62. PROFILE ON FUEL BRIQUETTE

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I. SUMMARY

This profile envisages the establishment of a plant for the production of 7,000 tonnes of fuel briquette per annum.

The current demand for the proposed product is estimated at 11,800 tonnes per annum and it is projected to reach 22,510 tonnes by the year 2019.

The project will create employment opportunity for 30 persons.

The total investment cost of the project is estimated at about Birr 2.98 million, out of which Birr 800,000 is required for plant and machinery.

The project is financially viable with an internal rate of return (IRR) of 24% and a net present value (NPV) of Birr 2.62 million, discounted at 10.5%.

II. PRODUCT DESCRIPTION AND APPLICATION

Scarcity in availability of conventional fuels created a need to search for alternative fuels for cooking and other applications. Conversions of wastes like agricultural residues from fields, solid municipal waste, waste from agro-industries, etc., into useful fuel is a necessity from economy & pollution point of view.

These materials can continuously be fed to briquette units to produce combustible fuel briquettes mainly for household use. The agro-based briquettes are expected to have calorific values ranging from 3,000-4,500 kilocalories/kg depending on the type of agro-waste used. The use of agro- based briquettes is economical and convenient; briquettes can easily be packed, transported and stored.

The briquette's dimensions depend on the machinery and process used and normally they are manufactured with 45-80 mm diameter and 50-250 mm length. Agro-briquettes do not emit any smoke with sulphur or phosphorus or generate fly ash.

III. MARKET STUDY AND PLANT CAPACITY

A MARKET STUDY

1. Past supply and Present Demand

Benishangul - Gumuz is one of the remote areas of the country where energy sources are dominated by traditional forms of energy that are derived from biomass. Biomass is often the only source of energy in the rural areas (like all parts of Ethiopia) and the major source of energy in urban centers too. Firewood is the most important among biomass sources, contributing to about 97% of total domestic energy in Benishangul Gumuz. Distribution of households by type of fuel they use for cooking purpose is shown in Table 3.1.

Table 3.1

DISTRIBUTION OF HOUSEHOLDS BY TYPE OF FUEL ENERGY USED FOR COOKING PURPOSES

Sr. No.	Type of Fuel	No. of households	%
1.	Firewood/Charcoal	2857	84.0
2.	Animal dung/crop residue	97	2.9
3.	1&2	395	11.6
4.	Gas	1	-
5.	Electricity	6	0.2
6.	1&4	1	-
7.	1,2&4	-	-
8.	Other	27	0.8
9.	Not stated	18	0.5
	Total	**3402**	**100**

Source:- *House hold level socio-economic survey, Benishangul-Gumuz Region UNDP /UNECA/SAERP 1997.*

The same survey has also reveled that about 85 % of households have no kitchen while about 14 % use traditional kitchen (see Table 3.2).

Table 3. 2

DISTRIBUTION OF HOUSEHOLDS BY TYPE OF KITCHEN

Type of Kitchen	No. Households	%
No Kitchen	2914	85
Traditional kitchen -Private	407	12.0
Traditional Kitchen-shared	60	1.8
Modern Kitchen-private	3	0.1
Not stated	18	0.5
Total	**3402**	**100**

Source:- *Household level socio-economic survey, Benishangul /Gumuz region, UNIDO/UNECA/SAERP, 1997.*

As population grows, consumption of firewood and charcoal is likely to increase since the supply of alternative sources of energy are limited. This phenomena will in turn aggravate deforestation; thus calling for alternative sources of energy. One of those is fuel briquette which could be made available cheaply for low income households.

As indicated in the Resource Potential study of Benishangul -Gumuz conducted by IPS (2003), the current urban population is estimated at 600,000 and the average urban family size 3.9. In terms of housing units, this is equivalent to 153,800 households. As mentioned earlier, about 84% of households in the region use firewood and charcoal to meet their energy needs. The number of households which use firewood and charcoal would, hence, be about 129,200.

Low income households are assumed to consume, on average, 2.5 kg of firewood per day. On this assumption, total annual consumption by all urban households in a year would amount 118,218 tonnes. Assuming that about 10% of the demand will be covered by fuel briquette, effective demand for fuel briquette in the region is estimated at 11,800 tonnes.

2. Projected Demand

The future demand for fuel briquette is projected on the basis of the urban population growth rate of 4%; and the result, as shown in Table 3.3, ranges from 12,320 tonnes by the year 2005 to 22,510 tonnes by the year 2019.

Table 3.3

PROJECTED DEMAND FOR FUEL BRIQUETTE

Year	Projected Demand (Tonnes)
2004	11,800
2005	12,320
2006	12,861
2007	13,427
2008	14,017
2009	14,635
2010	11,278
2011	15,950
2012	16,652
2013	17,385
2014	18,150
2015	19,950
2016	19,783
2017	20,650
2018	21,562
2019	22,510

3. Pricing and Distribution

The current retail price of charcoal, which is the closest substitute for fuel briquette in the region, is birr 20 per 20 kg (Birr 1 per kg). Thus, it would be both profitable and socially sound if the envisaged plant sells the product at Birr 0.5 /kg.

The product can be distributed directly to end-users by establishing its own small outlet, or by using agents and charcoal traders.

B. PLANT CAPACITY AND PRODUCTION PROGRAMME

1. Plant Capacity

A small briquetting unit has a production capacity of 0.75 tonnes/hour. To run a commercially viable briquetting plant, it is recommended that two such units shall be operated with a combined capacity of 1.5 tonnes/hour, which will be operated three shifts of 8 hours per day.

Due to high wear and tear in hammer mills and the associated routine maintenance requirements, hammer mills must not be operated for more than 20 hours per day. Assuming 300 working days per annum, the plant will have an annual capacity of 7,650 tonnes/annum. Of this, the flash dryer is expected to consume 650 tonnes per year for drying purposes. On this basis, the annual saleable production is 7,000 tonnes per year.

2. Production Programme

The envisaged production programme is given in Table 3.4 below. The schedule is worked out in consideration of the time required for gradual build-up in labour productivity and fine-tuning of machinery. Production starts at 75% of plant capacity in the first year of operation and reaches full-gear in the 3rd year of operation and thenafter.

Table 3.4

PRODUCTION PROGRAMME

Year	**1**	**2**	**3-10**
Capacity Utilization [%]	75	85	100
Production [Tonnes]	5,250	5,950	7,000

IV. MATERIALS AND INPUTS

A. MATERIALS

The required raw materials are agro wastes from fields like rice husk, sawdust, bagasse, groundnut shell, coffee husk, tobacco stems, etc. To produce one tonnes of briquette, about 1.1 tonnes of these materials is required; 10% is allowed for moisture and wastage.

The finished briquettes are supposed to be packed in 100-kg PP-bag, which is distributed by wholesalers to retailers who then can re-pack the product in cheap PE sachets or sell it in bulk to consumers.

The major agricultural residues that could be obtained in the Benishangul-Gumuz Regional State include: coffee husks, maize stalks & cobs and other related materials.

Table 4.1 shows annual raw material requirement and associated cost at full production capacity.

Table 4.1

ANNUAL MATERIALS REQUIREMENT AND COST

Sr. No.	Description	Unit of Measure	Qty	Unit Cost (Birr)	Total Cost ('000 Birr)
1.	Agro-waste	tonne	8,000	200.00	1,600.00
2.	PP bags	pieces	7,0000	3.00	210.00
	Grand Total				**1,810.00**

B. UTILITIES

Electricity and water are the two major utilities required by the plant. Table 4.2 below shows annual requirements and associated costs at full production capacity.

Table 4.2

ANNUAL UTILITIES REQUIREMENT AND COSTS

Sr. No.	Description	Unit of Measure	Qty	Unit Cost (Birr)	Total Cost ('000 Birr)
1.	Electricity	kWh	405,000	0.335	135.675
2.	Water	m^3	1500	1.50	2.25
	Grand Total				**137.925**

V. TECHNOLOGY AND ENGINEERING

A. TECHNOLOGY

1. Production Process

The fuel Briquettes are made out of loose agro-wastes into a compressed form to increase its specific weight, thus increasing the fuel efficiency (combustion efficiency) as compared to its loose condition.

Previously, employed technologies required binders in the production of briquettes from agro-waste. Currently available technologies, however, use the BINDERLESS technology, which is found to be very economical. Due to existence of solid form lignite in the agro- waste, which acts as a natural binder, there is no need to add chemicals or any other foreign substance to the process. Therefore, the technology has come to be known as "Binderless Technology". Briquettes, thus, produced are easy to store & pack and hygienic to handle.

There are two different types of briquetting machines available in the market, screw type and ram type. On account of its suitability for organic agricultural wastes, the screw press is recommended, which involves the following operations:

- Screening to remove undesirable materials by means of a vibratory screen;
- Pulverizing to small particle size, i.e. 6-8mm particle size and 10-20% fines by means of hammer mills;
- Drying of raw material to about 12-15% moisture content by using flash driers;
- Charging into intermediate storage bin;
- Briquetting by means of a screw extruder;
- Cutting to required length;
- Cooling in a conveyer belt;
- Storage; and
- Packing.

Fuel briquettes production does not result in any adverse impacts on the environment.

2. Source of Technology

The manufacturing technology and machinery for the production of briquettes from agro-waste can be obtained from suppliers in Europe and Asia. SREE Engineering Works from India are renowned manufacturers and exporters of Briquetting machines and plants. Their address is:

SREE Engineering Works,

26 A, Ferozguda, Bowenpally (P.O), Hyderabad - 500 011,

A.P., India

Phone: 0091-40-27751841; Fax: 0091-4027751841.

B. ENGINEERING

1. Machinery And Equipment

The list of machinery and equipment required to manufacture fuel briquettes is given in Table 5.1 below. On this basis, total cost of machinery and equipment is estimated at Birr 800,000, out of which Birr 520,000 is required in foreign currency.

Table 5.1

LIST OF MACHINERY AND EQUIPMENT

Sr. No.	Description	Qty. No.
1	Screw feeder	1
2	Hammer mill	2
3	Flash drier	1
4	Silo with feeder	1
5	Screw conveyer, main	1
6	Return feeder	1
7	Preheater	2
8	Heater	2
9	Cooling conveyer	1
10	Furnace	1
11	Fluid system	1
12	Fume exhaust	1
13	Storage bins	3
14	Auxiliaries	Set

2. Land, Building And Civil Works

Total land requirement of the project is estimated at 3,000m^2, out of which 500m^2 is built-up area. Cost of building construction at a unit cost of Birr 1000 per m^2 is estimated at Birr 500,000. Total land lease cost, for a period of 70 years land holding and at a lease rate of Birr 2 per m^2, is estimated at Birr 420,000. Thus, the total investment cost for land, building ad civil works assuming that the total land lease cost will be paid in advance is estimated at 920,000.

3. Proposed Location

The sizable percentage of the Region's irrigable area, amounting to about 2,780 hectares, is located in the Assosa zone. With the development of this area and the expansion of commercial farms, it is believed that agricultural residues will be available as a by product. Hence, the most optimal location for a briquetting plant is Assosa zone. Assosa town could be a place of choice in view of its relatively better infrastructure and its high population, which is supposed to be the target market for the product.

VI. MANPOWER AND TRAINING REQUIREMENTS

A. MANPOWER REQUIREMENT

Total manpower requirement, including skilled and unskilled labour, is 30 persons. Correspondingly, total annual labour cost, including fringe benefits, is estimated at Birr 577,500. Table 6.1 below shows the list of manpower required and the estimated annual labour costs.

Table 6.1

MANPOWER REQUIREMENT AND ANNUAL LABOR COST

Sr. No.	Description	Req. No.	Monthly Salary [Birr]	Annual Salary [Birr]
1.	General Manager	1	2000	24000
2.	Production & Technique Head	1	1800	21600
3.	Finance & Administration Head	1	1600	19200
4.	Commercial Head	1	1600	19200
5.	Accountant	1	600	7200
6.	Sales person	1	600	7200
7.	Purchaser	1	500	6000
8.	Clerk	1	350	4200
9.	Secretary	1	600	7200
10.	Quality Control Head	1	1600	19200
11.	Production Foreman	3	2400	86400
12.	Chemist	1	800	9600
13.	Operator	4	2000	96000
14.	Mechanic	1	700	8400
15.	Electrician	1	700	8400
16.	Unskilled labour	5	1250	75000
17.	Guard	3	600	21600
18.	Diver	2	900	21600
	Total	**30**	**20600**	**462000**
	Worker's Benefit = 25% of Basic Salary		5150	115500
	Grand Total	**30**	**25750**	**577500**

B. TRAINING REQUIREMENT

An on-site training programme can be arranged for key production, maintenance and quality control personnel in consultation with the machinery and technology supplier. The training can be best carried out during commissioning and performance testing of the factory. The cost of such training is estimated at Birr 50,000 and will take about 2 months.

VII. FINANCIAL ANALYSIS

The financial analysis of the fuel briquette project is based on the data presented in the previous chapters and the following assumptions:-

Construction period	2 years
Source of finance	30 % equity
	70 % loan
Tax holidays	3 years
Bank interest	10.5%
Discounted cash flow	10.5%
Repair and maintenance	5 % of the total plant and machinery
Accounts receivable	30 days
Raw material, local	30 days
Work in progress	2 days
Finished products	30 days
Cash in hand	5 days
Accounts payable	30 days

A. TOTAL INITIAL INVESTMENT COST

The total initial investment cost of the project including working capital is estimated at Birr 2.98 million, of which about 17.5% will be required in foreign currency.The major breakdown of the total initial investment cost is shown in Table 7.1.

Table 7.1

INITIAL INVESTMENT COST ('000 BIRR)

Sr. No.	Cost Items	Foreign Currency	Local Currency	Total
1	Land	-	420.00	420.00
2.	Building and Civil Work	-	500.00	500.00
3.	Plant Machinery and Equipment	520.00	280.00	800.00
4.	Office Furniture and Equipment	-	75.00	75.00
5.	Vehicle	-	250.00	250.00
6.	Pre-production Expenditure*	-	478.00	478.00
	Total Investment cost	**520.00**	**2003.00**	**2523.00**
7	Working Capital	-	454.10	454.10
	Grand Total	**520.00**	**2457.1**	**2977.10**

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* *Pre-production expenditure include interest during construction (Birr 328,000 thousand), training (Birr 50,000), and costs of registration, licensing and formation of the company including legal fees, commissioning expenses, etc.*

B. PRODUCTION COST

The annual production cost at full operation capacity of the plant is estimated at Birr 2.87 million (see Table 7.2). The material and utility cost accounts for 68 per cent while repair and maintenance take 1.4 per cent of the production cost.

Table 7.2

ANNUAL PRODUCTION COST ('000 BIRR)

Items	Year			
	3	**4**	**7**	**10**
Raw Material and Inputs	1,357.5	1,538.6	1,810.0	1,810.0
Labour direct	207.9	235.6	277.2	277.2
Utilities	103.4	117.2	137.9	137.9
Maintenance and repair	30.0	34.0	40.0	40.0
Labour overheads	86.6	98.2	115.5	115.5
Administration cost	138.6	157.1	184.8	184.8
Total Operating Cost	**1924.1**	**2,180.8**	**2,565.3**	**2,565.3**
Depreciation	191.0	191.0	191.0	111.0
Cost of Finance	190.3	171.2	114.2	57.1
Total Production Cost	**2,305.3**	**2,543.0**	**2,870.6**	**2,733.5**

C. FINANCIAL EVALUATION

1. Profitability

According to the projected income statement, the project will start generating profit in the first year of operation. Important ratios such as profit to total sales, net profit to equity (Return on equity) and net profit plus interest on total investment (return on total investment) show an increasing trend during the life-time of the project. The income statement and the other indicators of profitability show that the project is viable.

2. Break-even Analysis

The break-even point of the project is estimated by using income statement projection.

$$Be = \frac{\text{Fixed Cost}}{\text{Sales} - \text{Variable cost}} = 30\ \%$$

3. Pay-back Period

The investment cost and income statement projection are used to project the pay-back period. The project's initial investment will be fully recovered within 5 years.

4. Internal Rate of Return and Net Present Value

Based on the cash flow statement, the calculated IRR of the project is 24 % and the net present value at 10.5% discount rate is Birr 2.62 million.

D. ECONOMIC BENEFITS

The project can create employment for 30 persons. In addition to supply of the domestic needs, the project will generate Birr 2.88 million in terms of tax revenue. Moreover, the Regional Government can collect employment, income tax and sales tax revenue.