99. DIESEL GENERATOR POWER SUPPLY

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I. SUMMARY

This profile envisages the establishment of a diesel generator power plant with a capacity to generate an electric power of 500 KVA per annum.

The present demand for the proposed product is estimated at 3,750 kW per annum. The demand is expected to reach at 5,000 kW by the year 2010.

The power will create employment opportunities for 8 persons.

The total investment requirement is estimated at Birr 1.35 million, out of which Birr 0.94 million is required for plant and machinery.

The project is financially viable with an internal rate of return (IRR) of 16% and a net present value (NPV) of Birr 0.44 million, discounted at 8.5 %.

II. PROJECT DESCRIPTION

A Diesel - Generator is an equipment designed and manufactured for the generation of electricity by employing diesel - engine as prime mover to an alternator. Diesel engines are normally cooled by water. The Diesel - Generator set can be operated either on a continuous basis or as a stand-by for short period of time. The starting mode can be effected either by manual key start or by Auto-Start. Diesel-Generators are manufactured for voltages of 400/230 volts, 0.8 pf, 50Hz, balanced three - phase output, and for total power ranging from as much as 10KVA to as much as 500 KVA, 1000 KVA, and even higher capacities.

Diesel - Generators are now a-days supplied with control panels and instrumentation including voltmeters, selector switches, Ammeters, combined frequency meter / tachometer, Hour run meter, circuit breaker, output terminal block, gauges for oil pressure and water temperature, protective devices for engine against high temperature and over speed with warning lights, etc.

Diesel-Generator power supply is versatile for localities where the ICS is not available. Supply of hydro - power to population in small towns of the region might be expensive. It would, therefore, be more economical to supply electricity from Diesel-Generators.

This would enhance economic development of the rural population, encourage investors, and would bring significant improvement on environmental conditions.

III. MARKET STUDY AND PLANT CAPACITY

A. MARKET STUDY

1. Past Supply and Present Demand

Benishangul Gumuz is one of the least electrified regions in Ethiopia. Electric supply is limited to few urban centers. The population size of electrified towns is show in Table 3.1.

Table 3.1
APPARENT SUPPLY OF ELECTRICITY

Towns	Population	Type of Electricity Supply
Assosa	1880	Generator
Debre Zeit	3028	Generator
Mandura	N.A	Hydro-Power
Almu	2540	Hydro-Power
Tango	2340	Generator
Bulen	4071	Generator
Menge	232	Generator
Kurmuk	403	Generator
Bambaji	6600	Generator
Dangur	5204	Hydro-Power
Pawe	8915	Hydro-Power

Source:- *Resource Potential Assessment of Benishangul - Gumuz Region, IPS, 2003.*

The regional capital, Assosa town has a generator with capacity of 700 kW. Dangur is connected with 15 kV line and Almu with 66/63 kV substations. *Mankursh, Dibate*, Sherkole, Oda, Komesha, Yaso, Koncho Kamashi, Agalo Meti and Belo Giganfoy are towns that are looking for electrification in the future. Both diesel and mini-hydro are options for these towns.

In most woredas of the region, decentralized diesel generators are very common (more than 76 diesels units are believed to exist).

The major services are flour mills (more than 44), government offices (more than 15), hotels (more than 8), NGOs, workshops.

The present use of diesel generators indicates the trend of small and medium business potential in the region. Therefore, considering the nature and need of all the potential consumers, it is found reasonable to assume a 5000 kW diesel generator would satisfy the maximum demand deriving from one such entity.

2. Projected Demand

Adequate and efficient supply of energy is a prerequisite for development in general, and industrialization in particular. As population increases, the demand for electricity is also bound to increase in order to fulfill a diversity of needs. These include household demand for lighting, and powering electronic appliances.

In addition to households, various other sectors (street lighting, Offices, Hotels, restaurants, etc) will require increased supply of electricity as their numbers and operations expand. Diesel power development will also boost the effort to electrify rural areas.

Therefore, many units of diesel generators will be required to satisfy the increasing demand. The 5000 kW diesel generators, however, could start operation with 75% capacity and increase to 85% and 100% capacity utilization in subsequent years. The demand projection executed on this basis is shown in Table 3.2.

Table 3.2
PROJECTED DEMAND FOR DIESEL GENERATED ELECTRICITY

Year	Projected Demand (kW)
2005	3750
2006	4250
2007	5000
2008	5000
2009	5000
2010	5000
2011	5000
2012	5000
2013	5000
2014	5000
2015	5000
2098	5000
2017	5000
2018	5000

3. Pricing and Distribution

The pricing of electricity generated by the power plants under Ethiopian Electric Power Corporation (EEPCo.) varies according to different categories of users. There are also different tariff categories and blocks within each user category. The domestic tariff category includes dwelling houses, government schools, health institutions, etc. The general category includes government offices, private offices, international organizations and most business sectors. Industries are included in the third, fourth and fifth categories.

The current energy tariff or price of electricity for different categories of users and blocks ranges from 0.273 Birr/kWh to Birr 0.6087 /kWh. However, the flat rate of Birr 0.4736 /kWh is recommended as the lowest price, the envisaged plant could charge. It should, however, be noted that this tariff should be used only as the lowest reference price to find out, during the financial analysis what level of price would make the project feasible through judicious iteration.

B. POWER GENERATION CAPACITY AND GENERATION PROGRAMME

1. Power Generation Capacity

Market study indicates several towns in the region look for electrification. Towns, like Mankush, Dibate, Sherkole, Oda, Komesha, Yaso, Koncho Kamashi, Agalo Meti and Belo Gigantoy are not connected to the national grid. The residents of these towns do not have any access to the national grid nor do they have their own generating system. They employ firewood for lighting and for cooking purposes. Electricity for lighting is a major requirement, although hotels, health centers, grain mills and other facilities are potential consumers of electricity. It would also be appropriate to consider an induced growth in the demand of electricity once diesel-generators are installed in towns. Small businesses would be established due to the availability of electric power.

The size of the generating set is determined using the following parameters:

(i) Operating hours per day - 11 Hrs.
(from 6:00 a.m - 12:00 a.m)
(from 6:00 p.m - 11:00 p.m)

(ii) Day time power requirement
- Industrial and domestic appliances
Estimate: 500 kW

(iii) Night time power requirement
- Lighting and appliances
Estimated: 400 kW

(iv) Power factor: 0.80

Assuming a simultaneity factor of 70%, the capacity of the generating set will be about 500 KVA. Note that the above power demand calculation is done for a town of 10,000 inhabitants living in about 3000 houses. Each house is assumed to utilize two light points of 40 watts each. The other consumers can be health centers, schools, hotels, street lighting, grain mills of about 15 and other small enterprises.

The market study indicates that there exist power demand of 5000 kW. It is, therefore, proposed that generating sets of 500 KVA will be installed in each town having no supply of electricity. In case the demand is higher than the supply, a second generating set can be installed to meet the growing need of electricity.

2. Generation Programme

Once it is confirmed that there is sufficient demand of power, all the equipment in the generation, transmission and distribution systems will have to be installed, commissioned and then properly tested. Following this, it would be advisable to prepare schedule of plant operation. Accordingly, production of electricity will be effected. The output of the Diesel-Generator set depends on the capacity of the connected load and the simultaneity of operation of the load. The envisaged plant will start operation at 75% of its capacity during first year and increase to 85% and 100% capacity utilization in second and third year, and thenafter.

IV. CONSUMABLES AND UTILITIES

A. CONSUMABLES

The major input considered as a raw material is diesel fuel. This is supplied to the generating system, where energy conversion takes place, to produce the required electrical energy. The annual requirement of diesel oil for running the diesel engine for 365 days (11 hours a day) is estimated at Birr 450,000 (including 10% contingency).

B. UTILITIES

Utilities required for the plant consist of water and lubricants. Water is required for cooling the diesel engine and for general purpose (including drinking water).

Lubricants (SEA 40) is required at 50 litres per month, at the rate of Birr 18 per litre. Annual water consumption is estimated at 500 m^3. Table 4.1 below shows annual estimated cost of utilities.

Table 4.1
ANNUAL UTILITIES REQUIREMENT AND COST

Sr. No.	Description	Qty.	Annual Expenditure (Birr)
1	Lubricant (SEA 40)	600 lts	10,800
2	Water	500 m^3	750
	Total		**11,550**

V. TECHNOLOGY AND ENGINEERING

A. TECHNOLOGY

1. Power Generation Process

Three sub - processes are required to generate and supply electric power to consumers. These are generation, transmission and distribution. Generation is carried out by running the Diesel - Generator set. The electrical power thus generated has to be transmitted to where consumers are located. The voltage level

has to be raised to make it suitable for transmission. For this step-up transformers are required. Wooden poles, conductors, insulators, and other accessories are also materials required in the transmission and distribution networks. Moreover, step-down transformers are required to reduce the voltage level.

2. Source of Technology

Diesel - Generator sets are manufactured and supplied by companies in Europe, Asia and Far East. One such supplier is presented here:-

United Kingdom
4-6 church street, Wilmslow
Cheshire SK 9 1 AU, England
Tel: +44(0) 9825 536519
Fax : +44(0) 9825 536520
E-mail: forest city @compuserve.com.

B. ENGINEERING

1. Machinery and Equipment

Machinery and equipment required for the plant is shown in Table 5.1 below.

Table 5.1
MACHINERY AND EQUIPMENT REQUIREMENT AND COST

Sr. No.	Description	Cost, ('000 Birr)		
		LC	FC	TC
1	Diesel-Generator set, with control panel and accessories	20	300	300
2	Poles, conductors, insulators, stay wires and accessories	50	200	250
3	Power Transformers: 1 x 500 KVA (including pole mounted isolators and surge arrestors)	10	150	980
4	Distribution Transformers: 2 x 200 KVA	10	200	210
	Grand Total	**90**	**850**	**940**

2. Land, Building and Civil Works

The total land requirement will be about 500m^2, of which 100m^2 will be covered by building. At a land lease value of Birr 2.0 per m^2, and for 70 years land holding, the total land lease value will be Birr 70,000. The cost of building will be Birr 100,000, at a rate of Birr 1,000 per m^2. Thus, the total expenditure on land, building and civil works assuming that the total land lease cost will be paid in advance will be Birr 170,000.

3. Proposed Location

The Diesel-Generator set proposed for this project can be installed in towns where there is no supply of electricity from the national grid. Examples of towns in the region where the plant can be established are Mankursh, Dibate, Sherkole, Oda, Komesha, etc.

VI. MANPOWER AND TRAINING REQUIREMENT

A. MANPOWER REQUIREMENT

The total manpower requirement of the envisaged project is 8 persons. Details of manpower requirement and annual labour cost is shown in Table 6.1 below.

Table 6.1
MANPOWER REQUIREMENT AND ANNUAL LABOUR COST

Sr. No.	Description	Req. No.	Monthly Salary, Birr	Annual Salary, Birr
1	Production Manager	1	800	9600
2	Operator	1	350	4200
3	Grease Boy	1	200	2400
4	Electrician	1	400	4800
5	Assistance Electrician	1	250	3000
6	Guard	3	250	9000
	Grand Total	**8**		**33,000**

B. TRAINING REQUIREMENT

Training of personnel including production manager, operator and electrician is required. Estimated cost for training is Birr 10,000.

VII. FINANCIAL ANALYSIS

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

Construction period	1 years
Source of finance	30 % equity
	70 % loan
Tax holidays	3 years
Bank interest	7.5 %
Discounted cashflow	8.5 %

Repair and maintenance	3 % of the total plant and machinery
Accounts receivable	30 days
Consumables	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 1.35 million, of which 63.1 per cent 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

Sr. No.	Cost Items	Total ('000 BIRR)
1	Land lease value	70
2.	Building and Civil Work	100
3.	Plant Machinery and Equipment	940
4.	Office Furniture and Equipment	35
5.	Vehicle	-
6.	Pre-production Expenditure*	87.6
7	Working Capital	115.4
	Total Investment cost	**1,348.0**
	Foreign share	**63.1%**

** N.B Pre-production expenditure includes interest during construction (Birr 72.6 thousand), training (Birr 10 thousand), and (Birr 5 thousand) 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 0.7million (see Table 7.2). The material and utility cost accounts of the plant for 71 per cent while repair and maintenance take 0.8 per cent of the production cost.

Table 7.2
ANNUAL PRODUCTION COST AT FULL CAPACITY ('000 BIRR)

Items	Cost	%
Raw Material and Inputs	450	69.2
Utilities	11.6	1.8
Maintenance and repair	5	0.8
Labour direct	12.7	1.9
Plant overheads	1.0	0.2
Administration Cost	1.0	0.2
Total Operating Costs	**481.2**	**74.0**
Depreciation	109.0	98.8
Cost of Finance	60.3	9.3
Total Production Cost	**650.6**	**100**

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 lifetime 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 including cost of finance when it starts to operates at full capacity (year 3) is estimated by using income statement projection.

$$BE = \frac{\text{Fixed Cost}}{\text{Sales} - \text{Variable cost}} = 60\ \%$$

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 16% and the net present value at 8.5% discount rate is Birr 0.44 million.

D. ECONOMIC BENEFITS

The project can create employment for 8 persons. In addition to supply of the domestic needs, the project will generate Birr 0.31 million in terms of tax revenue when it starts to operate at full capacity. Moreover, the Regional Government can collect employment, income tax and sales tax revenue.