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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FEASIBILITY STUDY FOR AN INDUSTRIAL PLANT DESIGNED TO MANUFACTURE HYDRAULIC MICRO-TURBINES IN ETHIOPIA

UNIDO PROJECT NR. US/GLO/84/086

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FINAL REPORT

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0. SUMMARY AND CONCLUSIONS

The present feasibility study analyses the viability of a new plant consisting in a manufacturing and assembling line of micro hydroplants with power rating ranging from 5 to 6 KW. The mechanical component of these plants, that is the turbine wheel (PELTON or BANKI-MICHELL type) should be manufactured locally by the factory which is considered in this study, while the other electric and electronic components (generator coupled to the turbine wheel, control board and regulator) should be imported from the foreign partner.

The production assembling capacity of the envisaged plant will be 25 micro-hydroplants per year at full capacity, that is foreseen to be reached at the third year of operation.

The personnel employed will be 10 units, including management, administratives and production manpower.

The initial fixed investment should be in the range of 564,000 US dollars, shared into 349,000 US$ of foreign currency and the balance of 215,00 US $ of equivalent local currency.

The internal rate of return (IRR) is 30.44%.

The net present value (NPV) computed at 10% discounting rate is 1,082,880 US $.

More financial details are shown in the COMFAR SCHEDULES at the end of this study.

1. PROJECT BACKGROUND AND HISTORY

1.1 INTRODUCTION

New and renewable sources of energy, solar, wind, biomass and small hydro power station are major strategic elements in promoting local economic possibilities and helping to satisfy basic needs.

The provision of small energy resources in rural areas can stimulate rural development, including rural industries, water pumping for local agriculture (irrigation) and other applications which can stimulate rural employment and reduce the migration from villages to urban centres.

A programme, specifically finalized to the identification and promotion of industrial projects for the production in developing countries of machinery and equipment for the utilization of renewable energies, has been conducted by UNIDO with the financing of the Italian government and with cooperation of the Italian agency for nuclear and alternative energy (ENEA).

In the frame hydropower has been found as a major option for energy development, specially in those countries where the hydropotential has still large possibilities of exploitation.

Ethiopia is one of the countries where hydraulic energy potential is very high, with only a very little percentage of it presently exploited.

Ethiopia's population, 45 million about in 1986, is largely rural and is expected to reach 80 million in 2005-2010, out of which 3/4, that is 60 million, will still be living in rural areas.

The existence of a large and growing rural population means the need of increasing the energy sources, to improve the living conditions in the areas far from the urban centres.

In this context, the Ethiopian Ministry of Mines and Energy carried out a study to identify the sites where small hydro-electric power plants could be installed.

An Italian partner was identified (IREM Co. of Turin), owner of the technology for manufacturing the equipment and available to transfer the production technology.

Within this frame of cooperation it is foreseen that in the first step of this project all the mechanical and electrical components will be supplied by the Italian partner as separate parts or CKDS (completely knock down), while in a second step some components should be produced locally.

1.2 HYDROPOWER OPTION

Electricity is a useful form of energy for both industrial and social purposes.

Electric energy can be produced by means of an electric generator coupled with a fuel operated engine or a turbine; turbine can be operated by water, gas or steam.

It is estimated that only a quarter of the whole electric energy presently consumed in the world is produced by hydraulic sources.

Countries like Western Europe (especially Switzerland) and Japan have reached high levels of utilization of their own hydraulic potential.

Water power is a ideal form of energy, being recyclable, free and clean.

Hydro-resources are identified with low cost when compared with other energy form. Projects can be large-scale for big industrial developments or small-scale for rural and decentralized industrial applications.

1.3 GENERALITIES ON HYDRAULIC TURBINES

Hydraulic turbine is a machine that produces power by converting the energy contained in a continuously flowing water stream into rotational energy. Power may range from few kilowatts to many thousands of kilowatts in the largest power plants.

Turbines can be used to produce mechanical energy by operating directly coupled machines like grain mills; more frequently, turbines are used for converting hydraulic energy into electric energy.

Generally operating the capital costs of a hydroelectric power plant including all the facilities and ancillaries (i.e. reservoir, pipelines, turbines, etc.) are higher than thermal station, but they have many advantages, some of which are:

1. potentially inexhaustible supply of free energy
2. no atmospheric pollution
3. high efficiency
4. operational flexibility
5. low wear and tear

Types of turbines can be classified considering the water flow related to the rotating member of turbine. If the flow is essentially axial with no radial movement of the streamlines, then the turbine is classed as an axial flow machine. If the flow is mainly radial it is classed as a radial flow machine.

Other types of turbines exist between the two principal above mentioned ones.

The following definitions will be useful for an easy understanding of the matter concerned:

<u>ROTOR</u> : the rotating member of an axial flow turbine

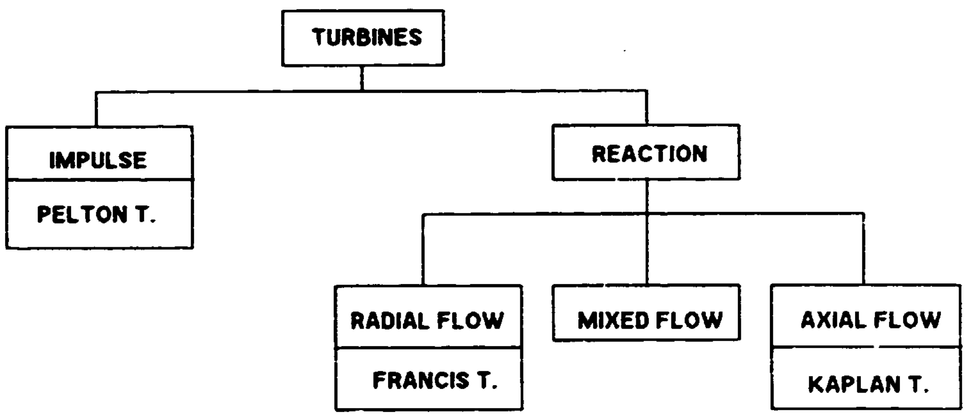
<u>RUNNER</u>: the rotating member of a radial-flow hydraulic turbine

DRAUGHT TUBE: a diffuser situated at the outlet of an hydraulic turbine; it converts kinetic energy into static pressure head.

VOLUTE: a spiral passage that serves to increase the velocity of the water before entry the runner.

An other classification of turbine type refers to the operating mode of the fluid (water): according to this, the main types of turbines used today are impulse and reaction turbines.

A complete classification of turbine types is shown in the following scheme:

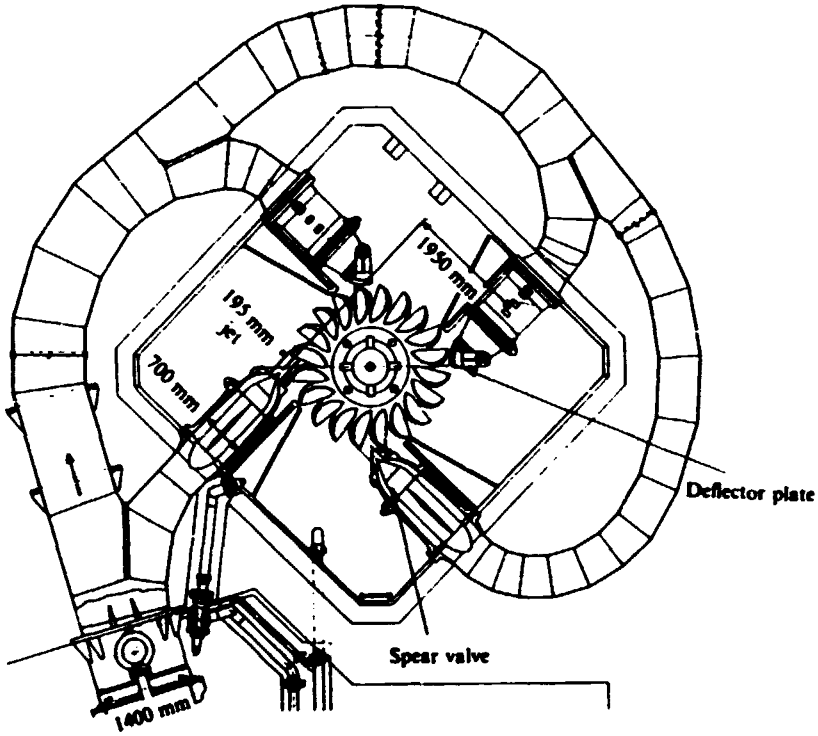


These terms will be clarified in the following paragraphs, where each type of turbine will be considered in detail.

1.3.1 Pelton wheel turbine

The Pelton wheel turbine is a pure impulse in which a jet of fluid issuing from a nozzle impinges on a succession of curved buckets fixed to the periphery of a rotating wheel.

The buckets deflect the jet through an angle of between 160 and 165 in the same plan as the jet and it is the turning of the jet that causes the momentum change of the fluid and its reaction on the buckets. A bucket is therefore pushed away by the jet and the next bucket moves round to be similarly acted upon. The spent water falls vertically into the lower reservoir or tailrace and the whole energy transfer from nozzle outlet to tailrace takes place at constant pressure.



Elements of a Pelton wheel turbine with four jets.

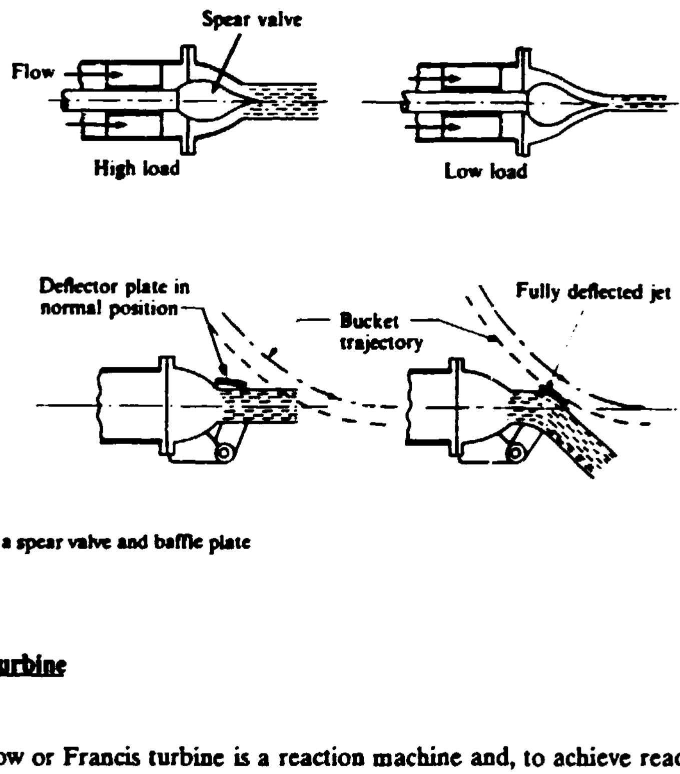
A shallow-slope pressure tunnel extends from the reservoir to a point almost vertically above the location of the turbine.

A pipe of almost vertical slope called the penstock joins the end of the pressure tunnel to the nozzle, while a surge tank is installed at the upper end of the penstock to damp out flow control pressure and velocity transients. It is emphasized that, compared with the penstock, the pressure tunnel could be extremely long, its slope is extremely shallow and it should undergo no large pressure fluctuations caused by inlet valve flow control. The penstock must be protected against the large pressure fluctuations that could occur between the nozzle and surge tank, and is usually a single steel-lined concrete pipe or a steel-lined excavated tunnel. At the turbine end of the penstock is the nozzle, which converts the total head at inlet to the nozzle into water jet with velocity C, at atmospheric pressure.

The water impact on the buckets results in moving the wheel around its rotation axis.

Hydraulic turbines are usually coupled directly to an electrical generator and, since the generator must run at a constant speed, the speed of the turbine must remain constant when the load changes. It is also desirable to run at maximum efficiency, that occurs if the jet velocity does not change. The only way left to adjust to a change in turbine load is to change the input water power.
The device to obtain the load control in the Pelton turbine is a spear valve which alters the jet cross-sectional area as shown in the following figure, which demonstrates also the working manner. The position of the spear is controlled by a servo-mechanism that senses the load change.

For a sudden loss of load, a baffle plate rises to remove the jet totally from the buckets and to allow time for the spear to move slowly to its new load position. This prevents excessive overspeeding.

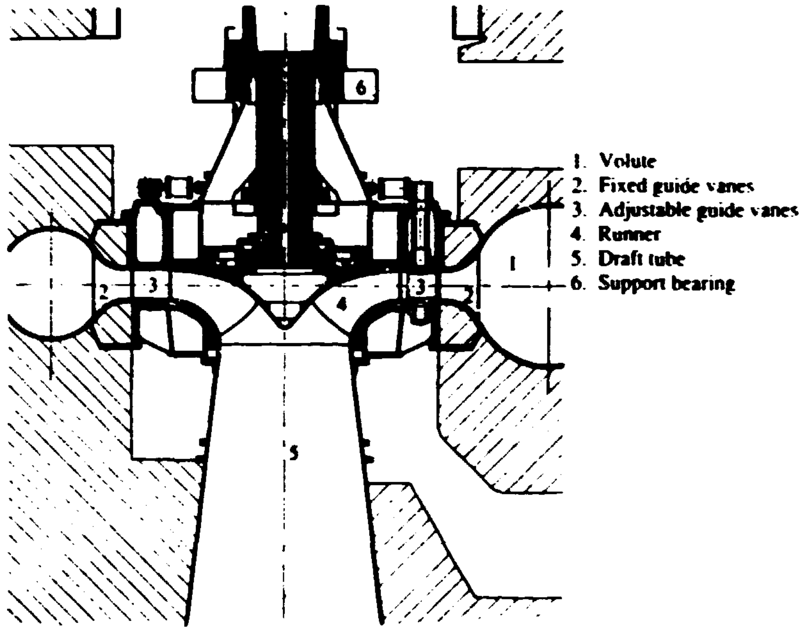


Load control by a spear valve and baffle plate

1.3.2 Radial flow turbine

The radial flow or Francis turbine is a reaction machine and, to achieve reaction, the rotor must be enclosed by a casing to prevent deviation of the fluid streamlines around the edge of the blades. The essential difference between the reaction rotor and impulse wheel is that in the former the water, under a high static head, has its pressure energy transformed into kinetic energy in a nozzle, which in itself forms part of the rotor. Therefore, since a static pressure drop occurs across the turbine rotor, part of the work done by the fluid on the runner is due to reaction from the pressure drop, and part is due to a change in kinetic energy, which represents an impulse function.

The following figure shows a cross section through a Francis turbine.



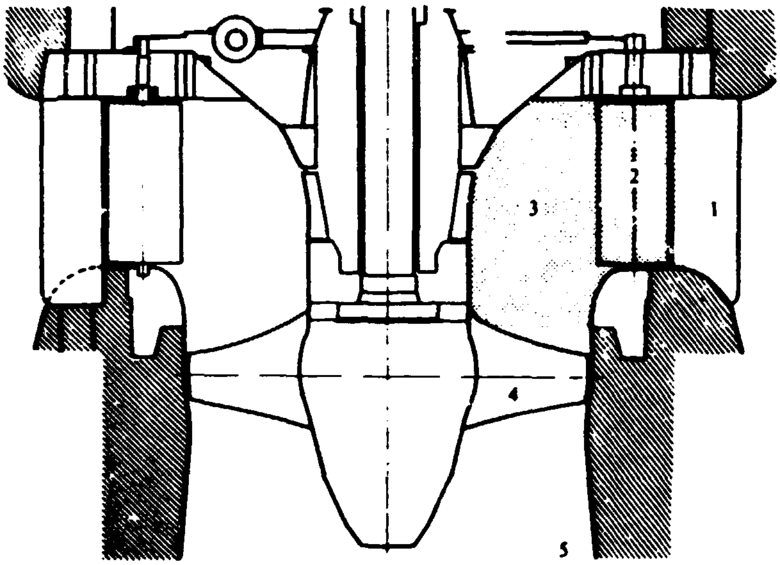
The water first enters a volute or spiral casing. It then passes through a row of fixed guide vanes followed by adjustable guide vanes, the cross-sectional area between the adjustable vanes being varied for flow control at part load. The water then passes immediately into the rotor where it moves radially through the rotor vanes and exits from the rotor blades at a smaller diameter, after which it turns through through 90 into the draft tube.

The function of the draft tube is to bring the water pressure back to the pressure of the tailrace, and during this process to remove the kinetic energy still existing at the runner outlet. In some rotors the work transfer is accomplished not only while the water is moving radially but also in a part axial direction. This is done by a judicious choice of rotor design.

1.3.3 Axial flow turbine

A Kaplan turbine is illustrated in the following figure. The inlet guide vanes are fixed and are situated at a plane higher that the runner blades such that the fluid must turn through 90 to enter the runner in the axial direction. Load changes are effected by adjustment of the runner blade angle. The function of the guide vanes is to impart whirl to the fluid so that the radial distribution of velocity is the same as in a free vortex. Since this type of turbine is used for low heads and high flow rates, the blades must be long and have large chords so that they are strong enough to transmit the very high torques that arise.

Normally an axial flow turbine has a four- five- or six-bladed runner.

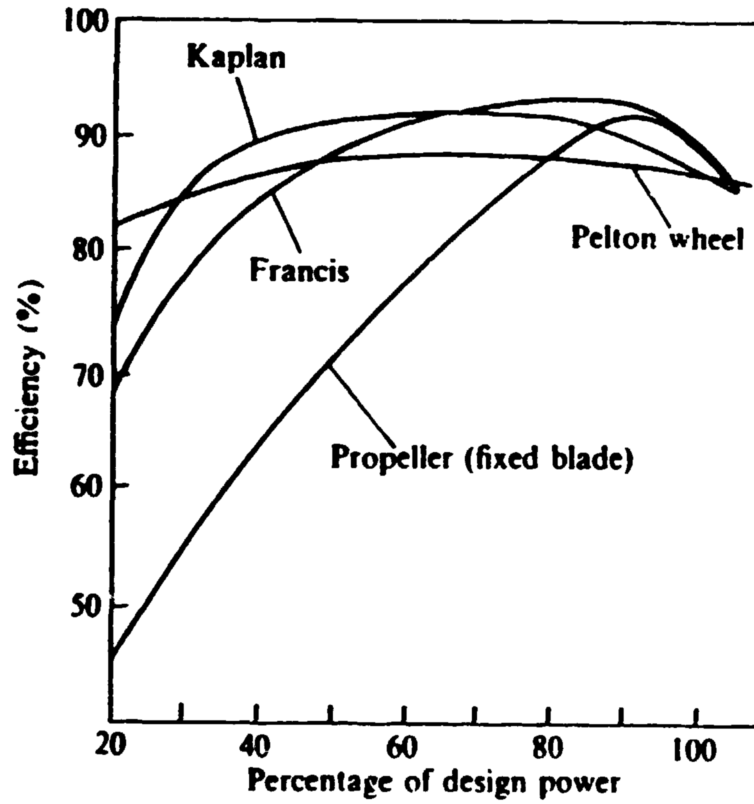


1. Spiral casing with fixed guide vanes
2. Adjustable inlet guide vanes
3. Transition passage
4. Runner
5. Draft tube

Axial flow Kaplan turbine

1.3.4 Comparison of hydraulic turbine efficiencies

Efficiency curves of the various types of turbine are illustrated in the following figure.



A comparison of the efficiencies of the various types of turbine at partial load, leads to the following considerations:

the Pelton wheel efficiency curve is much flatter although the maximum efficiency is lower. The Francis turbine peaks at the highest efficiency but falls off rapidly at part load, while the Kaplan turbine has a much flatter curve than the Francis and exhibits a similar maximum efficiency.

The advantage of adjustable blades on the Kaplan turbine is shown by comparing it with the curve for a fine-blade propeller turbine (also shown in the previous figure).

1.4 CROSS-FLOW TURBINE (MICHELL-BANKI)

The classical turbines described in the previous paragraphs, developed on the basis of the theoretical calculations, are high quality prime movers in their fields of application.

Nevertheless, in addition to the initial cost which is very high, these turbo-engines have a common disadvantage, they do not meet the requirements for economic exploitation of small water powers.

In fact these machines are not suitable for operating with variable water flow rates, as in general occurs in the case of mountain streams. The cross-flow turbine, also known as Michell-Banki turbine, was developed to cover the needs of harnessing small to medium flows of water. The cross-flow turbine is a radial and partial admission free stream turbo-engine. The guide vanes generates a water flow with a rectangular cross-section. Water flows through the blade ring of the cylindrical rotor, first form outside inwards, then after passing through the whole rotor, from inside outwards again.

A view of this type of turbine is shown in figures 1.4A to 1.4C. Figure 1.4.D shows efficiency characteristics of Michell-Banki turbine in comparison with the Francis turbine.

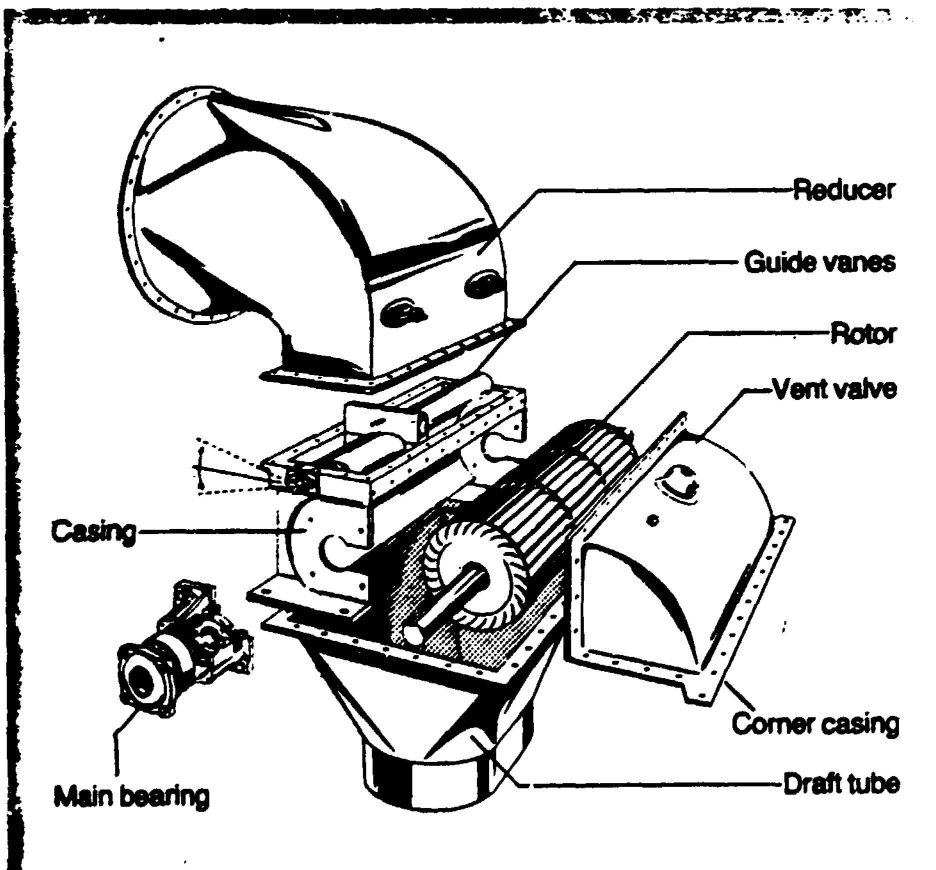


Fig. 1.4.A - Components of a MICHELL-BANKI TURBINE

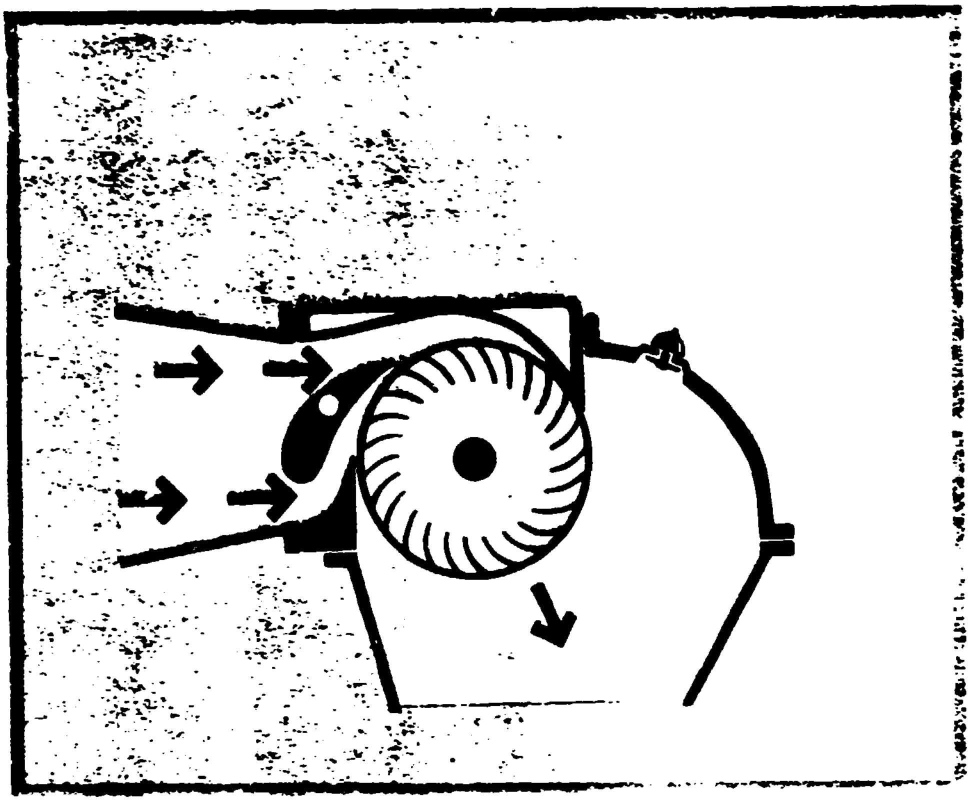


Fig. 1.4.B - Horizontal inflow

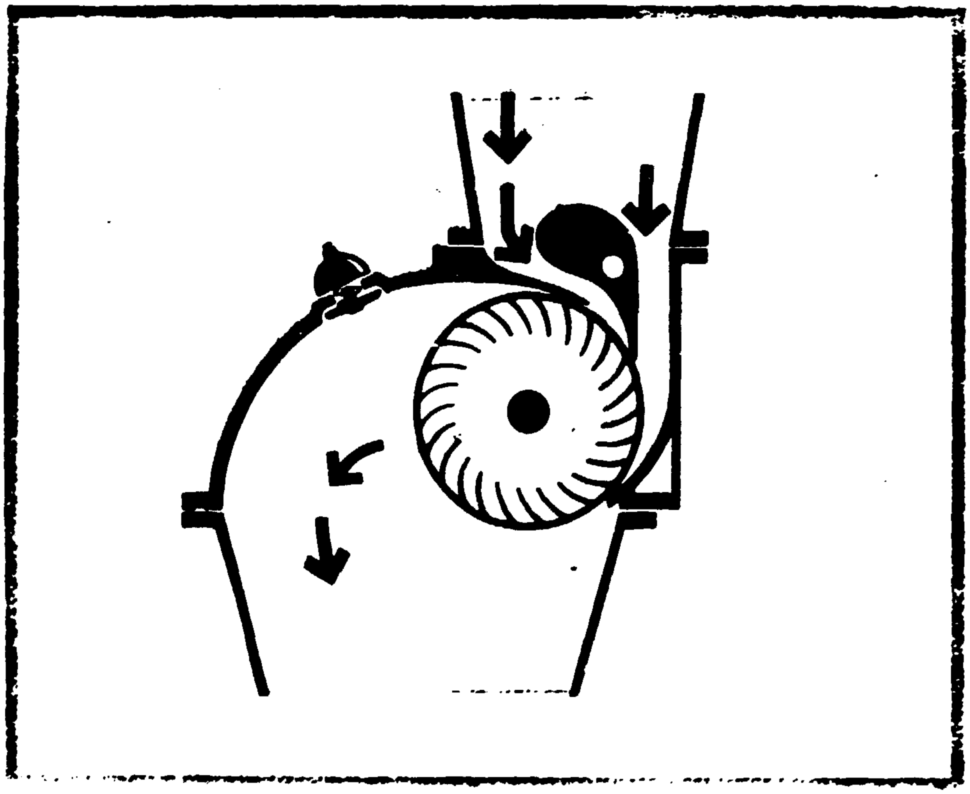


Fig. 1.4.C - Vertical inflow

This diagram shows that the efficiency of the MICHELL-BANKI is above 80% with flow rate ranging from 20 to 100%, while efficiency of the FRANCIS rapidly reduces when flow rate is lower.

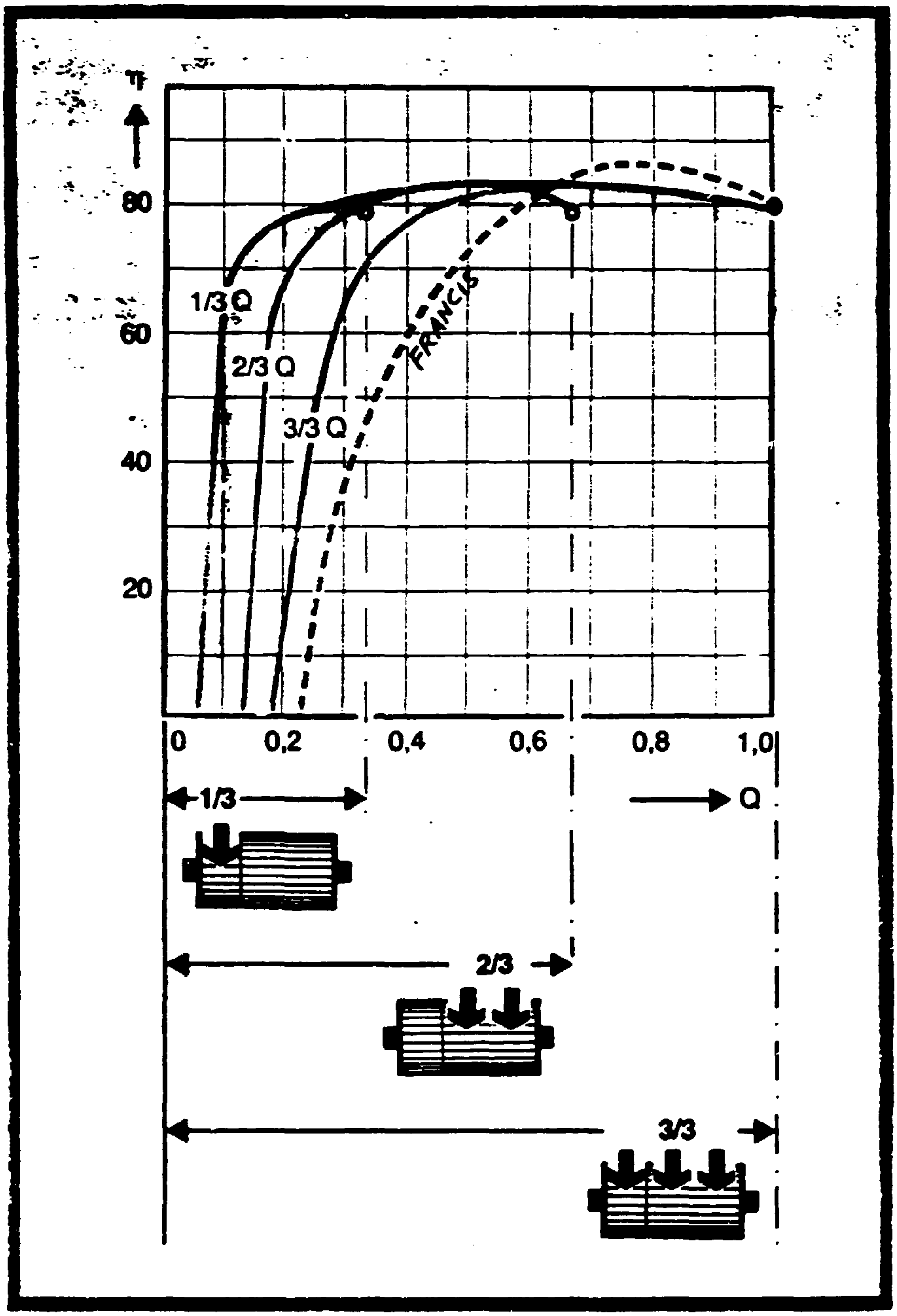


Fig. 1.4.D - Efficiency characteristic of a MICHELL-BANKI turbine compared with the FRANCIS turbine

1.5 HYDRAULIC MICRO-TURBINES AND MICRO-HYDRO POWER PLANTS

Turbines that will be considered in the present study will be suitable to exploit energy of small rivers to supply electric power to a limited area; their power output will be within 100 KW and therefore they are called "micro-turbines".

In particular this project foresees the production of turbines with four power ratings, that are 5, 10, 30 and 60 KW.

These installations can generally be operated by flowing water, even without any dam or construction to hold back water to feed the turbine. This contributes to keep low cost of investment.

The increasing costs of diesel fuel will of course increase the attractiveness of micro-hydro installations for many sites, despite higher investment costs.

Comparison between diesel and hydro installation should be made on the basis of the following considerations:

a) fuel cost, including transport to the site, is a factor adverse to a diesel-operated gen-set;

b) economic life of the plant : 30 to 40 years is the economic life expected for an hydroplant, compared with 10-15 years for a diesel plant;

c) maintenance cost, availability of spare parts and time required for maintenance are favourable to the hydroplant;

d) air pollution is another factor adverse to the diesel installation.

1.6 CHOICE OF TURBINE

The first criterion for choosing between the two types of turbine (Pelton or Banki) is the analysis of the characteristics of the stream which is available as power source.

Heads between 6 and 200 meters with effective flow rates ranging between 0.2 and 100 litres/second call for the Pelton wheel.

Heads between 3 and 50 meters with effective flow rates in the range of 5 to 1,000 litres/sec. are more suitable for crossflow (Banki) turbines.

Then to size the turbine power output it is sufficient to sum the actual power required by all the utilizers, taking into consideration the contemporaneously of the consumption of electric energy.

2. MARKET AND PLANT CAPACITY

2.1 THE MARKET

2.1.1. Generalities

Ethiopia has very large hydroenergy potential. The last figure assessed (1989) shows a gross river hydro energy potential (GRHP) in excess of 650 Twh/yr.

In this respect ENEC, the Ethiopian National Energy Committee is studying the development and introduction of renewable energies and is giving special attention to the rural areas with limited economic activities to enhance their development and reduce the gap with the urban centres. With the collaboration of other agencies ENEC is doing an assessment of minihydro power resources taking into consideration the following advantages versus other energy generation systems:

- lower installation costs compared to the rather high connection costs for long transmission lines
- the lower level of consumer price for electricity generated from hydro
- the lower generation cost during the long life time
- oil import substitution
- the important rule that the availability of cheap energy can have to promote decentralized crop processing in remote area, upgrading rural living standards with consequent reduction of immigration of manpower to urban areas.
- hydropower equipment are commercially available and well tested if compared with other renewable energy production systems.

2.1.2 Hydropotential

It has been already indicated that the hydropotential is very high. The following table shows the hydropotential by region per capita.

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Regions	Pop.density P/km^2	Hydropotential MW	Kw/capita KW/Km^2	
Gojam	46.3	945	124.7	2.69
Shewa	104.4	306	119.2	1.14
Sidano	34.4	492	150.5	4.37
Gamu Gofa	28.6	22	69	2.44
Kefa	54.5	23	158.6	2.91
Ilubator	23.6	252	372.7	15.7
Welega	29.1	578	298.9	10.27

It can be assumed that the preliminary rural electrification requirement is 100 W per capita. Therefore the potential is at least 14 times that minimum value.

The following table shows 16 sites that have been already identified where mini and micro hydro schemes can be installed.

Site	Basin/river	Adm.Region	Set.	Nearest Urb. settlem. m^3/sec	Flow mt	Head KW	Power	Notes
Welkesa	Wabi Shebala	Arsi	2400	Ticho	0.45	75	232	
Logita (B)	Genale	Bale	2600	Kokosa	1.5	30	330	
Logita (S)	Genale	Sidamo	2500	Deyo	3	60	1,324	
Godoro	Omo	Niomo	2100	Gerese	1.5	80	880	
Weyra	Blate Sega &Dowe	S.Shewa	1950	Achamo	0.55	45	182	
Shencora	Awash	E. Shewa	2000	Arerti	0.2	95	140	
Arba	Awash	Arsi	1800	Tinsael Merti	0.32	30	70.6	
Fato Melka	Abay	Wershewa	2300	Tiku Incheni	0.5	120	440	
Suder	Abay	W.Gojam	2350	AdisKedama	0.3	30	66	
Ramis	WabiShabala	Haraghe	1300	Golelcha	1.5	44	485	
GilgolAbay		Gojam			4.01	6	195.5	
Andarsa		Gojam			2.2	5.4	88.9	
Asher		Gojam			1.91	11	83.3	
Muga		Gojam			0.45	47.3	83.3	
Sedab 1		Gojam			0.62	45.1	125	

Other potential sites are listed here below:

		Head	Flow	Inst.KW
Fetam 3	Gojam	58	0.88	217
Fetam 1	Gpjam	18	1.49	224
Ardie	Gojam	14.5	0.79	92
Dura	Gojam	26	2.36	173
Belo	Shewa	16	0.57	65
Bite	Shewa	41.5	0.40	61.1
Walga	Shewa	31.5	0.49	125
Wenkie	Shewa	6	2.3	61.1
Ameka	Shewa	37	0.8	111.1
Gemuna	Shewa	17.5	0.88	126
Logita	Sidomo	16.5	1.75	222.2
Bonora	Sidomo	31	1.38	352
Weyibo	Sidomo	58	0.97	444.4
Menessa	Sidomo	30.6	0.51	122.2
Weshy	Kefa	26	0.774	84
Sor	Ilubatoro	45.5	1.824	222.2
Gumbi	Welega	23.6	0.72	122.2
Uke	Welega	10.5	0.76	28.9
Endris	Welega	38.5	0.552	83.5
Negeso	Welega	30	1.054	138.9
Keto	Welega	29	1.52	177.8
Aweto	Welega	23.6	0.72	61.1

	Basin		Flow	Head	Power	
Gombala Tere	Omo	Shewa	0.04	78	61	Bako
Hohe&Selga	BlueNile	Welega	10	10	98.1	Assosa
Mojjo	Awash	Shewa	0.75	21	154	Debrezeye
Darge	Awash	Shewa	0.75	21	154	Walkite
Birr	BlueNile	Gojam	1.5	11	160	FenoteSelom
Sanka	Awash	Wollo	1	10.5	103.1	Wolaja
Jarra	Awash	Shewa	0.07	325	156	Ataye
Sede	WabiShebali	Harerge	0.28	120	248	Girawa
Ajora	Omo	Sidono	0.06	300	178	Areka
Meribo	Wobistebla	Bale	0.3	70	145	Adaba
Weyib	Wobistebla	Bale				
Omonado	Omo	Keffe	0.2	32	74	Nada
Gumara	BlueNile	Gonder	0.48	36	153	Wanzaye

2.1.3 Typical application

A study has been carried out to analyze the site of Nada (Keffa) and to investigate the possible application of a micro/mini hydro scheme.

Hydropotential 31 KW

Hydro net power 22 KW

Energy demand (1982)

Number of villages	9
Head of families	7820
Demand 30 W/family	235
Total length of transmission lines	22.5 Km

Three alternatives are possible:

a. Provide energy to three villages, 3322 families, 100 KW demand, 2.5 Km transmission lines, 6,500 cu.mt. reservoir.

b. two villages, 2222 families, 67 KW demand, 1.5 Km transmission lines, 3,800 cu.mt. reservoir.

c. energy only for Omonada village, 800 families, 24 KW demand, 1 Km transmission lines.

The typical consumption of energy connected to the installation of energy generation equipment has been calculated as follows:

Lighting: one 30 W incandescent lamp per each household

Street lighting: in a typical model rural Ethiopian village of 400 families there are 20 rows of 20 houses each, with a road every two rowa. There is a main road cutting through the rows and passing through the central square. Thus 6 fluorescent lamps of 81 W for the square and 40 fluorescent lamps of 25 W for the roads.

Refrigeration : dispensary with refrigerator 70 W - Bar refrigerator 300 W.

Milling : For the rural villages grain consumption during dry season is greater than during wet season. In this case 1.25 kg/family is required or 5 days/week of 8 working days.

In wet season only 3 working days/week.

Water pumps : The average water requirement in a rural Ethiopian village is estimated to be 20 lt/head/day. In line with World Health Organization recommendations water requirements are calculated assuming an average size of 4.25 persons for family for an average pumping head of 35 m for 13 continuous pumping hours/day.

2.1.4 Market potential

Two elements are available:

- extremely high hydropotential scattered in the country
- extremely high demand of low cost energy in the rural areas

The sites in which micro hydro generation units can be installed are hundreds.

The main concern is the financing of these schemes. The Agricultural and Industrial Development Banks is available to finance the schemes.

2.2 PLANT CAPACITY AND PRODUCTION PROGRAMME

The envisaged plant should be able to produce two types of hydraulic micro-turbines :

1) PELTON

2) MICHELL-BANKI

It is foreseen that the plant will only manufacture the turbines, while the other main components as electric generator and load control system will be imported and assembled.

Power ratings for each type of turbine will be 5, 10, 30 and 60 KW; these are the most common power outputs required by the rural communities, sufficient to satisfy the needs both of householders (home lighting, radio-set, cooking, refrigerators, etc.) and farmers (water pumping, irrigation).

It is foreseen that the production capacity, based on 250 working days per year at 8 hours per day, will be in the range of 20-25 units per year, shared into the various models. A preliminary production programme has been studied and is presented in the following table; on the basis of this all the calculations of costs and revenues have been calculated, as shown in the following pages.

Table 2.2 Microturbines production programme (units per year)

Turbine type	1st year	2nd year	3rd year
PELTON 5 KW	2	2	2
10 KW	2	2	2
30 KW	1	2	3
60 KW	1	2	2
BANKI 5 KW	2	2	2
10 KW	3	4	6
30 KW	3	4	6
60 KW	1	2	2
TOTAL	15	20	25

As said before, it is foreseen that other components, that are electric generators, control boards and electronic regulators, will be imported ready to be assembled into complete power units with the same power rating than the turbines listed in table 2.2.

Therefore the production programme foresees to supply complete hydro-power plants, as detailed in the next paragraph. This production is, of course, the same than the one described for turbines, as far as the number of units produced/assembled per year is concerned.

2.3 SALES PRICES AND REVENUES

The models of hydro-plants which will be produced and assembled in the envisaged plant are shortly described here below, complete with relevant sales prices, that should be competitive on the local market.

The eight foreseen models are the following (shared into four models PELTON type and BANKI type):

A1) Micro hydropower plant 5 KW - Pelton type, consisting of the following equipment:

- PELTON wheel 5KW power rate, complete with speed multiplier;
- Synchronous electric generator, four poles, brushless type;
- Control board with instrumentation and alarms, including protection devices
- No. 3 electronic regulators with 2 KW electric resistors for heating air.

This unit is able to supply single or three-phase alternate current at 220 Volts-50 Hertz.

. Sale price of the unit = 13,000 US $

B1) Micro hydropower plant 10 KW - Pelton type, consisting of the following equipment:

- PELTON wheel 10KW power rate, complete with speed multiplier;
- Synchronous electric generator and control board as the above described unit;
- No. 6 electronic regulators with electrical resistors for heating air.

This unit is able to supply single or three-phase alternate current at 220 Volts and three-phase AC at 380 V-50 Hertz.

. Sale price of the unit = 21,000 US $

C1) Micro hydropower plant 60 KW - Pelton type, consisting of the following equipment:

- PELTON wheel 60 KW power rate;
- Synchronous electric generator and control board similar to the above described units;
- No. 6 electronic regulators with electrical resistors for heating water.

This unit is able to supply single-phase AC 200 V and three-phase AC at 380 V-50 Hz.

. Sale price of the unit = 40,000 US $

A2) Micro hydropower plant 5 KW/Banki type, consisting of the same equipment than the PELTON type, exception made, of course, for the BANKI turbine. The supply of electric energy is like the above mentioned 5 KW PELTON type.

. Sale price of the unit = 19,000 US $

B2) Micro hydropower plant 10 KW/Banki type. Technical characteristics and performances are similar to the ones of PELTON unit.

. Sale price of the unit = 30,000 US $

C2) Micro hydropower plant 30 KW/Banki type. Technical characteristics and performances are similar to the ones of PELTON unit.

. Sale price of the unit = 38,000 US $

D2) Micro hydropower plant 60 KW/Banki type. Technical characteristics and performances are similar to the ones of PELTON unit.

. Sale price of the unit = 78,000 US $

According to the foreseen production and assembling programme the revenues will be those shown in the following table.

Table 2.3 Sales prices and revenues

Ref.	Model of hydro-power plant	Sales price ($/unit)	Revenues 1st year		2nd year		3rd year	
A1	PELTON 5 KW	13,000	2	26,000	2	26,000	2	26,000
B1	10 KW	21,000	2	42,000	2	42,000	2	42,000
C1	30 KW	32,000	1	32,0000	2	64,000	3	96,000
D1	60 KW	40,000	1	40,000	2	80,000	2	80,000
A2	BANKI 5 KW	19,000	2	38,000	2	38,000	2	38,000
B2	10 KW	30,000	3	90,000	4	120,000	6	180,000
C2	30	38,000	3	114,000	4	152,000	6	228,000
D2	60	78,000	1	78,000	2	156,000	2	156,000
	TOTAL	--	**15**	**460,000**	**20**	**678,000**	**25**	**846,000**

3. MATERIALS AND INPUTS

Generally speaking, the basic raw materials needed are:

- carbon steel plates of various thickness
- carbon steel profiles of various shape
- screws, nuts, gaskets
- carbon steel pipes of various diameter and thickness
- carbon steel round bar (for the turbine shaft
- bronze and stainless steel round bar (for nozzles)
- standard channels
- flanges
- gate valves
- roll bearings and supports
- rust preventor
- enamel painting

Tables at the following pages refer to models of hydraulic micro-turbines which are foreseen in the components and the material list with the relevant quantities required to manufacture each model of turbine. Theoretical times (in minutes) of direct labour for each model of turbine are also shown in these tables, shared into the main operations.

Most part of the components could be manufactured by local workshops provided with common equipment and tools required for machining.

Some parts, for instance buckets of PELTON wheel should be supplied by the foreign partner or produced by a local foundry. The electric generator, the control board, the electronic load control unit and the speed multiplier should be imported.

TABLE 3.A - PELTON 5 kW HYDRAULIC TURBINE

ASSEMBLY DESCRIPTION	ITEM	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
WATER DISTRIBUTOR							72.00	420.00	30.00	
	TOP FLANGE		C STEEL	1	17.00	17.00	30.00			
	BOTTOM FLANGE		C STEEL	1	17.00	17.00	30.00			
	INTERNAL RING		C STEEL	1	40.00	40.00				
	EXTERNAL RING		C STEEL	1	25.00	25.00				
	CASING FEET		C STEEL	4	0.90	3.60				
	WATER INLET FLANGE		C STEEL	1.6 kg	1.25	2.00	51.00			
	NOZZLE SUPPORT.PIPE		C STEEL	6	0.60	3.60				
MATCHING FLANGE			ALUMINIUM	1	68.00	68.00	51.00			
RUNNER TYPE 38/210	DISK		SS-AISI 316 L	1	7.50	7.50	480.00			
	BUCKETS	F	SS-AISI 316 L	24	5.90	141.60				
HUB-COUPLING GROUP	COUPLING DEVICE		SS-AISI 303	3.43 kg	4.10	14.06	198.00			
	COUPLING DEVICE		SS-AISI 303	2.86 kg	4.10	11.73	93.00			
	DISK COVER		SS-AISI 303	0.34 kg	4.10	1.39	22.00			
TURBINE BASEMENT										
	RING		C STEEL	1	20.00	20.00	16.00		10.00	
	BRACKETS		C STEEL	4	0.50	2.00				
GENERATOR LIFTING BRACKET			C STEEL	1	49.00	49.00			10.00	
WATER FEEDING GROUP 3"										
	GATE VALVE 3"	F	BRONZE	1	25.40	25.40				
	WATER FEED PIPE		C STEEL	1	9.60	9.60	7.50	15.00		
	COCK 1 1/2"	F	BRASS	1	15.70	15.70				
	WATER INLET PIPE 3"		C STEEL	1	5.50	5.50	45.00	22.00		
NOZZLES		F	NYLON	6	1.20	7.20	30.00			
TOTAL						486.88	1,125.50	457.00	50.00	140.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

TABLE 3.8 - PELTON 10 kW HYDRAULIC TURBINE

ASSEMBLY DESCRIPTION	ITEM	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
WATER DISTRIBUTOR							150.00	480.00	40.00	
	TOP FLANGE		C STEEL	1	17.50	17.50	38.00			
	BOTTOM FLANGE		C STEEL	1	17.50	17.50	38.00			
	INTERNAL RING		C STEEL	1	55.00	55.00				
	EXTERNAL RING		C STEEL	1	60.00	60.00				
	CASING FEET		C STEEL	4	0.90	3.60				
	WATER INLET FLANGE		C STEEL	1.6 kg	1.25	2.00	51.00			
	NOZZLE SUPPORT.PIPE		C STEEL	6	2.60	15.60	210.00			
MATCHING FLANGE			C STEEL	18 kg	1.80	32.40	360.00			
RUNNER TYPE 38/280	DISK		SS-AISI 316 L	1	32.70	32.70	540.00			
	BUCKETS	F	SS-AISI 316 L	32	5.90	188.80				
HUB-COUPLING GROUP	COUPLING DEVICE		SS-AISI 303	3.8 kg	4.10	15.58	245.00			
	COUPLING DEVICE		SS-AISI 303	3 kg	4.10	12.30	88.00			
	DISK COVER		SS-AISI 303	0.34 kg	4.10	1.39	22.00			
TURBINE BASEMENT										
	RING		C STEEL	1	25.00	25.00	20.00		12.00	
	BRACKETS		C STEEL	4	0.50	2.00				
GENERATOR LIFTING BRACKET			C STEEL	1	49.00	49.00			10.00	
WATER FEEDING GROUP 3"										
	GATE VALVE 3"	F	BRONZE	1	25.40	25.40				
	WATER FEED PIPE		C STEEL	1	9.60	9.60	7.50	15.00		
	COCK 1 1/2"	F	BRASS	1	15.70	15.70				
	WATER INLET PIPE 3"		C STEEL	1	5.50	5.50	45.00	22.00		
NOZZLES		F	NYLON	6	1.20	7.20	30.00			
TOTAL						593.77	1844.50	517.00	62.00	140.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

TABLE 3.C - PELTON 30 kW HYDRAULIC TURBINE

ASSEMBLY DESCRIPTION	ITEM	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
WATER DISTRIBUTOR								960.00	120.00	
	TOP FLANGE		C STEEL	1	100.00	100.00	60.00			
	BOTTOM FLANGE		C STEEL	1	90.00	90.00				
	INTERNAL RING		C STEEL	1	140.00	140.00				
	EXTERNAL RING		C STEEL	1	100.00	100.00				
	CASING FEET		C STEEL	8	0.90	7.20				
	WATER INLET FLANGE		C STEEL	7.5 kg	1.30	9.75	90.00			
	NOZZLE SUPPORT.PIPE		C STEEL	12	2.50	30.00	180.00			
MATCHING FLANGE			C STEEL	21 kg	1.30	27.30	480.00			
	PARABOLA		ALUMINIUM	1	25.00	25.00	20.00			
RUNNER TYPE 75/200	DISK		SS-AISI 316 L	1.7 kg	8.00	13.60	510.00			
	BUCKETS	F	SS-AISI 316 L	17	19.00	323.00				
HUB-COUPLING GROUP	COUPLING DEVICE		SS-AISI 303	8.6 kg	4.80	41.28	450.00			
	COUPLING DEVICE		SS-AISI 303	7.85 kg	4.80	37.68	200.00			
	DISK COVER		SS-AISI 303	0.46 kg	4.80	2.21	35.00			
TURBINE BASEMENT										
	RING		C STEEL	1	50.00	50.00	38.00	30.00	6.00	
	BRACKETS		C STEEL	8	0.50	4.00				
GENERATOR LIFTING BRACKET			C STEEL	1	65.00	65.00			15.00	
WATER FEEDING GROUP 3"							205.00	80.00		
	GATE VALVE 5"	F	BRONZE	1	120.00	120.00				
	WATER FEED PIPE		C STEEL	1	58.00	58.00	35.00	30.00		
	COCK 2"	F	BRASS	1	23.10	23.10				
	WATER INLET PIPE 5"		C STEEL	9 kg	1.30	11.70	120.00	20.00		
NOZZLES		F	NYLON	6	2.50	15.00	45.00			
TOTAL						1,293.82	2468.00	1120.00	141.00	240.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

TABLE 3.D - PELTON 60 kW HYDRAULIC TURBINE

ASSEMBLY DESCRIPTION	ITEM	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
WATER DISTRIBUTOR								1,080.00	150.00	
	TOP FLANGE		C STEEL	1	120.00	120.00	60.00			
	BOTTOM FLANGE		C STEEL	1	100.00	100.00				
	INTERNAL RING		C STEEL	1	150.00	150.00				
	EXTERNAL RING		C STEEL	1	120.00	120.00				
	CASING FEET		C STEEL	8	0.90	7.20				
	WATER INLET FLANGE		C STEEL	7.5 kg	1.30	9.75	90.00			
	NOZZLE SUPPORT.PIPE		C STEEL	12	2.50	30.00	180.00			
MATCHING FLANGE			C STEEL	51 kg	1.48	75.48	600.00			
	PARABOLA		ALUMINIUM	1	35.00	35.00	20.00			
RUNNER TYPE 75/300	DISK		SS-AISI 316 L	4.7 kg	8.00	37.60	720.00			
	BUCKETS	F	SS-AISI 316 L	24	19.00	456.00				
HUB-COUPLING GROUP	COUPLING DEVICE		SS-AISI 303	16.5 kg	4.80	79.20	600.00			
	COUPLING DEVICE		SS-AISI 303	13 kg	4.80	62.40	300.00			
	DISK COVER		SS-AISI 303	1 kg	4.80	4.80	45.00			
TURBINE BASEMENT					0.00					
	RING		C STEEL	1	60.00	60.00	38.00	30.00	6.00	
	BRACKETS		C STEEL	8	0.50	4.00				
GENERATOR LIFTING BRACKET			C STEEL	1	90.00	90.00			15.00	
WATER FEEDING GROUP 5"					0.00		205.00	80.00		
	GATE VALVE 5"	F	BRONZE	1	120.00	120.00				
	WATER FEED PIPE		C STEEL	1	58.00	58.00	35.00	30.00		
	COCK 2"	F	BRASS	1	23.10	23.10				
	WATER INLET PIPE 5"		C STEEL	9 kg	1.30	11.70	120.00	20.00		
					0.00					
NOZZLES		F	NYLON	6	2.50	15.00	45.00			
TOTAL						1,669.23	3,058.00	1,240.00	171.00	360.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

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TABLE 3.E - BANKI-MICHELL 5 kW TURBINE

ASSEMBLY DESCRIPTION	I T E M	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
TURBINE CASING							120.00	720.00		
	END FLANGES		C STEEL	2	15.00	30.00	450.00			
	INJECTOR		C STEEL	2	15.00	30.00	240.00			
	PLATE WALLS		C STEEL	1	52.00	52.00		50.00		
	BASEMENT		C STEEL	26 kg	1.20	31.20	360.00			
	INSPECTION DOOR		C STEEL	1	12.00	12.00	170.00			
	COUPLING FLANGE		C STEEL	8 kg	1.20	9.60	40.00			
ROTOR	END DISKS		C STEEL	6 kg	1.50	9.00	360.00			
	SHAFT FASTENERS		SS-AISI 303	0.9 kg	4.80	4.32	210.00			
	BLADES		C STEEL	1	21.75	21.75	290.00	150.00		
	CENTER DISK		C STEEL	0.6 kg	0.80	0.48	130.00	20.00		
	SHAFT		C STEEL	1	25.00	25.00	330.00			
	TURNING						130.00			
GUIDE VANE	END DISKS		C STEEL	2	5.00	10.00	200.00			
	GUIDE VANE SECTOR		C STEEL	2	5.00	10.00	75.00			
	GUIDE BUSHINGS		NYLON	2	1.20	2.40	30.00			
	DRIVE		VARIOUS	1	20.00	20.00	360.00			
	PINION SHAFT		SS-AISI 303	1 kg	4.80	4.80	45.00			
BEARINGS SUPPORTS			C STEEL	2	15.00	30.00	660.00			
	INTERNAL PARTS		VARIOUS	1	20.00	20.00	160.00			
BUTTERFLY VALVE			C STEEL	1	200.00	200.00	1,440.00			
T O T A L						522.55	5,800.00	940.00	120.00	720.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

TABLE 3.F - BANKI-MICHELL 10 kW TURBINE

ASSEMBLY DESCRIPTION	I T E M	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
TURBINE CASING							150.00	780.00		
	END FLANGES		C STEEL	2	35.00	70.00	660.00			
	INJECTOR		C STEEL	2	25.00	50.00	250.00			
	PLATE WALLS		C STEEL	1	70.00	70.00		60.00		
	BASEMENT		C STEEL	40 kg	1.20	48.00	420.00			
	INSPECTION DOOR		C STEEL	1	12.00	12.00	170.00			
	COUPLING FLANGE		C STEEL	12 kg	1.20	14.40	60.00			
ROTOR	END DISKS		C STEEL	10 kg	1.50	15.00	420.00			
	SHAFT FASTENERS		SS-AISI 303	0.9 kg	4.80	4.32	210.00			
	BLADES		C STEEL	1	66.00	66.00	450.00	280.00		
	CENTER DISK		C STEEL	1 kg	0.80	0.80	90.00	20.00		
	SHAFT		C STEEL	1	32.00	32.00	300.00			
	TURNING						180.00			
GUIDE VANE	END DISKS		C STEEL	8 kg	1.50	12.00	480.00	120.00		
	GUIDE VANE SECTOR		C STEEL	1	10.00	10.00	100.00			
	GUIDE BUSHINGS		NYLON	2	1.20	2.40	30.00			
	DRIVE		VARIOUS	1	20.00	20.00	360.00			
	PINION SHAFT		SS-AISI 303	1.5 kg	4.80	7.20	60.00			
BEARINGS SUPPORTS			C STEEL	2	15.00	30.00	660.00			
	INTERNAL PARTS		VARIOUS	1	20.00	20.00	160.00			
GENERATOR DRAFT TUBE FRAME			C STEEL	1	40.00	40.00	450.00	120.00		
BUTTFRFLY VALVE			C STEEL	1	220.00	220.00	1,500.00			
T O T A L						744.12	7,160.00	1,380.00	150.00	840.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

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TABLE 3.G - BANKI-MICHELL 30 kW TURBINE

ASSEMBLY DESCRIPTION	I T E M	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
TURBINE CASING							180.00	960.00		
	END FLANGES		C STEEL	2	48.00	96.00	900.00			
	INJECTOR		C STEEL	2	30.00	60.00	270.00			
	PLATE WALLS		C STEEL	1	85.00	85.00		90.00		
	BASEMENT		C STEEL	60 kg	1.20	72.00	480.00			
	INSPECTION DOOR		C STEEL	1	12.00	12.00	170.00			
	COUPLING FLANGE		C STEEL	16 kg	1.20	19.20	120.00			
ROTOR	END DISKS		C STEEL	17 kg	1.50	25.50	350.00			
	HUB		SS-AISI 303	7 kg	4.80	33.60	300.00			
	BLADES		C STEEL	1	105.70	105.70	450.00	300.00		
	CENTER DISK		C STEEL	1.6 kg	0.80	1.28	180.00	20.00		
	SHAFT		C STEEL	1	37.00	37.00	300.00			
	TURNING						240.00			
GUIDE VANE	END DISKS		C STEEL	13 kg	1.50	19.50	285.00	120.00		
	GUIDE VANE SECTOR		C STEEL	1	16.00	16.00	150.00			
	GUIDE BUSHINGS		NYLON	2	1.50	3.00	45.00			
	DRIVE		VARIOUS	1	30.00	30.00	420.00			
	PINION SHAFT		SS-AISI 303	2.5 kg	4.80	12.00	75.00			
BEARINGS SUPPORTS			C STEEL	17	2.50	42.50	720.00			
	INTERNAL PARTS		VARIOUS	1	30.00	30.00	240.00			
BASE FRAME			C STEEL	1	60.00	60.00	660.00	150.00		
BUTTERFLY VALVE			C STEEL	1	250.00	250.00	1,620.00			
T O T A L						1,010.28	8,155	1,640	180.00	960.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

TABLE 3.H - BANKI-MICHELL 60 kW TURBINE

ASSEMBLY DESCRIPTION	I T E M	NOTE	MATERIAL	QUANTITY	UNITARY COST (U.S. $)	TOTAL COST (U.S. $)	DURATION OF OPERATIONS IN MINUTES: MECHANIC. OPERATION	STEEL STRUCTURE	PAINTING	ASSEMBLING
TURBINE CASING							240.00	1,920.00		
	END FLANGES		C STEEL	2	88.00	176.00	1,320.00			
	INJECTOR		C STEEL	2	37.00	74.00	480.00			
	PLATE WALLS		C STEEL	1	287.00	287.00	120.00	150.00		
	BASEMENT		C STEEL	53 kg	1.20	63.60	720.00			
	INSPECTION DOOR		C STEEL	2	16.00	32.00	310.00			
	COUPLING FLANGE		C STEEL	56 kg	1.20	67.20	480.00			
ROTOR	END DISKS		C STEEL	2	37.00	74.00	630.00			
	HUB	F	SS-AISI 303	9 kg	4.80	43.20	240.00			
	BLADES		C STEEL	1	768.00	768.00	1,800.00	600.00		
	CENTER DISK		C STEEL	1	21.60	21.60	390.00			
	SHAFT		C STEEL	1	89.40	89.40	300.00			
	TURNING						480.00			
GUIDE VANE	END DISKS		C STEEL	2	35.00	70.00	600.00			
	GUIDE VANE SECTOR		C STEEL	1	55.00	55.00	150.00			
	GUIDE BUSHINGS		BRONZE	2	20.00	40.00	120.00			
	DRIVE		VARIOUS	1	120.00	120.00	800.00			
	PINION SHAFT		SS-AISI 303	9 kg	4.80	43.20	195.00			
BEARINGS SUPPORTS			C STEEL	24 kg	2.50	60.00	840.00			
	INTERNAL PARTS		VARIOUS	1	45.00	45.00	300.00			
BASE FRAME			C STEEL	160 kg	1.20	192.00	1,290.00	480.00		
BUTTERFLY VALVE			C STEEL	1	300.00	300.00	1,800.00			
T O T A L						2,621.20	13,605	3,150	240.00	1,440.00

F = FOREIGN SUPPLY (PART TO BE IMPORTED)

Table 3.I/1 resumes the cost of materials for each model of micro hydro-plant, identified with the same model of turbine.

Table 3.I/1 Cost of materials (U.S. $)

Model of hydroplant	Cost per unit: Local materials (A)	Cost per unit: Imported equip. (B)	Cost per unit: Cost of materials (A+B)
PELTON 5 KW	487	7,000	7,487
10 KW	594	12,500	13,094
30 KW	1,294	14,800	16,094
60 KW	1,669	26,300	27,969
BANKI 5 KW	523	7,000	7,523
10 KW	744	12,500	13,244
30 KW	1,010	14,800	15,810
60 KW	2,621	26,300	28,921

Column (A) shows the cost of the equipment manufactured by the envisaged plant, that mainly consists of the turbine wheel.
Column (B) shows the estimated costs of the imported equipment, that is electric generator, control board and electronic regulator.

Table 3.I/2 displays the estimated costs of materials for the first, second and third year of production, as per the foreseen production programme.

It has been assumed that the plant will give the full production at the third year of operation. Cost of labour, overheads and other production costs will be considered in the next paragraphs and detailed in the COMFAR input tables.

Table 3.I/2 Cost of materials (U.S. $)

MODEL OF HYDROPLANT	FIRST YEAR OF PRODUCTION: UNITS PER YEAR	LOCAL EQUIPM. (C)	IMPORTED EQUIPM. (D)	TOTAL (C+D)	SECOND YEAR OF PRODUCTION: UNITS PER YEAR	LOCAL EQUIPM. (E)	IMPORTED EQUIPM. (F)	TOTAL (E+F)	THIRD YEAR OF PRODUCTION: UNITS PER YEAR	LOCAL EQUIPM. (G)	IMPORTED EQUIPM. (H)	TOTAL (G+H)
PELTON 5 kW	2	974	14,000	14,974	2	974	14,000	14,974	2	974	14,000	14,974
10 kW	2	1,188	25,000	26,183	2	1,188	25,000	26,188	2	1,188	25,000	26,188
30 kW	1	1,294	14,800	16,094	2	2,588	29,600	32,188	3	3,882	44,400	48,282
60 kW	1	1,669	26,300	27,969	2	3,338	52,600	55,938	2	3,338	52,600	55,938
BANKI 5 kW	2	1,046	14,000	15,046	2	1,046	14,000	15,046	2	1,046	14,000	15,046
10 kW	3	2,232	37,500	39,732	4	2,976	50,000	52,976	6	4,464	75,000	79,464
30 kW	3	3,030	44,400	47,430	4	4,040	59,200	63,240	6	6,060	88,800	94,860
60 kW	1	2,621	26,300	28,921	2	5,242	52,600	57,842	2	5,242	52,600	57,842
TOTAL	15	14,054	202,300	216,354	20	21,392	297,000	318,392	25	26,194	366,400	392,594

As far the utilities are concerned, it has been estimated that the consumption of electric energy (for welding machines and other shop equipment, offices, lighting) will be in the range of 15,000 kWh/year with a cost of 1,500 US dollars.

4. LOCATION AND SITE

This manufacturing plant could be located in any place, provided that it is next to some main roads, railways and other communication facilities. The choice of the place should, of course, also take into consideration the availability of local labour and staff personnel.

In addition the presence of a foundry and of some mechanical workshops in the neighbourhood should be considered as a priority criterion to choose the place.

5. PROJECT ENGINEERING

5.1 PROCESS DESCRIPTION

The production line described in this paragraph is suitable to produce few units per year, say 24 microturbines in the whole, both Pelton and Michell-Banki type.

Machinery and tools required are those commonly used in any well equipped mechanical workshop.

The following description refers particularly to the production of PELTON turbine, but it is applicable also for the BANKI one. The main steps of the manufacturing process are clearly indicated in the following flow-diagram. The running paddles coming from the foundry are finished and suitably drilled in order to be fixed to the runner by means of bolts. The running operation is carried out on the turbine shaft, the runner disk and other components of the injection group (nozzle, pin and pin stem). All these elements, after threading, are then ready to be assembled.

On the runner disk the following operations are carried out:

turning to define its external diameter, milling on both sides and drilling for fixing the turbine paddles.

Another step consists in cutting and bending metal sheets to manufacture the case and the basement; all these parts are assembled together by arc welding.

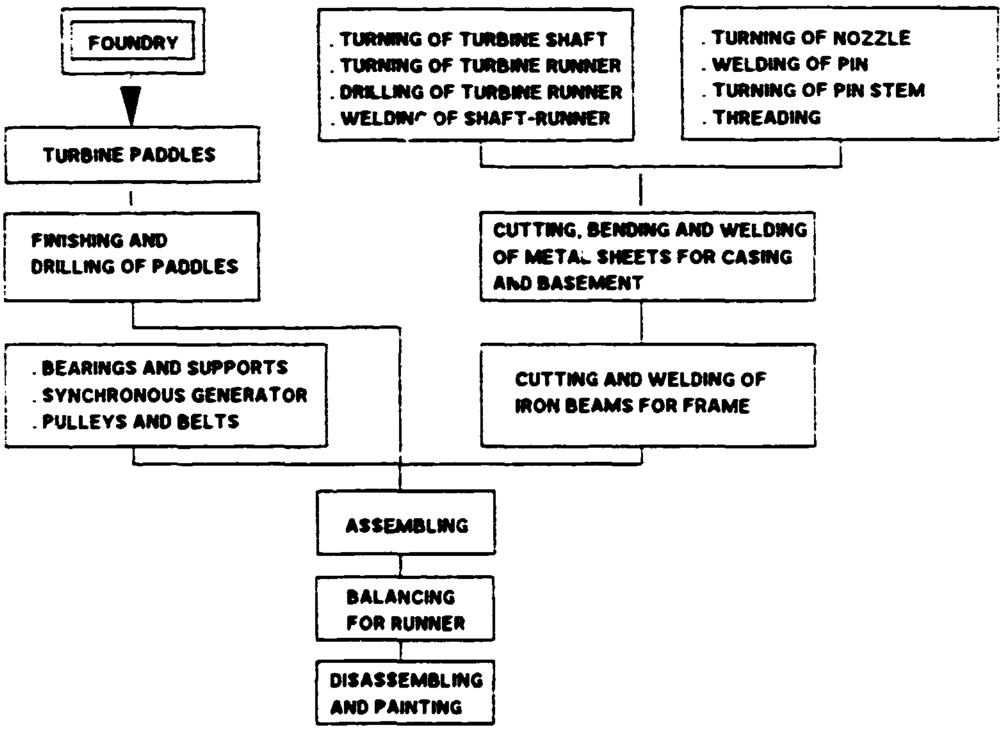
The last part to be manufactured is the supporting frame, consisting in U-iron beams suitably cut and welded to the whole structure.

All the above mentioned parts are then assembled together, along with shaft bearings and relevant supports, pulley and belts (this system is needed only when the rotation speed of the electric generator has to be increased in comparison with the turbine's one) and the electric generator.

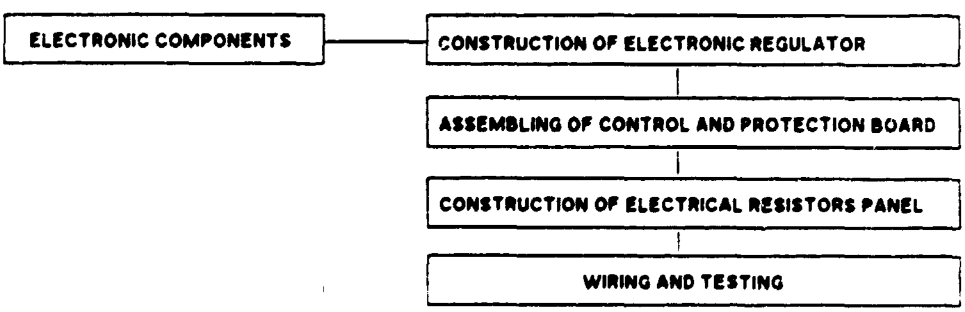
After assembling the machine is balanced by means of a stroboscopic system. Then the parts that need to be protected with paint are disassembled and placed in the storehouse with the other components of the equipment, ready to be shipped to the final installation place.

The control and regulation board is assembled using electric and electronic components of standard quality, following the main steps shown in the flow-diagram. As far as the electric equipment assembling is concerned, no particular problem is foreseen.

Manufacture of hydraulic microturbines : flow-diagram



Control and regulation board



The following table 5.1 gives the hours of direct labour required to manufacture each model of turbine.

Table 5.1 Direct labour required in hours

Model of turbine	OPERATIONS				
	Mechanical	Structure	Painting	Assembling	Total
PELTON 5 KW	19	8	1	2.5	30.5
10 KW	31	9	1.5	2.5	44
30 KW	42	19	3	4	68
60 KW	51	21	3	6	81
BANKI 5 KW	97	16	2	12	127
10 KW	120	23	2.5	14	159.5
30 KW	136	28	3	16	183
60 KW	227	53	4	24	308

The hours shown in this table have been assumed as basis for the computation in the next paragraphs; they have been derived from tables of paragraph 3 (tables 3.A through 3.H), where figures have been rounded.

5.2 LAYOUT AND CIVIL WORKS

The layout of the whole plant is shown in figure 5.2. The covered area needed to operate in good conditions is estimated in the range of 430 square meters and includes workshop, assembling and testing department, storehouse and offices.

The total area of the plant, considering also a strip of land all around the shed, is in the range of 1,200 square meters.

The building of the shed will have a structure made with reinforced concrete or alternatively with metal carpentry, with brick partitions and external walls.

The roof will be covered with asbestos-cement sheets, insulated with mineral wool lagging.

The floor of the production department and of storehouse will be reinforced concrete with a hard aggregate as finishing surface. The floor of the office will be covered with cement tiles.

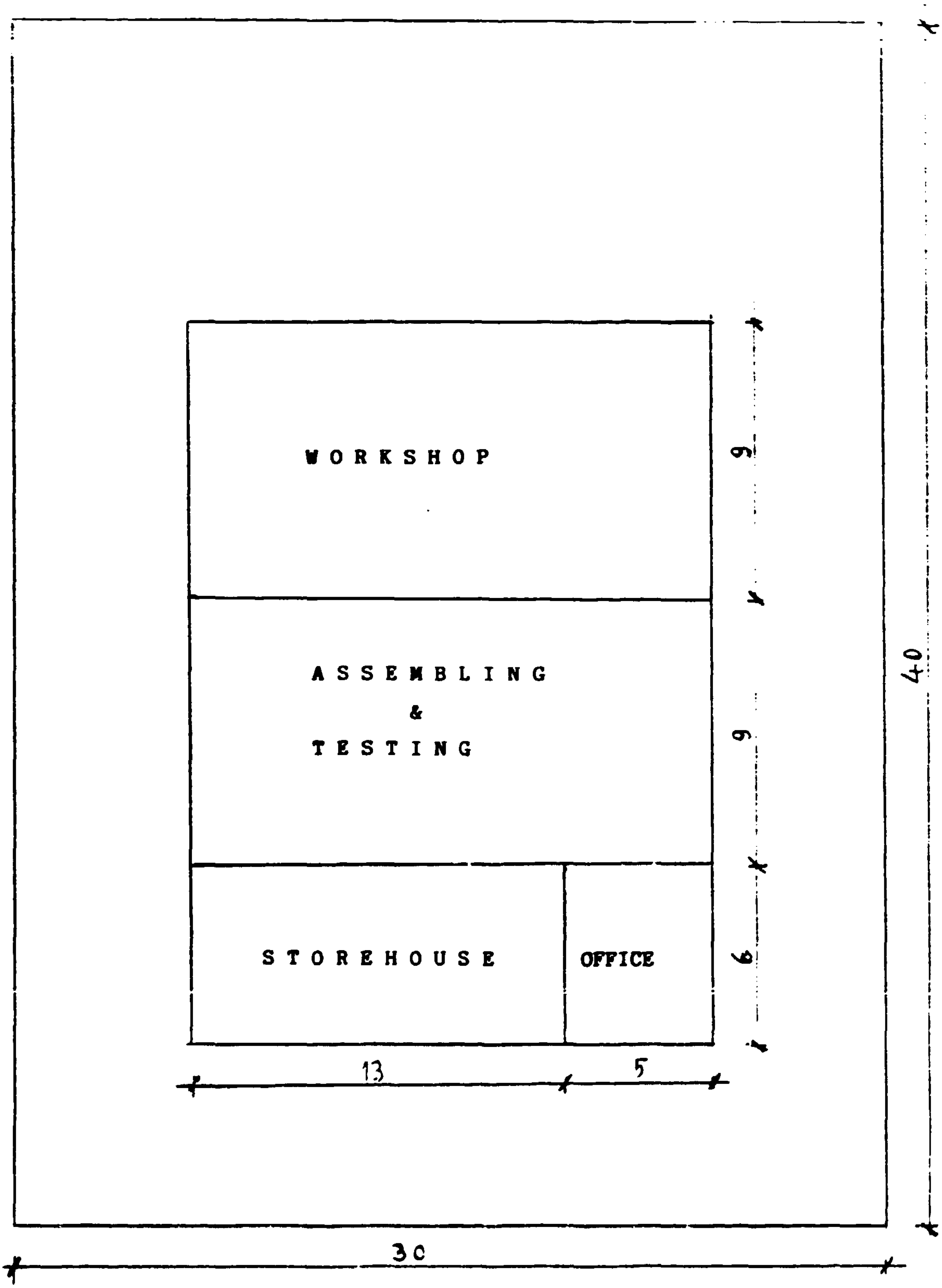
All the area outside the building will be simply rolled and covered with gravel.

The investment cost of civil works have been estimated on the basis of the following assumptions:

. cost of land = 10 US $/sq. meter
. cost of shed and building = 350 US $/sq. meter.

Fig. 5.2 **PLANT LAYOUT** **Scale 1:200**

(measures in meters)



5.3 EQUIPMENT LIST

The main machinery and equipment for the production workshop are:

- standard tolls (screwdrivers, hammers, tongs, pliers, etc.)
- grinding machine
- lathe : turning max. diameter 80 mm, span 1,500 mm
- shears for metal sheets 5 mm thick, length 2,000 mm
- calender for metal sheets 5 mm thick, length 2,000 mm
- milling machine
- pillar drilling machine
- 2 portable drilling machines
- air compressor 200 litres/minute capacity
- pneumatic bolt driver
- arc-welding machine, direct current 5 KW
- oxyacetylene welding/cutting equipment for metal sheets 10 mm thick
- bench milling machine
- portable milling machine
- hoist 1,500 kg lifting capacity
- alternative sewing machine for metal sheets 5 mm thick
- stroboscopic balancing machine
- 3 work-benches
- painting equipment
- fork lift battery operated
- No. 1 van for transport of equipment to be mounted at site
- miscellaneous equipment (welding masks, gloves, etc.)

The installed electric power is in the range of 20 KW, while the average consumption is in the range of 6 KW.

The investment cost of the machinery and equipment is estimated in the range of 280,000 US $, FOB Italian port.

5.4 INVESTMENT COSTS

The estimated investment costs are shown in the following table, where FC stands for "Foreign Currency" and LC for "Load Currency".

Exchange rate has been assumed at 1 US $ = 2.07 Birr.

Table 5.4 Initial fixed investment

Description	FC (US $)	LC (US $)	Total (US $)	COMFAR line
. Civil works and buildings including land	--	180,000	180,000	15
. Machinery & equipment FOB Italian port	280,000	--	280,000	8
. Transport & Insurance	15,000	10,000	25,000	5,17
. Erection	30,000	20,000	50,000	9,21
. Pre-production expenditures	--	5,000	5,000	23
. Technology & training	24,000	--	--	6
TOTAL	349,000	215,000	564,000	

Figures of the right column refer to the lines of COMFAR INPUT TABLES.

6. PLANT ORGANIZATION

The plant will be organized as an autonomous production unit operating with a proper management. The plant organization is explained in detail in the following paragraph.

7. MANPOWER AND PERSONNEL

Direct labour needs have been calculated considering 250 working days per year at 8 hours per day, that is 2,000 hours/year, which have been reduced to 1,800 hours actually worked, considering a prudential yield od 90%.

The following tables shows the hours of direct labour required to manufacture the foreseen units according to the production schedule.

Labour hours have been shared into the four main operations, that are mechanical, structure, painting and assembling.

Table 7 Direct labour required hours/year According to the production programme

Units/ year	Model of turbine	Mechanical	Structure	Painting	Assembling
2	PELTON 5 KW	38	16	2	5
2	10 KW	62	18	3	5
3	30 KW	126	57	9	12
1	60 KW	51	21	3	6
2	BANKI 5 KW	194	32	4	24
6	10 KW	720	138	15	84
6	30 KW	816	168	18	96
2	60 KW	454	106	8	48
24	**TOTAL**	**2,461**	**556**	**62**	**280**

From the above table it is possible to see that mechanical operations need the most part of the whole worked time.

The sum of all the hours/year is 3,359, that means, in theory, that only 2 "all purpose" workers could be strictly sufficient to cover the foreseen production.

In practice the required manpower will consist of :

. No. 1 foreman

. No. 1 metal carpenter/welder

. No. 1 mechanic worker

. No. 1 painter

. No. 1 helper

It is foreseen that these same workers will spend part of their time, when necessary, in mounting the micro hydroplants equipment at the site of installation.

A scheme of personnel required by the envisaged plants is presented here below, shared into management, administrative and production departments.

For each position the relevant yearly cost has been estimated, including social securities and allowances like lease, etc.

7.1 SCHEME OF PERSONNEL WITH YEARLY COST

	Annual Cost US $
<u>Management</u>	
No. 1 General and administrative manager	9,500
No. 1 Technical manager	7,500
Total	17,000
<u>Administrative Dept.</u>	
No. 1 Senior accountant	2,500
No. 1 Clerk	2,200
No. 1 Warehouse head	2,500
Total	7,200
<u>Production Dept.</u>	
No. 1 Foreman	2,500
No. 3 Skilled workers (at 2,200 US$)	6,600
No. 1 Helper	1,700
Total	10,800

Therefore the total cost of the whole personnel is estimated to be 35,000 US $ per year.

8. IMPLEMENTATION SCHEDULE

The duration of plant erection and installation of production equipment is estimated to be 8-12 months, say a year.

It is foreseen a training period for the Ethiopian personnel, both in Italy and in Ethiopia.

9. FINANCIAL EVALUATION

The financial evaluation of the envisaged project has been carried out by means of the COMFAR (Computer Model for Feasibility Analysis and Reporting), a programme specifically conceived and developed for this purpose by UNIDO.

The COMFAR tables here attached consist of two parts :

1) INPUT TABLES, which contain the entries according to assumptions and calculations carried out separately to evaluate the investment and the production costs.

2) SCHEDULES, which are the computer output after the data processing. These tables contain the main financial parameters and results to evaluate the project viability.

More details are given in the next pages.

9.1 COMFAR INPUT TABLES ASSUMPTIONS

The following basic assumptions have been considered valid for the financial analysis of the project:

1) Discounting rate for net present value = 10%

2) Economic life: 15 years have been considered the operational life of the plant. This life span is largely sufficient to appreciate the profitability of a project; the IRR (internal rate of return) has been considered at the main parameter for the first evaluation of the investment.

3) Depreciation : straight-line type:

   a. for machinery and equipment, preproduction expenditures, depreciation has been calculated over 15 years, with a scrap value of 10% with reference of the initial value;

   b. for civil works the depreciation period has been considered 20 years, with 50% of scrap value.

4) Foreign loan :

   a. the amount considered is 85% of the value of the imported machinery and equipment including the installation costs, as per the "consensus" terms;

   b. repayment period : 8 years, starting from the first year of production;

   c. amortization type : constant principal, with interest rate of 10%;

   d. working capital requirements :

   minimum coverage in days considered in the programme (FC = Foreign Currency; LC = Local Currency):

	F.C.	L.C.
- accounts	30	30
- cash in hand	15	15
- inventory raw materials	180	30
- inventory energy	1	1
- inventory spare parts		
- work in progress	30	30
- finished products	30	30
- accounts payable	30	30

e. taxes :

The products are considered as sold ex-factory. Consequently only the profit tax of 50% has been included in the calculations.

Moreover 3 years of tax holidays have been taken into consideration.

f. currency:

All figures, as far as costs, revenues and other financial items are concerned, are expressed in US dollars, both for the foreign and the local items.

The exchange rate has been assumed as 2.07 Birr per 1 US dollar.

g. Electric energy:

The cost of electric energy has been assumed equal to 0.2 Birr/kWh = 0.097 $/kWh.

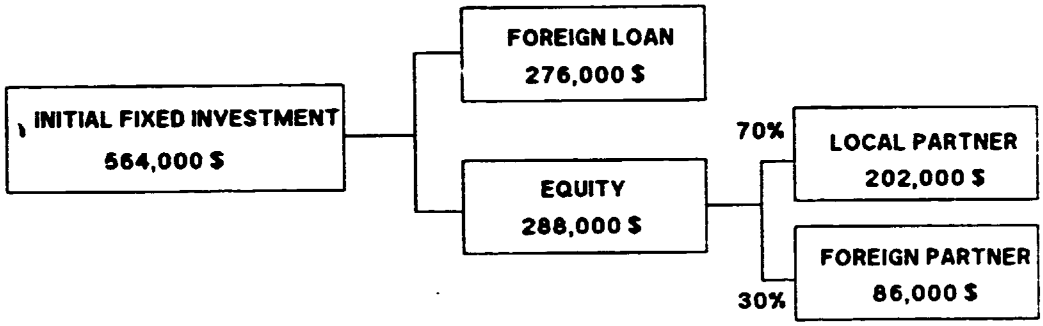
h. With reference to the COMFAR INPUT tables the following data have been considered, in addition to those ones of table 5.4:

As far as technology and training are concerned, it has been assumed that the Ethiopian personnel will be instructed in Italy during the pre-production phase for a total of 8 months-man at a cost of 24,000 US$ (COMFAR line 6).

In addition to this it has been foreseen a training in Ethiopia to start and supervise production, installation and maintenance of turbines, so totalizing 24 months-man at a cost of 220,000 US$, this cost will be divided over a period of 2 years (COMFAR line 30), during the production phase.

9.2 SOURCES OF FINANCE

According to the basic assumptions taken in the previous paragraph, the sources of finance present the following scheme:



baldo & c.

COMFAR

SCHEDULES

HYDRAULIC MICROTURBINES
++++++++++
ETHIOPIA

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: 1,000 U.S. DOLLARS

Total initial investment during construction phase

fixed assets:	577.80	62.790 % foreign
current assets:	0.00	0.000 % foreign
total assets:	577.80	62.790 % foreign

Source of funds during construction phase

equity & grants:	288.00	29.861 % foreign
foreign loans :	276.00	
local loans :	0.00	
total funds :	564.00	64.184 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	252.25	354.59	429.09
depreciation :	34.61	45.61	56.61
interest :	27.60	24.15	20.70
production costs	314.47	424.36	506.41
thereof foreign	80.51 %	83.76 %	85.38 %
total sales :	460.00	678.00	846.00
gross income :	145.53	253.64	339.59
net income :	145.53	253.64	339.59
cash balance :	-109.05	90.33	314.57
net cashflow :	-46.95	148.98	369.77

Net Present Value at: 10.00 % = 1082.88
Internal Rate of Return: 30.44 %
Return on equity1: 71.16 %
Return on equity2: 38.06 %

Index of Schedules produced by COMFAR

Total Initial Investment in 1,000 U.S. DOLLARS

Year	1992
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	180.000
Auxiliary and service facilities	0.000
Incorporated fixed assets	49.000
Plant machinery and equipment	330.000
Total fixed investment costs	559.000
Pre-production capital expenditures.	18.800
Net working capital	0.000
Total initial investment costs	577.800
Of it foreign, in %	62.790

Total Current Investment in 1,000 U.S. DOLLARS

Year	1993	1994	1995
Fixed investment costs			
Land, site preparation, development	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000
Incorporated fixed assets	110.000	110.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000
Total fixed investment costs	110.000	110.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000
Working capital	144.692	64.428	47.131
Total current investment costs	254.692	174.428	47.131
Of it foreign, %	96.142	99.258	98.166

Total Production Costs in 1,000 U.S. DOLLARS

Year	1993	1994	1995	1996	1997	1998
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000	0.000
Raw material 1	202.300	297.000	366.400	366.400	366.400	366.400
Other raw materials	14.054	21.392	26.194	26.194	26.194	26.194
Utilities	0.000	0.000	0.000	0.000	0.000	0.000
Energy	0.900	1.200	1.500	1.500	1.500	1.500
Labour, direct	10.800	10.800	10.800	10.800	10.800	10.800
Repair, maintenance	0.000	0.000	0.000	0.000	0.000	0.000
Spares	0.000	0.000	0.000	0.000	0.000	0.000
Factory overheads	0.000	0.000	0.000	0.000	0.000	0.000
Factory costs	228.054	330.392	404.894	404.894	404.894	404.894
Administrative overheads	24.200	24.200	24.200	24.200	24.200	24.200
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000	0.000
Depreciation	34.614	45.614	56.614	56.614	56.614	56.614
Financial costs	27.600	24.150	20.700	17.250	13.800	10.350
Total production costs	314.468	424.356	506.408	502.958	499.508	496.058
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	80.510	83.757	85.382	85.281	85.180	85.077
Of it variable,%	0.000	0.000	0.000	0.000	0.000	0.000
Total labour	35.000	35.000	35.000	35.000	35.000	35.000

HYDRAULIC MICROTURBINES --- +++++++++

COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY

Total Production Costs in 1,000 U.S. DOLLARS

Year	1999	2000	2001- 2	2003	2004	2005
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000	0.000
Raw material 1	366.400	366.400	366.400	366.400	366.400	366.400
Other raw materials	26.194	26.194	26.194	26.194	26.194	26.194
Utilities	0.000	0.000	0.000	0.000	0.000	0.000
Energy	1.500	1.500	1.500	1.500	1.500	1.500
Labour, direct	10.800	10.800	10.800	10.800	10.800	10.800
Repair, maintenance	0.000	0.000	0.000	0.000	0.000	0.000
Spares	0.000	0.000	0.000	0.000	0.000	0.000
Factory overheads	0.000	0.000	0.000	0.000	0.000	0.000
Factory costs	404.894	404.894	404.894	404.894	404.894	404.894
Administrative overheads	24.200	24.200	24.200	24.200	24.200	24.200
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000	0.000
Depreciation	56.614	56.614	56.614	47.614	36.614	25.614
Financial costs	6.900	3.450	0.000	0.000	0.000	0.000
Total production costs	492.608	489.158	485.708	476.708	465.708	454.708
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	84.972	84.866	84.759	86.359	86.037	85.699
Of it variable,%	0.000	0.000	0.000	0.000	0.000	0.000
Total labour	35.000	35.000	35.000	35.000	35.000	35.000

Total Production Costs in 1,000 U.S. DOLLARS

Year	2006	2007
% of nom. capacity (single product).	0.000	0.000
Raw material 1	366.400	366.400
Other raw materials	26.194	26.194
Utilities	0.000	0.000
Energy	1.500	1.500
Labour, direct	10.800	10.800
Repair, maintenance	0.000	0.000
Spares	0.000	0.000
Factory overheads	0.000	0.000
Factory costs	404.894	404.894
Administrative overheads	24.200	24.200
Indir. costs, sales and distribution	0.000	0.000
Direct costs, sales and distribution	0.000	0.000
Depreciation	16.150	6.868
Financial costs	0.000	0.000
Total production costs	445.244	435.962
Costs per unit (single product)	0.000	0.000
Of it foreign, %	85.395	85.090
Of it variable,%	0.000	0.000
Total labour	35.000	35.000

Net Working Capital in 1,000 U.S. DOLLARS

Year	mdc	coto	1993	1994	1995	1996-2007
Coverage	mdc	coto				
Current assets &						
Accounts receivable	30	12.0	21.021	29.549	35.758	35.758
Inventory and materials	168	2.1	101.189	148.559	183.273	183.273
Energy	1	360.0	0.003	0.003	0.004	0.004
Spares	0	---	0.000	0.000	0.000	0.000
Work in progress	30	12.0	19.004	27.533	33.741	33.741
Finished products	30	12.0	21.021	29.549	35.758	35.758
Cash in hand	15	24.0	1.458	1.458	1.458	1.458
Total current assets			163.697	236.652	289.992	289.992
Current liabilities and						
Accounts payable	30	12.0	19.004	27.533	33.741	33.741
Net working capital			144.692	209.120	256.251	256.251
Increase in working capital			144.692	64.428	47.131	0.000
Net working capital, local			9.826	11.120	11.984	11.984
Net working capital, foreign			134.867	198.000	244.267	244.267

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

Source of Finance, construction in 1,000 U.S. DOLLARS

Year	1992
Equity, ordinary ..	288.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	276.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	276.000
Current liabilities	0.000
Bank overdraft	13.800
Total funds	577.800

Source of Finance, production in 1,000 U.S. DOLLARS

Year	1993	1994	1995	1996-2000
Equity, ordinary ..	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000
Loan A, foreign .	-34.500	-34.500	-34.500	-34.500
Loan B, foreign..	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000
Total loan	-34.500	-34.500	-34.500	-34.500
Current liabilities	19.004	8.528	6.208	0.000
Bank overdraft	109.046	-90.331	-32.516	0.000
Total funds	93.551	-116.302	-60.807	-34.500

Cashflow Tables, construction in 1,000 U.S. DOLLARS

Year	1992
Total cash inflow	564.000
Financial resources	564.000
Sales, net of tax	0.000
Total cash outflow	577.800
Total assets	564.000
Operating costs	0.000
Cost of finance	13.800
Repayment	0.000
Corporate tax	0.000
Dividends paid	0.000
Surplus (deficit)	-13.800
Cumulated cash balance	-13.800
Inflow, local	202.000
Outflow, local	215.000
Surplus (deficit)	-13.000
Inflow, foreign	362.000
Outflow, foreign	362.800
Surplus (deficit)	-0.800
Net cashflow	-564.000
Cumulated net cashflow	-564.000

Cashflow tables, production in 1,000 U.S. DOLLARS

Year	1993	1994	1995	1996	1997	1998	1999
Total cash inflow . .	479.004	686.528	852.208	846.000	846.000	846.000	846.000
Financial resources .	19.004	8.528	6.208	0.000	0.000	0.000	0.000
Sales, net of tax . .	460.000	678.000	846.000	846.000	846.000	846.000	846.000
Total cash outflow . .	588.051	596.198	537.634	652.365	650.640	648.915	647.190
Total assets	273.697	182.956	53.340	0.000	0.000	0.000	0.000
Operating costs . . .	252.254	354.592	429.094	429.094	429.094	429.094	429.094
Cost of finance . . .	27.600	24.150	20.700	17.250	13.800	10.350	6.900
Repayment	34.500	34.500	34.500	34.500	34.500	34.500	34.500
Corporate tax . . .	0.000	0.000	0.000	171.521	173.246	174.971	176.696
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-109.046	90.330	314.575	193.635	195.360	197.085	198.810
Cumulated cash balance	-122.846	-32.516	282.059	475.694	671.054	868.139	1066.949
Inflow, local	462.146	678.636	846.425	846.000	846.000	846.000	846.000
Outflow, local	61.926	59.523	63.984	234.215	235.940	237.665	239.390
Surplus (deficit) .	400.220	619.114	782.442	611.785	610.060	608.335	606.610
Inflow, foreign . . .	16.858	7.892	5.783	0.000	0.000	0.000	0.000
Outflow, foreign . . .	526.125	536.675	473.650	418.150	414.700	411.250	407.800
Surplus (deficit)	-509.267	-528.783	-467.867	-418.150	-414.700	-411.250	-407.800
Net cashflow	-46.946	148.980	369.775	245.385	243.660	241.935	240.210
Cumulated net cashflow	-610.946	-461.966	-92.191	153.194	396.854	638.789	878.999

Cashflow tables, production in 1,000 U.S. DOLLARS

Year	2000	2001	2002	2003	2004	2005	2006
Total cash inflow . .	846.000	846.000	846.000	846.000	846.000	846.000	846.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	846.000	846.000	846.000	846.000	846.000	846.000	846.000
Total cash outflow . .	645.465	609.240	609.240	613.740	619.240	624.740	629.472
Total assets	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs . . .	429.094	429.094	429.094	429.094	429.094	429.094	429.094
Cost of finance . . .	3.450	0.000	0.000	0.000	0.000	0.000	0.000
Repayment	34.500	0.000	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	178.421	180.146	180.146	184.646	190.146	195.646	200.378
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	200.535	236.760	236.760	232.260	226.760	221.260	216.528
Cumulated cash balance	1267.484	1504.244	1741.004	1973.264	2200.024	2421.284	2637.813
Inflow, local	846.000	846.000	846.000	846.000	846.000	846.000	846.000
Outflow, local	241.115	242.840	242.840	247.340	252.840	258.340	263.072
Surplus (deficit) .	604.885	603.160	603.160	598.660	593.160	587.660	582.928
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	404.350	366.400	366.400	366.400	366.400	366.400	366.400
Surplus (deficit) .	-404.350	-366.400	-366.400	-366.400	-366.400	-366.400	-366.400
Net cashflow	238.485	236.760	236.760	232.260	226.760	221.260	216.528
Cumulated net cashflow	1117.484	1354.244	1591.004	1823.264	2050.024	2271.284	2487.812

Cashflow tables, production in 1,000 U.S. DOLLARS

Year	2007
Total cash inflow . .	846.000
Financial resources .	0.000
Sales, net of tax . .	846.000
Total cash outflow . .	634.113
Total assets	0.000
Operating costs . . .	429.094
Cost of finance . . .	0.000
Repayment	0.000
Corporate tax . . .	205.019
Dividends paid . . .	0.000
Surplus (deficit) .	211.887
Cumulated cash balance	2849.699
Inflow, local	846.000
Outflow, local	267.713
Surplus (deficit) .	578.287
Inflow, foreign . . .	0.000
Outflow, foreign . . .	366.400
Surplus (deficit) .	-366.400
Net cashflow	211.887
Cumulated net cashflow	2699.699

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	1236.14	at	10.00 %
Internal Rate of Return (IRRE1) ..	71.16 %		

b) Net Worth versus Net cash return:

Net present value	1082.88	at	10.00 %
Internal Rate of Return (IRRE2) ..	38.06 %		

c) Internal Rate of Return on total investment:

Net present value	1082.88	at	10.00 %
Internal Rate of Return (IRR) ..	30.44 %		

Net Worth = Equity paid plus reserves

Net Income Statement in 1,000 U.S. DOLLARS

Year	1993	1994	1995	1996	1997	1998
Total sales, incl. sales tax	460.000	678.000	846.000	846.000	846.000	846.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000	0.000
Variable margin	460.000	678.000	846.000	846.000	846.000	846.000
As % of total sales	100.000	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	286.868	400.206	485.708	485.708	485.708	485.708
Operational margin	173.132	277.794	360.292	360.292	360.292	360.292
As % of total sales	37.637	40.973	42.588	42.588	42.588	42.588
Cost of finance	27.600	24.150	20.700	17.250	13.800	10.350
Gross profit	145.532	253.644	339.592	343.042	346.492	349.942
Allowances	0.000	0.000	0.000	0.000	0.000	0.000
Taxable profit	145.532	253.644	339.592	343.042	346.492	349.942
Tax	0.000	0.000	0.000	171.521	173.246	174.971
Net profit	145.532	253.644	339.592	171.521	173.246	174.971
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Undistributed profit	145.532	253.644	339.592	171.521	173.246	174.971
Accumulated undistributed profit	145.532	399.176	738.768	910.289	1083.535	1258.506
Gross profit, % of total sales	31.637	37.411	40.141	40.549	40.957	41.364
Net profit, % of total sales	31.637	37.411	40.141	20.274	20.478	20.682
ROE, Net profit, % of equity	50.532	82.071	117.914	59.556	60.155	60.754
ROI, Net profit+interest, % of invest.	21.147	27.972	34.635	18.147	17.981	17.815

Net Income Statement in 1,000 U.S. DOLLARS

Year	1999	2000	2001	2002	2003	2004
Total sales, incl. sales tax	846.000	846.000	846.000	846.000	846.000	846.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000	0.000
Variable margin	846.000	846.000	846.000	846.000	846.000	846.000
As % of total sales	100.000	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	485.708	485.708	485.708	485.708	476.708	465.708
Operational margin	360.292	360.292	360.292	360.292	369.292	380.292
As % of total sales	42.588	42.588	42.588	42.588	43.652	44.952
Cost of finance	6.900	3.450	0.000	0.000	0.000	0.000
Gross profit	353.392	356.842	360.292	360.292	369.292	380.292
Allowances	0.000	0.000	0.000	0.000	0.000	0.000
Taxable profit	353.392	356.842	360.292	360.292	369.292	380.292
Tax	176.696	178.421	180.146	180.146	184.646	190.146
Net profit	176.696	178.421	180.146	180.146	184.646	190.146
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Undistributed profit	176.696	178.421	180.146	180.146	184.646	190.146
Accumulated undistributed profit	1435.202	1613.623	1793.769	1973.915	2158.561	2348.707
Gross profit, % of total sales	41.772	42.180	42.588	42.588	43.652	44.952
Net profit, % of total sales	20.886	21.090	21.294	21.294	21.826	22.476
ROE, Net profit, % of equity	61.353	61.952	62.551	62.551	64.113	66.023
ROI, Net profit+interest, % of invest.	17.649	17.483	17.318	17.318	17.750	18.279

Net Income Statement in 1,000 U.S. DOLLARS

Year	2005	2006	2007
Total sales, incl. sales tax	846.000	846.000	846.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000
Variable margin	846.000	846.000	846.000
As % of total sales	100.000	100.000	100.000
Non-variable costs, incl. depreciation	454.708	445.244	435.962
Operational margin	391.292	400.756	410.038
As % of total sales	46.252	47.371	48.468
Cost of finance	0.000	0.000	0.000
Gross profit	391.292	400.756	410.038
Allowances	0.000	0.000	0.000
Taxable profit	391.292	400.756	410.038
Tax	195.646	200.378	205.019
Net profit	195.646	200.378	205.019
Dividends paid	0.000	0.000	0.000
Undistributed profit	195.646	200.378	205.019
Accumulated undistributed profit	2544.353	2744.731	2949.750
Gross profit, % of total sales	46.252	47.371	48.468
Net profit, % of total sales	23.126	23.685	24.234
ROE, Net profit, % of equity	67.933	69.576	71.187
ROI, Net profit+interest, % of invest.	18.808	19.262	19.709

Projected Balance Sheets, construction in 1,000 U.S. DOLLARS

Year	1992
Total assets	577.800
Fixed assets, net of depreciation	0.000
Construction in progress	577.800
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	577.800
Equity capital	288.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	276.000
Current liabilities	0.000
Bank overdraft, finance required.	13.800
Total debt	289.800
Equity, % of liabilities	49.844

Projected Balance Sheets, Production in 1,000 U.S. DOLLARS

Year	1993	1994	1995	1996	1997	1998
Total assets	816.883	954.224	1233.009	1370.030	1508.776	1649.247
Fixed assets, net of depreciation	543.186	607.572	660.958	604.344	547.730	491.116
Construction in progress	110.000	110.000	0.000	0.000	0.000	0.000
Current assets	162.238	235.194	288.534	288.534	288.534	288.534
Cash, bank	1.458	1.458	1.458	1.458	1.458	1.458
Cash surplus, finance available	0.000	0.000	282.059	475.694	671.054	868.139
Loss carried forward	0.000	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000	0.000
Total liabilities	816.883	954.224	1233.009	1370.030	1508.776	1649.247
Equity capital	288.000	288.000	288.000	288.000	288.000	288.000
Reserves, retained profit	0.000	145.532	399.176	738.768	910.289	1083.535
Profit	145.532	253.644	339.592	171.521	173.246	174.971
Long and medium term debt	241.500	207.000	172.500	138.000	103.500	69.000
Current liabilities	19.004	27.533	33.741	33.741	33.741	33.741
Bank overdraft, finance required.	122.846	32.516	0.000	0.000	0.000	0.000
Total debt	383.351	267.048	206.241	171.741	137.241	102.741
Equity, % of liabilities	35.256	30.182	23.357	21.021	19.088	17.463

Projected Balance Sheets, Production in 1,000 U.S. DOLLARS

Year	1999	2000	2001	2002	2003	2004
Total assets	1791.443	1935.364	2115.510	2295.656	2480.302	2670.448
Fixed assets, net of depreciation	434.502	377.888	321.274	264.660	217.046	180.432
Construction in progress	0.000	0.000	0.000	0.000	0.000	0.000
Current assets	288.534	288.534	288.534	288.534	288.534	288.534
Cash, bank	1.458	1.458	1.458	1.458	1.458	1.458
Cash surplus, finance available	1066.949	1267.484	1504.245	1741.004	1973.264	2200.024
Loss carried forward	0.000	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000	0.000
Total liabilities	1791.443	1935.364	2115.510	2295.656	2480.302	2670.448
Equity capital	288.000	288.000	288.000	288.000	288.000	288.000
Reserves, retained profit	1258.506	1435.202	1613.623	1793.769	1973.915	2158.561
Profit	176.696	178.421	180.146	180.146	184.646	190.146
Long and medium term debt	34.500	0.000	0.000	0.000	0.000	0.000
Current liabilities	33.741	33.741	33.741	33.741	33.741	33.741
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000	0.000
Total debt	68.241	33.741	33.741	33.741	33.741	33.741
Equity, % of liabilities	16.076	14.881	13.614	12.545	11.611	10.785

Projected Balance Sheets, Production in 1,000 U.S. DOLLARS

Year	2005	2006	2007
Total assets	2866.094	3066.472	3271.491
Fixed assets, net of depreciation	154.818	138.668	131.800
Construction in progress	0.000	0.000	0.000
Current assets	288.534	288.534	288.534
Cash, bank	1.458	1.458	1.458
Cash surplus, finance available	2421.284	2637.813	2849.699
Loss carried forward	0.000	0.000	0.000
Loss	0.000	0.000	0.000
Total liabilities	2866.094	3066.472	3271.491
Equity capital	288.000	288.000	288.000
Reserves, retained profit	2348.707	2544.353	2744.731
Profit	195.646	200.378	205.019
Long and medium term debt	0.000	0.000	0.000
Current liabilities	33.741	33.741	33.741
Bank overdraft, finance required.	0.000	0.000	0.000
Total debt	33.741	33.741	33.741
Equity, % of liabilities	10.049	9.392	8.803

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C O M F A R

INPUT TABLES

Tabi TURBIN : Text Variables
-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Project Name:	HYDRAULIC MICROTURBINES
Date:	++++++++++
Name of Alternative:	ETHIOPIA
Accounting currency:	1,000 U.S. DOLLARS
Name of Product (A):	MICRO-HYDRO-PLANT

Tabi TURBIN : General Variables
-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Multiplier to compute foreign into accounting currency:	1.000
Multiplier to compute local into accounting currency:	1.000
Construction phase: 1 year(s), planned yearly	
Interest rate for computation of future values in % p.a.:	0.000
Percent rate for CF-Discounting:	10.000

Equity - O: first disbursement in year 1

Equity - P: not specified

Subsidies : not specified

Loan A: first disbursement in period 1
Amortization: constant principal
lasting for 8 year(s)
rates are paid yearly
Period of grace: 1 year(s)
Interests payable: 10.0 % for year 1 through 9

Loan B: not specified

Loan C: not specified

Overdraft: not specified

Tabi TURBIN : Subtable Initial Fixed Investment - foreign

Col	1	2	3	4	5	6	7
	Deprec- %	Type of de	Scrap - %	Depreciati	Amount- P1	Amount- P2	Amount- P3
L 1 Land..........................	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 2 Site preparation and developme	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 3 Structures and civil (a)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 4 Structures and civil (b)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 5 Incorporated fixed assets,-(a)	6.67	1.00	0.00	15.00	15.00	0.00	0.00
L 6 Incorporated fixed assets,-(b)	5.67	1.00	0.00	15.00	24.00	0.00	0.00
L 7 Incorporated fixed assets,-(c)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 8 Plant machinery and equipm-(a)	6.67	1.00	10.00	15.00	280.00	0.00	0.00
L 9 Plant machinery and equipm-(b)	6.67	1.00	0.00	15.00	30.00	0.00	0.00
L 10 Auxiliary and service faciliti	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 11 Pre-production expenditures...	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 12 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Initial Fixed Investment - local

COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY

Col	1	2	3	4	5	6	7
	Deprec- %	Type of de	Scrap - %	Depreciati	Amount- P1	Amount- P2	Amount- P3
L 13 Land..........................	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 14 Site preparation and developme	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 15 Structures and civil (a)......	5.00	1.00	50.00	20.00	180.00	0.00	0.00
L 16 Structures and civil (b)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 17 Incorporated fixed assets,-(a)	6.67	1.00	0.00	15.00	10.00	0.00	0.00
L 18 Incorporated fixed assets,-(b)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 19 Incorporated fixed assets,-(c)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 20 Plant machinery and equipm-(a)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 21 Plant machinery and equipm-(b)	6.67	1.00	0.00	15.00	20.00	0.00	0.00
L 22 Auxiliary and service faciliti	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 23 Pre-production expenditures...	6.67	1.00	0.00	15.00	5.00	0.00	0.00
L 24 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Current Fixed Investment - foreign

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Deprec-n %	Depreciati	Scrap - %	Depreciati	Amount- Y1	Amount- Y2	Amount- Y3
L 25 Land..........................	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 26 Site preparation and developme	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 27 Structures and civil (a)......	0.00	1.00	0.00	0 00	0.00	0.00	0.00
L 28 Structures and civil (b)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 29 Incorporated fixed assets,-(a)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 30 Incorporated fixed assets,-(b)	10.00	1.00	0.00	10.00	110.00	110.00	0.00
L 31 Incorporated fixed assets,-(c)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 32 Plant machinery and equipm-(a)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 33 Plant machinery and equipm-(b)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 34 Auxiliary and service faciliti	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 35 Pre-production expenditures...	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 36 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Current Fixed Investment - local

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Deprec-n %	Depreciati	Scrap - %	Depreciati	Amount- Y1	Amount- Y2	Amount- Y3
L 37 Land..........................	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 38 Site preparation and developme	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 39 Structures and civil (a)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 40 Structures and civil (b)......	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 41 Incorporated fixed assets,-(a)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 42 Incorporated fixed assets,-(b)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 43 Incorporated fixed assets,-(c)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 44 Plant machinery and equipm-(a)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 45 Plant machinery and equipm-(b)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 46 Auxiliary and service faciliti	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 47 Pre-production expenditures...	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 48 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabl TURBIN : Subtable Production Costs - foreign

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Inflator %	Adjust- Y1	Adjust- Y2	Adjust- Y3	Adjust- Y4	Adjust- Y5	Adjust- Y6
L 52 Raw material, annual cost (a).	0.00	202.30	297.00	366.40	366.40	366.40	366.40
L 53 Raw material, annual cost (b).	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 54 Utilities, annual cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 55 Energy, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 56 Labour (direct), annual cost..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 57 Maintenance, annual cost......	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 58 Spares, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 59 Factory overheads, annual cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 60 Administration, labour cost...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 61 Administration, non-labour cos	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 62 Marketing, labour cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 63 Marketing, non-labour cost....	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabl TURBIN : Subtable Standard Production Costs - foreign

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Quanti- A	Variat- A	Quanti- B	Variat- B	Quanti- C	Variat- C	Quanti- D
L 64 Raw material (a)..............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 65 Raw material, unit price (a)..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quanti- A	Variat- A	Quanti- B	Variat- B	Quanti- C	Variat- C	Quanti- D
L 66 Raw material (b)..............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 67 Raw material, unit price (b)..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Standa- A	Variat- A	Standa- B	Variat- B	Standa- C	Variat- C	Standa- D
L 68 Utilities, annual cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 69 Energy, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 70 Labour (direct), annual cost..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 71 Maintenance, annual cost......	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 72 Spares, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 73 Factory overheads, annual cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 74 Administration, labour cost...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 75 Administration, non-labour cos	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 76 Marketing, labour cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 77 Marketing, non-labour cost....	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Foreig- A	Foreig- B	Foreig- C	Foreig- D	Foreig- E	Foreig- F	Local - A
L 78 % of annual depreciation costs	100.00	0.00	0.00	0.00	0.00	0.00	100.00

Tabi TURBIN : Subtable Production Costs - foreign

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

8	9	10	11	12	13	14	15	16	17
Adjust- Y7	Adjust- Y8	Adjust- Y9	Adjust-Y10	Adjust-Y11	Adjust-Y12	Adjust-Y13	Adjust-Y14	Adjust-Y15	Not used
366.40	366.40	366.40	366.40	366.40	366.40	366.40	366.40	366.40	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Standard Production Costs - foreign

-- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

8	9	10	11	12	13	14	15	16	17
Variat- D	Quanti- E	Variat- E	Quanti- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Not used	Product E	Not used	Product F	Not used	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variat- D	Quanti- E	Variat- E	Quanti- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Not used	Product E	Not used	Product F	Not used	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variat- D	Standa- E	Variat- E	Standa- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Local - B	Local - C	Local - D	Local - E	Local - F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Production Costs - local

--- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Inflator %	Adjust- Y1	Adjust- Y2	Adjust- Y3	Adjust- Y4	Adjust- Y5	Adjust- Y6
L 82 Raw material, annual cost (a).	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 83 Raw material, annual cost (b).	0.00	14.05	21.39	26.19	26.19	26.19	26.19
L 84 Utilities, annual cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 85 Energy, annual cost...........	0.00	0.90	1.20	1.50	1.50	1.50	1.50
L 86 Labour (direct), annual cost..	0.00	10.80	10.80	10.80	10.80	10.80	10.80
L 87 Maintenance, annual cost......	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 88 Spares, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 89 Factory overheads, annual cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 90 Administration, labour cost...	0.00	24.20	24.20	24.20	24.20	24.20	24.20
L 91 Administration, non-labour cos	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 92 Marketing, labour cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 93 Marketing, non-labour cost....	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Standard Production Costs - local

--- COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY -----

Col	1	2	3	4	5	6	7
	Quanti- A	Variat- A	Quanti- B	Variat- B	Quanti- C	Variat- C	Quanti- D
L 94 Raw material (a)..............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 95 Raw material, unit price (a)..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quanti- A	Variat- A	Quanti- B	Variat- B	Quanti- C	Variat- C	Quanti- D
L 96 Raw material (b)..............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 97 Raw material, unit price (b)..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Standa- A	Variat- A	Standa- B	Variat- B	Standa- C	Variat- C	Standa- D
L 98 Utilities, annual cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 99 Energy, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 100 Labour (direct), annual cost..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 101 Maintenance, annual cost......	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 102 Spares, annual cost...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 103 Factory overheads, annual cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 104 Administration, labour cost...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 105 Administration, non-labour cos	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 106 Marketing, labour cost........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 107 Marketing, non-labour cost....	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Production Costs - local

8	9	10	11	12	13	14	15	16	17
Adjust- Y7	Adjust- Y8	Adjust- Y9	Adjust-Y10	Adjust-Y11	Adjust-Y12	Adjust-Y13	Adjust-Y14	Adjust-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26.19	26.19	26.19	26.19	26.19	26.19	26.19	26.19	26.19	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.00
10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	24.20	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Standard Production Costs - local

8	9	10	11	12	13	14	15	16	17
Variat- D	Quanti- E	Variat- E	Quanti- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Not used	Product E	Not used	Product F	Not used	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variat- D	Quanti- E	Variat- E	Quanti- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Not used	Product E	Not used	Product F	Not used	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Variat- D	Standa- E	Variat- E	Standa- F	Variat- F	Not used	Not used	Not used	Not used	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Col	1	2	3	4	5	6	7
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 146 Yearly production, local p- A	0.00	460.00	678.00	846.00	846.00	846.00	846.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 147 Unit price, local product A..	0.00	1.00	1.00	1.00	1.00	1.00	1.00
L 148 Sales tax, local product A...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 149 Other direct variable cost- A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 150 Direct non-variable cost, - A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 151 Labour included in direct - A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 152 Yearly production, local p- B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 153 Unit price, local product B..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 154 Sales tax, local product B...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 155 Other direct variable cost- B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 156 Direct non-variable cost, - B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 157 Labour included in direct - B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 158 Yearly production, local p- C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 159 Unit price, local product C..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 160 Sales tax, local product C...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 161 Other direct variable cost- C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 162 Direct non-variable cost, - C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 163 Labour included in direct - C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 164 Yearly production, local p- D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 165 Unit price, local product D..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 166 Sales tax, local product D...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 167 Other direct variable cost- D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 168 Direct non-variable cost, - D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 169 Labour included in direct - D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 170 Yearly production, local p- E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 171 Unit price, local product E..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 172 Sales tax, local product E...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 173 Other direct variable cost- E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 174 Direct non-variable cost, - E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 175 Labour included in direct - E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Reference	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 176 Yearly production, local p- F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 177 Unit price, local product F..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 178 Sales tax, local product F...	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 179 Other direct variable cost- F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 180 Direct non-variable cost, - F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 181 Labour included in direct - F	0.00	0.00	0.00	0.00	0.00	0.00	0.00

8	9	10	11	12	13	14	15	16	17
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
846.00	846.00	846.00	846.00	846.00	846.00	846.00	846.00	846.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quanti- Y7	Quanti- Y8	Quanti- Y9	Quanti-Y10	Quanti-Y11	Quanti-Y12	Quanti-Y13	Quanti-Y14	Quanti-Y15	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabi TURBIN : Subtable Working Capital Requirements - f/l

Col	1	2	3	4	5	6	7
	Covera- F	Covera- L	Covera- F	Covera- L	Not used	Not used	Not used
L 182 Accounts receivable C1/C2; cas	30.00	30.00	15.00	15.00	1.00	1.00	1.00
	Covera- F	Covera- L	not used	not used	Not used	Not used	Not used
L 183 Inventory, raw material (a)...	180.00	30.00	1.00	1.00	1.00	1.00	1.00
L 184 Inventory, raw material (b)...	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L 185 Inventory, utilities..........	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L 186 Inventory, energy.............	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L 187 Inventory, spare parts........	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L 188 Inventory, work-in-progress...	30.00	30.00	1.00	1.00	1.00	1.00	1.00
L 189 Inventory, finished products..	30.00	30.00	1.00	1.00	1.00	1.00	1.00
L 190 Accounts payable..............	30.00	30.00	1.00	1.00	1.00	1.00	1.00

Tabl TURBIN : Subtable Source of Finance - foreign

Col	1	2	3	4	5	6	7
	1st disbu	2nd disbu	3rd disbu	4th disbu	5th disbu	6th disbu	7th disbu
L 191 Equity-O (ordinary shares)...	86.00	0.00	0.00	0.00	0.00	0.00	0.00
L 192 Equity-P (preference shares).	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 193 Subsidies, grants............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 194 Loan A, foreign (AF).........	276.00	0.00	0.00	0.00	0.00	0.00	0.00
L 195 Loan B, foreign (BF).........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 196 Loan C, foreign (CF).........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 197 Overdraft during production...	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabl TURBIN : Subtable Source of Finance - local

COMFAR 2.1 - BALDO & CO. S.R.L., MILAN, ITALY

Col	1	2	3	4	5	6	7
	1st disbu	2nd disbu	3rd disbu	4th disbu	5th disbu	6th disbu	7th disbu
L 198 Equity-O (ordinary shares)...	202.00	0.00	0.00	0.00	0.00	0.00	0.00
L 199 Equity-P (preference shares).	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 200 Subsidies, grants............	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 201 Loan A, local (AL)...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 202 Loan B, local (BL)...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 203 Loan C, local (CL)...........	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 204 Overdraft during production...	0.00	0.00	0.00	0.00	0.00	0.00	0.00