SUMBA ICONIC ISLAND REPORTS

The Iconic Island For Renewable Energy

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Feasibility of Biogas in Sumba

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Hivos
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Executive summary

This report presents the findings and recommendations of a study to assess the feasibility of biogas in the island of Sumba, NTT province, Indonesia. The report is prepared based on the meetings with government officials, meetings with households and field observations which were carried out in the second week of February 2011.

A small market for biogas seems feasible in Sumba; however, there are many challenges and limiting factors as well. There are sufficient cattle in Sumba but the availability of dung in the yards is rather limited. This is due to the cattle rearing practices prevailing in Sumba. The local Government seems interested in promoting biogas as a sustainable technology.

The market is not big enough to attract the private sector. The technology is new in the island; therefore capacity needs to be built up within the implementing organisations. Motivating households to adopt biogas might be another challenge at the beginning, although people generally seem positive about new technologies. Ability to pay for biogas is rather low in general therefore higher level subsidies will be required. A micro credit system is yet to be developed, otherwise credit could be an option to resolve the problem of financing.

The priority of households is lighting or even generation of electricity. Therefore, besides small household size plants for cooking, larger size plants up to 20 m3 are proposed. These large sized plants can be installed at the community cattle shed and the gas can be shared to multiple households or used to generate electricity. However, it is a big challenge to have these plants managed by the communities.

The Department of Livestock (Dinas Peternakan) seems to be an appropriate partner for biogas promotion, however collaboration with other departments like ESDM will be essential. At this moment constructing some biogas plants as a pilot phase at strategic locations and assessing the response of people towards this new technology is recommended. It is also strongly recommended to construct cattle sheds with concrete floor at the household yard that enables to collect more cattle dung and urine for biogas as an additional activity.

A strong promotion and socialization package needs to be developed and implemented. Bio-slurry as fertilizer can be a strong extension message to the households to create more demand. Religious and cultural institutions can be used for such socialization programmes. Looking into the social structure and cultural values in Sumba, it is more likely that people may consider biogas as a symbol of social status and willing to install more biogas plants. These demonstration plants will have positive impacts on further demand of biogas.

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Feasibility of the Biogas in Sumba

1 Background

Hivos has shown a keen interest in promoting biogas technology in Sumba as part of the Iconic Island concept to make Sumba a complete Renewable Energy Island. In this regard, Hivos requested the Senior Advisor of the Netherlands Development Organisation (SNV)/ IDBP to carry out a feasibility study on biogas in Sumba.

The SNV Advisor visited Sumba on 07-11 February 2011 to collect information and assess the possibilities for biogas technology.

Meetings with the Government Officials in four districts were held during the study visit. In all meetings the officials expressed deep interest in promoting biogas in Sumba and therefore requested that the possibilities of biogas can be explored and a way forward can be recommended.

Keeping these reasons and requests in mind, the report is prepared in two parts. The first part discusses the feasibility of biogas in Sumba, whereas the second part briefly proposes the Pilot Biogas Programme.

1.2 Objective

The main objective of the study is to assess the feasibility of a biogas programme in Sumba and recommend the possible implementation modalities.

The information related to this study was collected from a number of sources:

a. Secondary information as in reports, government publications, websites etc.;
b. Meetings with government officials, field office staff and households (during 7-11 February 2011);
c. Information collected on construction material costs from local markets;
d. Field observation.

The report is prepared on the basis of factual information; however the writer used his own experience in some cases where information was not available.

2. Introduction

Sumba is one of the poorest and most isolated islands in Indonesia. With an area of 11,052 square kilometers, Sumba is a mountainous island rising from sea level and extending over 1,225 m high. The climate is humid and tropical and temperate is warm. Administratively, Sumba is divided into 4 regencies (districts), East Sumba, Central Sumba, West Sumba and Southwest Sumba.

The estimated population of Sumba is about 650,000 with a total of about 116,000 regular households. People live in small villages of 40 Districts. The average size of a Sumbanese household is 5.6 persons. About 60 percent of rural residents are estimated to have access to water. Sumba remains very dry for 7 to 8 months.

Sumba has a unique culture and social life. Sumbanese are traditionally divided into three levels of social life : (Raja/King) - Maramba, Customary Official - Kabihu, and Slaves - Ata. Most Sumbanese are Christian, however, they still strongly keep their native and original religion called Marapu. Most cultural objects are related to the Marapu religion such as the shape of traditional houses, ceremonies, or kings' graves and tombs.

Sumbanese's economy is predominantly agriculture and livestock. Most of the households own two or three animals. However, it is estimated that about 20 percent of the households own and keep more than 5 animals at home. The total livestock population is about 500,000 which include cattle, buffalo, horses and pigs. Livestock are an integral part of the Sumbanese social and cultural system. Livestock, mainly buffalos, are considered as a symbol of social status rather than economic activity. Large numbers of animals are sacrificed in ceremonies.

Households' access to electricity is estimated to be about 32 percent. Electricity is available mainly to those households which live in urban areas and around the road side. Another source of fuel for lighting is kerosene which is used commonly by rural people.

The price of kerosene is Rp 3,000 to 5,000 per liter. On average each rural household consumes about 10 liters of kerosene thus spends about Rp. 40,000 per month on kerosene.

Almost all households use fuel wood for cooking their meals. People generally cook two times and on average about 3 hours per day. Although Sumba is rich with natural forests, access to firewood is becoming difficult these days. This is mainly due to the government decision not to allow the random cutting of trees with the view of conserving the natural forests. People collect fuel wood from their own farm or nearby forests in rural areas whereas people who are residing in urban areas generally buy fuel wood. The price of fuel wood in urban areas is Rp 1,000 per kg. Generally a household consumes about 200 kg of fuel wood per month thus spending around Rp. 200,000 per month. In rural areas people do not buy fuel wood but spend about 4 person days per month for collecting fuel wood.

Because of high costs, LPG is hardly available in Sumba. Subsidized LPG is not introduced yet in Sumba.

3. History of Biogas in Sumba

Biogas is new for most of the Sumbanese household. A few attempts were made in the past to introduce biogas technology by installing about 20 biogas plants in Sumba. In 2007, a biogas plant was installed by the Kehati foundation in Karera. Later on in 2010, Yayasan Alam Lestari has installed 11 plants in East Sumba. Another 5 plants were installed in East Sumba later on by two technicians who came from Central Java. All of these plants are new and found not in operation, due to the fact that the technology was not much known to the installer, allowing them to make the plants functional. About 15 plants were of the fixed dome model whereas the other five plants were plastic digesters. The fixed dome model plant was copied from the old model plant promoted earlier in Central Java whereas the plastic digesters were imported from China.

All these plants were funded through a full grant from the Government, so there is no contribution from households. The users have even no idea about the cost of these plants. It appeared that the Government has spent 25 to 30 million Rupiah for each plant.

The local government in West Sumba and South West Sumba are planning to start constructing a number of biogas plants in areas where electricity is not available. When asking Government officials and potential households about the use of biogas, most of them wanted to use biogas for lighting, even generating electricity from biogas.

3.1 Benefits of Biogas plants

The benefits of biogas, in the context of Sumba, are similar to other provinces of Indonesia. Biogas mainly saves money by replacing firewood and kerosene, but it will also have many intangible benefits. In general biogas can have the following positive aspects:

- Biogas is a clean and easy source of cooking energy and does not produce bad smells.
- It saves time of cooking and fuel wood collection from the forests.
- It helps to preserve forests by saving firewood.
- Biogas can be used for lighting.
- Biogas reduces exposure to smoke indoors and improves health conditions, especially of women and children.
- It helps to maintain clean surroundings using the cattle dung to feed the digester. Toilet connection to the biogas improves sanitation conditions of the rural community.
- Bio-slurry is an excellent organic fertilizer for crop/ vegetable production.
- Cooking utensils are easy to clean as they do not get too dirty while cooking with biogas.

However, there are some negative aspects of biogas plants:

- Need to always keep the required number of cattle.
- Feeding dung and water to the digester everyday is sometimes difficult and means extra work.
- Initial investment is difficult for low income households.
- Natural calamities like earthquakes, landslides and floods can damage plants and when that happens the plants are difficult to repair.

4. Biogas potential in Sumba

While looking into the possibility of biogas technology in Sumba, generally the following factors need to be analyzed:

a) Is there sufficient dung available to the households?
b) Is water available to mix with the dung?
c) Is the temperature suitable for biogas generation?
d) Are construction materials readily available?
e) Can households pay for a biogas plant?
f) Is biogas socially acceptable?

These questions are briefly discussed below.

4.1 Availability of dung

Sumba has about 500,000 domestic animals (cattle, buffalo, horse and pigs). Buffalos are considered high value animals. Buffalos are kept mainly for sacrificing in ceremonies, but other animals are also kept as a symbol of social prestige. There are no animals for dairy purpose therefore; stall feeding practice is not in place at all. Sumba, mainly the eastern part, becomes completely dry in the dry season and it becomes sometimes difficult to find the green grazing lands for the cattle. Pigs (1 to 2) are commonly available animals in almost all households but are always freely roaming around, therefore pig dung is not available at the yard. Almost all households let their cattle/buffalos graze freely during day time and therefore the dung collection at the farm yard is rather small. Most of the houses have no cattle shed at their place. Cattle are kept just outside the home in an open space at night. This practice makes it highly difficult to

collect dung for biogas. Urine can be another highly valued source of materials for biogas but in case of Sumba collection of cattle urine is almost impossible.

High numbers of cattle and buffalos are usually owned by the rich people who generally live in town or even outside Sumba. These cattle and buffalos are taken care of by their servants. Generally the servants get 1 out of 5 newly born calves as compensation for taking care of these animals. These servants are very poor and are not in a position to make a cattle shed and improve the livestock practices, whereas the real cattle owners are not interested in an additional investment since they do not live in the village and do not feel the need. West Sumba is slightly in a better condition than East Sumba in terms of cattle population and cattle rearing practices.

Many households who have only 1 to 2 cows and buffalos even do not bring their cattle at home, but rather keep them in a community open stable at night. The size of cattle in such community sheds ranges from 10- 25. The community stable is made of bamboo fence without a roof. The floor of the stable is just raw earth, therefore dung is completely mixed with earth especially in the rainy season. People do not take out the dung from the stable during the rainy season (4 to 5 months). These community sheds are generally nearby to the houses but that is not always the case.

It is estimated that about 6 kg of dung per cattle per day is available in the community shed, whereas if these cattle were fully stabled, the availability of dung could reach up to 10 kg per day. It is estimated that a minimum of 5 adult cattle would be required for the smallest size biogas plant (4 m3) to fulfill the cooking requirement of 3-4 hours per day.

Considering the cattle population and their rearing practices it can be concluded that there is only a limited number of houses with availability of cattle dung for installing biogas plants in Sumba.

4.2 Availability of water

Water is another essential pre-requisite for a biogas plant. The cattle dung needs to be mixed with equal amounts of water and fed to the plant every day. At least 30 ltrs of water will be required for the smallest size biogas plant; however it is not necessary for the water to be of drinkable quality. Water sources in Sumba are mainly from artesian, stream or piped water. Water is not easily available everywhere, however most houses collect rain water during the rainy season. People reported to the writer that the rich people generally buy water or use their servants to fetch water whereas poor people always struggle with access to water and generally use dirty water. In such case, biogas plants could increase the workload for households in fetching additional water for the plant or even households may not be willing to operate biogas due to the additional workload of collecting water. It was a rough estimate that about 40 percent of the households do not have access to water all the time. The inaccessibility of water also is considered a limiting factor for biogas in Sumba.

4.3 Temperature

Sumba is an island with small mountains. The climate is warm and temperatures generally remain above 25 degrees Celsius. Therefore, the temperature in Sumba is highly suitable for biogas generation.

4.4 Availability of construction materials

The cost of a biogas plant depends on the availability of local construction materials. These materials are mainly bricks/stones, sand, gravel, cement, pipes and biogas appliances. Stones, sand and gravel are available but are expensive due to high transportation costs. Cement and pipes are readily available in local markets. Biogas appliances can be produced locally in the areas where electricity is available or they can be imported from Java. Construction masons can be available locally but needs thorough training and supervision. In case of non availability of skilled persons, biogas masons from Bali or Lombok can be hired.

4.5 Purchasing capacity of households

The purchasing power of rural Sumbanese seems very low. Most of the people are poor and their income source is mainly agriculture. The cost of biogas is still expensive for average rural farmers, comparing it to their income level. When households were asked during a field visit whether they could pay for a biogas plant, their answers were mostly no, whereas Government officials had the opinion that most of the people will be ready to pay partly if they really see the benefits of biogas. The writer observed that most of the development activities have lack of people's participation and ownership including all the earlier biogas plants. Therefore, expecting a financial contribution from the households for installing biogas plants seems far from realistic in Sumba. The interesting image obtained in Sumba is that people who want to pay have no money and people who have money do not want to pay.

Micro credit could be one of the ways to make biogas affordable to common people, but a micro credit system is not in place in Sumba. There are 7 livestock groups in Waingapu and another 14 groups outside the city promoted by PNPM[1] in East Sumba. West Sumba has also 11 livestock groups already established. Some of these are doing some micro credit business. The Kambajawa group is working very well and has collected about 80 million Rupiah. The groups receive support and funds from PNPM in which they pay 1.5 percent interest per month. The maximum size of the loan is 2 million and loan is mainly used for agriculture and livestock. These groups can be utilized for biogas credit however, they are in an infant stage and working in a limited number of areas.

4.6 Social acceptance

Since biogas is a completely new concept for ordinary Sumbanese people, it is rather difficult to estimate the social demand for biogas, however information from various sources reveals that Sumbanese people are quite receptive to new technology. People generally have no hesitation to handle cattle dung and use biogas for cooking however,

[1] PNPM Program Nasional Pemberdayaan Masyarakat, National Programme for Community Empowerment

they are not used to with biogas. Therefore it can be assumed that biogas would have no problems of social and cultural acceptance in Sumba.

4.7 Cost of biogas plant

The cost of a biogas plant in Sumba is slightly higher than in Java. The reasons of higher costs are simply the higher transportation costs. If the stones are used instead of bricks, the costs may come done slightly. Being a mountainous island and having stones available everywhere, it is proposed to adopt the biogas design promoted under BIRU. The plant would be constructed using bricks/bolder, cement, sand and gravel. Bricks are available but are very expensive. Local masons are available but need training for biogas construction. Other construction materials are available in the markets. Biogas appliances can be produced in local workshops, however importing them from Java is also possible. Based on the BIRU model plant, the tentative cost of a 6 m3 biogas plant is estimated to be about 6.7 million Rupiah. Details of cost breakdown are in Annex- 1.

4.8 Investment subsidy

Biogas plants in Sumba will require subsidy, but full subsidy is not desirable. As Hivos is looking into options of developing Sumba as Iconic Island in an integrated energy programme, it is difficult to consider biogas separately as a commercially and market oriented sector. In this context a higher level of subsidy is proposed. The logic behind the need for higher subsidy is:

- Biogas is a new technology for Sumba. Subsidy can be a strong tool for biogas promotion.
- The investment cost of biogas is not small for common rural households. The investment cost could be lowered with subsidy and therefore be within the range of affordability of common rural households.
- Biogas can have several social and environmental benefits at national and international level and subsidy can compensate the investment of households for these benefits.
- The concept of making Sumba as a Renewable Energy Island can not be complete without promoting biogas. In such case the subsidy rate should be higher since the biogas technology has very low potential to contribute to a market oriented biogas sector in Sumba.

4.9 Technical market potential

Taking into account the above parameters, the technical market potential of biogas plants in Sumba can be around 7,000 plants, which is calculated as per the table below:

Particulars	**No of Households**
Total households in Sumba	115,000
Households with more than 5 cattle (20 percent)	23,000
Households with cattle in night stabling (50%)	11,500
Household with access to water (all the time) 60%	6,900
Biogas Potential Households	**6,900**

Out of the total 115,000 households, about 23,000 (20 percent) households however have sufficient cattle, but are assumed to be free grazing and are not stabling at night therefore not all are suitable for biogas. Furthermore, out of the 23,000 households, only 50 percent (11,500 households) are estimated to have stabled cattle at night therefore are considered technically feasible for biogas. Pigs are not considered while calculating the potential because the collection of dung from pigs seems almost impossible. Water is not accessible all the time to these households to mix the dung regularly. It is assumed that about 60 percent of these households have access to water therefore, the real technical potential of biogas comes down to around 7,000 plants. The estimate is based on the current situation and current livestock rearing practices. However, if cattle sheds are constructed and night stabling practices are increased, the technical potential of biogas may become much higher.

5. Opportunities and Challenges

The Biogas technology has both opportunities and challenges in Sumba. The following is a list of the main opportunities and challenges in relation to biogas development in Sumba**.**

5.1 Strengths/ opportunities

1. The Government of NTT and the districts in Sumba are very keen and committed on promoting biogas technology. The Department of Livestock has already initiated the introduction of biogas technology in East Sumba. West Sumba and South West Sumba are also planning to introduce a biogas programme very soon.

2. There is a large number of animals producing large amounts of dung every day. Rearing practices need to be changed to make dung become available for biogas at the yard. A small initiative on making concreting cattle shed in each livestock house will tremendously increase the potential of biogas in Sumba.

3. Households seem receptive of new technology. There is a strong need of cooking and lighting energy in Sumba.

5.2 Threats/ Challenges

1. Construction and maintenance services could be difficult because of the lack of motor roads to the scattered houses. Construction costs will be higher if biogas plants need to be constructed in remote areas. All households will not be in a position to pay up-front for the construction of biogas plants and micro credit systems are not in place.

2. It seems that people are not used to be involved in management and maintaining projects like biogas. This may result in low functionality of biogas plants. It was suggested by some of the respondents that the managerial capacity of the Sumbanese is rather low. The introduction of Solar Home Systems managed by group did not work. Biogas plants installed by the Government free of costs are

also not operating. In such conditions, making biogas operational through the management of local people seems a challenge in Sumba.

3. Biogas technology is new in Sumba and there is a need to develop capacity within the potential implementing organisations.

4. The Biogas market is not big enough in Sumba to get the private sector interested to be involved in plant construction and maintenance.

6. Recommendations

The following are the main recommendations:

1. Compared to Java and some other provinces, the biogas market is rather limited in Sumba, however looking into the size of the population of the island, biogas could reach about 6 percent of the total households. Therefore, biogas could be promoted in Sumba by establishing a unit within the Iconic Island programme. The Department of Livestock seems to be the appropriate counterpart organisation from the government side. It has also been suggested that involvement of local NGOs on biogas construction and maintenance would help to sustain the biogas programme.

2. Biogas technology is new for Sumba. It is recommended to establish pilot plants in different strategic pocket areas in all districts to proof that biogas will work if a good quality plant is constructed and sufficient dung is fed into the plant regularly. These pilot plants are recommended to develop confidence at the users level and also to obtain concrete information about the users participation on operation and maintenance, plant functionality and management system.

3. It is suggested to introduce the same biogas model in Sumba as promoted under the BIRU programme, however, the community biogas plants will be up to 20 m3 and distribute gas to multiple houses. Electricity can be generated from large sized plants as per the need and demand of the users.

4. Biogas technology has to establish a good image among the communities first before being promoted more widely. Therefore it would be wise to start biogas construction in the areas where high cattle dung is available in the yard, access to water is available and in relatively densely populated areas where the probability of success and replication to many households will be much higher.

5. Households will need higher level subsidies for purchasing biogas plants in the first stage and it is considered that the programme pays for the materials and skilled masons costs whereas households contribute for labor costs.

6. Provision of soft loans to households would help to minimize the financial burden of purchasing a biogas plant. Obtaining loans in the early stage would be difficult however, therefore appropriate institutes need to be identified and developed

further in a next phase of implementation. Livestock groups promoted by PNPM could be one of the possibilities.

7. While constructing plants, strict attention needs to be paid to the quality of construction. Quality control, after sales services (regular maintenance), training for the users on operation and maintenance, as well as on bio-slurry utilization, are the key factors for the success of the biogas technology.

8. It is recommended to promote improved cattle sheds in each house that holds more than 5 cattle. The cattle shed does not necessarily need to be expensive but at least the floor should be concreted with a cheap thatched roof. This will help to collect urine which can be used for biogas to minimize the use of water. Cattle sheds also enables farmers to obtain fertilizer at home. This will encourage farmers to keep their cattle in the shed which eventually increases the potential of biogas. The Government may be willing to support the cattle shed improvement.

Biogas Pilot Programme, Sumba

As per the recommendation in Part I, a pilot programme is proposed before to start a full-fledged biogas programme in Sumba. The main objectives of this pilot programme are:

- to asses how the households respond in relation to the demand.
- to observe the functionality of the biogas plant.
- to assess the participation of users on operation and maintenance of plants.
- to determine the actual costs of biogas plants.
- to recommend an up-scaling programme for biogas.

Keeping these objectives in mind, the following activities are proposed.

Plant design:
The BIRU design is appropriate for Sumba, but in some cases stones will be used instead of bricks where stones are cheap and easily available. There will be two types of biogas plants: a) Household plant (4, 6, 8 and 10 m3) constructed in individual house for cooking and lighting purpose, and b) Community plants (12, 15 and 20m3) constructed in community cattle sheds for multiple houses. These plants also can produce electricity with the installation of a generator.

Piloting sites
All four districts are proposed for the pilot phase but the final decision can be done based on the discussions with the local governments. The number of plants in the pilot phase is proposed as follows:

	District	**Plant type**	**Number of plants**	**Tentative proposed places**
1	East Sumba	Household	15	Kahirik village, Eastern part of Waingapu, etc.
		Community	5	Mataway Maringo, etc.
2	Central Sumba	Household	10	To be identified
		Community	5	To be identified
3	West Sumba	Household	15	Waikabubak and surroundings.
		Community	5	Idem
4	South West Sumba	Household	15	Khori, Wejeiwa, Boronahaya
		Community	5	Idem
	Total		**75**	

Selection of exact house/site for plant construction needs to be fixed in consultation with the local government. If larger biogas plants are constructed for electricity generation, the site should be a place where electricity is not available.

Construction
The detailed bill of quantity and tentative costs for constructing biogas plants are in Annex-1. The total tentative construction costs maybe between Rp 6 million to 15 million

(4 to 20 m3 plant), but these amounts may differ from place to place due to transportation costs. The costs do not include a generator.

It is proposed to train a group of local masons (12 masons and 4 supervisors) in one place selecting from all four districts. These masons will construct one plant during the training. Afterwards, these masons will construct other biogas plants in selected sites in their own areas. Each supervisor supervises the work of 3 masons.

It is suggested to find a local partner (NGO or private company) which will be responsible for the management and supervision of construction activities. In such case the masons and supervisors shall be attached with the partner organization. Some of the livestock groups also can be used as construction partner. In case it is difficult to find a local partner, Hivos may hire a full time staff that will be responsible for supervision, coordination and management of construction activities.

Financial support
Since these plants are for piloting purposes, the majority of the costs would need to be subsidized. It is proposed that the labor costs for digging pits, collecting stones, sand and gravel should be managed by the household. In such cases the household should bear about 20 percent of the total costs. In any case, the plant should not be completely free to the household.

Promotion and socialization
A strong promotion and socialization package needs to be developed and implemented. Bio-slurry as fertilizer can be a strong extension message to the household to create more demand. Religious and cultural institutions can be used for such socialization programmes. Looking into the social structure and cultural values in Sumba, it is more likely that people may consider biogas as a symbol of social status and are willing to install more biogas plants.

Operation and management of plants
Installation of a biogas plant is a one time job but operation and maintenance is regular work. There must be a strong mechanism of ensuring proper operation and maintenance of the plants. The individual household plants need to be operated and managed by the owner for which they need to be properly trained and regular monitoring will be required. The community plants are more complicated in terms of management. It is suggested that the users should form a committee responsible for operation, maintenance and management of the plant. The committee should address the following issues before the installation of the plant:

- There will be no gas meters. How the gas will be distributed to several households? How many hours? In which time?
- Who owns the plant? Who is the owner of the land where plant is installed?
- Who is responsible for feeding the plant and operating the plant?
- How will the slurry be used? Will the slurry be divided to all or sold?
- If someone sells his cattle will he still get gas?
- How to contribute for construction and maintenance costs?

Annex-1

Costs Estimate for Biogas Plants in Sumba

Price per unit	Materials/ labours	Unit	Plant Sizes in M3					Plant Sizes in m3				
			4m3	6m3	8m3	10m3	12m3	4m3	6m3	8m3	10m3	12m3
1.2	Bricks	Pc	1400	1600	1900	2100	2400	1680	1920	2280	2520	2880
140	Coarse sand	M3	2	2.2	2.4	2.6	2.8	280	308	336	364	392
200	Aggregate	M3	1.3	1.5	1.7	1.9	2.1	260	300	340	380	420
63	Cement	Bag	13	16	20	23	27	819	1008	1260	1449	1701
15	MS rod	Kg	10	12	14	17	20	150	180	210	255	300
200	Main gas pipe	Pc	1	1	1	1	1	200	200	200	200	200
15	Fittings	Pc	10	10	10	12	12	150	150	150	170	170
6	Gas pipe	Mtr	12	12	12	12	12	72	72	72	72	72
40	Water drain	Pc	1	1	1	1	1	40	40	40	40	40
40	Gas tap	Pc	1	1	1	2	2	40	40	40	80	80
150	Stove	Pc	1	1	1	2	2	150	150	150	300	300
200	Mixer	Pc	1	1	1	1	1	200	200	200	200	200
17	Hose pipe	Mtr	1	1	1	2	2	17	17	17	34	34
10	Teflon tape	Pc	2	2	2	2	2	20	20	20	20	20
60	Inlet pipe	Pc	2	2	2	2	2	120	120	120	120	120
20	Emulsion paint	Ltr	1	1	1	2	2	20	20	20	40	40
50	Masons	Per	9	10	11	12	13	450	500	550	600	650
30	Labourers	Per	19	22	24	28	32	570	660	720	840	960
130	Lamp		1	1	2	2	3	130	130	260	260	390
50	Misc	LS						50	50	50	50	50
	Sub Total IDR							**5,418**	**6,085**	**7,035**	**7,994**	**9,019**
	Construction Fee							600	650	700	750	800
	Grand Total IDR							**6,018**	**6,735**	**7,735**	**8,744**	**9,819**

+ Detailed costs estimate of 15 and 20 m3 plants still to be done.

Annex-2

Persons contacted during the field visit

1. Mr. Arie Haudima, Yayasan Alam Lestari, East Sumba
2. Mr. Made Respita, East Sumba
3. Mrs. Siti, East Sumba
4. Mr. Bernd Unger, Pro Air, South West Sumba
5. Mr. Ori Genes, Section Head for Irrigation in Dinas PU East Sumba
6. Mr. Guntur, Sub Head for Irrigation (supervisor of Ori Genes) in Dinas PU
7. Mr. Martinus Njurumana, Head of Dinas Pertanian Central Sumba
8. Mr. Piet, Head of the Livestock Department, West Sumba
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