) and the partnership agreements (Annex III)

Scope of study

Objectives

The following are the objectives of the feasibility study;

1. Determine the quantity and percentage of biodegradable material present in the solid waste collected from Boudhanath.
2. Suggest suitable mode of collection of bio-degradable material based on research done at Boudhanath.
3. Make suggestions based on the quantity and type of biodegradable waste, their biogas/composting potential and the appropriate level at which the RRF can be established and operated.
4. Make suggestions regarding the minimum infrastructure requirement for RRF including specifications, tentative costs and organizational mechanism required for operating the same.
5. Conduct feasibility study on sustainability of RRF by identifying probable markets.
6. Make suggestions regarding the economic viability of operating and managing the RRF by SHG/NGO based micro enterprise units and private sector.

Area of Study

Geographically the study area is located at 27°43'37.37" N and 85°22'07.04" E with an elevation of 4455 foot above sea level. The study area lies 500 m from the UNESCO world heritage site Boudhanath Stupa, Boudhanath – 6, Kathmandu, Nepal. The climate is that of the Kathmandu valley, where summers are wet and winters are dry with a temperature variation from 0 °C (minimum) to 35 ° (maximum). The Tinchuli chowk that is the centre of the study area is an old traditional chowk (square) surrounded by mostly three story buildings and one Buddhist Monastery. Moving from Tinchuli chowk to the western part of the survey area, one finds the Ramhiti area, which is mostly comprised of single story buildings. The northern part of the study area has mostly 2 story buildings. The area is famous for the production of woolen carpets that are exported to the foreign markets.

In the designated study area, segregation practices of the waste are common and awareness about recycling is present. The area is shown in the map below.

Figure 1 Satellite map of Tinchuli, Bouddha

Methodology and Limitations

Data source and data collection methodology

With the help of Boudha Sarsafai Kendra (BSK), Tinchuli women group and volunteers from Pragya Seeds Nepal (PGSI), door to door visits were conducted reaching the designated study area of 200 houses at Tinchuli, Boudhanath. For the data collection awareness flyers with questionnaires were distributed and collected later on. The questionnaires gathered information on the number of kitchens, number of tenants/occupants, settlement details and amount of waste generated on a daily basis. Additional data for the study was collected directly through interviews and physical measurements. Please see Annex 1 for details.

Direct Sample Surveys

Altogether six settlements were selected for the direct sample surveys, where the waste of 24h was collected, weighed and measured. Representative of the settlements in the area, the survey was conducted with four different commercial settlements and three residential settlements. For the commercial survey one Buddhist monastery, one school hostel and three coffee shops and restaurants were surveyed. Please see Annex 1 for more details about the door to door visits and a workshop in the area.

Waste and Waste Source Data Characterization

Statistical information on the population of the target area was collected through door to door surveys and population reports from the Boudhanath ward office. (Source: Bureau of Statics of Nepal). The area includes as major settlements up to 5 story residential buildings, garment industries, a Buddhist Monastery, a school hostel, restaurants, and coffee shops were found as major settlements in ward no. 6. The settlement numbers are tabulated below.

Table 1: Estimated total number of settlements

Building around the Survey area	Settlements	Population	Percentage
Households (HH) Total	361	1756	87.10
1-Storey Households (1S HH)	111	422	
2-Storey Households (2S HH)	90	494	
3-Storey+ Households (3S HH)	160	840	
Buddhist Monastery (BM)	1	121	6.0

Small Restaurants/Tea shops	26	78	3.87
Carpet Industries	3	15	0.74
Bag Industry	1	5	0.25
School Hostel	1	41	2.03
Total	393	2016	100.00

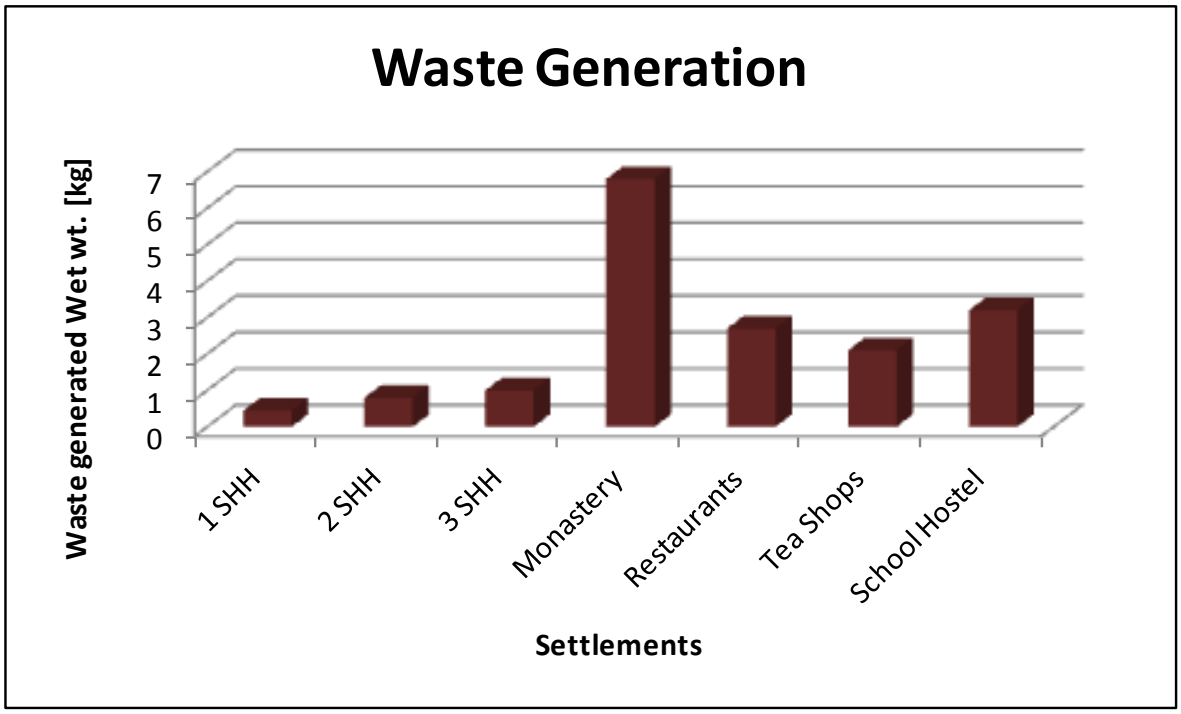
As mentioned in above table, it is estimated that the total number of settlements 393 (HH1S 111, HH2S 90, HH3S 160, BM 1, Small Restaurant/tea shops 26, Carpet industries 3, Bag industry 1 and School hostel 1) with a population of 2049 inhabitants. The settlements were counted using maps, survey data and information from the central bureau of statistics for Jorpati area (Source: CBS Nepal, Jorpati area details). The statistical information on the waste generated is tabulated below.

Table 2: Statistical information on the waste generation.

Ward No.	6
Area (Km^2)	0.25
Number of Settlements	393
Population of Survey Area	2016
Inhabitant In a Family (Inhb./kitchen)	3.80
Waste Generated (Kg/inhb.day)	0.12
Total Waste Generated (Kg/day)	238.74
Bio waste (kg/inhb.day)	0.0805
Total Bio waste Generated (kg/day)	162.3

Per settlement, the wet weights of 24 hours were weighed. The waste generation per settlement is shown by the chart below.

Figure 1: Waste Generation [Wet weight kg]



The wet weight waste measured from a one story building was 0.45 kg/day, a two story building was 0.8 kg/day, a three story building was 1 kg/day, the Monastery was 6.8 kg/day, a restaurant was 2.7 kg/day, a tea shop was 2.1 kg/day and the school hostel was 3.2 kg/day. Total wet waste collected was 19.45 kg/day with an average production of 2.4 kg/day per surveyed settlement.

The weight and volume was measured and density of the waste from each settlement was calculated. It was found that high density waste was obtained with high percentages of organic waste. Waste composition details are shown in the graphs below.

Figure 2: Waste Composition [Wet weight %]

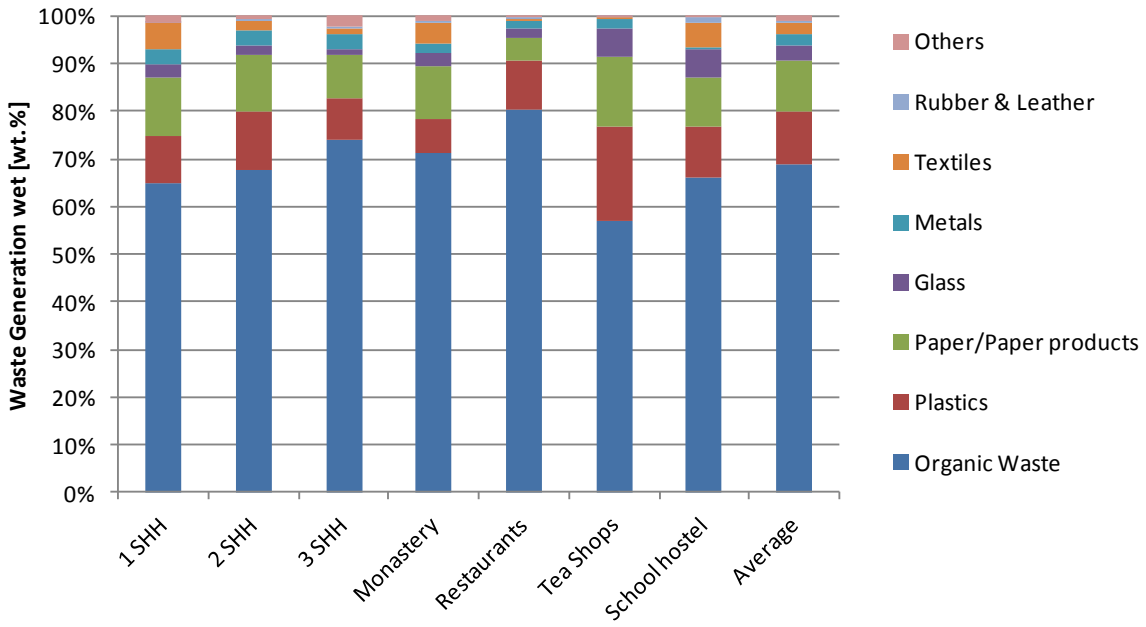
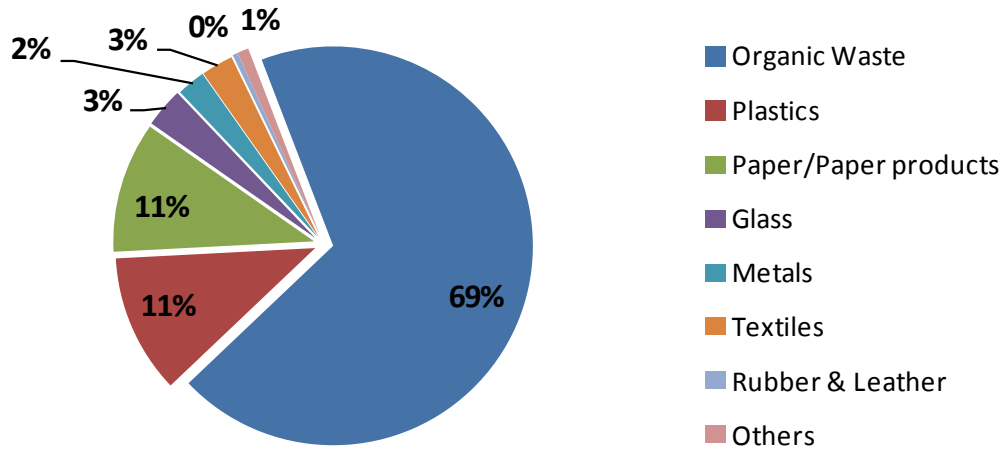


Figure 3: Waste Characterization [Wet Weight %]



Waste to Energy Project Background

As the main activity of the Resource Recovery Facility, the basic outlay of the Waste to Energy Project is the following: garbage collectors will deliver organic waste from 1000 houses in Boudhanath to the plant site in Alapot. Together with pig manure, the organic waste will be used to produce electricity and compost. The produced electricity will be used for water pumping activities thus enabling local women to increase farming revenues by year-round farming of non-seasonal products. Excess of electricity will be sold to the community for domestic use during load shedding hours. Compost will be sold as an organic fertilizer.

Figure 4: Waste to Energy project diagram

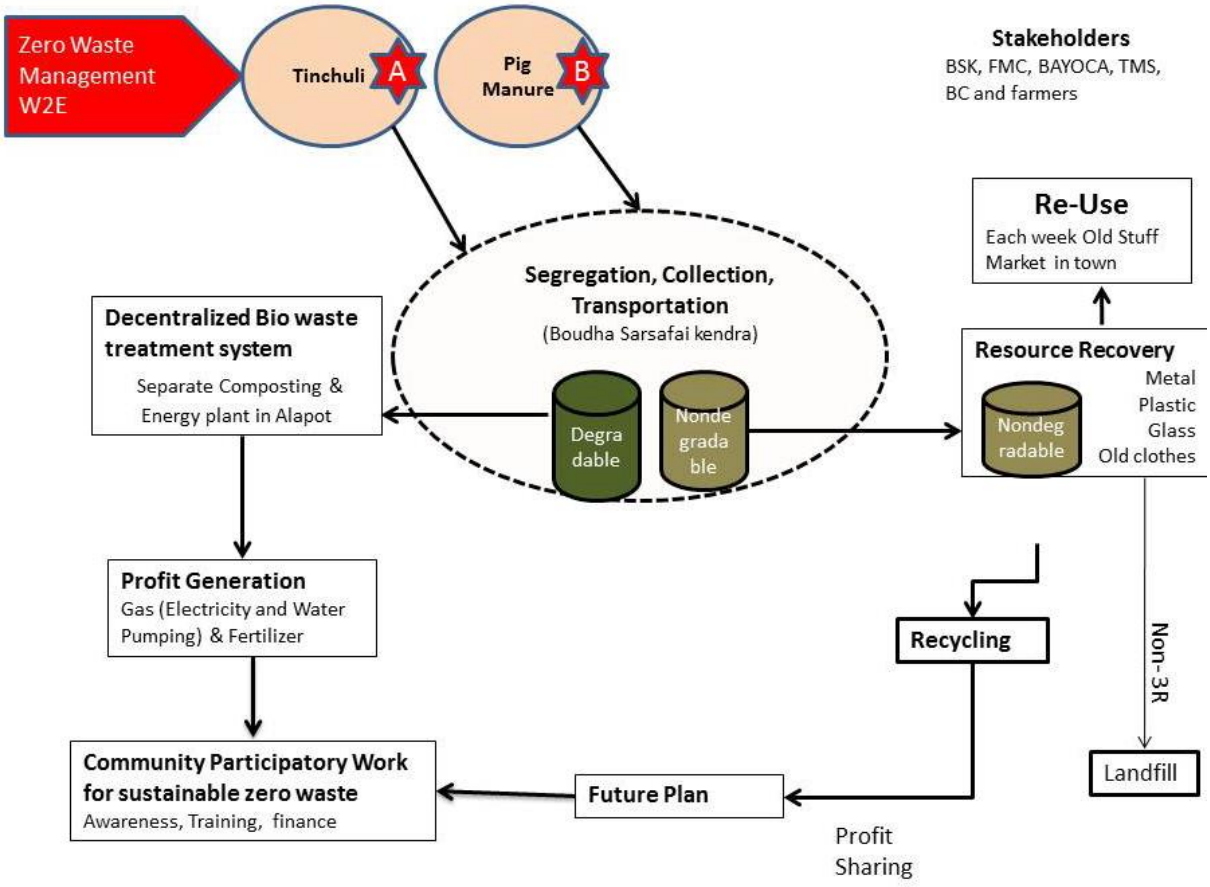
Beneficiaries:

1. Bouddhanath garbage collectors
2. Bouddhanath community-1000 houses
3. Alapot farmers

Explaining the process in more detail; the organic waste will be delivered to the Resource Recovery Facility at Alapot by the garbage collector organisation Boudha Sarsafai Kendra. Pig farmers will deliver pig manure. The RRF will contain a 50 cubic meter biogas plant and composting unit. The RRF will use a waste to energy approach by producing biogas, as well as compost. By converting the biogas to electricity, the energy is available to improve and support

the community. With the energy, a water pump can power irrigation activities for the local farmers as well as provide domestic electricity. Stakeholders of the Resource Recovery Facility are the waste collectors organization; Boudha Sarsafai Kendra (BSK), the local social organizations Bhagwan Yuva Club (Bayoca), Fohar Mahila Concern (FMC) and Tinchuli Indreni Mahila Samuha (TMS) and the farmer group. A part of profit generated will be used to support community participatory work.

Figure 5: Resource recovery Facility, Alapot



Viability of Resource Recovery Facility

Current resource recovery processes have been put in practice by NGO's and businesses. In order to reach a more sustainable cycle of resource recovery, a paradigm shift is needed that contains two important changes. Firstly, human rights and environmental health should be considered to be of the highest importance in determining the practices and processes of waste handling and processing. Secondly, suitable and responsible consumer behaviour is the key to ensuring prompt segregation at household level and regular deliveries to the RFF. This is where the door-to-door visits and the local involvement, as shown in the annex, are essential.

Within this context, the RFF can be analyzed for economic viability. In this study, a RFF with the capacity of 1 ton / day has been analyzed. This capacity will support the conversion of the waste of 1000 households in Tinchuli, Boudhanath, based on the quantity of organic waste produced by this area.

A resource Recovery Facility having a capacity of 1Ton / day has been analyzed for its economic viability. The assumptions are made on the characteristics and quantity of organic discards generated from households in an area only since number of commercial establishments or its proportion to number of households. A 1 Ton/Day capacity RRF can take discards generated in a Tinchuli, Boudhanath minimum of 1000 households including hotels and pig manure. Our study recommends installing a 1Ton/Day RRF because the running cost of the plant and fixed capital investment is high, so in order generate revenue and convert waste to energy successfully, we need to install a 50 cubic meter biogas plant and compost tanks with a capacity of 800 kg./day. We have further explained in Projected profitability on page 12, how 1 ton/day can generate revenue and successfully convert waste to energy.

Cost of Resource Recovery Facility

Table 3: Estimated of Working Capital Requirement of a RRF of 1TPD per year

S.N	Estimated Expenditure	Cost (in Rs.)	Cost (in Rs.)
1	Wages Salary		5,26,000
	Plant Manager	240000	
	Plant Worker	176000	
	Electrician	110000	
2	Transportation		2,71,000
	Diesel for BSK	190000	
	Pig Manure	81000	
3	Maintenance	12,500	
4	Electricity and Water	10,200	
5	Land Lease	84000	
6	Depreciation	74,000	
7	Miscellaneous	15,000	195700
	Total		**9,92,700**

The following table gives an account of Fixed Capital cost for a RRF. It is approximately Rs. 31,15,000/-.

Table 4: Estimate of Fixed Capital Requirement for a RRF of 1 TPD capacity

S.N	Assets	Cost (in Rs.)	Cost (in Rs.)	Comments
1	Plant – 50 cubic meter Biogas Plant (With complete setup)		20,00,000	Funded by Germany Embassy
2	Compost Tanks-10 Tanks		7,00,000	
3	Machinery		3,15,000	
	Shredder (Rs1,20,000) X 1units	1,20,000		
	Water Pumps (Rs.10,000)X2	20,000		
	Trolleys (Rs.8,000)X10	80,000		
	Tools and Equipment's	45,000		
	Weighing scales	40,000		
	Screening (Rs. 10,000) X 1	10,000		
4	Furniture and Fixtures		50,000	
5	Computer and Printer		50,000	
	Total (Rupees)		**31,15,000**	

Estimated By-Product Revenue Calculation

By-product revenues are generated by the sale of marketable products created as a by-product of solid waste management. Revenues derived from the sale of compost, and energy generated by a Waste to Energy (WTE) facilities are by-product revenues. On average, 1kg of organic waste will be collected from 1000 households and commercial establishments. The total quantity and value is stated as follows:

Total organic and discards

Supplied to RRF = 1Ton per day

Quantity of discards for composting = 700 kg.

Compost from 700 kg organic waste per day = 280Kg. per day

Average price for low value compost = Rs.14/Kg (280 x 14= Rs. 3920)

Quantity of discards for Biogas 50 Cubic mtr. = 300 kg.

Electricity from biogas = 3 KWh

Price for electricity as water pumping = Rs. 586 per day

Slurry Compost from Biogas Plant per Day 90 kg. = Rs.14/Kg (90 x 14= Rs. 1260)

Total Revenues from Biogas Plant = Rs. (586+1260) = Rs. 1846 per day

Total By-product revenue per day 3920 + 1846 = Rs. 5766

Total By-product revenue per year 5766 x 220 = **Rs. 1,26,8520/-**

(Twelve Lakhs sixty eight thousand five hundred and twenty only).