THULAPPALLY MICRO HYDEL PROJECT

I PREFACE

1.1 Hydro Power is probably the best form of renewable energy source in the world. There are large quantities of small Hydro Power Potential remaining untapped in our country. Construction of large Hydro Power Project may involve serious environmental problems, displacement and evacuation of local people and submergence of large agricultural or forest lands. Such large projects can be constructed only by State Electricity Boards or large Power construction corporations with Government Participation. Because of varied reasons, the construction period stretches far beyond its planned time schedules and thus will reduce its benefits. MICRO HYDEL Power Projects especially in the private sector can be completed within 4 months and it can be a remedy to our present power crisis.

1.2 The Ministry of Non-conventional Energy Sources and the various State Governments have initiated favourable steps for the construction of small hydro Projects through Non Governmental Organisations in various parts of our country. Many reputed Non governmental organisations also have showed interest in collaborating with such micro hydel Projects. These projects are largely envisaged in the remote areas where chances for supply from State Electricity Board is not easy. When projects are taken up through Non Governmental Organisations, procedural delay will be considerably reduced and the projects commissioning can be done in a shorter period. It will bring the benefit of the project to the beneficiary / participating people at an early date.

II INTRODUCTION

2.1 **Sustainable Development Agency -** SDA is a Non Governmental Organization registered under the Travancore Cochin Literary, Scientific and Charitable Societies Act of 1955. Registered in 1993 as No- K - 414/93, SDA has completed 12years of active intervention in the rural areas of the Southern States of Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Goa and Pondicherry. A general profile of SDA and its chief areas of intervention are given below.

Address	Sustainable Development Agency - SDA Parathode P.O. 686512 Kottayam District, Kerala
Chief Contact Person	Fr. Mathew Vadakkemuriyil
Legal Status	Registered Charitable Society & Registered Partnership of NGOs in South India. pursuing Non conventional Energy in the Southern States of India
Date Of Registration	11.08.1993 (K414 / 93) Under Travancore Cochin Literary Scientific & Charitable Societies Act of 1955
Type of Registration	Permanent Registration
Area of Operation	Southern States of India such as Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Goa and Pondicherry.
Objectives	Empowerment of rural communities Development of sustainable and renewable energy sources.

2.2 **Activities and Interests of Sustainable Development Agency - SDA** : SDA is exclusively devoted to development non conventional energy sources for rural development. Following are the thrust areas of SDA.

Thrust Areas

Biogas

Micro Hydel

Solar Water Heater, Solar Cookers & Photovoltaics

Biomass gasifiers

Wind Energy Systems

Energy Audit & Applications

Biomass Briquetting

As described above, Sustainable Development Agency - SDA has chosen the alternative energy sector as the most important area of its intervention. The energy crisis in the contextof Kerala and other southern states has assumed alarming proportions. At the same time, no constructive effort as yet has been made to develop and tap micro hydel energy potential in these states. Through isolated and stray attempts, it is proved in several places in southern States that it is a definite and feasible energy source, though mostly seasonal for eight months. However, even this seasonal potential has a benefical effect on the general energy scenario. to the extend that the more energy is generated out of micro hydel projects, the more water can be stored in the large hydel based electric projects. which can be stored to tide over the lean summer months, during which the potential is negligible or nil.

3.0 **Brief Case Study of the Project**

3.1 **Name of the Project** : **Naranamthodu Micro Hydel Project**

3.2 **Location**

A	**Political / Administrative**		
1	State	:	Kerala
2	District	:	Pathanamthitta
3	Panchayat	:	Perinad
B	**Geographical**		
1	Latitude	:	9^0 - 24' North
2	Longitude	:	76^0 - 58' East
3	Toposheet	:	No 58 C/15

3.3 **Access to the Project**

1	Air Port	:	Cochin 153 Km.
2	Rail Head	:	Kottayam 73 Km.
3	Nearest Town	:	Erumely 21 Km.

3.4 Hydrology, Ambient & Geology

1	Name of stream	:	**NARANANTHODU**, a tributary of River Pumpa
2	Maximum Temperature	:	35^0 C
3	Minimum Temperature	:	18^0 C
4	Average Rainfall	:	3100 mm
5	Catchment Area	:	10 Km^2
6	Geology	:	Sheet rocks available at weir site. Hard strata at one meter depth at head race channel and pen stock route available
7	Humidity	:	Up to95% in the Monsoon season

3.5 Power Potential

1	Net Head	:	25 M.
2	Discharge	:	100LPS expected for 9 months
3	Power potential	:	22.5 KW
4	Installed Capacity	:	20 KW
5	Energy generation possible	:	0.98 lakhs KWh

3.6 Water conductor system

1	Type of Weir	:	Concrete: over flow type
2	Length of weir	:	12M
3	Height	:	2 M
4	Bottom width	:	3 M
5	Top Width	:	1.5 M

3.7 Head Race Channel : Low Pressure Pipe - Length 600 M

3.8	**Forebay Tank**	:	2m x 2m x 2m
		:	Ferrocement construction
3.9	**Penstock**	:	MS Fabricated pipe 3mm thick 100 m long 20cm diameter
3.10	**Power House**	:	3m x 3m x 3m Tin sheet roof on RCC pillars Walls with local made cement blocks
3.11	**Turbine**	:	Pelton Wheel - Double jet Horizontal shaft
3.12	**Generator**	:	Synchronous type
3.13	**Total project cost**	:	
3.13.1	**Cost per KW**	:	
3.14	**Cost of Distribution Net work**	:	
3.15	**Cost of alternate arrangement** (Gas/Diesel): (during lean period)		

4.0 **Location details**: Naranamthodu is situated in the Northern part of Pathanamthitta district in the Perinad Panchayat close to the boundary of Kottayam and Idukki districts. The nearest town is Erumely which is about 21 Km towards North West. Nearest Railway station is Kottayam which is about 80 Km towards North West via Kanjirapally. The micro Hydel Project proposed is situated in the NARANANTHODE which is a Tributory of River Pumpa. Jeep road facility is available within 500m to the weir site. The Narananthode is starting from the ERAMANKULAM and THALAPPARAKOTTA Forest area. The starting point if the stream is at an elevation of approximately 300 m above MSL. Fairly good water flow is available through the stream for about 9 months in a year. The weir site is having a

narrow cross section and rock bed. For 2 m height, the length of the weir shall be about 12 m at the top. The location of the weir shall be at about 135m above MSL. Water shall over flow above the weir. 2m height may be an economical height for the weir. The project site is located in the GTS topo sheet No.58 C/15. The geographical coordinators are: Latitude 9^0 - 24' North: Longitude 76^0 - 58' East. Due to the construction of the weir no considerable submergence of land will occur. The water storage in the weir will be only about 10 m in the up stream side for a width of about 5 m. No forest problem is involved in the project.

5.0 Project Details

5.1 **The WEIR** : The weir constructed is concrete gravity type. The stream at weir site is narrow and having rock bed. For weir foundation some blasting, dressing and drilling was done. The bed slope of the stream is approximately 1:10. The bottom level of the weir is at about 135m above Mean Sea level. A height of 2m is for the weir. Head race channel started at about +136m above MSL. RCC is used for the weir construction. During the rainy season very large quantity of water shall flow through the stream at high velocity. Hence a strong weir was necessary.

5.2 **Head race channel**: About 600m head race channel was required. 1:300 slopes are adopted for it. Low Pressure Pipe is used for it.

5.3 **Forebay Tank**: At the starting of the Head Race channel the Forbay tank is constructed. Ferrocement technology is used for the construction of the tank. A size of 2m x 2m x 2m tank is constructed. The top level of the tank is + 136 m above the MSL and bottom level at +134 m above MSL. The forebay tank can be used as a disilting tank also. In Kerala, and especially for this project, the silt deposit will be much less compared to the Northern states of India. The storage capacity of the forebay tank shall be $8m^3$.

5.4 **Penstock**: Electrical welded mild steel pipes of about 3mm thickness and 20cm inside diameter are made. The length of the pipe is 100 m.

5.5 **Power House**: The size of Power House is about 3m x 3m and height is 3m G.I. sheet

roofing is given. Wall is made with locally made cement blocks.

5.6 **Spillway & Tail race channels**: Sophisticated spill way & Tail race channel was not be required since the water to be dealt with is only small quantity.

5.7 **Turbine**: Horizontal shaft double jet pelton wheel is used.

5.8 **Generator** : Synchronous generator with Horizontal shaft can be used. Frequency shall be 50 HZ. A four pole machine is used. Using stable speed increaser, the generator shall be is synchronous speed

5.9 **Control systems**: Electronic load divertor type control system is used.

5.10 **Transmission and Distribution network**: Naranamthodu is a remote village area. The total number of households over 500. They stay scattered in their respective homesteads. . The power generated is sufficient to supply about 200 houses & some shops. From a central point, 7 Nos radial lines is 1500 meters is there to reduce voltage drop. A total of 8km LT line is constructed. Compact Flourescent Lamps are used for lighting purposes.

5.11 **Lean Period Arrangements:** During the peak summer months. Sufficient water flow will not be available to run the Hydel Project. Then to maintain supply, a gasifier-cum- diesel fed generator of 20 KVA capacity is used as standby.

6.0 Power Potential Evaluation

6.1 **Flow Details**: The flow details through the stream is evaluated by flow measurements using float method and collecting details from the local people. It is estimated that approximately 100 LPS of flow is obtained for over 9 months in a year. So a discharge of 100 LPS is considered for 9 months duration for evaluation of the Power potential. For about 2 months of peak summer the generation is limited to 15KW, due to water shortage. For the remaining 1 month in the peak summer generation is practically nil.

6.2 **Head availability**: The bottom level of the weir is at +135m above Mean Sea Level (MSL)

Height of weir is 2m. Top level of the weir: +137m above MSL In take level shall be +136m above MSL A low pressure pipe of about 600m length is required to conduct the water to the penstock. A slope of 1:300 is provided for the Head race channel.

The centre line of the machines is 111m above MSL. Gross head available is 136-111 = 25m. Diameter of the Penstock pipe is 20 cm (inside). Electric welded mild steel pipe of thickness 3mm is used in the project.

The friction head loss estimated in the penstock is approximately 2m. So the net head available for power generation is 27-2 = 25m. The head availability details at various stages are shown in the schematic diagram for reference. All entry points are mouthed to reduce head loss.

Power generated P = 9.81 x efficiency x HQ, An efficiency of approximately 80 percent is in this power plant.

P = 9.81 x 0.80 x 25 x 100 = 19,620 W

Say 20 KW ; Approximately 20 KW power is generated in the project.

6.3 **Installed capacity**: One20 KW generator to tap this hydel potential. A synchronous generator is used. A Horizontal shaft double jet pelton wheel is used as the turbine.

6.4 **Spill Way** : At the weir site the water will flow over the weir during the rainy season and whenever the flow is more than what is taken through the low Pressure Pipe. There is a control device at weir site to regulate flow through low pressure pipe when there is no generation.

6.5 **Electrical Energy Generation**: The 20 KW generator is working for about 9 months at full load at a load factor of 0.6. For 2 months the machine is estimated to work at 15KW a day at the same load factor. The energy generation is as follows:

For 9 months :	9 x 30 x 24 x 20 x 0.7	=	90,720 KWh
For 1 months :	1x 30 x 24 x 15 x 0.7	=	7,560 KWh
Total Generation		=	98,280 KWh
Say			**98,000 KWH**

7.0 **Project cost**

7.1	Cost of Weir Excavation: 12m x 3m x 0.3m =10.8m^3 @ Rs.350/ m^3	Rs.	3,780.00
	Foundation: RCC 1:2:4 = 10.8m^3 @Rs.4000/- per m^3 =	Rs.	43,200.00
	Super structure 12m x 2.15m (ave)x 2m = 51.6 m^3 @ Rs.4000/-per m^3	= Rs	2,06,400.00
	Total Cost for the weir =	Rs.	2, 53,380.00

7.2 **Low Pressure Pipe**

Length of pipe= 600m.

Cost per meter @Rs.200. Therefore = 600 x 200 = Rs. 1, 20,000.00

7.3 **Forebay tank** Ferrocement technology is used for its construction

Size of tank: 2m x 2m x 2m Rs. 40,000.00

(Land is the contribution from the beneficiaries)

7.4 **Penstock**

Length of Penstock = 100m

Diameter of Pipe = 20 cm.

Thickness of pipe = 3mm

Weight per meter = 14.7 Kg.

Total weight = 14.7 x 100 = 1470 Kg.

Cost @ Rs.50/- per Kg = 1470 x 50 = Rs. 73,500.00

7.5 **Cost of Generator, Turbine and Control equipment**

at Rs.0.20 lakh/KW = 0.20 x 20 Rs. 4,00,000.00

7.6 **Power house** of size 3m x 3m x 3m, using G.I. sheet

on concrete pillars and cement block walls = Rs. 50,000.00

7.7	**Erection and commissioning** cost	=	Rs.	1,00,000.00
7.8	**Unforeseen items & contingency**	=	Rs.	63,120.00
	Total project cost	**=**	**Rs.**	**11, 00,000.00**

8.0 **Economical viability**

8.1	Installed capacity	=	20 KW
	Total project cost	=	11 lakhs
	Cost of installation/KW	=	$\frac{11}{20}$ = Rs.0.55 lakhs

Usual cost of installing a Hydel project is to the tune of Rs.450 lakhs to 500 lakhs per MW. For this project the cost/MW is to the tune of the usual value. Hence it is economically viable.

8.2 **Cost per KWh generated**.

Interest on capital @ 12%	=	11.0 x 0.12 = 1.32 lakhs
Depreciation @ 3%	=	11 x 0.03 = 0.33 lakhs
Operation expenses @ 2%	=	11 x 0.02 = 0.22 lakhs
Total recurring charges	**=**	**Rs.1.87 lakhs**
Total possible KWh generation	=	**0.98 lakhs**

Cost/KWh = $\frac{1.87}{0.98}$ = **Rs.1.91 /** unit and is lower than the usual values

The present energy charges are more than this value and hence it is economically viable.

9.0 **Power Evacuation**: For transmitting the power to the Households 8km of LT lines. Its cost is Rs.8 lakhs. The radial distance from the project is less than 2 km. This enhanced the project cost to Rs.20.00 lakhs

10.0 **Lean period Arrangement**: When flow of water is very low or practically nil, a gasifier cum diesel fed generating is used for power generation. A 20 KVA set is used and its cost is Rs.2.00 lakhs. Thus total project cost with this arrangement is Rs.22.00 lakhs.

11.0 **Advantages of the project** : Naranamthodu is an isolated area in the north east region of Pathanamthitta district. About 70% of the periphery of Naranamthodu is reserve forest. The chance for the State electricity Board supply to reach the locality is very remote due to the long distance of the existing supply mains. With the 20 KW power generated 200 families are provided supply for lighting and general purpose at an average rate of 100 watts. A diversity factor of 2.5 is assumed and average connected load is about 500 W per house. Most of the house holds are below average income group and average distance between houses estimated to about 100 mts. Total single phase distribution line requirement is 200 x 100 = 20000 mts. The distribution line cost for single phase line at 230 V is estimated to Rs.8 lakhs. The service line cost and maintenance cost is charged from the consumers as energy charges.

For lighting purpose Kerosene is used in every family. About 7 lit of Kerosene is used in every family in one month. With the Electric connection Kerosene saved in a year will be 7 x 200 x 12 x 90% = 15120 lit, Say 15000 litres

The use of Television, radio and computer is available now in the locality. This has improved the living conditions of the people.

12. **Conclusions:**

1 The Project is technically and economically feasible.

2 The project is improving the standard of living of the local people and a model for the country.

3 As a check dam is constructed as part of the project, it is improving the water table of the locality as well as agricultural productivity.

4 Project cost per KW of installed capacity is approximately Rs. 0.55 lakh/KW. Cost of

a unit of electricity produced is approximately Rs. 1.91

5 Generous subsidy and assistance from the Ministry of Non-conventional Energy Sources, Government of India was expected but noting came through. It is a people's project with UNDP assistance of Rs. 10 Lakhs.

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