UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

FEASIBILITY STUDY FOR INDUSTRIAL PLANT DESIGNED TO MANUFACTURE PHOTOVOLTAIC MODULES IN ZIMBABWE

PROJECT NO. US/GLO/84/086

OUR REF. : COMM B/213/89
JANUARY 1991

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0. SUMMARY AND CONCLUSIONS

Photovoltaic cells turn the solar radiation into electric energy and this process takes place without any fuel or other utility consumption; in addition the cells are maintenance free and have a very long lifespan (more than 30 years).

The photovoltaic modules technology is one of the most promising to-day, as far as development of the living conditions in the rural countries is concerned. Employment perspectives of the photovoltaic cells are increasing every day all over the world, while technology improves the cell yield.

On the other hand, in a lot of areas, because of the high cost of the electric energy produced by means of the traditional systems, the photovoltaic electric energy should be the sole solution to energy supplying problems.

The local production of photovoltaic modules, along with the preparation of technicians, will contribute to actually solve many of the local problems: water pumping, food refrigeration, lighting, communcations etc.

It is important to point out that the aim of the new joint venture company is to supply complete solar systems, say lighting, domestic refrigeration and water pumping solar systems, ready to be operated immediately after their installation and not merely the separate photovoltaic modules.

This new approach to solve the problems of the rural peoples and other utilizers will give the best chances of success to this initiative.

An other point to be considered as positive for the project is that the supply of photovoltaic cells and other components will be assured by the Italian partner Helios Technology. This will result in a lot of advantages like time saving, standard quality of the components, continuity of the supply and others.

The envisaged plant is dimensioned to produce 1 MWatt/year of photovoltaic cells assembled into modules, on the basis of one 8-hour working shift per day. The output could reach 2 or 3 MWatt/year by simply considering 2 or 3 working shifts per day, without any adjustment of the equipment investment.

Each of the next years, of course, the output of the plant will be added to the existing installations so the saving of traditional fuel and relevant hard currency will be correspondly increasing year by year. The present feasibility study takes into account only the "assembling" of the photovoltaic cells as manufactured and supplied by Helios Technology to the envisaged plant.

The main results of the study can be summarized as follows:

- Total initial investment costs = 2,713,120 $ (from COMFAR)

- Total required area = 2,500 sq. meters

- Total personnel (1 shift only) = 61

- IRR = 23.49% (from COMFAR)

In this feasibility study for accounting purposes it has been considered the following exchange rate:

1 US Dollar = 2.70 Zimbabwe Dollars

0.1 FUTURE LOCAL PRODUCTION OF PHOTOVOLTAIC CELLS

It is foreseen that the plant in the early years of production will only assemble the photovoltaic cells into modules, importing the cells from Helios Technology - Italy, that is the know-how owner as far as the manufacture of photovoltaic cells is concerned. After this "settlement" period the plant will be ready and capable to broaden its range by producing the photovoltaic cells themselves. It can be foreseen that this period will take about four years before starting with the cell production.

Just to give an idea about this future production line the following data can be taken into consideration:

- the estimated additional investment cost is in the range of 2,700,000 US Dollars;

- the additional required area is 800 sq. meters;

- time required for commissioning and installation of the line is 12 months;

- foreseen production of cells equivalent to 1,500,000 - 2,000,000 Watt per year;

- required personnel: 1 chief-engineer, 3 technicians and 15 labours;

- training of personnel: 3 months at least;

- type of product: monocrystalline and polycrystaliine silicon cells with high efficiency and low production cost;

- buy-back: possible up to 30% of the max production capacity.

1. PROJECT BACKGROUND AND HISTORY

The project concerning the photovoltaic modules production was born as part of a more ample program finalized to the promotion of industrial investments for the production, in developing countries, of machinery and equipment for the utilization of renewable energy (solar, wind, biomass and other).

It has been conducted by UNIDO with the financement of the Italian Government and with cooperation of ENEA, the Italian national agency for nuclear and alternative energy.

Various Italian industries and local sponsors were interested, what resulted in meetings and subsequently in cocperation agreements. In this context, a letter of intent for the establishment of a joint venture was made between Ecological Designs Co. of Zimbabwe and Helios Technology, an Italian company owning the know-how for manufacturing solar panels.

Ecological Designs Co. is already marketing some of the components that should be produced once the joint venture will be finalized. The photovoltaic modules produced in the envisaged new plant will be supplied for typical applications like water pumping, lighting and refrigeration, as better detailed in the following paragraphs.

2. **MARKET AND PLANT CAPACITY**

2.1 **THE PRODUCT: THE PHOTOVOLTAIC SYSTEM**

The first step in understanding a photovoltaic (PV) system is to understand the elements that compose it. There are several major subsystem (Figure 1). The array subsystem provides DC electrical energy to the power conditioning subsystem. The power conditioning subsystem converts the DC electrical energy into the appropriate form to supply the load. When sunlight is unavailable, the load demand is met by the utility company or by back-up power systems.

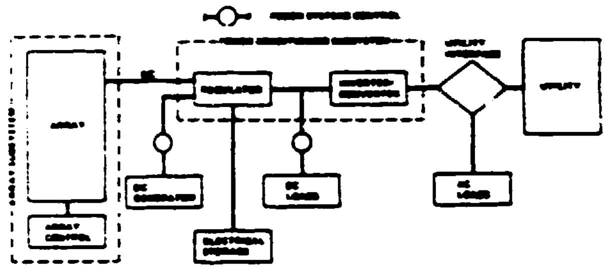


Figure 1. Block and Interface Diagram of a PV Power System.

The purpose of this chapter is to provide a brief overview of the system technology. It will:

1) Define the elements and characteristics of PV power systems;

2) Describe the development status of the major components;

3) Discuss the cost and performance trace-offs of system design. While this chapter focuses on utility-connected systems, most of the discussion on system performance and hardware characteristics is applicable to stand-alone applications.

2.1.1 **The collector**

The PV collector is an assembly of interconnected solar cells which produce DC energy when exposed to sunlight. Figure 2 illustrates the construction of a PV cell. in figure 2, electrical of a PV cell. In figure 2, electrical current is generated when sunlight (photons) strikes the N-type semiconductor layer of the cell, dislodging an electron from its energy level. These "free" electrons and the resultant positive charges or "holes" drift in opposite directions through the semiconductor material and are collected at the metallic contacts applied to the front and back surfaces of the cells.

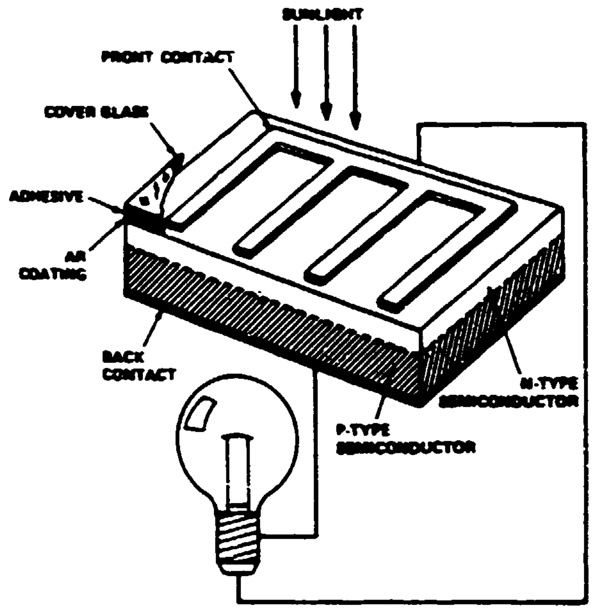


Figure 2. PV Cell Construction

Presently, most cells are made from ultra-high purity silicon. The single-crystal silicon is processed into wafers, approximately 0.30 millimeters (mm) thick, and then treated by standard semiconductor industry processes to produce cells. In large-scale production, bare cell conversion efficiency is presently about 14%. Laboratory single-crystal silicon cells have achieved efficiencies as high as 19% under normal illumination.

Other cell technologies are being investigated that could replace silicon in the future. Thin film technologies, such as amorphous silicon, offer the potential of lower cost but also have lower efficiency. Higher efficiency solar cell materials such as gallium arsenide or multijunction (layered) devices are also being investigated for use in concentrating collectors.

The electrical characteristics of a silicon cell (or module or array) can be represented using its current-voltage (I-V) relationship (Figure 2). The standard I-V curve relates the solar cell's output current and voltage from a short circuit (zero resistance) to an open circuit (infinite resistance) condition when the cell is at a standard specified condition or peak rating. This condition is defined as a cell temperature of 25 C and an irradiance of 100 mW/cm^2 (1000 W/m^2).

The typical maximum power voltage for a cell at these conditions is about 0.5 VDC. For a 10 cm square cell at 100 mW/cm^2 irradiance, up to 2 amps current and 1.0 W power may be produced. Reporting conditions are specified since the cell's output is affected by temperature and irradiance: an increase in temperature reduces the cell voltage, while an increase in irradiance increases the current output.

This temperature and irradiation dependence lead to the characterization of photovoltaics as an unregulated (variable voltage) DC source. It is also a "soft" source, incapable of producing fault currents much higher than normal operating levels.

PV cells are interconnected in series and in parallel to form strings at useful voltage and current levels. When cells are put in series, their voltage is additive; when cells are put in parallel, their current is additive. These interconnected solar cells are fabricated into modules to protect the cells from the environment and to protect the user from possible safety hazards. Typical module construction uses glass for the top cover, an encapsulant over and around the cells, and a high resistivity polymer back cover for electrical isolation.

2.1.2 **Balance of system**

The balance of system (BOS) defines that part of the PV power system other than the PV collector BOS includes the support structure, foundations, wiring, tracking, control equipment, power conditioning, any electrical storage and switchgear.
The major BOS elements, the array field, power conditioning, and utility interface, are discussed below.

2.1.2.1 **Array field**

The array field encompasses all the elements necessary to support and interconnect a collector in the field, connect the collector field into source circuits, and connect the source circuits to a power conditioning subsystem. This includes site preparation, support structure, foundations. DC wiring and grounding and fault detection and protection equipment. All of these elements are present in both large and small systems, although their definitions may change with system size. For example, collectors in residential applications are typically roof-mounted so that site preparation, structure and foundation refer to roof penetrations and hardware. In large systems the more conventional definitions hold.

The optimal design of array fields has been studied for some time by means of cost and performance tradeoffs. In general, good engineering practice with an eye to simple structure design is sufficient to achieve the necessary low structure costs. Another key to cost reduction has been the development of standardized modular array field designs. This eliminates the need for most site-specific engineering.

When discussing collector technologies and array field costs, it is important to remember that the contribution of array field BOS costs to total system cost depends on collector efficiency.
Lower collector efficiency requires larger fields and more structure and wiring to achieve the same energy output as a field with a higher collector efficiency. This must be considered when discussing the economics of any application.

2.1.2.2 **Power conditioning subsystems**

The power conditioning subsystem (PCS) interfaces the array with the outside electrical world: the loads and the utility. The PCS controls the operation of the array, starting it up in the morning and shutting it off at night, and maintaining the proper array voltage for maximum power extraction. It also takes the variable voltage DC electrical output of the array and converts it to constant voltage AC electrical energy to meet on-site loads.

The remaining function of the power conditioner is to control the PV system energy flow into the loads and the utility. In the event of abnormal conditions on the utility line such as out-of-limit voltage or frequency or the loss of utility power, the PCS is required to shut the system down. This keeps the PV system from energizing an otherwise dead utility line, which might endanger utility personnel and protects the power conditioner from being damaged by utility faults.

There are basically two types of power conditioners: square-wave and synthesized sine wave. The square-wave units are typically line-commutated, single-phase, and low power (10 kW or less). They have lower costs than the sine-wave units, but they also have poor quality, especially power factor. As a result of this power quality concern, square-wave units may not be allowed to attach to the utility without the addition of corrective hardware.

If this occurs, the cost of corrective hardware may reduce the current cost differential between PCS types for small systems. In larger, 3-phase power conditioners, the distinction between inverter types disappears. The power quality from these larger unit is inherently better, and the difficulty of producing an acceptable power quality is minimized.

Presently, there are several small power conditioning units of the sine-wave type commercially available. These units tend to have sophisticated internal controls so that they meet the requirements for safe utility-interconnected operation.
The efficiency of the power conditioning unit is very important. Since all energy flows through the PCS, a 1% change in efficiency means a 1% change in total energy output, and is equivalent to a 1% change in system cost. Therefore, if the PCS price is only 10% of the system cost, and the efficiency can be increased by 1%, then 10% more can be paid for it on a breakeven analysis. This is obviously a consideration in optimizing power conditioning subsystem design.

2.1.3 Overall system efficiency

Overall system efficiency is the product of the module efficiency and BOS efficiency. Using silicon single crystal cells (about 14% efficient), and projected low-cost flat plate module constructions, an average annual module efficiency of 11.2% is expected. This is 20% less than the basic cell efficiency under standard reporting conditions because it includes optical losses in the module, the module packing factor, and the effect of average annual cell temperature which is 20 C higher than rating temperature (Figure 5). Obviously with 16% cells, module efficiency would be significantly increased, resulting in smaller array fields for the same power.

The effect of BOS efficiency can be seen by the following the energy flow in figure 5. In this example, wiring accounts for another 2% loss and power conditioning accounts for a 10% loss in energy. Therefore, only 99 W/m^2 or 9.9% of the 1000 W/m^2 of incident sunlight on the module reaches the utility or the load.

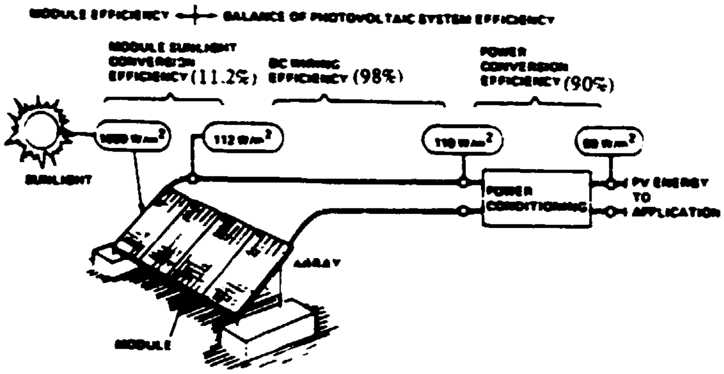


Figure 5. PV System Efficiency (Simplified)

MODULE EFFICIENCY

$$\eta_M = \eta_c \times \eta_T \times \eta_{NOCT} \times \eta_p$$
$$= (0.14)^* \times (0.95) \times (0.92) \times (0.92)$$
$$\eta_M = 0.112 = 11.2\%$$

WHERE,

NOCT	=	Nominal operating cell temperature – the module cell temperature under ambient conditions defined as: insolation = 100mW/cm²; air temperature = 20°C; wind average velocity = 1 m/s; mounting = oriented normal to solar noon, mounted on structure typical of application; and electrical load = open circuit
η_c	=	Bare cell efficiency at 28°C cell temperature and 100 mW/cm² irradiance
η_M	=	Module efficiency at an air mass (AM) 1.5 irradiance level of 100 mW/cm² and cell temperature equal to the nominal operating cell temperature (NOCT)
η_{NOCT}	=	NOCT efficiency
η_p	=	Module packing efficiency
η_T	=	Optical transmission efficiency, measured through encapsulant materials to cell

*Present bare cell efficiency

2.1.4 System application

The photovoltaic system basically produces energy that is therefore used for a variety of applications. Of course the cost of one kW of energy produced in such way is expensive and therefore cost/benefit analysis has to be carried out case by case.

Due to recent reduction in production and installation costs, anyway, photovoltaic systems are competitive in many cases with diesel generators and in some cases even when a grid is available but connection costs are very high like the case of Zimbabwe.

Main applications for which photovoltaic systems are currently employed are:

- Rural electrification:	remote village and houses, holiday resorts
- Village power:	remote villages, islands, social centres, schools
- Telecommunications:	radio and TV repeaters, radio telephones, satellite receivers, radar stations, etc.
- Water pumping:	drinkable water for villages, irrigation systems, etc.
- Refrigeration:	domestic uses, food stuffs, vaccine
- Medical:	hospitals, medical equipments, health care centres and mobile medical units
- Lighting:	houses, street lights, rural villages, town districts
- Data recording:	meteorological stations, pollution recording units, water level metering, fire alarm systems, earthquake alarm systems
- Signalling:	railroad traffic, highway, off-shore rigs, seabuoys
- Cathodic protection:	oil, gas and water distribution systems
- Electric fencing in cattle rising	

Some of the major applications are described in the following paragraphs.

2.1.4.1 Refrigerators

Refrigerators are well known equipment, both in the industrial and in the domestic field.

In the context of this report it is not the case to take into consideration the equipment normally manufactured in many standard types, to be used fed by conventional energies; but only those specifically studied to be used with photovoltaic systems This destination does not imply a different process design, but rather a more efficient construction design, to allow power consumption and to keep losses to a minimum.

The two major refrigerator classes are: the compression type using electricity as energy source and the absorption type using a heat source, as for instance the direct combustion of a fuel.
Of these two types, the latter would seem the best fit to be used with renewable energies, using a solar heater as a heat source. As a matter of fact, even if with few or no moving parts is difficult to operate, requires good maintenance and precise temperature selection to assure reliable continuous

operation; there are very few refrigerators of this type yet on the market.
More reliable and more diffused is the compression type refrigerator especially for domestic use.

The most important features of these solar operated refrigerators are: low power consumption, low losses, extra-large capacity, and precise temperature control.
Typical capacity is in the range of 50 to 200 litres.
Cold temperature range is also very ample, from a few centigrades to as low as -25 C.

Health is certainly one of the fields that can better take advantage of the characteristics of this type of refrigerator; in fact these types offer to health programs the possibility of expanding in many rural areas where refrigerators are in fact the only means for storing vaccines, medical supplies, veterinary specialities, food and beverages.

For medical application the vaccine storage temperatures required are: - 15 to -25 C for oral polio, yellow fever, measles, 0 to +8 C for DPT, tetanus and BCG.
In this temperature range it is also possible to preserve foods of very high nutritional value, but easily perishable.

2.1.4.2 Lower power consumption lights

The lights we are referring to are designed for use with photovoltaic systems.
Generally they work with direct current generators and are suitable for a wide range of voltages.

The typical light powers used are: 6 W - 20 W and 40 W.
The average light output is very high: 40 W lamp can emit about 3000 lumens.
Therefore these lights have an advantageous ratio of light to power.
Their use is important in houses, hospitals, dispensaries, social centres, schools, workshops and for rural lighting. Due to their low power consumption, they don't require great installations for electricity generation.

2.1.4.3 Water pumping systems

Water supply in remote areas is in any cases a problem: the water table is very often not too low but there is a lack of power when pumping the water up. The most common solution is the use of diesel generators but the transport of the fuel to produce energy also costs energy ....

The photovoltaic water pumping systems are non competitive with diesel powered pumping sets if the water table is not too low and for low to medium amount of water to be lifted (it depends, of course, on the cost of diesel oil in that specific area). The photovoltaic system operated submersible pumps, made of steel. They are driven by A.C. motors powered through special inverters DC/AC with high efficiency (higher than 90%).

2.2 THE HELIOS PHOTOVOLTAIC SYSTEM

Helios, the Italian Company that is studying the possibility of making a joint-venture with the Zimbabwean company, Ecological design, is currently producing a variety of photovoltaic systems and their components.

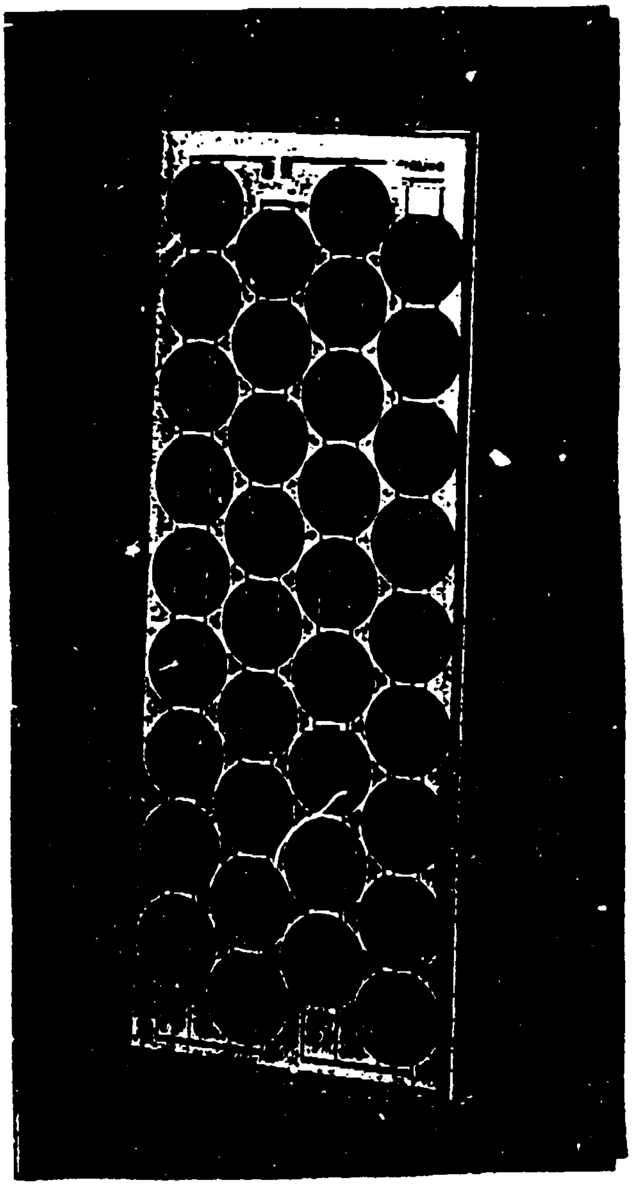
Major data of these components and systems, whose production technology would be transferred, are provided in the following pages.

HELIOS TECHNOLOGY

HELIOS TECHNOLOGY SpA
35015 Galliera Veneta/PD Italy Via
Tel. 049/5969655 3 linee r.a.
Telex 431581 HELIOS I
Telefax 049/5958255

Photovoltaic module **H60**

PHOTOVOLTAIC MODULE WHICH CONTAINS 36 MONOCRYSTALLINE SILICON ROUND CELLS WITH 5 INCHES DIAMETRE.



ELECTRIC CHARACTERISTICS
(at 100 mW/cm², 25°C, AM 1,5)

Peak power	Watts	60 W
Short circuit current	Amp.	4.10
Open circuit voltage	Volts	20.5
Voltage at max power	Volts	16.6
Current at max power	Amp.	3.60
NOCT Nominal operating cell temperature	°C	40°
Current at 14,5 (V battery)	Amp	3 78
Voltage variation in temperature	mv/°C	70
Cell efficiency	%	14%

Generated current is proportional to the solar radiation.

Storage and operating temperature from —40°C to +95°C.

R. Humidity up to 100%.

Weight Kg. 6,5

Out put values are ±10%.

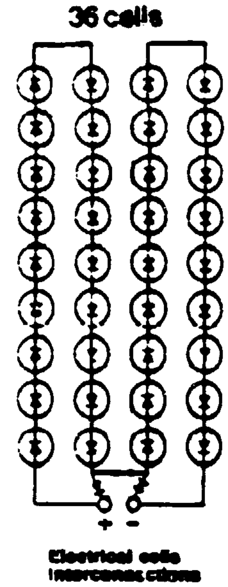
Helios Technology modules have satisfactorily passed the European Economic Community's qualification test n° 502 at the ISPRA Laboratory. Specifications are subjected to change without notice.

DIMENSIONS: mm 1220 x 472 x 34

DISTRIBUTED BY

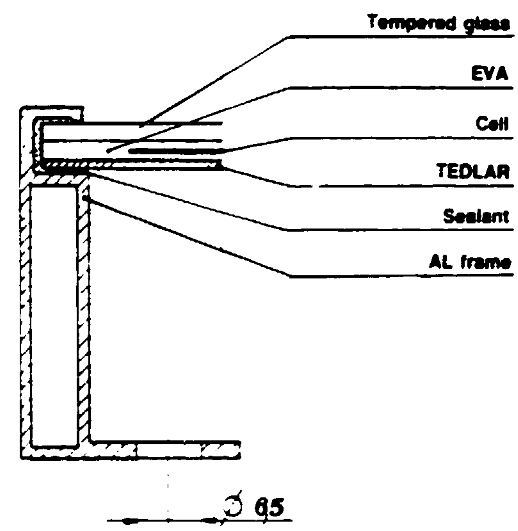
Module physical features

This module is assembled by lamination. By using the latest manufacturing technologies, it attains a superb durability and a very long lifespan (typically more than 30 years).
The four holes on the metal frame make mounting easy and provide a strong fixing of the modules to the supporting structure. The modules can withstand winds over 200 Km/h.



Module cross section

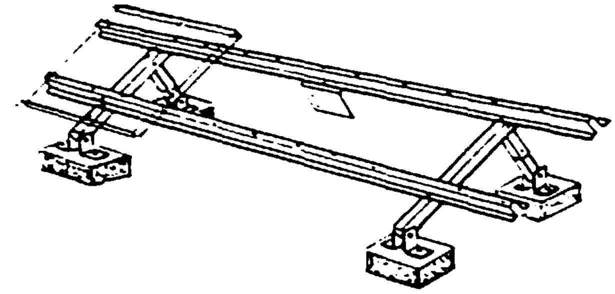
The materials used during the course of manufacture are shown on the pictured section.
The module frame is made of anodized aluminium.
The module is packaged in a 3mm thick tempered low iron glass, that provides an effective protection against environmental and mechanical effects.
The glass is characterized by high trasparency for direct and diffuse light incidence.
The back of the module is permanently sealed with a white Tedlar which offers an optimum protection against the penetration of moisture and against corrosion of sea water.



Junction box

A water-proof junction box, IP655, contains the by-pass diodes and the connecting terminals are marked with the positive pole one and the negative pole the other.
If needed the end user can assemble one blocking diode directly into the junction box (we suggest Schottky diodes) and he can also put the supplied PG 11 cable gland in the preconstituted positions.
A further cable gland is available by request, for particular string connections.

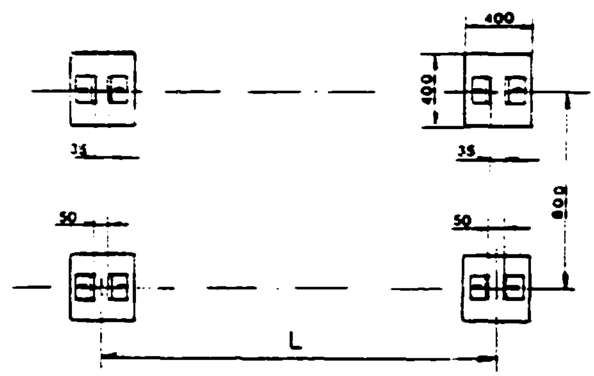
MODULES SUPPORT STRUCTURES.

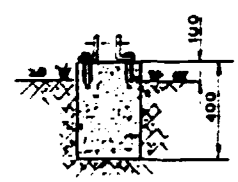


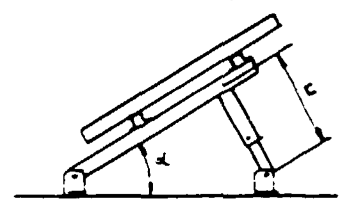
They are divided in: STH 2-8 onzontal structure, STP 1-3 pole structure and STV 8 vertical structures. They are all suitable for the H40 or H45 and H55 modules.

STH Horizontal Structures

The STH modules structures are made of 3.5 mm thick hot galvaniz.ed steel. Their stable design allows them to withstand winds of more than 180 kmh. All the parts of the structure are hot zinc coated with a layer of zinc not lower than 0.08 mm and all the bolts and nuts are made of stainless steel. These characteristics, in comparison with other products, allow the structures to attain a very long lifespan (over 20 years) and to resist to atmospheric influences even in severe environmental conditions. For ground installations they need very simple and quickly prepared concrete blocks, in conformity with the measures and modalities shown on the picture. The structures are supplied with a prearranged inclination for different tilt angles: (A) tilt 10°-25° for tropical latitudes and (E) tilt 30°-60° for European latitudes.



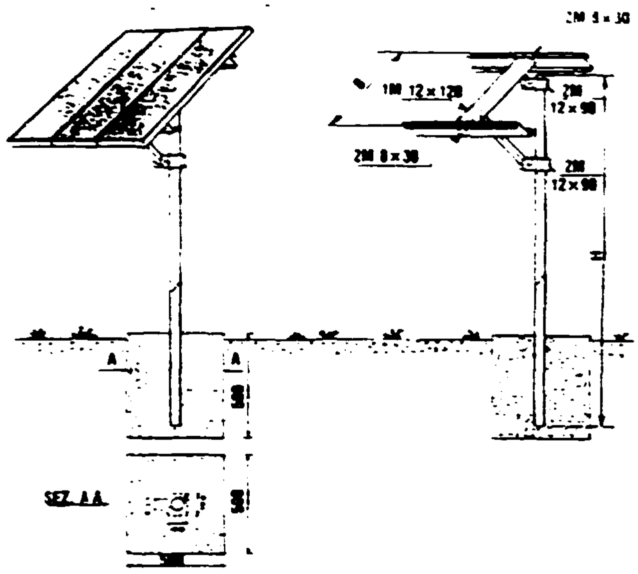




TYPE	DESCRIPTION	TILT α°	L (mm)	C (mm)	WEIGHT (Kg)
STH 240 A	2 MOD. H40	10÷25	787	150÷350	21
STH 240 E	2 MOD. H40	30÷60	787	400÷800	21
STH 440 A	4 MOD. H40	10÷25	1189	150÷350	24
STH 440 E	4 MOD. H40	30÷60	1189	400÷800	24
STH 640 A	6 MOD. H40	10÷25	1608	150÷350	27
STH 640 E	6 MOD. H40	30÷60	1608	400÷800	27
STH 840 A	8 MOD. H40	10÷25	2412	150÷350	30
STH 840 E	8 MOD. H40	30÷60	2412	400÷800	30
STH 255 A	2 MOD. H45 or H55	10÷25	847	150÷350	21
STH 255 E	2 MOD. H45 or H55	30÷60	847	400÷800	21
STH 455 A	4 MOD. H45 or H55	10÷25	1279	150÷350	24
STH 455 E	4 MOD. H45 or H55	30÷60	1279	400÷800	24
STH 655 A	6 MOD. H45 or H55	10÷25	1728	150÷350	27
STH 655 E	6 MOD. H45 or H55	30÷60	1728	400÷800	27
STH 855 A	8 MOD. H45 or H55	10÷25	2592	150÷350	30
STH 855 E	8 MOD. H45 or H55	30÷60	2592	400÷800	30

STP Pole Structure

These structure present the same general characteristics stated for the horizontal type.
Their pole construction mke them suitable for situations where an elevation of 3-4 mts from the ground is required.
They are extremely strong and are composed by a supporting frame with a collar which can be fixed to the pole. (Ø pole head 65 ÷ 70 mm).
The pole itself can also be supplied by request.
The structures are supplied with a prearranged inclination for different tilt angles: (A) tilt 10°- 25° for tropical latitudes and (E) tilt 30°- 60° for European latitudes.

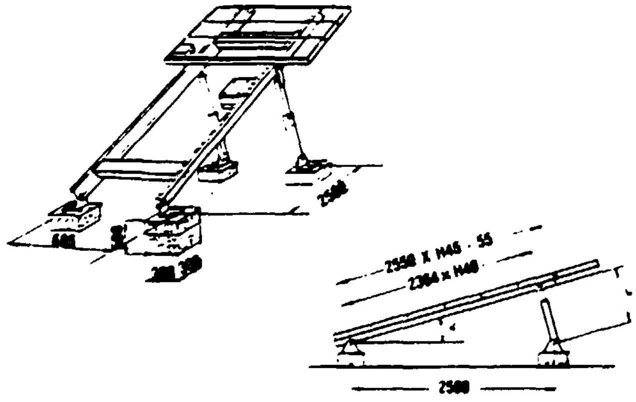


TYPE	DESCRIPTION	TILT α°	WEIGHT (Kg)
STP 140 A	1 MOD. H40	10 ÷ 25	18
STP 140 E	1 MOD. H40	30 ÷ 60	18
STP 240 A	2 MOD. H40	10 ÷ 25	21
STP 240 E	2 MOD. H40	30 ÷ 60	21
STP 340 A	3 MOD. H40	10 ÷ 25	24
STP 340 E	3 MOD. H40	30 ÷ 60	24
STP 440 A	4 MOD. H40	10 ÷ 25	27
STP 440 E	4 MOD. H40	30 ÷ 60	27
STP 155 A	1 MOD. H45 or H55	10 ÷ 25	18
STP 155 E	1 MOD. H45 or H55	30 ÷ 60	18
STP 255 A	2 MOD. H45 or H55	10 ÷ 25	21
STP 255 E	2 MOD. H45 or H55	30 ÷ 60	21
STP 355 A	3 MOD. H45 or H55	10 ÷ 25	24
STP 355 E	3 MOD. H45 or H55	30 ÷ 60	24
STP 455 A	4 MOD. H45 or H55	10 ÷ 25	27
STP 455 E	4 MOD. H45 or H55	30 – 60	27

STV Vertical Structures

These structures present the same general characteristics stated for the horizontal type.
They should be used in medium and large installations.
The structures are supplied with a prearranged inclination for different tilt angles: (A) tilt 10°- 25° for tropical latitudes and (E) tilt 30°- 60° for European latitudes.

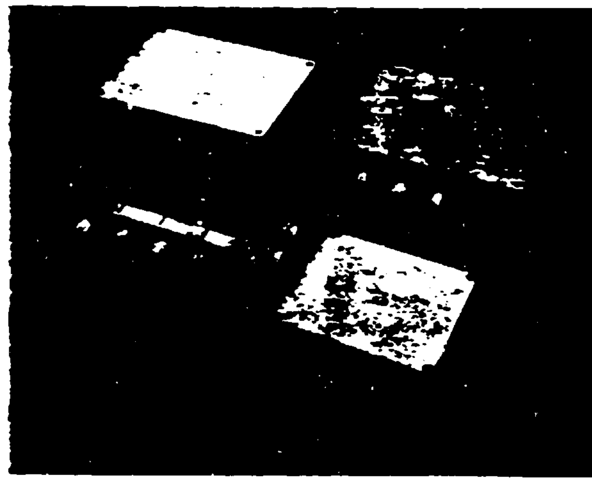
NB.: The modules must be inclined towards sud in the nothern hemisphere and towards north in the southern hemisphere as many degrees as those of the latitude.



TYPE	DESCRIPTION	TILT α°	L (mm)	WEIGHT (Kg)
STV 840 A	8 MOD. H40	10 – 25	450 – 1200	36
STV 840 E	8 MOD. H40	30 – 60	1300 – 2500	36
STV 855 A	8 MOD. H45 or H55	10 – 25	450 – 1200	36
STV 855 E	8 MOD. H45 or H55	30 – 60	1300 – 2500	36

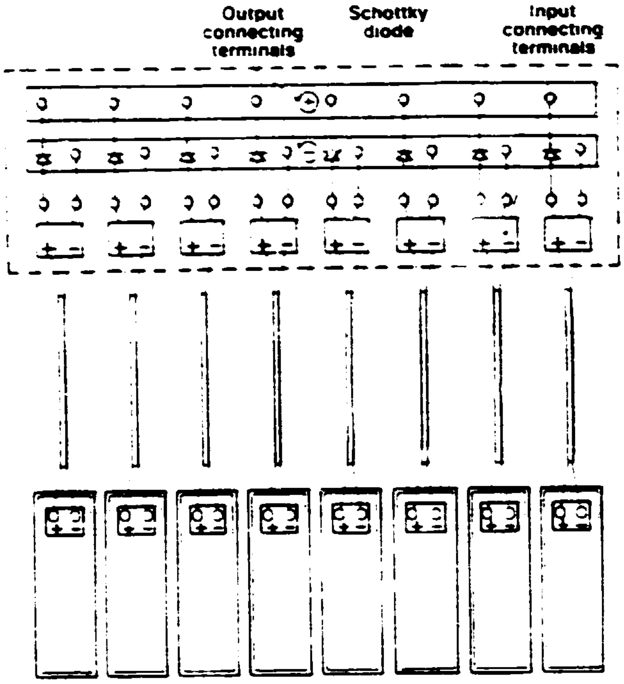
Junction boxes JB

They are water-proof junction boxes with an IP557 protection degree, containing 5 Amp. blocking diodes Schottky type and provided with input and output cable glands and connecting terminals. They are employed when there is a connection between two or more modules.
The connection among the modules is made inside the junction box, in parallel for the 12V type and in series parallel for the 24V type.
The use of this junction box simplifies the modules wiring and at the same time its maintenance.
The input and output connecting terminals are marked with the positive and negative poles in order to make the connections easier.
In each installation the Helios Technology junction boxes should be employed as they offer the great advantage of separating the strings of modules by the use of several blocking diodes. These diodes are Schottky type and have a low voltage drop (0.4 volts) and consequently a reduced loss of output power from each single module or string.
The set of JB ..S 220 is particularly useful for the mounting in parallel of the strings of modules connected in series (at 110VDC or 220VDC).



TYPE	DESCRIPTION	DIMENSIONS L x H x W (mm)	WEIGHT Kg	NUMBER OF CABLE GLANDS IN	TYPE OF CABLE IN (2 mm)	NUMBER OF CABLE GLANDS OUT	TYPE OF CABLE OUT (2 mm)
JB0212	Junction Box for 2 modules AT 12V	120 x 80 x 50	0.3	2 PG11	2 x 2.5	1 PG 13.5	2 x 6
JB0224	Junction Box for 2 modules AT 24V	120 x 80 x 50	0.3	2 PG11	2 x 2.5	1 PG 13.5	2 x 6
JB0312	Junction Box for 3 modules AT 12V	150 x 110 x 70	0.4	3 PG11	2 x 2.5	1 PG 13.5	2 x 6
JB0412	Junction Box for 4 modules AT 12V	150 x 110 x 70	0.5	4 PG11	2 x 2.5	2 PG 11	1 x 10
JB0424	Junction Box for 4 modules AT 24V	150 x 110 x 70	0.5	4 PG11	2 x 2.5	1 PG 13.5	2 x 6
JB0612	Junction Box for 6 modules AT 12V	150 x 110 x 70	0.9	6 PG11	2 x 2.5	2 PG 11	1 x 10
JB0624	Junction Box for 6 modules AT 24V	150 x 110 x 70	0.9	6 PG11	2 x 2.5	2 PG 11	1 x 10
JB0812	Junction Box for 8 modules AT 12V	190 x 140 x 70	0.9	8 PG11	2 x 2.5	2 PG 11	1 x 16
JB0824	Junction Box for 8 modules AT 24V	190 x 140 x 70	0.9	8 PG11	2 x 2.5	2 PG 11	1 x 10
JB1012	Junction Box for 10 modules AT 12V	240 x 190 x 90	0.9	10 PG11	2 x 2.5	2 PG 13.5	1 x 25
JB1024	Junction Box for 10 modules AT 24V	240 x 190 x 90	0.9	10 PG11	2 x 2.5	2 PG 11	1 x 16
JB1224	Junction Box for 12 modules AT 24V	300 x 220 x 120	1.0	12 PG11	2 x 2.5	2 PG 11	1 x 16
JB1624	Junction Box for 16 modules AT 24V	300 x 220 x 120	1.2	16 PG11	2 x 2.5	2 PG 13.5	1 x 25
JB2S	Junction Box for 2 strings up to 220V	240 x 190 x 90	0.7	4 PG11	1 x 4	1 PG 13.5	2 x 6
JB3S	Junction Box for 3 strings up to 220V	240 x 190 x 90	0.8	6 PG11	1 x 4	1 PG 13.5	2 x 6
JB4S	Junction Box for 4 strings up to A 220V	240 x 190 x 90	0.8	8 PG11	1 x 4	1 PG 13.5	2 x 6
JB5S	Junction Box for 5 strings up to A 220V	240 x 190 x 90	0.8	10 PG11	1 x 4	1 PG 13.5	2 x 6

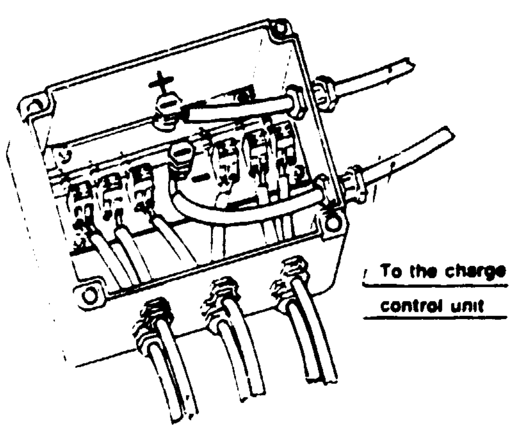
12V JUNCTION BOX TYPE JB0812



Photovoltaic modules

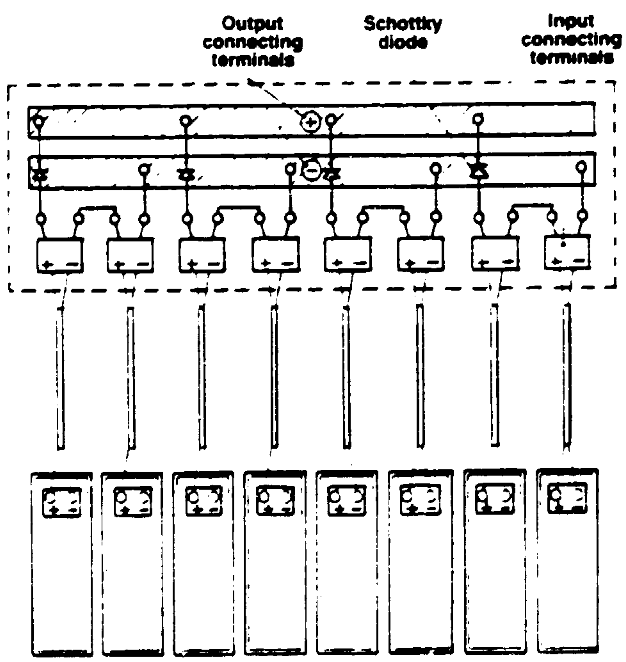
Each input of a modules string is supplied with one Schottky blocking diode type VKS 520, connecting terminals having a 4 square millimetres section and cable glands which are defined on the data table.
At each output there are two connecting terminals marked + and - for a cable having a section up to 25 square millimetres and cable glands defined on the data table.

JUNCTION BOX TYPE JB0612



From the photovoltaic modules

24V JUNCTION BOX TYPE JB0824



Photovoltaic modules

CHARGE CONTROLERS

General Characteristics

CHARGE CONTROL UNIT

This range of charge control units has been specifically designed for providing the best performances and the protection of the batteries in photovoltaic installations which produce currents from 3.5 A to 60 A at 12V or 24V nominal voltage. These units control both the minimum and the maximum battery charge assuring a long lifespan to the batteries.
The experience acqired from the thousands of intallations made, has contributed to the final design of these control units.
In the NG6 and MX2 types the battery control is made by a Shunt type circuit. All other control units are serial type.

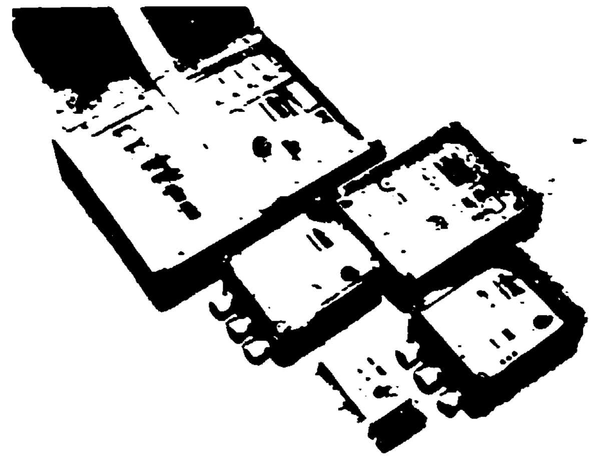
PERFORMANCES

- Low consumption.
- High reliability with solid state CMOS electronics.
- High efficiency. They contribute to reducing the electrolyte battery comsumption and their need of maintenance.
- They safeguard the batteries from an excessive discharge by cutting the consumption of the load.

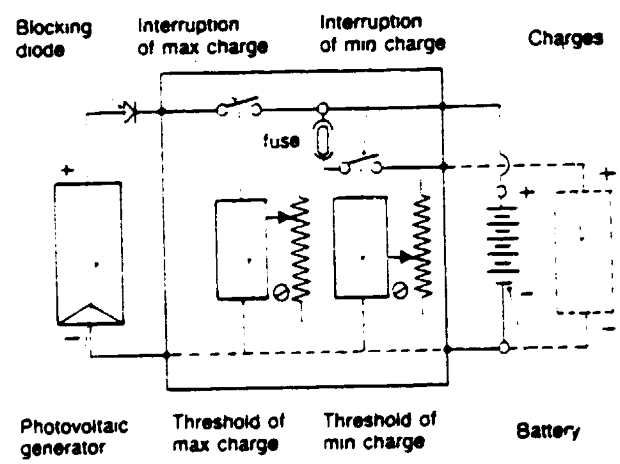
TECHNICAL FEATURES

- The green led shows the cutting off of the photovoltaic modules in case of battery overvoltage.
- The yellow led shows the battery state of charge.
- The red led shows che cutting off of the load in case the battery is flat.
- All models are protected against polarity inversion.
- All the control units are equipped with a built-in delay that avoids frequent commutations in case of high current surges.

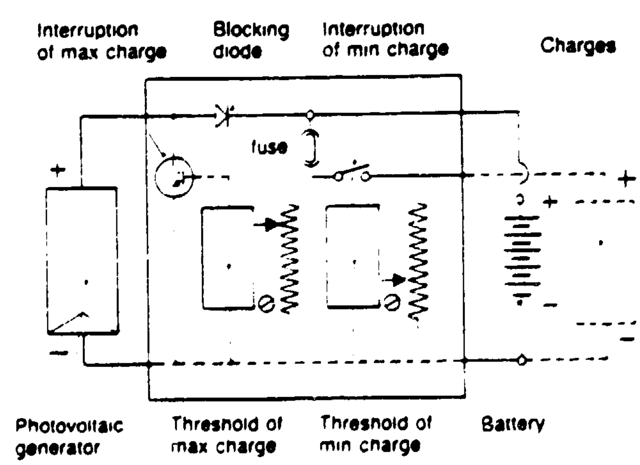
The M1 and M2 control units are specifically designed for more powerful and professional installations where the electrical parameters have to be measured and displayed.



SERIAL TYPE CIRCUIT NG8 - NG16 - NG30 - M1 - M2



SHUNT TYPE CIRCUIT NG6 - MX2



ELECTRICAL CHARACTERISTICS		NG6	MX2	NG8	NG16	NGE30	PROFESSIONALS M1	PROFESSIONALS M2
Nominal voltage		12V o 24V	12V o 24V	12V o 24V	12V o 24V	12V o 24V	12V o 24V	12V o 24V
Voltage of max charge and disconnection P.V.		14.50V o 29V	14.50V o 29V	14.50V o 29V	14.50V o 29V	14.50V o 29V	14.50V o 29V	14.50V o 29V
Voltage of reinsertion P.V.		13.5V o 27V	13.5V o 27V	13.5V o 27V	13.5V o 27V	13.5V o 27V	13.5V o 27V	13.5V o 27V
Voltage diconnection of load		11.3V o 22.6V	11.3V o 22.6V	11.3V o 22.6V	11.3V o 22.6V	11.3V o 22.6V	11.3V o 22.6V	11.3V o 22.6V
Voltage reinsertion of load		12.3V o 24.6V	Manual	12.3V o 24.6V	12.3V o 24.6V	12.3V o 24.6V	12.3V o 24.6V	12.3V o 24.6V
Temperature effect on voltage threshold		+ 1,8 MV/C°	+ 1,8 MV/C°	+ 1,8 MV/C°	+ 1,8 MV/C°	+ 1,8 MV/C°	+ 1,8 MV/C°	+ 1,8 MV/C°
Typical current consumption		7 MA	1.5 MA	12 MA	2 MA	2 MA	2 MA	4 MA
Maximum current from P.V. array		3.5 A	5 A	8 A	16 A	30 A	30 A	60 A
Maximum current to load		5 A	15 A	8 A	16 A	30 A	30 A	60 A
Fuse		5 A	15 A	10 A	16 A	> 30 A	> 30 A	> 60 A
STANDARD FUNCTIONS ●								
Max and min battery charging control		●	●	●	●	●	●	●
Current measurement (with amperometre)							●	●
Built-in delay to avoid frequent commutations		●	●	●	●	●	●	●
Diagnostic Leds		●	●	●	●	●	●	●
Protection against polarity inversion		●	●	●	●	●	●	●
Fuse		●	●	●	●	●	●	●
OPTIONAL FUNCTIONS x	REF. LETTER							
Water-proof container IP 54	A			●	●	●	x	x
Card for min voltage alarm	B						x	x
Card for max voltage alarm	C						x	x
Card for starting auxiliary generator	D						x	x
Temperature compensation	E			x	x	x	x	x
Different nominal voltage (36-48)	G	x	x	x	x	x	x	x
Lightining protection	H	x	x	x	x	x	x	x
Threshold level at different voltage values	I	x	x	x	x	x	x	x
Tropicalization	L	x	x	x	x	x	x	x
Dimension in mm.		135x85x35	190x150x70	190x140x85	220x180x120	286x180x120	390x300x180	390x300x180
Weight in Kg.		0,3	0,6	0,8	1	1.2	5	6

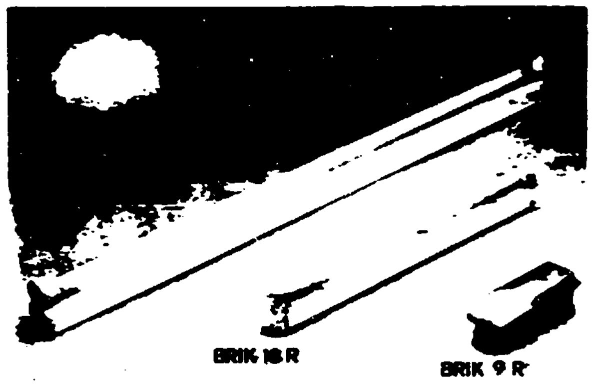
Characteristics are subjected to change without notice.
For higher power systems charge controllers type M3 (90A) ecc.

EX. ORDER CODE
NG8 - 12 - E I L

TYPE VOLTAGE OPTIONALS

REPHASED FLUORESCENT LAMPS POWERED AT 220 VOLTS ALTERNATE CURRENT

They are lamps particularly suitable for photovoltaic systems equipped with an inverter.
These lamps are carefully rephased by Helios Technology in order to considerably reduce the energy absorption.
The result is the possibility to restrain the inverter size and to reduce power and the cost of the photovoltaic system.
They are characterized by:
— low consumption
— high efficiency
— high light intensity
— long life-span of the tube (over 5000 hours)

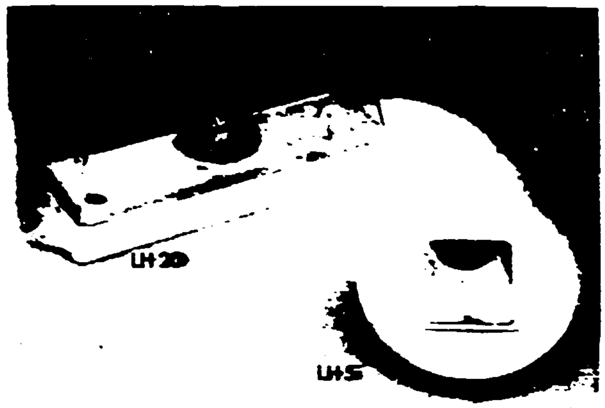


TYPE	DIMENSIONS LxHxD mm	CURRENT	NOMINAL VOLTAGE	BULB TYPE	LUMINOSITY LUMENS	COMPARISON WITH INCANDESCENT BULB
BRIK9 R	210 x 80 x 70	0.09 A	220 VAC	9 W	600	60 W
BRIK18 R	640 x 45 x 95	0.18 A	220 VAC	18 W	1050	100 W
BRIK40 R	130 x 45 x 95	0.36 A	220 VAC	36 W	2200	150 W

Characteristics are subjected to change without notice.

LOW CONSUMPTION LAMPS POWERED AT 12 OR 24 VOLTS DIRECT CURRENT

Helios Technology produces these special fluorescent and halogen lamps which are characterized by high light efficiency. These lamps are particularly suitable for photovoltaic systems as they satisfy needs such has long life-span and low consumption.



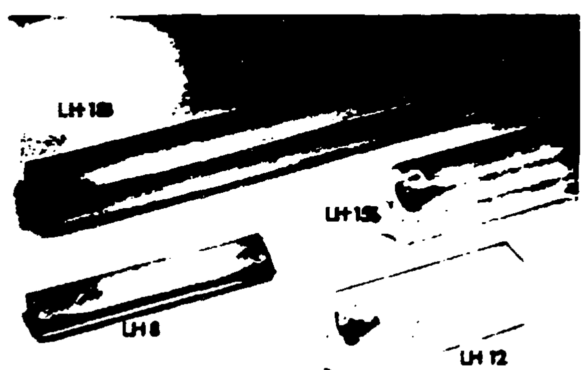
HALOGEN LAMPS

They are supplied with lamp body having halogen bulb. The latter has an average life-span of 2000 working hours (which is equal to about 2 operating years).

TYPE	NOMINAL VOLTAGE	CURRENT	BULB TYPE	LUMINOSITY LUMENS	COMPARISON WITH INCANDESCENT BULB
LH5	12 VDC	0.41 A	5 W	200	25 W
LH20	12 VDC	1.66 A	20 W	350	40 W
LH20	24 VDC	0.83 A	20 W	350	40 W

FLUORESCENT LAMPS POWERED AT 12 OR 24 VOLTS DIRECT CURRENT

They are composed by a high frequency ballast which feeds the fluorescent bulb. Helios Technology has specifically designed them to obtain a high efficiency and a long life-span of the bulb (over 5000 hours which are equal to about 5 years).
After such period it will be enough to replace the bulb. Unlike other products available on the market, the ballast will not burn but will keep working for over 15 years.
The lamps are battery powered and can stand considerable voltage variations.
The above mentioned characteristics are essential in photovoltaic systems which require high reliability and long life-span.



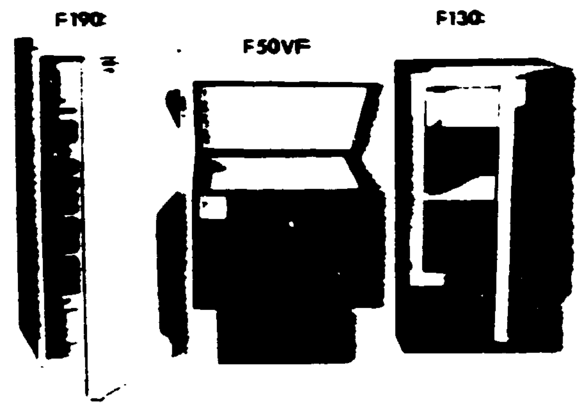
TYPE	DIMENSIONS L x H x D mm	CURRENT	NOMINAL TENSION	BULB TYPE	LUMINOSITY LUMENS	COMPARISON WITH INCANDESCENT BULB
LH8	310 x 32 x 70	0.8A/0.4A	12/24V	8 W	400	40 W
LH12	270 x 77 x 83	1.2A/0.6A	12/24V	9 W	600	60 W
LH15	270 x 77 x 83	1.5A/0.75A	12/24A	11 W	900	75 W
LH18	680 x 40 x 16	2.2A/1.1A	12/24V	18 W	1.050	100 W

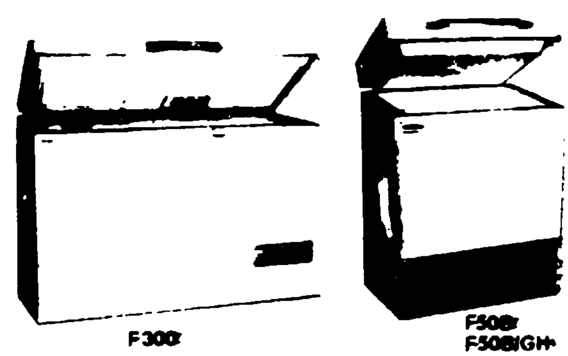
LOW CONSUMPTION REFRIGERATORS POWERED AT 12 AND 24 VOLTS DIRECT CURRENT

Helios Technology produces these special refrigerators which are particularly suitable for photovoltaic installations.
The thick wall made of polyurethane foam (measuring from 7 to 13 cm) grants a very low energy consumption and therefore a drastic reduction of the photovoltaic system cost.
The main characteristics are:

- low consumption
- rugged construction
- long life-span
- high reliability

The high quality of the employed materials and the rigorous tests make these refrigerators particularly suitable to operate in rural areas presenting severe environmental conditions. They can be used for food-staff storage or vaccine preservation. The average internal temperature is +5 degrees centigrade. Some models are also provided with deep freezing cell (in the cell the average temperature is -10 degrees centigrade).



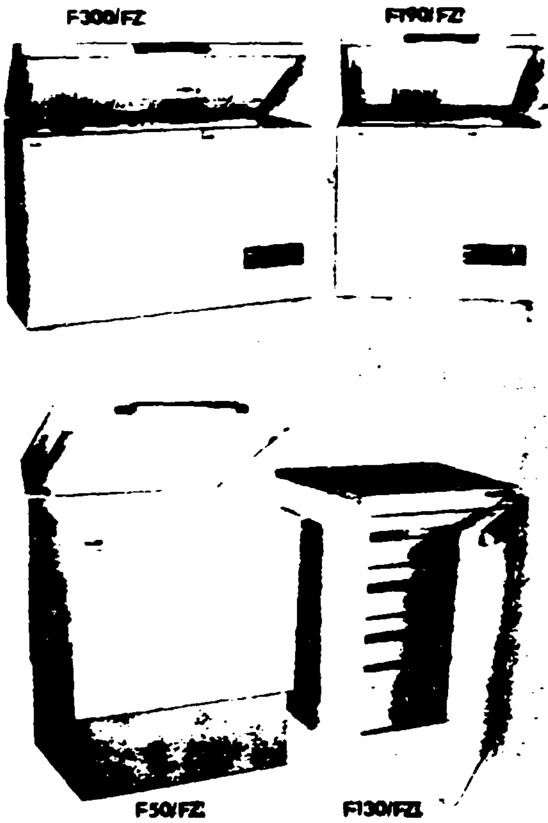


MODEL	W COMPRESSOR	LITRES	WEIGHT	DAILY AH CONSUMPTION EXT.TEMP. 32°C	DIMENS. CM H x L x P	NOTES
F 50 B	60	50	50	7	90 x 70 x 60	HORIZONTAL
F 50 B/GH	60	50	50	17	90 x 70 x 60	HORIZONTAL 2 KG. ICE-PROD. CELL
F 50 VF	60	50	22,5	12	65 x 60 x 47	HORIZONTAL
F 130	60	130	39	22	95 x 53 x 53	VERTICAL + DEEP FREEZER CELL
F 190	110	190	44	32	110 x 51 x 54	VERTICAL + DEEP FREEZER CELL
F 300	110	300	56	39	90 x 135 x 68	HORIZONTAL

BY REQUEST 12 VDC ARE AVAILABLE

LOW CONSUMPTION DEEP FREEZERS POWERED AT 12 AND 24 VOLTS DIRECT CURRENT

Helios Technology produces these special deep freezers which are particularly suitable for photovoltaic installations.
The thick wall made of polyurethane foam (measuring from 7 to 13 cm) grants a very low energy consumption and therefore a drastic reduction of the photovoltaic system cost.
The main characteristics are:
— low consumption
— rugged construction
— long life-span
— high reliability
The high quality of the employed materials and the rigorous tests make these deep freezers particularly **suitable to operate in rural areas** presenting severe environmental conditions. They are used for food-staff freezing and storage as well as for ice production.
The average internal temperature is about -12 degrees centigrade therefore it is suitable to preserve food even for long periods.
They are provided with an internal thermostat which can be regulated in order to obtain different internal temperatures.
Deep freezers have higher energy consumption than refrigerators and require more powerful photovoltaic arrays.



MODEL	W COMPRESSOR	LITRES	WEIGHT	DAILY AH CONSUMPTION EXT.TEMP. 32°C	DIMENS. CM H x L x D	NOTES
F 130/FZ	60	130	39	38	95 x 53 x 53	VERTICAL DEEP FREEZER
F 190/FZ	110	190	44	40	90 x 95 x 68	HORIZONTAL DEEP FREEZER
F 300/FZ	110	300	57	50	90 x 135 x 68	HORIZZONTAL DEEP FREEZER
F 50/FZ	60	50	50	20	90 x 70 x 60	HORIZZONTAL DEEP FREEZER

BY REQUEST 12 VDC ARE AVAILABLE

solar lighting system

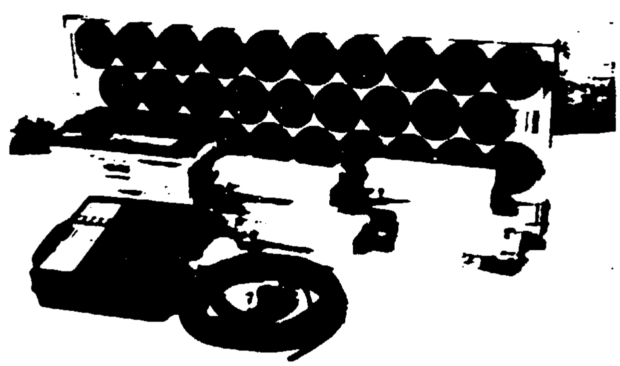
M40

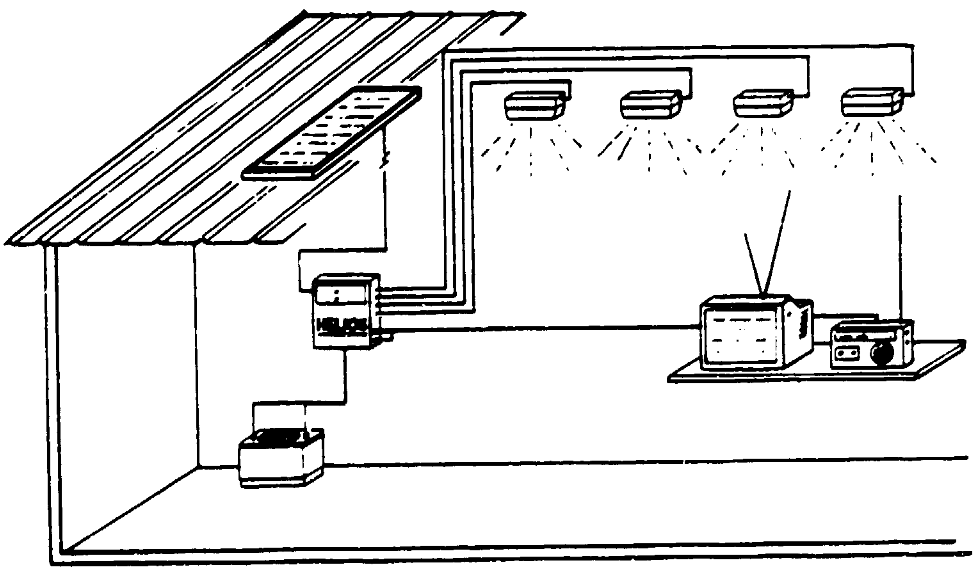
M40 is a solar system for lighting of rural houses, health centres, public offices, etc.

Every night free electric energy will be available to **power the four fluorescent lamps for** a total number of about **10 hours/night.** Each lamp has a light intensity equivalent to a 60 Watts incandescent light-bulb.

M40 is equipped with a 20 Amps power output plug where other appliances can be connected (i.e. **other 16 extra lamps**, radio set, portable TV, etc.).

M40 main features are:
- maintenance free.
- very easy to install (all components are preassembled and ready to be connected by blugs)
- long lifetime (typically more than 15 years)
- lightweight and easy to be trasported
- all components (solar panel, battery, lights, wires, switches, etc.) are enclosed in
- no monthly electric bills.





How M40 works:

The 40 Watts solar panel, to be fixed on the roof, transforms daylight into free electric power that is stored in a low maintenance battery and made available 24 hours/day.

A typical use of M40 kit is as follows:

- lighting of kitchen	5 hours
- lighting of dining-room	3 hours
- lighting of one bedroom	1 hour
- lighting of second bedroom	1 hour
Total (average)	10 hours every night

Besides a portable radio can be powered for a few hours (during day-time and night-time).
A 12 Volts portable TV can also be powered.

M40 solar lighting system is composed of:

— **one H40 solar panel** (40 Watts - 12 Volts) to be fixed on the roof. The panel is equipped with a 6 metres wiring and plug.
— **one control unit** including a charge regulator with warning lights, sockets for easy connection of panel and lamps, the lamps switches and the battery cable.
— **four LH12 fluorescent lamps,** each one equipped with a 6 metres wire and plug for an easy connection.
— **one low maintenance 12 Volts - 100 Ah battery.**
— **one voltage adaptor** suitable to power radios working at 3 - 4,5 - 6 - 7,5 - 9 Volts dc.
— **one installation handbook.**
— **one set of spare parts** including fuses, bulbs, etc. to grant a perfect working for many years.

OPTIONALS

M40 is ready to be equipped with the following items:

— one extra H40 solar panel to double the number of lighting hours per night.
— up to 16 extra lamps can be added and connected to the power output plug.

Upon request M40 kit can be supplied without battery and be connected to a locally available car battery.

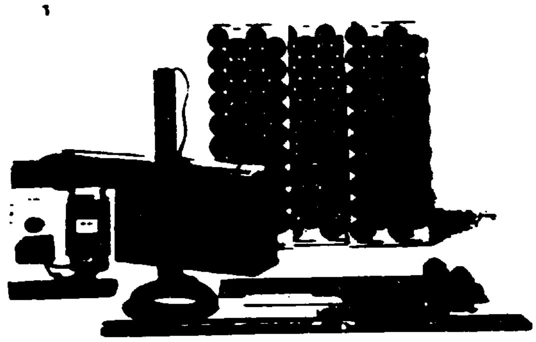
Weight of M40 kit is	Kg. 12
Weight of battery is	Kg. 29
Total weight is	Kg. 41

Once installed, M40 kit gives you the lighting of your house for more than 15 years without running costs!

The above performances are based on an average insolation of 6 KWh/sq.m./day, which is typical of tropical countries.

SOLAR PUMPING SYSTEM

KIT KTSP.....



It is a complete system working at low costs. It includes: photovoltaic modules, metallic support structure, inverter, multi-stage pump, set of wires and other components. The plumbing works are not included.

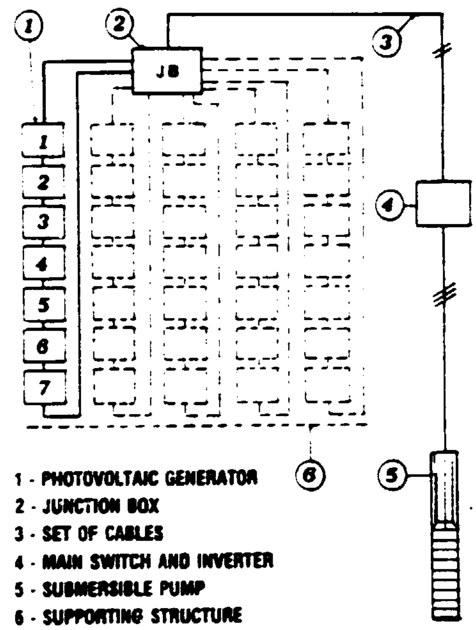
One of the most important problems afflicting human life conditions is the water supply. In fact a high insolation in many tropical countries has caused precarious life conditions because of the lack of water. Very often the water level is not too far below the ground but these areas often lack electricity to power the pumping systems which should pump the water up. Helios Technology has designed a photovoltaic solar generator that connected to the best submersible pumps makes it possible and even advantageous to search for water even in desert areas and at depths of over 100 mts.

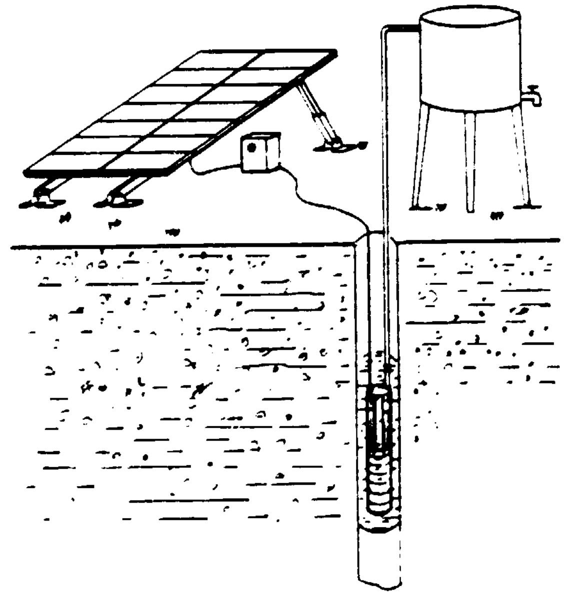
The protovoltaic solar generator is a maintenance free component having a long life. It does not pollute the environment and its combination with submersible pumps made of steel with 4" and 6" is the best solution to the water supply, as it is easy to install and reliable along the years.

The submersible pumps are set into motion by engines working in alternate current by means of a special inverter DC/AC which has an efficiency higher than 90%.

Submersible pumps working in alternate current solve the problem of the brushes maintenance, while with direct current the problem could not be easily solved.

The photovoltaic systems whose various models are written on the back of this sheet, are subdivided according to their different H total head values (in mts.) and to their daily water-flow (in m³/day). The data on the table are based on an average daily insolation of 6,5 kwh/m². When the daily insolation is inferior to the one quoted the quantity of water will also be inferior.





HELIOS TECHNOLOGY RESERVES THE RIGHT TO MAKE VARIATIONS WITHOUT PREVIOUS NOTICE.

PHOTOVOLTAIC SOLAR GENERATOR COMPOSED OF 8 MODULES TYPE H40 CONNECTED IN SERIES

PUMPING SYSTEM TABLE

H	KTSP 403-A	KTSP 404-A	KTSP 405-A	KTSP 402-B	KTSP 403-B	KTSP 404-B	KTSP 405-B	KTSP 402-C	KTSP 403-C	KTSP 404-C	KTSP 405-C	KTSP 402-D	KTSP 403-D	KTSP 404-D	KTSP 405-D	KTSP 403-E	KTSP 404-E	KTSP 405-E	KTSP 403-F	KTSP 404-F	KTSP 405-F
5	130	190	230	80	120	150	170														
8	40	90	140	40	80	110	140	50	70	85	100	40	50	60	65						
11				10	50	80	100	35	55	75	85	35	45	55	60						
20								8	25	40	55	20	35	42	55						
30												10	20	28	35	19	23	28			
40												3	10	18	25	15	19	24			
50																11	15	20			
60																8	12	16			
70																6	9	13			
80																4	7	10	5	7,5	9,5
90																			4,2	6,5	8,8
100																			3,5	5,8	8
110																			2,8	5	7
120																			2	4,5	6

H DAILY WATERFLOW IN CUBIC METRES / DAY

ESEMPIO: The KTSP 403-B model is able to pump 80 m³/day with 8 m head.

PHOTOVOLTAIC SOLAR GENERATOR COMPOSED OF 8 MODULES TYPE H45 CONNECTED IN SERIES

PUMPING SYSTEM TABLE

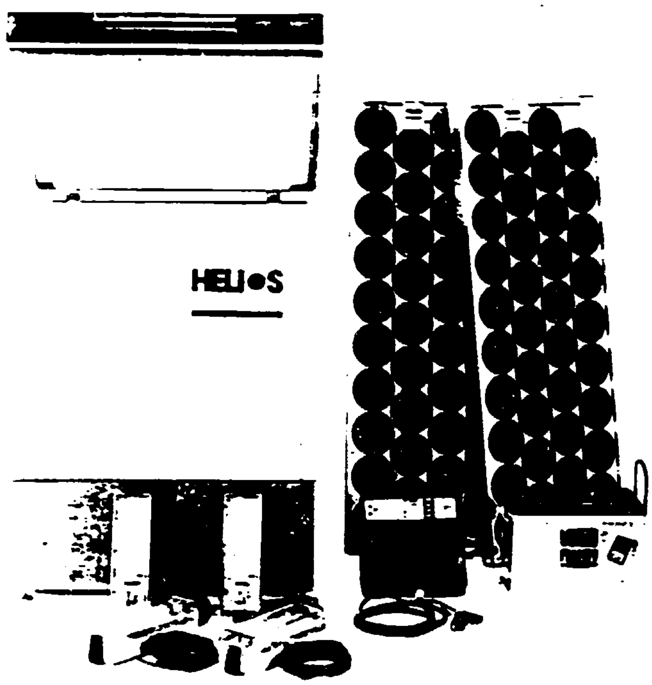
H	KTSP 453-A	KTSP 454-A	KTSP 455-A	KTSP 452-B	KTSP 453-B	KTSP 454-B	KTSP 455-B	KTSP 452-C	KTSP 453-C	KTSP 454-C	KTSP 455-C	KTSP 452-D	KTSP 453-D	KTSP 454-D	KTSP 455-D	KTSP 453-E	KTSP 454-E	KTSP 455-E	KTSP 453-F	KTSP 454-F	KTSP 455-F
5	175	256	310	108	162	202	230														
8	54	121	189	54	108	148	189	68	94	115	135	54	68	81	88						
11				13.5	68	108	135	47	74	101	115	47	61	74	81						
20								11	34	54	74	27	47	57	74						
30												13,5	27	36	47	26	31	38			
40												4	13,5	24	34	20	26	32			
50																15	20	22			
60																11	16	21			
70																8	12	17			
80																6,5	9	13,5	7	10	13
90																			5,6	8,8	11,9
100																			10	7,8	18,8
110																			3,8	6,8	9,5
120																			2,7	6	8,1

H DAILY WATERFLOW IN CUBIC METRES / DAY

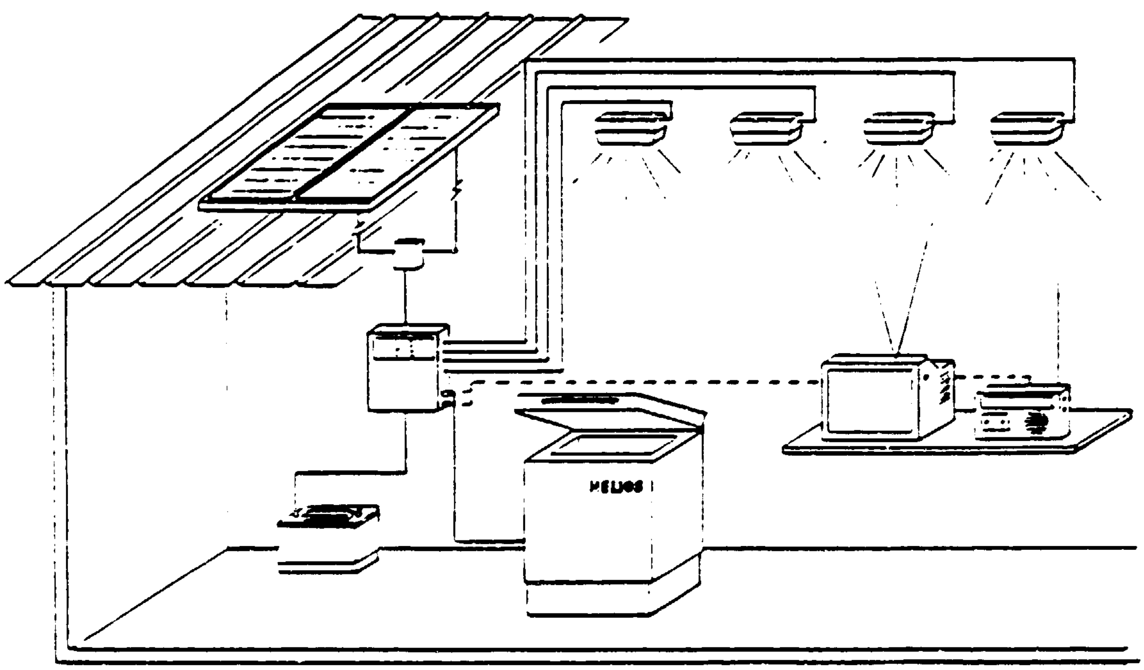
SOLAR REFRIGERATION SYSTEM

KIT FR50

FR50 is a low cost complete system, including a special refrigerator for vaccine storage or food conservation and four lamps for lighting purposes.



It has been conceived to operate in rural areas where there is a high degree of humidity and high temperatures. This system is suitable for both domestic and clinical uses. It solves forever lighting and refrigeration problems, working without pollution or noise.
Tha:ks to the advanced technology of these products, 24 hours a day electricity for lighting and refrigeration purposes can be obtained without maintenance or operating costs.
The **FR50** system can also power other appliances (such as 12 other lamps, radio set, portable TV, etc.) working at direct current, from 3 to 12 Volts. The special voltage adaptor allows powering any commercial appliance.



The FR50 main advantages of the FR50 are the following:
— simple and easy installation, which can be done in a few minutes, as all the components are already wired.
— high operating reliability
— sturdy construction (there is no possibility of damaging the system, either during installation or when it is used).
— long life-time (more than 15 years)
— light weight and reduced bulk
— no operating cost.

Performance and use
The **FR50** solar refrigeration system grants **24 hours a day perfect vaccine storage or food conservation. Besides it allows an 8-10 hours lighting period nightly.**
Thanks to the energy stored in the battery and to the low consumption appliance, the system operates also during long periods of bad weather. The high system efficiency allows these exceptional performances.
In particular, the refrigerator is manufactured by Helios with a 12-centimeter thermal insulation.
The LH12 fluorescent lamps, supplied with the system, consume only 12 Watts but have a light intensity corresponding to the traditional incandescent 40-Watt light-bulb and their life-time is longer than 5000 hours, corresponding to several years of use.
The **FR50** solar refrigeration system can also be used by untrained personnel, as it is protected against misuse.
It has been created to operate in places where there is a humidity percentage up to 100% and with external temperatures higher than 40 degrees centigrade.

The FR50 solar refrigeration system is composed of:
— 2 Helios photovoltaic modules (type H40), with support structures, wires and connection plugs.
— 1 electronic control board containing the charge control unit, signalling lamps, switches and fuses.
— 1 storage battery (12 Volts - 150 Amperes hours).
— 1 special low consumption, battery-powered FRB50 refrigerator. It has a 50-litre capacity and an internal temperature between +2 and +8 degrees centigrade.
— 4 Helios LH12 fluorescent lamps (12 Volts - 12 Watts), each one with a 6 metre wire and plug.
— 1 voltage adaptor suitable to power any appliance working at 3 - 4,5 - 6 - 7,5 - 9 - 12 Volts.
— 1 instruction handbook for the correct installation and use of the **FR50** system.
— The **FR50** system is already wired and complete with all parts and materials.
Thanks to the junction connectors among the several components, the system can be quickly assembled without making any mistakes.
Upon request, up to 12 extra lamps can be added to the **FR50** system.

Characteristics
Total weight of the system: Kg 150
Total volume of the system: m^3 0.86
Packing: wooden box cm 100 x 75 x 105

Helios Technology manufactures several solar powered refrigeration systems, including low consumption refrigerators and deep-freezers (temperature -10°C) suitable for food freezing, with 130- and 300-litre volume.

The above-mentioned performances are based on an average insolation of 6 KWh/sq.mt/day, which is typical of tropical areas.
For other places Helios reserves the right to size the system so that it suits the particular environmental and use conditions.

2.3 THE MARKET

2.3.1 Notes on the world market

A comprehensive historical analysis of the photovoltaic market in the world (trends, territorial subdivisions, pricing, etc.) is offered in the following tables 4 and 5 and by the fig. 6.
The differences between the two tables are due to a revision of the data concerning the years 1983 and 1984: in table 4 forecastings have been included, while the values in table 5 should be actual data.
The tables 4 and 5 give evidence of the growing importance of extra U.S.A. market: from the 40% in 1983 to 54% in 1984; this result seems due first of all to the availability of financial facilitations for investment in this field (see para 2.3).

The successive table 2.3 shows the importance of the various applications on the total market, present and future: two of the most promising sectors are the "water pumping" and the "remote villages electrification", which are of special interest for the developing countries whose potential market for these items is very large.
The forecasts for the year 2000 are perhaps optimistic: in any case even the trend in the module pricing, as shown in fig. 6 is a confirmation of a likely large expansion of this sector.

Table 4

Photovoltaic World Production(1)

Year	U.S.A.			All other countries			Total		
	M$	kWp	%(2)	M$	Wp	%(2)	M$	kWp	%Wp
1976	5.7	207	86	1.1	34	14	6.8	241	28.46
1977	7.6	416	92	1.0	34	8	8.6	450	19.13
1978	11.6	841	88	2.4	114	12	14.0	955	14.68
1979	15.3	1,240	85	4.3	220	15	19.6	1,460	13.43
1980	32.3	2,876	86	7.0	454	14	39.3	3,330	11.80
1981	37.1	3,960	75	19.8	1,335	25	56.9	5,295	10.76
1982	42.8	4,630	60	39.9	3,070	40	82.7	7,700	10.74
1983(3)	76.2	9,680	63	60.4	5,650	37	136.6	15,330(4)	8.91
1984(3)	88.8	12,000	56	82.5	9,300	44	171.3	21,300(5)	8.04

(1) Photovoltaic modules with supports - kWp: peak kilowatts
(2) tal market percentage
(3) Estimated
(4) 99% increase from 1982 to 1983
(5) 39% increase from 1983 to 1984

Table 5

Photovoltaic World Production in MWp

			Variation	Market division	
	1983	1984		1983	1984
U.S.A.	9.3	8.5	+9%	60%	46%
Japan	3.8	6.6	+74%	24%	36%
Europe	2.2	2.6	+18%	14%	14%
Others	0.3	0.8	+167%	2%	4%
Total	15.6	18.5	+19%	--	--

baldo & c.

Fig. 6 Photovoltaic modules; module and system cost (Japanese source)

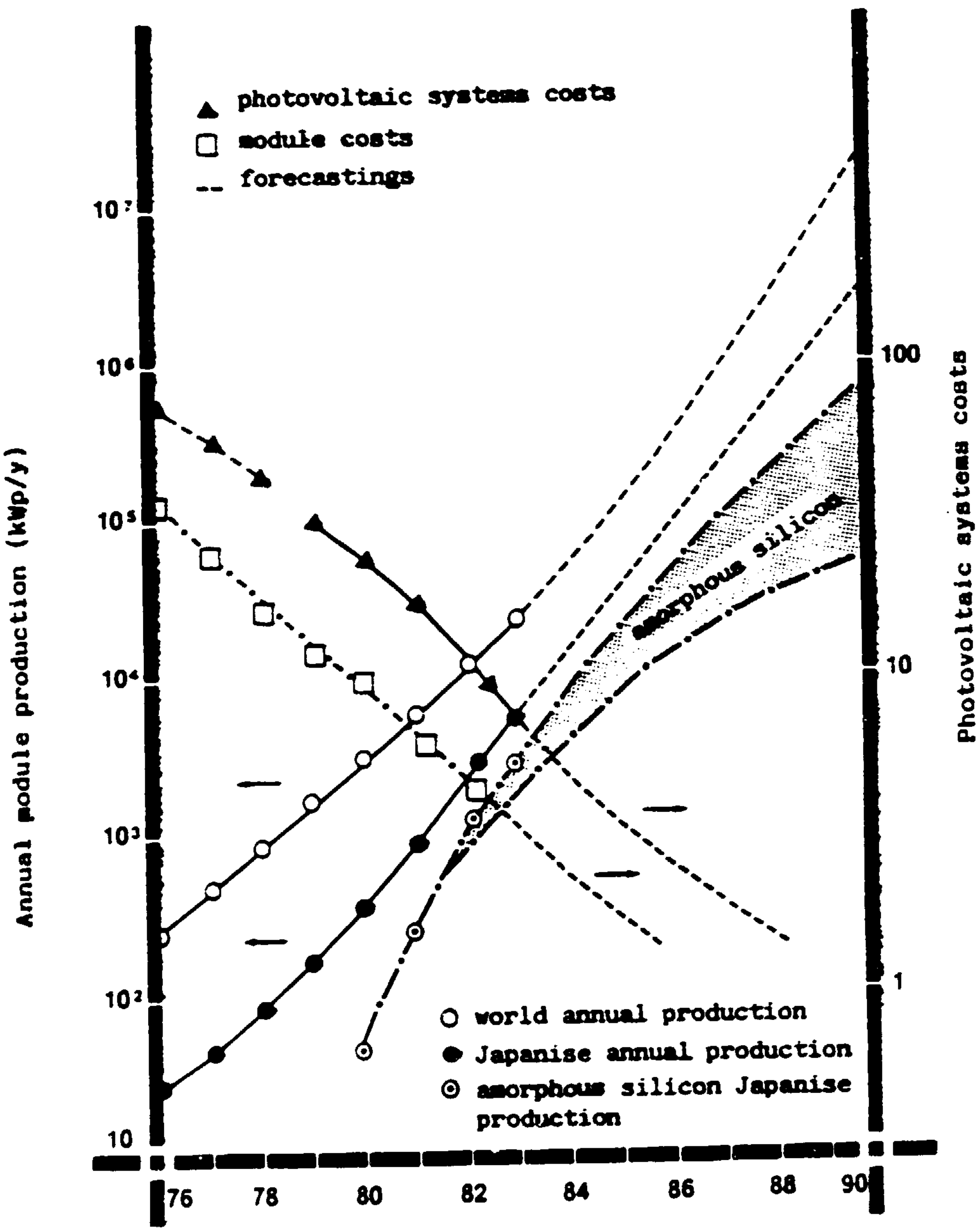


Table 7

Photovoltaic modules annual production subdivided into applications

(actual 1982 values and future projections) MWp

Communications	1.776	2.125	5.3	12	84	304
Telemetering	0.126	0.140	0.2	1	3	5
Cathodic protection	0.234	0.350	0.8	3	15	45
Navigation signals	0.164	0.180	0.3	2	3	3
Railway signals	0.099	0.120	0.3	2	3	5
Water pumping	0.418	0.650	1.8	8	100	76
Remote village electrification[6]	0.658	0.965	3.1	12	220	1,400
Others[7]	0.613	0.750	0.9	1	2	3
	--------	--------				
Subtotal	4.150	5.280				
Consumer[8]	1.090	2.400	4.2	8	10	12
Plants connected to the grid	0.060	0.200	1	6	65	260
Governmental projects	1.200	2.450	5	6	5	3
Special projects	1.200	5.000	6	--	--	--
	--------	--------	---	---	---	-----
Total	7.700	15.33	28.9	60	510	2,800

Source: Strategies Unlimited and Baldo & C.

The most recent information on the world market for photovoltaic systems show that in 1989 the production reached 42 MWp in 1988. The same 20% increase in world market existed for 1988 over 1987.

The market increase by area is as follows:

United States	33%	
Europe	23%	
Rest of the world	44%	(Japan excluded)

It is very important to notice that the developing countries are increasing the demand of photovoltaic systems at a much faster rate than forecasted: in the last four year the demand increased by 400%.

In developing countries major applications are:

- communication

- water pumping

- houses/villages electrification

- fencing electrification in ranching

(6) Including desalinators, medical supply refrigerators, etc.

(7) Including remote areas lighting, airports lighting, etc.

(8) Watches, calculators, toys

2.3.2 <u>The market of photovoltaic systems in Zimbabwe</u>

2.3.2.1 **Energy in Zimbabwe**

The total quantity of energy consumed in Zimbabwe in 1982 amounted to 244 Peta Joules (PJ or 10^{15} Joules) or 40 million barrels of oil equivalent[9].

- Wood accounted for over 50% of the total energy consumption, the other fuel supplies were coal and coal products (20%), liquid fuel (11.3%) and electricity (11.1%).

- Rural energy consumption accounted for over 60%. The majority of this was used by rural household for cooking (133 PJ). Fuelwood and construction wood accounted for nearly 99% of the energy used by rural households.

- Agricultural energy consumed 20.8 PJ or 8.5% of natural end use demand. The large scale commercial farming sector used over 90% of all energy used in agriculture.

- Mining and manufacturing establishments consumed nearly 50 PJ. Coal and coke are the most important industrial energy fuels followed by electricity.

- The transportation sector 28.2%, diesel fuel the most important followed by coal and petrol.

- In 1982 the-e end-use energy demand were met through the consumption of 8.96 million tonnes of wood, the extraction of 2.8 mill. ton coal, the generation of 7.8 thousand GWH and the consumption of 630,000 ton of liquid fuel.

<u>ENERGY CONSUMPTION IN 1982 AND (2002)</u>
<u>ALL DATA IN PETA JOULES</u>

	Paraffin	Diesel	LPG	Coal/Coke	Electricity	Fuel wood
Rural household	0.74(1.2)			2.7(1.84)	0.13(0.2)	102.2(167.82)
Urban household	0.25(0.68)		0.02(0.04)	0.7(2.23)	3.45(8.02)	3.19(9.18)
Agriculture		2.78(2.82)		8.79(8.79)	1.94(2.05)	7.32(7.32)
Industry		0.91(1.75)		14.14+13.45	17.35(33.61)	
				(28.27+23.26)		
Municipality					1.34(3.88)	
Informal ind.	--				0.02(0.04)	0.24(063)
Commercial		0.37(0.72)			2.04(3.96)	

According to demographic projection in 2002 the population should be 14.4 mil and 60% of population will live in the rural areas.

Total energy forecast is in 2002 399.5 PJ or 65.3 million barrels oil equivalent.

The demand for wood will grow to nearly 13.7 million tons by 2002.
This will result in serious wood shortage where neither yields nor stocks will be sufficient to meet demand in the majority of the country.

Mashonaland East will begin to experience absolute shortage of accessible wood resources in 1992. Manicaland and Masvingo will face the same problems in 1997.

(9) Source: Policy options for energy and development in Zimbabwe. The Beijer Institute, Royal Swedish Academy of Sciences, 1985.

- critical shortage of fuelwood will occur in the next decade forcing rural households to revert to other more expensive commercial fuels, thus placing a heavy burden on them.

- Rural areas currently face shortage of development energy particularly for draught power and water pumping.

- Electricity generation will increase to 15.4 thousand GWh by 2002.

- Farm forestry has the advantage they do not take land out of agricultural production. Small, unused parcels of hard can be devoted to tree-crop production and if species are carefully selected, trees can be interplanted with agricultural crops with no appreciable decrease in yields.

- Urban electrification could result in a saving of about 563,000 tons of wood and 20 mil litres paraffin.

- In 1985 only 200,000 households were electrified, mainly urban areas while the bulk of the rural households that are over 1,150,000 in number rely on fuelwood for cookies, heating and lighting. Paraffin is used largely for lighting in rural households.

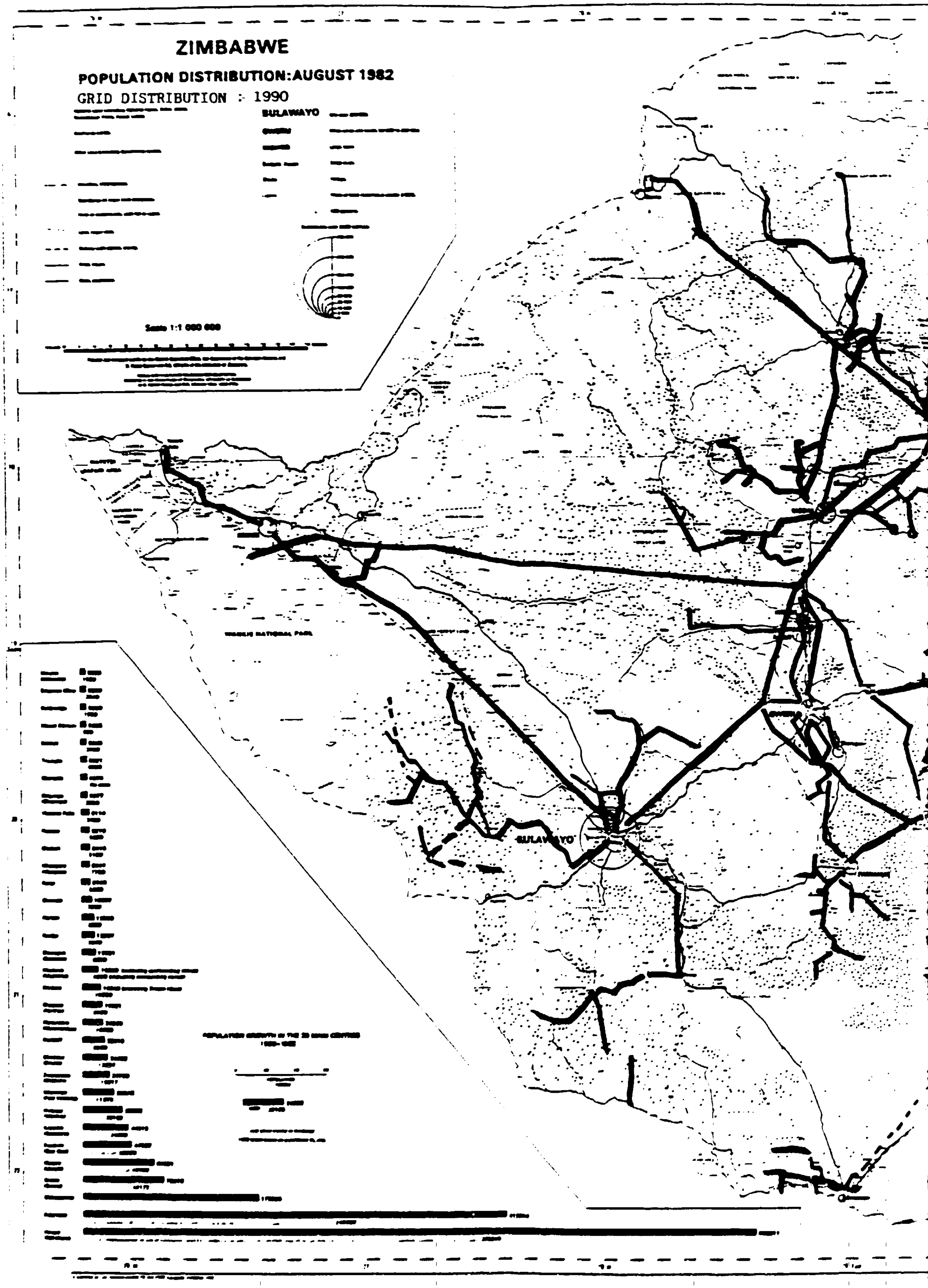
In 1982 Rural households are divided as follows:

	Popul. ('000)	Average household size	Number of households (1000)
Communal Areas	4,331.5	5	866.3
Resettled Areas	128.7	4.7	25.8
Small scale commercial farms (SSCFA)	182.1	7	26
Large scale commercial farms (LSCFD)	1,068.4	4.5	237.4
TOTAL	5,710.6	4.9	1,155.5

Rural household end use energy consumption (Peta Joules or million giga Joules)

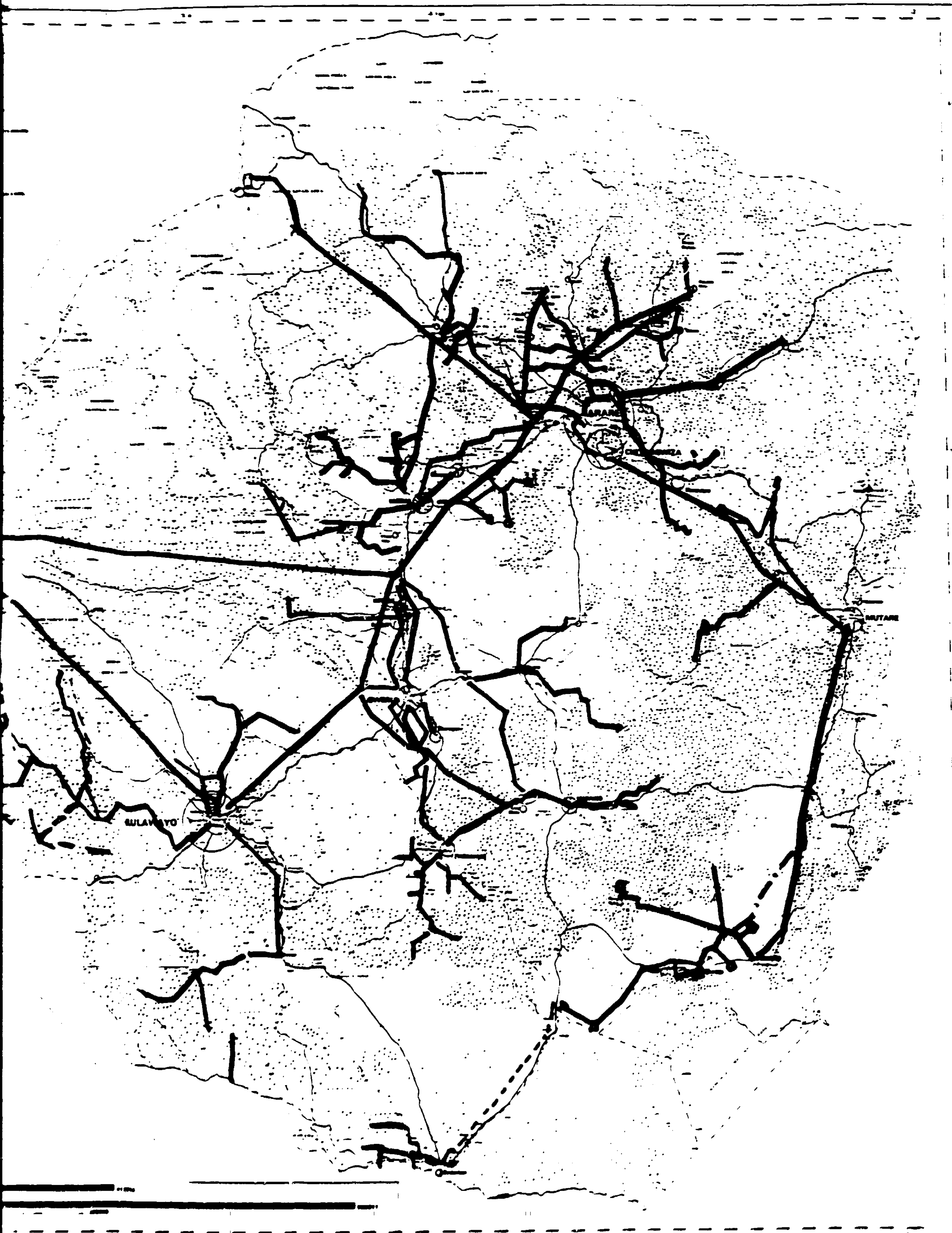
	Fuelwood	Petroleum	Paraffin	Coal	Electricity	Total
Communal areas	79.56	22.44	0.60	--	0.11	102.71
Resettled areas	2.46	0.90	0.01	--	--	3.37
SSCFA	2.57	0.18	--	--	--	2.76
LSCFD	17.67	3.93	0.12	2.7	0.02	24.43
	102.26	27.45	0.73	2.7	0.13	133.27

In communal areas 0.1% of the households have electricity and 0.6 uses paraffin. In large-scale farms 0.1% have electricity and 0.4 uses paraffin.



ZIMBABWE
POPULATION DISTRIBUTION:AUGUST 1982
GRID DISTRIBUTION : 1990
BULAWAYO
Scale 1:1 000 000
BULAWAYO

SECTION 1



SECTION 2

Energy for agriculture (Peta Joules) by source

	Diesel	Coal	Electricity	Wood	Tot.
Commercial	0.02	--	--	--	0.02
Large-scale farms	2.65	8.75	1.81	7.27	20.49
Resettlement	0.01	--	--	--	0.01
State farms	0.07	0.02	0.10	--	0.19
Small scale farms	0.02	--	--	--	0.01
Small scale irrigated farms	--	--	0.01	--	0.01
Cooperative farms	0.02	0.02	0.02	0.04	0.1
	-------	-------	--------	-------	------
	2.79	8.79	1.94	7.31	20.83

Large scale farm uses 95.3% of all diesel corresponding to 45.5 GJ/ha. 93.3% of electricity is also used by large-scale farms corresponding to 3.1 GJ/ha while the State farms use 6.2 GJ/ha.

Urban household end use energy consumption in 1982 (Peta Joules)

	Paraffin	LPG	Electricity	Coal	Fuelwood	Total
High density areas	0.15	0.01	0.88	0.7	2.35	4.09
Low density areas	0.1	0.01	2.57	--	0.84	3.51
	-----	------	------	-----	------	------
	0.25	0.02	3.45	0.7	3.19	7.6

Tot of 344,000 urban household (299,000 in high density areas).

A high density household will use an average of 17.9 MJ of energy per annum. A low density 30.5 MJ. Electricity average consumption is 22.3 GJ/household in low density and 3.8 in high density.

As far as the electric energy is concerned Zimbabwe is a net importer. The electrical energy distributed is shown in the following table:

(Values in million KWh)

Year		Of which imports
1980	7,272	--
1981	7,524	11.2
1982	7,742	15.3
1983	7,466	18.4
1984	7,455	13.1
1985	8,093	13.5
1986	8,498	21.7
1987	8,713	16.8
1988	9,037	17

As shown in the enclosed map the grid is quite extended but only geographically and not as far as the number of households connected.
In fact the construction of the grid has been carried out, in the past, in order to privilege the mining and the large farms activities. If comparing the distribution of the grid with the map of the population in the country a large portion of population has no access to electrical energy from the grid.

The programmes of rural electrification and extension of the grid stated in 1974-1985 have slowed down or even halted in 1986 due to the lack of foreign exchange needed to import equipment and items needed (transformers, insulators, meters, etc.).

The lack of distribution equipment and their high cost make the connection very expansive for households not only in the rural areas but also in the urban areas (the connection fee is 2500 $ in urban areas).

The number of households connected is now estimated in 300,000 over a total of 1,700,000. The consumption of electric energy by the households is therefore low as shown by the following table[10]

Year	Electric energy used by domestic consumers (millions of kWh)
1980	928
1981	990
1982	988
1983	926
1984	926
1985	1,221
1986	1,278
1987	1,298
1988	1,363
1989(estimates)	1,445

The situation is also bad from the reliability of energy supply and since 1989 the number and length of black-outs have been increasing.

Summarizing the energy supply/use data it can be pointed out that:

- conventional energy supply is in shortage

- only a limited number of households (approximately 20%) are supplied with energy. In rural areas electrification is insignificant.

- Only large commercial farms are supplied with energy and this is generally only used to power irrigation schemes and few other points within the farms.
  Small scale farms, commercial land, resettled lands have very little access to power, therefore to irrigation. Jeopardizing, in many cases the efforts to increase yield.

2.3.2.2 Traditional energy saving

It is worthy of mention the fact that for each MWatt (i.e. 1,000 kW) of photovoltaic panels installed the amount of traditional fuel oil saved may be evaluated in the range of more than 800 tons per year, saving about 450,000 US Dollars at the curent price of diesel oil.

As a matter of fact, assuming that the photovoltaic cells can supply electric energy during 8 hours each day through 360 days per year, the relevant supplied energy will be 2,880,000 kWh/year. This energy can be supplied by traditional diesel-engine coupled generators consuming about 830 tons of high-cost fuel.

(10) Quarterly Digest of Statistics, Central Statistical Office, Harare, June 1969

In case the whole full production of the plant should be sold and installed (3 MWatts/year), the saved diesel oil will reach 2,400 tons/year and the relevant hard currency 1,350,000 US Dollars. In such a manner, owing to the new installations added to the existing ones, saving of fuel and relevant hard currency will be increasing, year by year.

In conclusion, the investment in photovoltaic modules as free energy source, is an investment for the future.

2.3.2.3 Present demand and supply

Four companies are active in Zimbabwe in the field of photovoltaics:

- William Smith & Gourock, Hi Tech

- McDiarmid, working with UK and Japanese companies

- Ecological Designs, representing Helios Technology

The history of photovoltaic in Zimbabwe started at the beginning of the eighties with a number of demonstration projects, namely:

- 1 photovoltaic powered clinic financed by the USA

- 1 7,5 kW unit to power Marymount Hospital

- 2 pumps and lighting sets donated to the districts councils by W. Smith & Gourock, Hi Tech to Katsande (Muzdi District) in November 1982 and Siyahokwe (Takawira District) in April 1983.
  The success of these systems rapidly spread in the country and several units were bought by the railways (more than 200 units already in operation) by the Telecommunication system and other agencies and private enterprises.
  In 1987 when the number of units was already in the hundreds a local company decided to start the production of photovoltaic modules on the basis of a Canadian licence. Plant was commissioned in 1988.

It was not a great success mainly because the company did not sell complete systems but only modules plus other components not well "homogenixed" among them. It has been seen that the photovoltaic system must be considered a single operating "block" in which each component is tied up with the upstream and downstream ones by a very unique and important relationship (dimensioning, characteristics, operation features, etc.); a failure in one of the components means the failure of the whole system.

Last but not least the Canadian licensor did shot down the operations and therefore cells are imported from various manufacturers with the results that, being characteristic of cells of various producers different systems cannot be standardized.

The failure of this industrial enterprise does not mean the failure of the concept, on the contrary, photovoltaic systems are becoming more and more requested and installed in the country and in the neighbourough ones.

- Even when power is available its reliability is low and large scale farms also are considering alternative sources of energy to overcome black-outs

- The programmes of rural electrification are going ahead very slowly for financial constraints

- The fee charged for grid connections is extremely high and few enterprises and households can afford it.

Large quarters of heavy populated towns are without electrical energy and local authorities are considering the possibilities of using alternative sources of energy for district lighting and to provide households with a minimum of energy.

The situation is therefore very promising for the development of alternative sources of energy.

An example of the wide acceptance of photovoltaic systems is for instance given by the fact that in Zimbabwe Railways and National Parks Authority decided to cover all energy needs by means of photovoltaic systems. Copy of the tender of National Railways for 228 systems is in Annexe to this report.

1) The Zimbabwe Development Bank is now requiring that alternative sources of energy can be taken into consideration for all new projects (and photovoltaic systems could be suitable for a number of that).

2) Malawi has recently got a grant from the World Bank worth 10,000,000 US $ to finance 400 pumping systems that will be powered by photovoltaic systems.

3) Tanzania has eliminated all duties on the import of renewable energy products and it is considered to become a major user of photovoltaic systems in a very near future.

4) South Africa imported photovoltaic modules equivalent to 1 MWatt in 1990 and it is expected that importations will reach 1.8 MWatts in 1991.

One of the companies presently involved in photovoltaic systems sales (Ecological Design) recently started an aggressive marketing programme consisting of:

- appointment of sole distributors in all important towns;

- organization of a stock with a considerable number of systems for early delivery;

- presentation of operating systems at various national and international exhibitions;

- organization of show rooms at company offices.

The results of this strategy have been very encouraging for all applications of photovoltaic systems.

2.3.2.4 Potential market in Zimbabwe

<u>Pumps</u>

The BEIJER Institute [11] study indicates that "one solution to the problems of low productivity in communal agriculture is the expansion of irrigation into communal areas". However, if this option is to be seriously pursued, careful through must be given to the energy source being used to pump the irrigation water. Diesel pumps would required increased imports of fuels, and electric pumps would require expensive extension of the electricity grid.

If the policy is to be pursued, an evaluation of alternative pumping technologies should provide an integral part of the analysis.

As a matter of fact, several studies and symposis have discussed the water pumping and compared various energy sources:

- wind mill

[11] See previous note

- ox pump

- hand pump

- electric pump

- solar pump

- diesel pump

The results of these studies are variable and depend ont the site and hypothesis taken for the main variables which are:

- availability of money

- availability of foreign currency

- fuel escalation probability

- availability of wind

- actualization factor etc.

The BEIJER Institute had estimated that up to the year 2002, 10,000 photovoltaic units could be installed, while they estimated 50,000 wind mills. We are of the opinion that a part of the potential wind mill market could be taken by photovoltaic pumps. Other markets for pumping should also be considered like boreholes for drinking water for man and animals, the water supply in national parks and many others.

Small power generators

For electricity requirements below 2 kWh a day, photovoltaic systems could be more interesting than diesel power generators. In the future with decreasing photovoltaic costs, the higher loads could become interesting for photovoltaic systems.
The present market of small disel generators is around 1,000 units/year, a reasonable share of this market could be taken over.

Household applications

It has been seen that 70 to 80% of all households are in lack of electric energy. The photovoltaic systems can be used in two main cases:

- single household application, providing energy for low consumption lights, radio/TV set and, if needed, a refrigerator;
- district/village application, providing energy for the uses as in the previous example and, in addition, limited street lighting and light + refrigeration + radio/TV/communication to local social services.

Beside the social aspect of the availability of electric energy there is also the import substitution one that should be taken into consideration. A large amount of paraffin (over 70,000 tons/year) is imported and its use is mainly for lighting purposes.

Touring Industry

The touring industry is rapidly expanding and is becoming a major customer of photovoltaic systems.

Conclusions

We believe that a large potential market exist for photovoltaic equipment in Zimbabwe. The market penetration will depend on:

- availability of foreign currency (this drawback could be overcome by partial local production of equipment);

- future price trends of diesel fuel (we believe it will increase under the pressure of the World Bank recommandations);

- future trends of photovoltaic prices, it is decreasing probably not as quickly as expected but will do so with the introduction of the new technology (amorphous silicon).

Main markets will be:

- farmers (mainly for water pumping);

- commercial enterprises in growth points and rural areas (refrigeration and lighting);

- households (lighting and refrigeration);

- municipalitities (district lighting);

- governmental agencies (schools, railways, communication, army);

- Town Councils and Rural District Councils (Schools, staff housing etc., tender for 100 systems recenty issued).

The cost of the photovoltaic system is quite high but an investigation carried out during the April 1990 international trade fair at Bulawayo has shown that the energy issue is getting the highest priority and public and operations reacted very favourably to the systems proposed and relevant prices.

2.3.2.5 Potential export market

The 50% of the production of the envisaged factory will be exported to South Africa, Malawi, Botswana, Tanzania and other African countries.
Selling agents already exist in Malawi, Botswana, Namibia, Tanzania and agreement is under negotiation for Mozambique.

The licensing company Helios Technology is presently distributing its products through distributors in South Africa, Swaziland and Lesotho. Once the Zimbabwe's envisaged plant will be in production this will supply the products to all of these countries. In addition the proposed plant will be the only one of this type in the whole Africa and it will be qualified to export to PTA countries as well as to Malawi and Botswana or OGL (Open General export Licence) duty free for all parts having 25% of local components as in this case.

2.3.2.6 Marketing

For the marketing organization it is foreseen one main distributor each 55 growth points and in each main city.

2.3.2.7 Benefits arising from the photovoltaic modules project

Benefits arising from the production in Zimbabwe of photovoltaic modules and complete systems will be the following:

- decrease of import of electric energy;
- saving of electric components and electric lines (grid system) for distribution to final users;
- decrease of foreign exchange for diesel fuel, diesel engines and spares, paraffin and other materials actually used for lighting purposes;
- increase of agriculture output due to irrigation (solar pumping systems);
- increase of tourism, mainly safari;
- increase of trading turn-over by rural traders due to availability of solar lighting and refrigeration systems;
- decrease of food losses due to refrigerators availability;
- creation of 330 new jobs for installation of the solar systems (considering 6 operators for each of the 55 rural growth points);
- additional job opportunities in the urban centres for distribution and installation of the solar systems;
- additional job opportunities for additional crops processing (increasing yield of agriculture due to irrigation performed by means of solar pumping systems);
- income generation for rural entrepreneurs to set up battery charge services;
- better living conditions (lighting, food refrigeration, radio and TV sets fed by free available electric energy, etc.);
- educational benefits from use of audio-visual aids in schools;
- better conditions for growth points developments;
- decrease of deforestation (saving of fuelwood);
- clean and renewable energy.

2.4 PLANT PRODUCTION CAPACITY

2.4.1 Sales estimate

The capacity of the plant has been calculated on the basis of the following sales estimate, taking into consideration that the new joint venture company will concentrate in the supply of complete solar systems designed to solve specific problems (refrigeration, lighting, water pumping, etc.) and not merely of single panels.

This is a dramatic change in phylosophy compared with previous, and unsuccessful, approach in the country and it is considered the most appropriate one to really develop the market of the solar systems in the whole sub-region.

SALES ESTIMATE				
ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
A) Solar lighting systems [1]	720	1,800	5,800	7,500
B1) Solar refrigeration system (190 lit.) [2]	80	180	580	720
B2) Solar refrigeration system (300 lit.) [2]	40	120	380	480
C) Solar water pumping systems [3]	35	85	280	350
Solar power produced (Total)	0.1 MW	0.26 MW	0.84 MW	1.06 MW

2.4.2 Components of the systems

The above mentioned systems consist of the following components (technical features are available in the annexed brochures):

A) Solar lighting system with 4 fluorescent lamps

- No. 1 photovoltaic module 60 W (type H60)
- No. 1 control unit including a charge regulator
- No. 4 low consumption fluorescent lamps
- No. 1 low maintenance battery (12 Volt-100 Ah)
- No. 1 voltage adaptor
- No. 1 set of cables and accessories

B1) Solar refrigeration system (190 litres capacity) complete with 4 lamps for lighting purposes

- No. 6 photovoltaic modules 60 W (type H60)
- No. 1 supporting structure

(1) Medium size system with 4 low consumption lamps
(2) System including freezer and 4 low consumption lamps
(3) Medium size system with pumping capacity of 40 cubic meters/day at 8 meters of depth.

- No. 1 junction box
- No. 1 electronic control board including the charge control unit
- No. 2 storage batteries (12 V-150 Ah)
- No. 1 battery powered 190 litres refrigerator
- No. 4 low consumption fluorescent lamps
- No. 1 voltage adaptor suitable to power any appliance working at voltage ranging from 3 to 12 Volt.
- No. 1 set of cables and accessories

B2) Solar refrigeration system (300 litres capacity) complete with 4 lamps for lighting purposes

- No. 8 photovoltaic modules 60 W (type H60)
- No. 1 supporting structure
- No. 1 junction box
- No. 1 electronic control board including the charge control unit
- No. 2 storage batteries (12 V-150 Ah)
- No. 1 battery powered : 300 litres refrigerator
- No. 4 low consumption fluorescent lamps
- No. 1 voltage adaptor suitable to power any appliance working at voltage ranging from 3 to 12 Volt.
- No. 1 set of cables and accessories

C) Solar water pumping system, daily pumping capacity 40 cubic meters at 8 meters of depth

- No. 8 photovoltaic modules 60 W (type H60)
- No. 1 supporting structure
- No. 1 junction box
- No. 1 inverter
- No. 1 submersible pump complete with electric motor working in alternate current
- No 1 set of cables and accessories

2.4.3 Plant production lines

Taking into consideration the above mentioned production, the envisaged plant will essentially consist of three lines, that are the following:

A) photovoltaic modules assembling line

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B) components production line

C) systems assembling line

The first line A is designed to assemble the photovoltaic cells in modules type H60 (60 Watt peak power). All the cells, manufactured by Helios Technology, will be imported from Italy.

The second line B will produce various components, namely:

- charge controllers of various rating for batteries
- fluorescent lamp holders complete with electronic components
- electronic ballasts for feeding fluorescent bulbs
- junction boxes for photovoltaic modules
- photovoltaic module supporting structures
- electronic control boards
- voltage adaptors
- inverters.

The third line C will assemble the following systems:

- solar refrigerators
- solar lighting systems
- solar water pumping systems.

2.4.3.1 **Components required**

The following table displays the amount of components required by each unit of the systems marked A, B1, B2 and C.

Item	A	B1	B2	C
	Lighting	Refrig. 190	Refrig. 300	Pumping
	No.	No.	No.	No.
Photovoltaic module	1	6	8	8
Charge controller	1	1	1	--
Fluorescent lamp	4	4	4	--
Battery 12 V-100 Ah	1	--	--	--
Battery 12 V-150 Ah	--	2	2	--
Voltage adaptor	1	1	1	--
Junction box	--	1	1	1
Electronic cont.board	1	1	1	1
Inverter	--	--	--	1
Structure	--*	1	1	1
Set of cables & access.	1	1	1	1

* The photovoltaic module to be fixed on the roof.

A) SOLAR LIGHTING SYSTEMS

ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
Photovoltaic module	720	1,800	5,800	7,500
Charge controllers	720	1,800	5,800	7,500
Fluorescent lamp	2,880	7,200	23,200	30,000
Battery 12 V-100 A	720	1,800	5,800	7,500
Battery 12 V-150 Ah	--	--	--	--
Voltage adaptor	720	1,800	5,800	7,500
Junction box	--	--	--	--
Electronic cont. board	720	1,800	5,800	7,500
Inverters	--	--	--	--
Structure(4)	--	--	--	--
Set of cables & accessories	720	1,800	5,800	7,500

(4) The photovoltaic module to be fixed on the roof

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B1) SOLAR REFRIGERATION SYSTEMS (190 LITRES)

ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
Photovoltaic module	480	1,080	3,480	4,320
Charge controllers	80	180	580	720
Fluorescent lamp	320	720	2,320	2,880
Battery 12 V-100 A	--	--	--	--
Battery 12 V-150 Ah	160	360	1,160	1,440
Voltage adaptor	80	180	580	720
Junction box	80	180	580	720
Electronic cont. board	80	180	580	720
Inverters	--	--	--	--
Structure	80	180	580	720
Set of cables & accessories	80	180	580	720

B2) SOLAR REFRIGERATION SYSTEMS (300 LITRES)

ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
Photovoltaic module	320	960	3,040	3,840
Charge controllers	40	120	380	480
Fluorescent lamp	160	480	1,520	1,920
Battery 12 V-100 A	--	--	--	--
Battery 12 V-150 Ah	80	240	760	960
Voltage adaptor	40	120	380	480
Junction box	40	120	380	480
Electronic cont. board	40	120	380	480
Inverters	--	--	--	--
Structure	40	120	380	480
Set of cables & accessories	40	120	380	480

C) SOLAR WATER PUMPING SYSTEMS

ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
Photovoltaic module(*)	280	680	2,240	2,800
Charge controllers	--	--	--	--
Fluorescent lamp	--	--	--	--
Battery 12 V-100 A	--	--	--	--
Battery 12 V-150 Ah	--	--	--	--
Voltage adaptor	--	--	--	--
Junction box	35	85	280	350
Electronic cont. board	35	85	280	350
Inverters	35	85	280	350
Structure	35	85	280	350
Set of cables & accessories	35	85	280	350

(*) As average system it has been considered a model based on 8 photovoltaic modules, that is one of the most used.

RECAPITULATIVE TABLES OF THE COMPONENTS

The amounts of each component required in the whole to produce the scheduled systems are shown in the following table, detailed per each year according to the foreseen production program:

ITEM	TOTAL OF UNITS PER YEAR				
	1st year	2nd year	3rd year	4th year	NOTES[6]
Photovoltaic module	1,800	4,520	14,560	18,460	PIF
Charge controliers	840	2,100	6,760	8,700	PIF
Fluorescent lamp	3,360	8,400	27,040	34,800	PIF
Battery 12 V-100 A	720	1,800	5,800	7,500	imported
Battery 12 V-150 Ah	240	600	1,920	2,400	imported
Voltage adaptor	840	2,100	6,760	8,700	PIF
Junction box	155	385	1,240	1,550	PIF
Electronic cont. board	875	2,185	7,040	9,050	PIF
Inverters	35	85	280	350	PIF
Structure	155	385	1,240	1,550	PIF
Set of cables & accessories	875	2,185	7,040	9,050	local purch.

As far as the 190 and 300 litre refrigerators are concerned, the cabinet and various plastic and metal components will be manufactured locally, while the components listed in the following table will be imported:

(6) PIF = Produced in the factory
Imported = goods to be imported or purchased on the local market

190-300 litre REFRIGERATORS ASSEMBLING LINE

LIST OF ITEMS TO BE IMPORTED

ITEM	UNITS OR SETS PER YEAR			
	1st year	2nd year	3rd year	4th year
DC and AC low consumption compressors	80	180	580	720
Condensers (fan type)	80	180	580	720
Electronics for the DC compressor	80	180	580	720
Gaskets and magnets	80	180	580	720
Lock	80	180	580	720
Thermostat	80	180	580	720
Copper tubing	80	180	580	720
Insulating foam	80	180	580	720
Plasticized metal sheet	80	180	580	720
Epoxy coating	80	180	580	720
Polypropilene and HDPE in granules	80	180	580	720

2.4.3.2 Production program

The production program will be suited accordingly to the expected sales volume of the systems labelled A, B1, B2, and C, as explained in the paragraph 2.4.1. Therefore the production program will be as follows:

SYSTEMS PRODUCTION PROGRAM				
ITEM	UNITS PER YEAR			
	1st year	2nd year	3rd year	4th year
A) Solar lighting systems (1)	720	1,800	5,800	7,500
B1) Solar refrigeration system (190 lit.) (2)	80	180	580	720
B2) Solar refrigeration system (300 lit.) (2)	40	120	380	480
C) Solar water pumping systems (3)	35	85	280	350

The above production figures have been calculated considering 250 working days per year on the basis of one 8-hours shift. The production could be increased, of course, by two and three times respectively, by operating on the basis of two or three daily working shifts.

2.5 SELLING PRICES AND SALES REVENUES

The following selling prices have been assumed (and the joint venture partner Ecological Design is presently marketing the systems at the same price):

A) Solar lighting system = 1,400 US $/each

B1) Solar refrigeration system (190 litres) = 5,200 US $/each

B2) Solar refrigeration system (300 litres) = 6,800 US $/each

C) Solar water pumping system = 12,800 US $/each

The above selling prices are very competitive with the average ones of the imported products, that are the following (duty free prices):

A) Solar lighting system = 1,430 US $/each

B1) Solar refrigeration system (190 l) = 5,920 US $/each

B2) Solar refrigeration system (300 l) = 7,475 US $/each

C) Water pumping system = 9,000 to 16,000 US $/each according to type.

(1) Medium size system with 4 low consumption lamps
(2) System including 4 low consumption lamps
(3) Medium size system with pumping capacity of 40 cubic meters/day at 8 meters of depth.

The actual selling prices to the agents will be 15% discounted, to allow the agents to earn this as their reward. So the actual selling prices will be the following:

A) Solar lighting system = 1,190 US$/each

B1) Solar refrigeration system (190 litres) = 4,420 US $/each

B2) Solar refrigeration system (300 litres) = 5,780 US $/each

C) Solar water pumping system = 10,880 US $/each

Therefore, the expected revenues (of which 50% coming from export) will be as shown in the table:

ITEM	REVENUES (1,000 US DOLLARS)			
	1st year	2nd year	3rd year	4th year
A) Solar lighting systems	856.8	2,142	6,902	8,925
B1) Solar refrigeration system (190 lit.)	353.6	795.6	2,563.6	3,182.4
B2) Solar refrigeration system (300 lit.)	231.2	693.6	2,196.4	2,774.4
C) Solar water pumping systems	380.8	924.8	3,046.4	3,808
GRAND TOTAL	1,822.4	4,556.0	14,708.4	18,689.8

3. MATERIALS AND INPUTS

The following pages deal with the raw materials necessary to produce the components which will be utilized to manufacture the final solar systems (lighting, refrigeration and water pumping).
Part of these materials will be imported from Helios Technology (Italy) or other suppliers, part will be available on the local market.
In order to evaluate the final cost of raw materials delivered to the factory in Masvingo, duty charges and internal transport cost have been considered as detailed in the following tables.

According to the information collected in Zimbabwe, the following assumptions has been made:

as far as the imported goods are concerned duty charges have been calculated on the CIF values. Duty charge on the final complete systems is 40%, while it is 20% on the components imported separately.
Duty on the imported photovoltaic cells is only 20%.
As local transportation cost an additional percentage of 3% has been considered.

3.1 PHOTOVOLTAIC MODULES ASSEMBLING LINE

The materials needed to produce the photovoltaic modules are the following:

a) photovoltaic cells (36 cells for each module type H 60)

b) tinned copper ribbons of various sizes

c) E.V.A. (ethylen-vinil-acetate)

d) non-woven fiberglass sheets

e) Tedlar (sheets of poly-vinyl-fluoride)

f) aluminium frames and corners

g) waterproof junction boxes

h) printed circuit boards with diodes and connecting terminals

i) output cable gland for junction boxes

l) tempered glass

m) other material as detailed in the following table

The photovoltaic cells will be supplied by Helios Technology together with other components.
The costs of imported and locally available materials needed to manufacture the photovoltaic modules are listed in detail in the following table; values are in US dollars.

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Material costs of module type H60 (60 Watt)						
		CIF costs (US dollars)			duty	final cost
Items	q.ty	unit	module	tot.	%	$
Imported materials						
. Photovoltaic cells 1.66 Wp type	36	5.50	198.00	198.00	20%	237.60
. ribbon 0.1	12,6 m	0.22	2.77			
. ribbon 0.2	0.5 m	0.44	0.22			
. label	--	--	0.73			
. primer	--	--	0.01			
. flux	2.5 ml	17.60$/l	0.04	28,55	30%	37.12
. temp. glass	0.45 m^2	20.9	9.41			
. E.V.A.	0.9 m^2	12.87	11.58			
. tedlar	0.45 m^2	6.93	3.12			
. fibers	--	--	0.31			
. film	--	--	0.36			
*Subtotal A	--	--	226.55	--	--	274.72
Local materials						
. frame	3 m	2.94	8.82	--	--	--
. corners	4	0.31	1.24	--	--	--
. sil/rubber	--	--	0.58	--	--	--
. wires	--	--	0.04	--	--	--
. connectors	--	--	1.98	--	--	--
. junct. box	1	2.82	2.82	--	--	--
*Subtotal B	--	--	15.48	--	--	15.48
*Subtotal C	--	--	242.03	--	--	290.20
Local Transport	--	--	--	--	--	8.80
Grand total	--	--	--	--	--	299.00

Other inputs to be considered:

. Labour: 2.5 hours/module are required

. Energy: 2 kWh/module are required

3.2 COMPONENTS PRODUCTION LINE

The materials needed to produce the components are:

a) diodes

b) transistors

c) electric wires

d) condensers

e) trimmers

f) relays

g) terminals

h) leds

i) coils

j) printed circuits

k) plastic and metal boxes

l) sundry small items

m) aluminium frames and corners

The items a) to j) included will be imported or supplied by Helios Technology. The items k) and m) are expected to be locally available or otherwise imported.

The components produced will be mainly those foreseen for the construction of the solar systems, that are:

- charge controllers of various size
- fluorescent lamps
- junction boxes of various size
- supporting structures for photovoltaic modules
- voltage adaptors

The following tables show the raw material costs in detail for some of the components manufactured in the factory.

All the cost figures are in US dollars.

Material costs of charge controller type NG 20/24 V				
Items	CIF $	duty %	final cost $	notes
. water proof box . mother board . relais . electronic components	-- 4.95 10.45 8.80	-- 30% 30% 30%	8.58 6.44 13.59 11.44	locally available imported imported imported
Subtotal	30.80	--	40.05	
Local Transport	--	--	1.20	
Grand total	--	--	41.25	

Other inputs to be considered:

- Labour: 8 hours/unit

Material costs of fluorescent lamp				
Items	CIF $	duty %	final cost $	notes
. body and cover . electronic components . mother board . bulb (type LH 12)	-- 5.06 0.72 5.20	-- 30% 30% 30%	3.15 6.58 0.94 6.76	locally available imported imported imported
Subtotal	--	--	17.43	
Local Transport	--	--	0.52	
Grand total	--	--	17.95	

Other inputs to be considered:

- Labour: 5.10 hours/unit

Material costs of junction box type JB8/24				
Items	**CIF $**	**duty %**	**final cost $**	**notes**
. water proof box . mother board . diodes . accessories	-- 3.30 2.20 2.75	-- 30% 30% 30%	4.29 4.29 2.86 3.58	locally available imported imported imported
***Subtotal**	--	--	**15.02**	
Local Transport	--	--	**0.45**	
Grand total	--	--	**15.47**	

Other inputs to be considered:

- Labour: 0.70 hours/unit

For other components produced in the factory the production costs are indicated in the tables of the solar systems in the following pages.

3.3 SYSTEMS ASSEMBLING LINE

This line will assemble the photovoltaic modules and the other components manufactured in the factory into the final solar systems, that are foreseen to be:

- solar lighting systems

- solar refrigeration systems

- solar water pumping systems

Some of the components (refrigerators, pumps, etc.) will be imported or supplied by the local market, as indicated in detail for each item in the following tables.

To take into account that several components of the refrigerators and other items of the solar systems will be produced locally (e.g. cabinets, plastic components, etc.) and will be subcontracted to manufacturing companies of Zimbabwe, the costs indicated in the following tables have been split into foreign exchange components and locally available ones.

A) SOLAR LIGHTING SYSTEM (4 LAMPS)

Cost of materials									
Item	**q.ty**	**CIF $**	**duty %**	**cost $**	**local transp. $**	**INPUT $**		**final cost $**	**Notes (*)**
						foreign	**local**		
photovoltaic module	1	--	--	--	--	274.72	24.28	299.00	PIF
distribution board	1	--	--	--	--	130.00	34.00	164.00	PIF
charge controller	1	--	--	--	--	32.67	8.58	41.25	PIF
fluorescent lamps	4	--	--	--	--	59.08	12.72	71.80	PIF
battery 12 V-100 Ah	1	225.00	30	292.50	8.78	301.28	---	301.28	imp.ted
voltage adaptor	1	8.80	30	11.44	0.34	11.78	2.95	14.73	PIF
cables & accessories	1	--	--	--	--	---	72.00	72.00	LA
Total	--	--	--	--	--	**809.53**	**154.53**	**964.06**	
Labour: 4 hours									

B1) SOLAR REFRIGERATION SYSTEM (190 LITRES + 4 LAMPS)

Cost of materials									
Item	**q.ty**	**CIF $**	**duty %**	**cost $**	**local transp. $**	**INPUT $**		**final cost $**	**Notes (*)**
						foreign	**local**		
photovoltaic modules	6	--	--	--	--	1,648.32	145.68	1,794.00	PIF
supporting structure	1	--	--	--	--	--	42.00	42.00	PIF
junction box	1	--	--	--	--	11.18	4.29	15.47	PIF
electron.control board	1	236.00	30	306.80	9.20	316.00	79.00	395.00	PIF
charge controller	1	--	--	--	--	32.67	8.58	41.25	PIF
batteries 12V-150 Ah	2	528.00	30	686.40	20.59	706.99	--	706.99	imp.ted
190 litres refrigerator	1	620.00	40	868.00	25.00	893.00	223.50	1,116.50	PIF
fluorescent lamps	4	--	--	--	--	59.20	12.60	71.80	PIF
voltage adaptor	1	8.78	30	11.41	0.35	11.76	2.97	14.73	PIF
cables & accessories	1	--	--	--	--	--	94.00	94.00	LA
Total	--	--	--	--	--	**3,679.12**	**612.62**	**4,291.74**	
Labour: 6 hours									

(*) LA = Locally available; PIF = produced in the factory

B2) SOLAR REFRIGERATION SYSTEM (300 LITRES + 4 LAMPS)

Cost of materials									
Item	q.ty	CIF $	duty %	cost $	local transp. $	INPUT $		final cost $	Notes (*)
						foreign	local		
photovoltaic modules	8	--	--	--	--	2,197.76	194.24	2,392.00	PIF
supporting structure	1	--	--	--	--	--	56.00	56.00	PIF
junction box	1	--	--	--	--	11.18	4.29	15.47	PIF
electronic control board	1	236.00	30	306.80	9.20	316.00	79.00	395.00	PIF
charge controller	1	--	--	--	--	32.67	8.58	41.25	PIF
batteries 12 V - 150 Ah	2	528.00	30	686.40	20.59	706.99	--	706.99	Imp.ted
300 litres refrigerator	1	784.00	40	1,097.60	32.40	1,130.00	286.25	1,416.25	PIF
fluorescent lamps	4	--	--	--	--	59.20	12.60	71.80	PIF
voltage adaptor	1	8.78	30	11.41	0.35	11.76	2.97	14.73	PIF
cables & accessories	1	--	--	--	--	--	94.00	94.00	LA
Total	--	--	--	--	--	**4,465.56**	**737.93**	**5,203.49**	
Labour: 6 hours									

C) SOLAR WATER PUMPING SYSTEM

Cost of materials									
Item	q.ty	CIF $	duty %	cost $	local transp. $	INPUT $		final cost $	Notes (*)
						foreign	local		
photovoltaic modules	8(**)	--	--	--	--	2,197.76	194.24	2,392.00	PIF
supporting structure	1	--	--	--	--	--	42.00	42.00	PIF
junction box	1	--	--	--	--	11.18	4.29	15.47	PIF
inverter	1	582.00	30	814.80	25.20	840.00	217.81	1,057.81	PIF
submers.electric pump	1	520.00	40	728.00	21.84	749.84	--	749.84	imp.ted
cables & accessories	1	--	--	--	--	--	65.00	65.00	LA
Total	--	--	--	--	--	**3,798.78**	**523.34**	**4,322.12**	
Labour: 6 hours									

(*) LA = Locally available; PIF = produced in the factory

(**) Number of modules varies from 6 to 16 according to applications. Costing has been based on the 3 modules system that is one of the most used.

3.4 UTILITIES CONSUMPTION

The electric energy required to produce each photovoltaic module type H60 is about 2 kWh.
Considering also other electric consumptions for offices, lighting, workshop the total electric consumption can be evaluated in the range of 120,000 kWh/year, on the basis of one working shift only.
This figure includes also the consumption due to the compressed air generating station.
No other utilities have to be taken into account, apart the potable water for hygienic and drinking purposes.

4. LOCATION

The plant should be located in an area where good facilities are available as fas as transportation, water and electric energy are concerned.

The suitable site is at Masvingo where Ecological Design is already operating and where an extension of the existing plant will be built.

5. PROJECT ENGINEERING

5.1 DESCRIPTION OF THE PROCESS

Please see the annexed plant lay-out for references.

5.1.1 Photovoltaic modules production line

This line will be able to assemble the photovoltaic cells into modules which will be utilized to manufacture the solar systems as explained in the previous pages. The input raw materials are the photovoltaic cells manufactured by Helios Technology in Italy and the various components which will be utilized in the module construction, that are tinned copper ribbons, E.V.A. and Tedlar sheets, junction boxes, printed circuit boards, aluminium frames and other materials.

Each lot of imported photovoltaic cells is random tested considering 5 to 10% of the whole lot, by means of the cell testing system (B-13)

It is important to say that all of the raw materials will have been previously checked by Helios Technology's Quality Control department before shipment, in order to minimize the subsequent tests to be locally performed.

After testing the cells are loaded onto the front tabbing automatic machine (B-4), which performs the soldering of the tinned ribbons onto the cells, after deoxidizing fluxing.

After soldering the coinstacked cells are placed onto the working table (B-1), from where they are then taken by the back tabbing operators and manually placed onto an aligning mask (B-3). Then a deoxidizing fluxing is carried out on the cells (by means of a little panel and tweezers), before soldering the ribbons.

After this operation, the soldered panels are placed onto trolleys which are taken to the lay-up department C (dehumidified room). Here the soldered panels are manually placed, one by one, by two operators onto the light table (C-5), together with the other components (glass, E.V.A., Tedlar, non-woven fiberglass sheet) so that the whole results in a well aligned sandwich.

These sandwiches are then placed onto airtight plates of the mobile trolleys (C-6), that are taken to the lamination room (D). Each trolley, containing a maximum of 7 modules, is then introduced into the lamination furnace (D-7), where the "baking" of the module under high vacuum takes place. This operation lasts about 30 minutes and is automatically performed.

When the cycle is finished, the operator is warned by an acoustic signal, so he can draw out the trolley and put inside an other one. Plates are finally opened and the module is extracted, ready to be suitably trimmed and cleaned.

The next step consists of applying the aluminium frame by means of four corners fixed by pression. A silicon layer had been previously spread on the frame to make a sealant "cushion" between the module and the frame itself.

The module, equipped with junction box containing diodes and connecting terminals, is finally tested under standard conditions by means of the sun simulator and its electrical features are reported in the technical form.

As last step of the process, modules are grouped on the basis of their characteristics and stored in the area (E), ready to be shipped or assembled in the system assembling room (G).

5.1.2 Components production line

The components line (area F on the annexed drawing) will be able to assemble various items like the following ones:

- electronic ballasts for feeding of fluorescent lamp;

- charge controllers;

- low consumption lamps;

- junction boxes for modules and systems;

- distribution boards;

- module supporting metal structures.

- various electronic devices (voltage adaptors, inverters, etc.)

The materials utilized as input include:

- diodes, transistors, electric wires, condensers, trimmers, relays, connecting terminals, leds, coils, printed circuits;

all these materials will be ready and available in the storehouse as supplied by the local or foreign market. The various components, ready on the operator table (F-1), will be mounted onto the printed circuit boards following the foreseen scheme of connections.

Then each of these so prepared boards will enter the solder (F-10), which automatically fastens the components on the printed circuit. A test and a calibration will be carried out on the table (F-11), then the printed circuit boards will be introduced into the burn-in furnace (F-12), where they will remain as long as needed.

A final test will be performed on the boards by means of a special electronic equipment. Then each of the printed circuit boards will be mounted inside a waterproof plastic on metal box and equipped with the accessories according to the proper scheme.

The manufactured components will be temporarily stored to be mounted inside the final products (modules and solar systems).

5.1.3 Systems assembling line

The solar systems will be assembled in the working area marked (G). The photovoltaic modules and the components produced inside the factory will be assembled together with other components supplied from other manufacturers (for instance batteries, electric wires, metal supporting structures, etc.).
As far as refrigerators are concerned, cabinets will be supplied by local subcontractors, the other components will be imported and assembled in the factory.

5.2 PLANT LAY-OUT

With reference to the annexed drawing the main sections of the envisaged plant are the following:

a) commercial and technical offices

b) tabbing area

c) lay-up area

d) lamination area

e) modules storage

f) components assembling area

g) system assembling area

5.3 MAIN EQUIPMENT LIST

The main equipment foreseen for the envisaged plant is listed on the following pages.

For each item are indicated:

- layout reference (see the annexed drawing)
- equipment description
- equipment function
- number of units
- main technical features
- installed electric power and utilities consumption

5.3.1 **Main equipment technical features**
(NOTE: please see the annexed drawing layout reference)

LAYOUT REF.	:	B - 3
EQUIPMENT DESCRIPTION	:	Back tabbing workstation
FUNCTION	:	Soldering of cells for string interconnections
QUANTITY	:	No. 4
MAIN CHARACTERISTICS	:	Each workstation is equipped with a set of special plates for cells alignment and tools such as soldering irons, flux dispenser, cutters, etc.
UTILITIES	:	220 Vac - 1 Ph - 0.9 KVA Exhaust: 4 pipes 100 mm diametre, 175 CU. mt/hour

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LAYOUT REF.	:	B - 4
EQUIPMENT DESCRIPTION	:	Front tabbing automatic equipment
FUNCTION	:	Soldering of tinned copper bus bars onto the cells
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	The equipment automatically provides the loading and alignment of the cells, the flux dispensing, the soldering of the two ribbons, the unloading and coinstack of the cells
UTILITIES	:	380 Vac - 1 Ph - 1.7 KVA Air: 6-7 kg/sqcm 350 lt/h

LAYOUT REF.	:	B - 13
EQUIPMENT DESCRIPTION	:	Solar cells tester/sun simulator
FUNCTION	:	Quality control of the cells
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	The equipment makes the electrical quality control of the imported cells. 10% of the imported cells are checked in order to make sure they meet the performance specs.
UTILITIES	:	220 Vac - 1 Ph - 700 KVA Air 5 to 7 kg/sqcm - 50 lt/h Exhaust: no. 1 pipe 120 mm diametre 300 CU. mt/hour

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LAYOUT REF.	:	C - 5
EQUIPMENT DESCRIPTION	:	Light tables
FUNCTION	:	Modules components assembling
QUANTITY	:	No. 2
MAIN CHARACTERISTICS	:	Two operators make the sandwich with the various new materials (glass, E.V.A., Tedlar, cells, etc.). By means of the light table a perfect alignment can be done. Afterwards they put each sandwich on the trolley.
UTILITIES	:	220 Vac - 1 Ph - 0.3 KVA Air: 5 to 7 kg/sqcm - 100 lt/hour

LAYOUT REF.	:	C and D - 6
EQUIPMENT DESCRIPTION	:	Lamination trolleys
FUNCTION	:	Accommodate up to 7 assembled sandwich to be laminated under vacuum.
QUANTITY	:	No. 5
MAIN CHARACTERISTICS	:	Each trolley is complete of 7 sets made of special Aluminium plates with gaskets and vacuum fittings. All materials are temperature cycling proof.
UTILITIES	:	None

LAYOUT REF.	:	D - 7
EQUIPMENT DESCRIPTION	:	Lamination furnace
FUNCTION	:	Modules lamination under vacuum
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	The furnace provides the modules lamination including the E.V.A. curing under vacuum. It accommodates one trolley full of modules sets. The furnace is complete of vacuum pump and accessories.
UTILITIES	:	380 Vac - 3 Ph - 40 KVA Exhaust No. 2 pipes 350 mm diametre 5000 CU. mt/hour

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LAYOUT REF.	:	D - 8
EQUIPMENT DESCRIPTION	:	Sun simulator
FUNCTION	:	Module testing equipment
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	The sun simulator provides a constant light intensity of 1000 W/sqm on the whole surface of the module. Each module performance is tested and the data are monitored and stored by a personal computer.
UTILITIES	:	380 Vac - 3 Ph - 12 KVA

LAYOUT REF.	:	F - 10
EQUIPMENT DESCRIPTION	:	PC Board Soldering equipment
FUNCTION	:	Automatic soldering of the PC boards
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	Each P.C.B. is equipped with the electronic components. The soldering equipment provide a perfect soldering of all components onto the PC Board.
UTILITIES	:	220 Vac - 1 Ph - 3 KVA

LAYOUT REF.	:	F - 12
EQUIPMENT DESCRIPTION	:	Burn-in furnace
FUNCTION	:	Burn-in of the assembled electronic circuits.
QUANTITY	:	No. 1
MAIN CHARACTERISTICS	:	The furnace is capable to allocate hundreds of circuits and to provide their heating according to a preset temperature and timing.
UTILITIES	:	220 Vac - 1 Ph - 3 KVA

LAYOUT REF.	:	G - F - D
EQUIPMENT DESCRIPTION	:	Various electric and pneumatic tools
FUNCTION	:	System assembling, workshop, pneumatic guns, silicon rubber dispensaries, etc.
QUANTITY	:	
MAIN CHARACTERISTICS	:	
UTILITIES	:	380 Vac - 3 Ph - 10 KVA Air : 6 - 7 kg/sqcm 150 lt/hour

LAYOUT REF.	:	A
EQUIPMENT DESCRIPTION	:	Personal computer 40 MB with software
FUNCTION	:	Administration, production planning, system's design
QUANTITY	:	No. 2
MAIN CHARACTERISTICS	:	
UTILITIES	:	200 Vac - 1 Ph - 0,5 KVA

5.3.2 **Utilities**

The envisaged plant needs electric energy, compressed air and potable water. No steam is required. The installed electric power is about 75 kVA, so the electric substation will be dimensioned for 80 kVA taking into account other utilizers (lighting, computers, etc.) and ancillary equipment.

The compressed air required by the plant is rather low, say 800 litres/hour, that will be sufficient to cover the production needs. As far as water is concerned, just potable water for drinking is needed, because no process water is required by the plant. Therefore the utilities main equipment will consist of:

- N. 2 (1+1 stand-by) 80 kVA transformers

- N. 1 air compressor 800 liters/hour at 7 bar complete with air tank

5.3.3 **Handling equipment and commercial vehicles**

For handling of materials and finished products inside the factory's area, it is foreseen a fork-lift (preferably electric type) with a lifting capacity of 1,000 kg. (cost = 40,000 US $)

The commercial vehicles foreseen are:

- 6 pick-ups (total cost = 200,000 Z$ = 74,000 US $)

- 1 truck 7 tons capacity with trailer (cost = 200,000 Z$ = 74,000 US $)

- 2 sedan cars (total cost = 130,000 Z$ = 48,000 US $)

5.4 LAYOUT AND CIVIL WORKS

The covered area required by the plant is about 1,000 square meters, including production department, storage and offices. The additional uncovered area necessary for the internal roads, loading and unloading yard and other facilities can be evaluated in the range of 1,500 square meters, therefore the whole required area will be at least 2,500 square meters.

A scheme of the plant lay-out is proposed in the annexed drawing, where the various production departments are indicated with their dimensions in scale. For the production and the modules storage area a steel carpentry shed is foreseen with dimensions 25 x 30 meters x 6 m high. As far as the offices are concerned a single storey building is foreseen, prefabricated or masonry type, having an area of about 200 square meters. The offices building can be separated or contiguous to the production shed, as shown in the attached drawing.

The floor of the production plant is made of reinforced concrete with hard aggregate as finishing surface. The roof is made of galvanised corrugated sheets insulated with mineral wool. The internal roads will be preferably asphalted, otherwise simply rolled and covered with gravel. A fencing consisting of metal net supported by metal poles will surround the whole plant area.

5.5 INVESTMENT COSTS

The investment costs for the machinery and equipment of the plant, utilities and civil works have been estimated as listed in the following table. Investments have been split into foreign (FC) and local currency (LC).

ITEM	FC $	LC $	TOTAL $	COMFAR REF.
. Machinery & Equipment	1,100,000	--	1,100,000	L8
. Transportation & insurance	30,000	30,000	60,000	L5/L17
. Erection	50,000	50,000	100,000	L9/L21
. Civil works (land included)	200,000	350,000	550,000	L3/L15
. Spare parts 5%	55,000	--	55,000	L10
. Trial production run	50,000	20,000	70,000	L6/L18
. Know-how fee	345,000	--	345,000	L6
. Pre-production expenditures	185,000	40,000	225,000	L11/L23
. Commercial vehicles and handling eqpt	88,000	--	88,000	L7
GRAND TOTAL	**2,103,000**	**490,000**	**2,593,000**	

<u>Pre-production expenditures</u>; the following costs have been considered:

a) New company establishment = 6,000 US $

b) Personnel hired before production:

- 12 months for a technical manager
- 6 months/each for one mechanic and one electrician
- 2 months for 25 operators for the production lines

Total cost = 34,000 US $

Grand total a + b = 40,000 US $ has been considered a[illegible] expenditure (Comfar input table, line L23).

c) Technical training for 6 operators to be held in the know-how owner's premises in Italy lasting 3 months, including board and lodging. Cost has been evaluated in 185,000 $, considered as foreign currency expenditure (Comfar input table, line L23).

Commercial vehicles and handling equipment: it is foreseen to purchase during the construction period one fork-lift (40,000 US$) and two sedan cars (48,000 US$) that will be used before production.
In the first year of production one truck (74,000 US$) and 6 pick-ups (74,000 US$) will be purchased in addition. All the commercial vehicles will be renewed and purchased brand-new each 5 years.

6. PLANT ORGANIZATION

The plant is considered as an autonomous production unit, complete with utilities and facilities, operating under the direction of an independent organization.

7. MANPOWER

No particular skill is required for any of the positions listed below, exception made for the technical manager and foremen.
It is recommended that the job training is carried out by an expert of the know-how's owner.
The administrative and labour costs (in US $) have been assumed as detailed in the following tables:

MANAGEMENT AND ADMINISTRATIVE DEPARTMENT		
DESCRIPTION	**No.**	**ANNUAL COST ($)**
General manager	1	21,000
Technical manager	1	21,000
Senior accountant	1	10,400
Purchasing dept. head	1	10,400
Sales dept. head	1	10,400
Clerks	2	10,400
Guards	3	6,300
Drivers	7	18,200
TOTAL	17	108,100

PRODUCTION AND MAINTENANCE DEPARTMENT		
DESCRIPTION	**No.**	**ANNUAL COST ($)**
Production foreman	2	9,000
Warehouse keeper	1	4,450
Modules and components assemblers	12	53,400
Systems assemblers	25	111,250
Mechanics	2	9,000
Electricians	2	9,000
TOTAL	44	196,100

Therefore the annual cost of the personnel, considering the management, administrative, production and maintenance departments is 304,200 US Dollars/year, social security contribution included.

8. IMPLEMENTATION SCHEDULE

From the signing of the contract, 12 months are expected to be necessary for the construction and the commissioning of the plant, including civil works.

9. FINANCIAL AND ECONOMIC EVALUATION

The financial and economic evaluation has been performed by using COMFAR, a program developed by UNIDO for evaluation of feasibility studies. The COMFAR schedules and input tables are attached to the present study. In particular, the following assumptions have been made with reference to the COMFAR input tables:

A) Depreciation:

- machinery and equipment = 10 years (scrap value = 10%)(COMFAR line L8, L9, L21)

- civil works and buildings = 20 years (scrap value = 50%)(L3, L15)

- cars and trucks = 5 years (scrap value = 10%)(L7)

B) Pre-production expenditures.

- company establishment and personnel hired before production = 40,000 US $ (Comfar L23)

- Training = 185,000 US $ (L11)

For details about these items see previous paragraph 5.5

C) Factory overheads (COMFAR L89):

The assistance of one foreign expert for the first operative year has been taken into account with the cost of 60,000 US Dollars.

In addition, 10,000 US Dollars each year have been considered to cover the expenditures of telephone, mailing and writing materials.

- working capital input table: minimum day coverage

	FC	LC	
raw materials	120	30	(Comfar L183, 184)
work in progress	1	5	(L188)
finished products	30	30	(L189)

E) These other assumptions have been made for the computation:

Electric energy cost = 0.19 $\frac{US\$}{kWh}$

9.1 SOURCE OF FINANCE

As far as the total investment is concerned, 30% as equity and 70% as loan have been considered to cover the required funds.

Equity has been shared into 75% of local and 25% of foreign, owned by the Italian partner.

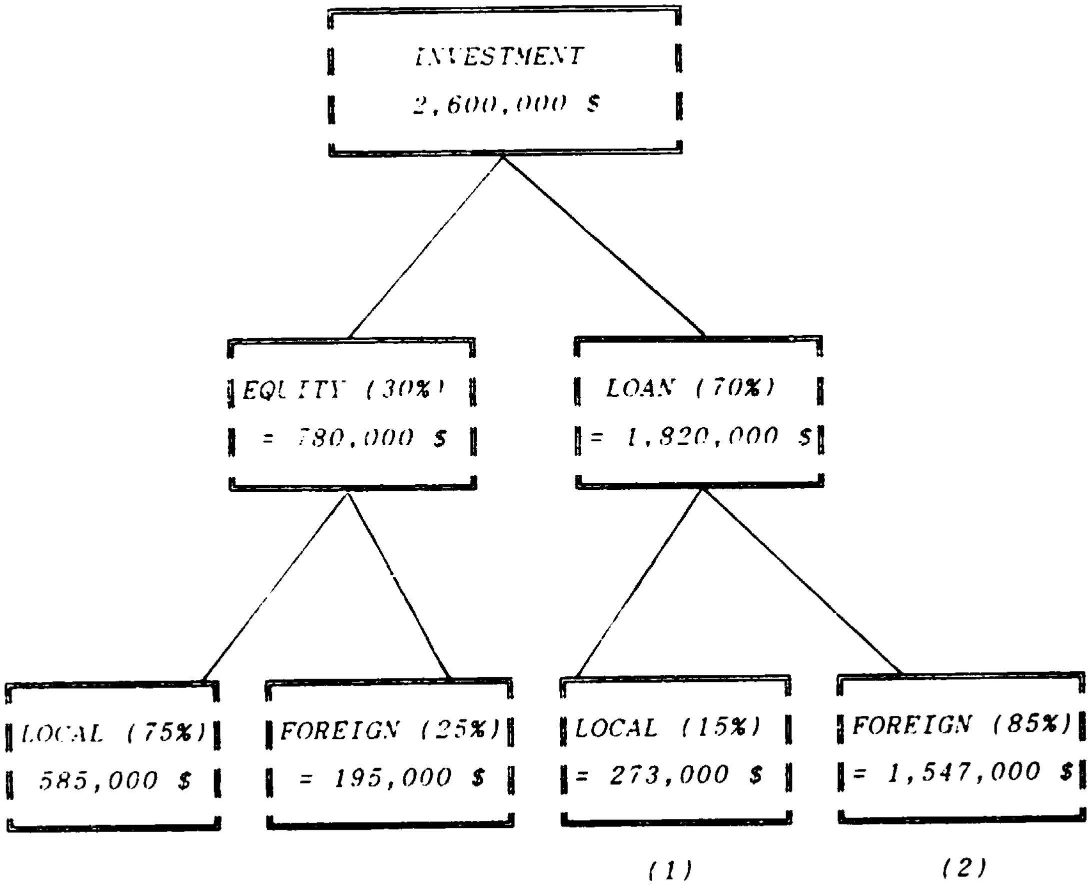
Loan has been shared into 15% of local and 85% of foreign.

The cost of the local loan taken into consideration was 20%, with reimbursement on 8 years and grace period of 1 year.

Foreign loan rate has been considered 12%, with reimbursement in 8 years out of which 2 grace years.

Overdraft rate considered at 20%.

The following diagram shows the structure of the sources of financing (in US$):



(1) Local loan: Interest rate = 20%, reimbursement in 8 years, 1 year of grace;

(2) Foreign loan: interest rate = 12%, reimbursement in 8 years, out of which 2 of grace.

COMFAR input tables (L stands for line number)

Figures in US Dollars: FC = Foreign currency; LC = Local currency

L3) Civil works (FC) = 200,000 $

L5) Transportation and insurance (FC) = 30,000 $

L6) Know-how fee (FC) = 345,000 $
Trial production run (FC) = 50,000 $

395,000 $

L7) Commercial vehicles and handling equipment:

1 fork lift = 40,000 $
2 sedan cars = 48,000 $

88,000 $ (FC)

L8) Machinery and equipment = 1,100,000 $ (FC)

L9) Erection of machinery and equipment = 50,000 $ (FC)

L10) Spare parts = 55,000 $ (FC)

L11) Technical training in Italy = 185,000 $ (FC)

L15) Civil works and cost of land (LC) = 350,000 $

L17) Transportation and insurance (LC) = 30,000 $

L18) Trial production run (LC) = 20,000 $

L21) Erection of machinery and equipment = 50,000 $ (LC)

L23) Company establishment = 6,000 $
personnel hired before production = 34,000 $

40,000 $ (LC)

L31) 1st year of production (Column C5):
Commercial vehicles:

1 truck = 74,000 $
6 pick-up = 74,000 $

148,000 $ (FC)

In the 6th and 11th years of production (Columns C10 and C15), the commercial vehicles will be replaced with new ones, therefore the cost will be:

2 sedan cars = 48,000 $

1 truck = 74,000 $

6 pick-up = 74,000 $

196,000 $ (FC)

9.2 ECONOMIC ANALYSIS

The economic analysis has been carried out by means of a COMFAR Software. The following parameters have been used:

- labour 0.75

- local goods and services 0.70

- imported goods and services 1

- discount rate 10%.

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COMFAR

INPUT TABLES

SV

Tabi HELIOS : Text Variables

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

Project Name:	PHOTOVOLTAIC MODULES
Date:	MARCH 1991
Name of Alternative:	ZIMBABWE
Accounting currency:	1,000 U.S. DOLLARS
Name of Product (A):	SOLAR LIGHTING SYSTEM
Name of Product (B):	SOLAR REFRIGERATION 190 LITRES SYSTEM
Name of Product (C):	SOLAR REFRIGERATION 300 LITRES SYSTEM
Name of Product (D):	SOLAR WATER PUMPING SYSTEM

Tabi HELIOS : 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: 3 year(s)
Interests payable: 12.0 % for year 1 through 15

Loan B: not specified

Loan C: not specified

Overdraft: not specified

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: 2 year(s)
Interests payable: 20.0 % for year 1 through 15

Loan B: not specified

Loan C: not specified

Overdraft: not specified

Tabi HELIOS : Subtable Initial Fixed Investment - foreign

-- 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 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)......	5.00	2.00	50.00	20.00	200.00	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)	10.00	2.00	10.00	10.00	30.00	0.00	0.00
L 6 Incorporated fixed assets,-(b)	10.00	1.00	0.00	10.00	395.00	0.00	0.00
L 7 Incorporated fixed assets,-(c)	20.00	2.00	10.00	5.00	88.00	0.00	0.00
L 8 Plant machinery and equipm-(a)	10.00	2.00	10.00	10.00	1100.00	0.00	0.00
L 9 Plant machinery and equipm-(b)	10.00	1.00	0.00	10.00	50.00	0.00	0.00
L 10 Auxiliary and service faciliti	10.00	1.00	0.00	10.00	55.00	0.00	0.00
L 11 Pre-production expenditures...	10.00	1.00	0.00	10.00	185.00	0.00	0.00
L 12 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabi HELIOS : 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	2.00	50.00	20.00	350.00	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)	10.00	2.00	10.00	10.00	30.00	0.00	0.00
L 18 Incorporated fixed assets,-(b)	10.00	1.00	0.00	10.00	20.00	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)	10.00	1.00	0.00	10.00	50.00	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...	10.00	1.00	0.00	10.00	40.00	0.00	0.00
L 24 Inventory, working capital....	0.00	1.00	0.00	0.00	0.00	0.00	0.00

Tabi HELIOS : 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)	0.00	1.00	0.00	0.00	0.00	0.00	0.00
L 31 Incorporated fixed assets,-(c)	20.00	2.00	10.00	5.00	148.00	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 HELIOS : 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 HELIOS : Subtable Current Fixed Investment - foreign

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

8	9	10	11	12	13	14	15	16	17
Amount- Y4	Amount- Y5	Amount- Y6	Amount- Y7	Amount- Y8	Amount- Y9	Amount-Y10	Amount-Y11	Amount-Y12	Amount-Y13
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	196.00	0.00	0.00	0.00	0.00	196.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabl HELIOS : Subtable Current Fixed Investment - local

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

8	9	10	11	12	13	14	15	16	17
Amount- Y4	Amount- Y5	Amount- Y6	Amount- Y7	Amount- Y8	Amount- Y9	Amount-Y10	Amount-Y11	Amount-Y12	Amount-Y13
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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 HELIOS : 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	1188.77	2978.16	9589.74	12193.48	12193.48	12193.48
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	20.00	20.00	20.00	20.00	20.00	20.00
L 58 Spares, annual cost...........	0.00	55.00	75.00	100.00	100.00	100.00	100.00
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

Tabi HELIOS : 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).............	7500.00	100.00	720.00	100.00	480.00	100.00	350.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 65 Raw material, unit price (a)..	0.81	0.00	3.68	0.00	4.47	0.00	3.80
	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......	7.83	100.00	4.51	100.00	4.00	100.00	3.66
L 72 Spares, annual cost...........	39.15	100.00	22.55	100.00	20.00	100.00	18.30
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

Tabl HELIOS : 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
12193.48	12193.48	12193.48	12193.48	12193.48	12193.48	12193.48	12193.48	12193.48	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabl HELIOS : 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
100.00	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
100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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 HELIOS : 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	208.11	521.46	1678.54	2137.44	2137.44	2137.44
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	3.20	6.50	18.50	23.00	23.00	23.00
L 86 Labour (direct), annual cost..	0.00	110.00	150.00	173.65	173.65	173.65	173.65
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	70.00	10.00	10.00	10.00	10.00	10.00
L 90 Administration, labour cost...	0.00	100.00	120.00	130.55	130.55	130.55	130.55
L 91 Administration, non-labour cos	0.00	100.00	100.00	100.00	100.00	100.00	100.00
L 92 Marketing, labour cost........	0.00	20.00	20.00	20.00	20.00	20.00	20.00
L 93 Marketing, non-labour cost....	0.00	35.00	35.00	35.00	35.00	35.00	35.00

Tabi HELIOS : 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)..............	7500.00	100.00	720.00	100.00	480.00	100.00	350.00
	Product A	Not used	Product B	Not used	Product C	Not used	Product D
L 97 Raw material, unit price (b)..	0.15	0.00	0.61	0.00	0.74	0.00	0.52
	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...........	9.30	100.00	5.10	100.00	4.40	100.00	4.20
L 100 Labour (direct), annual cost..	68.00	100.00	39.10	100.00	34.80	100.00	31.70
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	3.91	0.00	2.26	0.00	2.00	0.00	1.83
L 104 Administration, labour cost...	51.10	0.00	29.45	0.00	26.15	0.00	23.85
L 105 Administration, non-labour cos	39.15	0.00	22.55	0.00	20.00	0.00	18.30
L 106 Marketing, labour cost........	7.83	0.00	4.51	0.00	4.00	0.00	3.66
L 107 Marketing, non-labour cost....	13.70	0.00	7.90	0.00	7.00	0.00	6.40

Tabl HELIOS : Subtable Production Costs - local

-- CONFAR 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
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2137.44	2137.44	2137.44	2137.44	2137.44	2137.44	2137.44	2137.44	2137.44	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	0.00
173.65	173.65	173.65	173.65	173.65	173.65	173.65	173.65	173.65	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	0.00
130.55	130.55	130.55	130.55	130.55	130.55	130.55	130.55	130.55	0.00
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00
20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00
35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	0.00

Tabl HELIOS : Subtable Standard Production Costs - local

-- CONFAR 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
100.00	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
100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tab: HELIOS : Subtable Production Program and Sales - foreign

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

Col	1	2	3	4	5	6	7
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 110 Yearly production, export - A	0.00	360.00	900.00	2900.00	3750.00	3750.00	3750.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 111 Unit price, export product A.	0.00	1.19	1.19	1.19	1.19	1.19	1.19
L 112 Sales tax, export product A..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 113 Other direct variable cost- A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 114 Direct non-variable cost, - A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 115 Labour included in direct - A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 116 Yearly production, export - B	0.00	40.00	90.00	290.00	360.00	360.00	360.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 117 Unit price, export product B.	0.00	4.42	4.42	4.42	4.42	4.42	4.42
L 118 Sales tax, export product B..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 119 Other direct variable cost- B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 120 Direct non-variable cost, - B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 121 Labour included in direct - B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 122 Yearly production, export - C	0.00	20.00	60.00	190.00	240.00	240.00	240.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 123 Unit price, export product C.	0.00	5.78	5.78	5.78	5.78	5.78	5.78
L 124 Sales tax, export product C..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 125 Other direct variable cost- C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 126 Direct non-variable cost, - C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 127 Labour included in direct - C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 128 Yearly production, export - D	0.00	17.00	42.00	140.00	175.00	175.00	175.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 129 Unit price, export product D.	0.00	10.88	10.88	10.88	10.88	10.88	10.88
L 130 Sales tax, export product D..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 131 Other direct variable cost- D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 132 Direct non-variable cost, - D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 133 Labour included in direct - D	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 134 Yearly production, export - 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 135 Unit price, export product E.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 136 Sales tax, export product E..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 137 Other direct variable cost- E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 138 Direct non-variable cost, - E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 139 Labour included in direct - E	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Not used	Quanti- Y1	Quanti- Y2	Quanti- Y3	Quanti- Y4	Quanti- Y5	Quanti- Y6
L 140 Yearly production, export - 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 141 Unit price, export product F.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 142 Sales tax, export product F..	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 143 Other direct variable cost- F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 144 Direct non-variable cost, - F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 145 Labour included in direct - F	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tab: HELIOS : Subtable Production Program and Sales - foreign

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
3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
240.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
5.78	5.78	5.78	5.78	5.78	5.78	5.78	5.78	5.78	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
175.00	175.00	175.00	175.00	175.00	175.00	175.00	175.00	175.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
10.88	10.88	10.88	10.88	10.88	10.88	10.88	10.88	10.88	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Tab: HELIOS : Subtable Production Program and Sales - local

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

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	360.00	900.00	2900.00	3750.00	3750.00	3750.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 147 Unit price, local product A..	0.00	1.19	1.19	1.19	1.19	1.19	1.19
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	40.00	90.00	290.00	360.00	360.00	360.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 153 Unit price, local product B..	0.00	4.42	4.42	4.42	4.42	4.42	4.42
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	20.00	60.00	190.00	240.00	240.00	240.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 159 Unit price, local product C..	0.00	5.78	5.78	5.78	5.78	5.78	5.78
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	18.00	43.00	140.00	175.00	175.00	175.00
	Inflat- %	1st year	2nd year	3rd year	4th year	5th year	6th year
L 165 Unit price, local product D..	0.00	10.88	10.88	10.88	10.88	10.88	10.88
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

Tab: HELIOS : Subtable Production Program and Sales - local

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

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
3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	3750.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	360.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
240.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	240.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
5.78	5.78	5.78	5.78	5.78	5.78	5.78	5.78	5.78	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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
175.00	175.00	175.00	175.00	175.00	175.00	175.00	175.00	175.00	0.00
7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year	Not used
10.88	10.88	10.88	10.88	10.88	10.88	10.88	10.88	10.88	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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

Tab: HELIOS : Subtable Working Capital Requirements - f/l

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

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	1.00	75.00	1.00	5.00	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)...	120.00	30.00	1.00	1.00	1.00	1.00	1.00
L 184 Inventory, raw material (b)...	120.00	30.00	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........	120.00	1.00	1.00	1.00	1.00	1.00	1.00
L 188 Inventory, work-in-progress...	1.00	5.00	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 HELIOS : Subtable Source of Finance - foreign

-- 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 191 Equity-C (ordinary shares)...	195.00	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)..........	1547.00	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 HELIOS : 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)...	585.00	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)............	273.00	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

Tab: HELIOS : Subtable Income, Tax, Cashflow

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

Col	1	2	3	4	5	6	7
	Variab- ?	Yearly- %	Tax ho-(y)	Years loss	Tax credit	Differ- F	Differ- L
L 205 Income tax....................	0.00	50.00	0.00	0.00	0.00	0.00	0.00
	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
L 206 Investment allowance (deducted	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 207 Depreciation allowance (initia	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 208 Adjustment of income tax......	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 209 Tax rate in % (if defined var	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 210 Profit distributed Equity--PF)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 211 Profit distributed Equity--PL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 212 Profit distributed Equity--OF)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L 213 Profit distributed Equity--OL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

baldo & c.

COMFAR

SCHEDULES

PHOTOVOLTAIC MODULES
MARCH 1991
ZIMBABWE

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:	2713.12	80.933 % foreign
current assets:	0.00	0.000 % foreign
total assets:	2713.12	80.933 % foreign

Source of funds during construction phase

equity & grants:	780.00	25.000 % foreign
foreign loans :	1547.00	
local loans :	273.00	
total funds :	2600.00	67.000 % foreign

Cashflow from operations

Year:	1	2	3
operating costs:	1910.08	4036.12	11875.98
depreciation :	225.50	252.14	252.14
interest :	240.24	240.24	233.42
production costs	2375.82	4528.50	12361.53
thereof foreign	69.44 %	76.97 %	81.89 %
total sales :	1822.40	4556.00	14708.40
gross income :	-553.42	27.50	2346.87
net income :	-553.42	13.75	1173.43
cash balance :	-1077.11	-479.35	-1416.12
net cashflow :	-836.87	-204.99	-955.20

Net Present Value at: 10.00 % = 6364.00
Internal Rate of Return: 23.49 %
Return on equity1: 54.96 %
Return on equity2: 26.96 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

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

Year	1991
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	550.000
Auxiliary and service facilities .	55.000
Incorporated fixed assets	563.000
Plant machinery and equipment . . .	1200.000
Total fixed investment costs	2368.000
Pre-production capital expenditures.	345.120
Net working capital	0.000
Total initial investment costs . . .	2713.120
Of it foreign, in %	80.933

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

Year	1992	1993	1994	1995	1996
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	0.000	0.000
Incorporated fixed assets	148.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	148.000	0.000	0.000	0.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	601.197	711.116	2614.191	1023.612	0.000
Total current investment costs	749.197	711.116	2614.191	1023.612	0.000
Of it foreign %	76.057	86.236	86.035	86.203	0.000

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

Year	1997	1998-2001	2002
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	196.000	0.000	196.000
Plant, machinery and equipment	0.000	0.000	0.000
Total fixed investment costs	196.000	0.000	196.000
Preproduction capitals expenditures.	0.000	0.000	0.000
Working capital	0.000	0.000	0.000
Total current investment costs	196.000	0.000	196.000
Of it foreign, %	100.000	0.000	100.000

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

Year	1992	1993	1994	1995	1996
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	1188.771	2978.159	9589.735	12193.480	12193.480
Other raw materials	208.106	521.462	1678.542	2137.436	2137.436
Utilities	0.000	0.000	0.000	0.000	0.000
Energy	3.200	6.500	18.500	23.000	23.000
Labour, direct	110.000	150.000	173.650	173.650	173.650
Repair, maintenance	20.000	20.000	20.000	20.000	20.000
Spares	55.000	75.000	100.000	100.000	100.000
Factory overheads	70.000	10.000	10.000	10.000	10.000
Factory costs	1655.077	3761.121	11590.430	14657.570	14657.570
Administrative overheads	200.000	220.000	230.550	230.550	230.550
Indir. costs, sales and distribution	55.000	55.000	55.000	55.000	55.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	225.502	252.142	252.142	252.142	252.142
Financial costs	240.240	240.240	233.415	203.385	173.355
Total production costs	2375.819	4528.503	12361.530	15398.650	15368.620
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	69.438	76.974	81.886	82.493	82.504
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	230.000	290.000	324.200	324.200	324.200

PHOTOVOLTAIC MODULES --- MARCH 1991

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

Year	1997	1998	1999	2000	2001
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	12193.480	12193.480	12193.480	12193.480	12193.480
Other raw materials	2137.436	2137.436	2137.436	2137.436	2137.436
Utilities	0.000	0.000	0.000	0.000	0.000
Energy	23.000	23.000	23.000	23.000	23.000
Labour, direct	173.650	173.650	173.650	173.650	173.650
Repair, maintenance	20.000	20.000	20.000	20.000	20.000
Spares	100.000	100.000	100.000	100.000	100.000
Factory overheads	10.000	10.000	10.000	10.000	10.000
Factory costs	14657.570	14657.570	14657.570	14657.570	14657.570
Administrative overheads	230.550	230.550	230.550	230.550	230.550
Indir. costs, sales and distribution	55.000	55.000	55.000	55.000	55.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	236.302	244.942	244.942	244.942	244.942
Financial costs	143.325	113.295	83.265	53.235	23.205
Total production costs	15322.750	15301.360	15271.330	15241.300	15211.270
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	82.496	82.516	82.526	82.537	82.547
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	324.200	324.200	324.200	324.200	324.200

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

Year	2002- 6
% of nom. capacity (single product).	0.000
Raw material 1	12193.480
Other raw materials	2137.436
Utilities	0.000
Energy	23.000
Labour, direct	173.650
Repair, maintenance	20.000
Spares	100.000
Factory overheads	10.000
Factory costs	14657.570
Administrative overheads	230.550
Indir. costs, sales and distribution	55.000
Direct costs, sales and distribution	0.000
Depreciation	49.030
Financial costs	0.000
Total production costs	14992.150
Costs per unit (single product)	0.000
Of it foreign, %	82.402
Of it variable,%	0.000
Total labour	324.200

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

Year	mdc	coto	1992	1993	1994	1995	1996-2006
Coverage	mdc	coto					
Current assets &							
Accounts receivable	14	25.2	138.158	209.154	478.272	582.045	582.045
Inventory and materials	107	3.4	413.599	1036.175	3336.457	4242.614	4242.614
Energy	1	360.0	0.009	0.018	0.051	0.064	0.064
Spares	120	3.0	18.333	25.000	33.333	33.333	33.333
Work in progress	2	218.9	8.945	18.092	53.092	66.761	66.761
Finished products	30	12.0	154.590	331.760	985.081	1240.677	1240.677
Cash in hand	4	87.4	5.486	5.542	6.086	6.086	6.086
Total current assets			739.120	1625.740	4892.373	6171.580	6171.580
Current liabilities and							
Accounts payable	30	12.0	137.923	313.427	965.869	1221.464	1221.464
Net working capital			601.197	1312.313	3926.504	4950.116	4950.116
Increase in working capital			601.197	711.116	2614.191	1023.613	0.000
Net working capital, local			179.377	277.256	642.316	783.546	783.546
Net working capital, foreign			421.820	1035.057	3284.188	4166.570	4166.570

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

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

Year	1991
Equity, ordinary ..	780.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	1547.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	273.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	1820.000
Current liabilities	0.000
Bank overdraft	113.120
Total funds	2713.120

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

Year	1992	1993	1994	1995	1996	1997
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	-193.375	-193.375	-193.375	-193.375
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	-34.125	-34.125	-34.125	-34.125	-34.125
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	0.000	-34.125	-227.500	-227.500	-227.500	-227.500
Current liabilities	137.923	175.504	652.442	255.595	0.000	0.000
Bank overdraft	1077.114	479.350	1416.115	-646.608	-1685.233	-753.857
Total funds	1215.037	620.729	1841.057	-618.513	-1912.733	-981.357

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

Year	1998-2000	2001
Equity, ordinary ..	0.000	0.000
Equity, preference.	0.000	0.000
Subsidies, grants .	0.000	0.000
Loan A, foreign .	-193.375	-193.375
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	-34.125	0.000
Loan B, local....	0.000	0.000
Loan C, local....	0.000	0.000
Total loan	-227.500	-193.375
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	-227.500	-193.375

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

Year	1991
Total cash inflow . .	2600.000
Financial resources .	2600.000
Sales, net of tax . .	0.000
Total cash outflow . .	2713.120
Total assets	2593.000
Operating costs . . .	0.000
Cost of finance . . .	120.120
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	-113.120
Cumulated cash balance	-113.120
Inflow, local	858.000
Outflow, local	517.300
Surplus (deficit) .	340.700
Inflow, foreign . . .	1742.000
Outflow, foreign . . .	2195.820
Surplus (deficit) .	-453.820
Net cashflow	-2593.000
Cumulated net cashflow	-2593.000

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

Year	1992	1993	1994	1995	1996	1997
Total cash inflow . .	1960.323	4731.504	15360.840	18945.400	18689.800	18689.800
Financial resources .	137.923	175.504	652.442	255.595	0.000	0.000
Sales, net of tax . .	1822.400	4556.000	14708.400	18689.800	18689.800	18689.800
Total cash outflow . .	3037.437	5210.854	16776.960	18298.790	17004.570	17193.470
Total assets	887.120	886.620	3266.633	1279.207	0.000	196.000
Operating costs . . .	1910.077	4036.121	11875.980	14943.120	14943.120	14943.120
Cost of finance . . .	240.240	240.240	233.415	203.385	173.355	143.325
Repayment	0.000	34.125	227.500	227.500	227.500	227.500
Corporate tax . . .	0.000	13.749	1173.434	1645.578	1660.592	1683.527
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-1077.114	-479.350	-1416.116	646.607	1685.234	1496.330
Cumulated cash balance	-1190.234	-1669.584	-3085.700	-2439.093	-753.858	742.472
Inflow, local	949.249	2308.162	7453.594	9383.517	9344.900	9344.900
Outflow, local	912.892	1188.036	3886.030	4530.135	4358.478	4374.588
Surplus (deficit) .	36.357	1120.126	3567.564	4853.382	4986.423	4970.313
Inflow, foreign . . .	1011.074	2423.342	7907.248	9561.880	9344.900	9344.900
Outflow, foreign . . .	2124.545	4022.818	12890.930	13768.650	12646.090	12818.880
Surplus (deficit) .	-1113.470	-1599.476	-4983.681	-4206.772	-3301.188	-3473.982
Net cashflow	-836.874	-204.985	-955.201	1077.493	2086.091	1867.156
Cumulated net cashflow	-3429.874	-3634.859	-4590.061	-3512.567	-1426.477	440.679

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

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

Year	1998	1999	2000	2001	2002	2003
Total cash inflow . .	18689.800	18689.800	18689.800	18689.800	18689.800	18689.800
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	18689.800	18689.800	18689.800	18689.800	18689.800	18689.800
Total cash outflow . .	16978.130	16963.120	16948.110	16898.960	16987.940	16791.940
Total assets	0.000	0.000	0.000	0.000	196.000	0.000
Operating costs . . .	14943.120	14943.120	14943.120	14943.120	14943.120	14943.120
Cost of finance . . .	113.295	83.265	53.235	23.205	0.000	0.000
Repayment	227.500	227.500	227.500	193.375	0.000	0.000
Corporate tax . . .	1694.222	1709.237	1724.252	1739.267	1848.826	1848.826
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	1711.666	1726.682	1741.695	1790.836	1701.857	1897.857
Cumulated cash balance	2454.138	4180.819	5922.515	7713.351	9415.208	11313.070
Inflow, local	9344.900	9344.900	9344.900	9344.900	9344.900	9344.900
Outflow, local	4378.457	4386.647	4394.838	4368.902	4478.461	4478.461
Surplus (deficit) .	4966.443	4958.253	4950.063	4975.998	4866.439	4866.439
Inflow, foreign . . .	9344.900	9344.900	9344.900	9344.900	9344.900	9344.900
Outflow, foreign . . .	12599.680	12576.470	12553.270	12530.060	12509.480	12313.480
Surplus (deficit) .	-3254.780	-3231.572	-3208.367	-3185.162	-3164.582	-2968.582
Net cashflow	2052.461	2037.446	2022.431	2007.416	1701.857	1897.857
Cumulated net cashflow	2493.140	4530.586	6553.017	8560.433	10262.290	12160.150

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

Year	2004	2005	2006
Total cash inflow	18689.800	18689.800	18689.800
Financial resources	0.000	0.000	0.000
Sales, net of tax	18689.800	18689.800	18689.800
Total cash outflow	16791.940	16791.940	16791.940
Total assets	0.000	0.000	0.000
Operating costs	14943.120	14943.120	14943.120
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	1848.826	1848.826	1848.826
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	1897.857	1897.857	1897.857
Cumulated cash balance	13210.920	15108.780	17006.640
Inflow, local	9344.900	9344.900	9344.900
Outflow, local	4478.461	4478.461	4478.461
Surplus (deficit)	4866.439	4866.439	4866.439
Inflow, foreign	9344.900	9344.900	9344.900
Outflow, foreign	12313.480	12313.480	12313.480
Surplus (deficit)	-2968.582	-2968.582	-2968.582
Net cashflow	1897.857	1897.857	1897.857
Cumulated net cashflow	14058.000	15955.860	17853.720

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	8485.89	at	10.00 %
Internal Rate of Return (IRRE1) ..	54.96 %		

b) Net Worth versus Net cash return:

Net present value	6110.62	at	10.00 %
Internal Rate of Return (IRRE2) ..	26.96 %		

c) Internal Rate of Return on total investment:

Net present value	6364.00	at	10.00 %
Internal Rate of Return (IRR) ..	23.49 %		

Net Worth = Equity paid plus reserves

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

Year	1992	1993	1994	1995	1996
Total sales, incl. sales tax	1822.400	4556.000	14708.400	18689.800	18689.800
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	1822.400	4556.000	14708.400	18689.800	18689.800
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	2135.579	4288.263	12128.120	15195.260	15195.260
Operational margin	-313.179	267.737	2580.282	3494.540	3494.539
As % of total sales	-17.185	5.877	17.543	18.698	18.698
Cost of finance	240.240	240.240	233.415	203.385	173.355
Gross profit	-553.419	27.497	2346.867	3291.155	3321.184
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-553.419	27.497	2346.867	3291.155	3321.184
Tax	0.000	13.749	1173.434	1645.578	1660.592
Net profit	-553.419	13.749	1173.434	1645.578	1660.592
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-553.419	13.749	1173.434	1645.578	1660.592
Accumulated undistributed profit	-553.419	-539.670	633.763	2279.341	3939.933
Gross profit, % of total sales	-30.368	0.604	15.956	17.609	17.770
Net profit, % of total sales	-30.368	0.302	7.978	8.805	8.885
ROE, Net profit, % of equity	-70.951	1.763	150.440	210.971	212.896
ROI, Net profit+interest, % of invest.	-9.370	6.266	21.100	24.040	23.845

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

Year	1997	1998	1999	2000	2001
Total sales, incl. sales tax	18689.800	18689.800	18689.800	18689.800	18689.800
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	18689.800	18689.800	18689.800	18689.800	18689.800
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	15179.420	15188.060	15188.060	15188.060	15188.060
Operational margin	3510.379	3501.738	3501.738	3501.739	3501.738
As % of total sales	18.782	18.736	18.736	18.736	18.736
Cost of finance	143.325	113.295	83.265	53.235	23.205
Gross profit	3367.054	3388.443	3418.474	3448.504	3478.533
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	3367.054	3388.443	3418.474	3448.504	3478.533
Tax	1683.527	1694.222	1709.237	1724.252	1739.267
Net profit	1683.527	1694.222	1709.237	1724.252	1739.267
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1683.527	1694.222	1709.237	1724.252	1739.267
Accumulated undistributed profit	5623.459	7317.681	9026.918	10751.170	12490.440
Gross profit, % of total sales	18.015	18.130	18.291	18.451	18.612
Net profit, % of total sales	9.008	9.065	9.145	9.226	9.306
ROE, Net profit, % of equity	215.837	217.208	219.133	221.058	222.983
ROI, Net profit+interest, % of invest.	23.162	22.917	22.727	22.537	22.346

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

Year	2002	2003	2004	2005	2006
Total sales, incl. sales tax	18689.800	18689.800	18689.800	18689.800	18689.800
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	18689.800	18689.800	18689.800	18689.800	18689.800
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	14992.150	14992.150	14992.150	14992.150	14992.150
Operational margin	3697.651	3697.651	3697.651	3697.651	3697.651
As % of total sales	19.784	19.784	19.784	19.784	19.784
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	3697.651	3697.651	3697.651	3697.651	3697.651
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	3697.651	3697.651	3697.651	3697.651	3697.651
Tax	1848.826	1848.826	1848.826	1848.826	1848.826
Net profit	1848.826	1848.826	1848.826	1848.826	1848.826
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	1848.826	1848.826	1848.826	1848.826	1848.826
Accumulated undistributed profit	14339.260	16188.090	18036.910	19885.740	21734.570
Gross profit, % of total sales	19.784	19.784	19.784	19.784	19.784
Net profit, % of total sales	9.892	9.892	9.892	9.892	9.892
ROE, Net profit, % of equity	237.029	237.029	237.029	237.029	237.029
ROI, Net profit+interest, % of invest.	22.873	22.873	22.873	22.873	22.873

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

Year	1991
Total assets	2713.120
Fixed assets, net of depreciation	0.000
Construction in progress	2713.120
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available .	0.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	2713.120
Equity capital	780.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	1820.000
Current liabilities	0.000
Bank overdraft, finance required.	113.120
Total debt	1933.120
Equity, % of liabilities	28.749

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

Year	1992	1993	1994	1995	1996
Total assets	3928.157	4562.635	7563.376	8050.771	7798.629
Fixed assets, net of depreciation	2487.618	2383.476	2131.334	1879.192	1627.050
Construction in progress	148.000	0.000	0.000	0.000	0.000
Current assets	733.634	1620.198	4886.286	6165.493	6165.493
Cash, bank	5.486	5.542	6.086	6.086	6.086
Cash surplus, finance available	0.000	0.000	0.000	0.000	0.000
Loss carried forward	0.000	553.419	539.670	0.000	0.000
Loss	553.419	0.000	0.000	0.000	0.000
Total liabilities	3928.157	4562.635	7563.376	8050.771	7798.629
Equity capital	780.000	780.000	780.000	780.000	780.000
Reserves, retained profit	0.000	0.000	0.000	633.763	2279.341
Profit	0.000	13.749	1173.434	1645.578	1660.592
Long and medium term debt	1820.000	1785.875	1558.375	1330.875	1103.375
Current liabilities	137.923	313.427	965.869	1221.464	1221.464
Bank overdraft, finance required.	1190.234	1669.584	3085.699	2439.091	753.857
Total debt	3148.157	3768.886	5609.942	4991.430	3078.697
Equity, % of liabilities	19.857	17.095	10.313	9.689	10.002

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

Year	1997	1998	1999	2000	2001
Total assets	8500.799	9967.521	11449.260	12946.010	14491.900
Fixed assets, net of depreciation	1390.748	1341.806	1096.864	851.922	606.980
Construction in progress	196.000	0.000	0.000	0.000	0.000
Current assets	6165.493	6165.493	6165.493	6165.493	6165.493
Cash, bank	6.086	6.086	6.086	6.086	6.086
Cash surplus, finance available	742.472	2454.136	4180.814	5922.508	7713.342
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	8500.799	9967.521	11449.260	12946.010	14491.900
Equity capital	780.000	780.000	780.000	780.000	780.000
Reserves, retained profit	3939.933	5623.459	7317.681	9026.918	10751.170
Profit	1683.527	1694.222	1709.237	1724.252	1739.267
Long and medium term debt	875.875	648.375	420.875	193.375	0.000
Current liabilities	1221.464	1221.464	1221.464	1221.464	1221.464
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	2097.339	1869.839	1642.339	1414.839	1221.464
Equity, % of liabilities	9.176	7.825	6.813	6.025	5.382

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

Year	2002	2003	2004	2005	2006
Total assets	16340.730	18189.550	20038.380	21887.210	23736.030
Fixed assets, net of depreciation	557.950	704.920	655.890	606.860	557.830
Construction in progress	196.000	0.000	0.000	0.000	0.000
Current assets	6165.493	6165.493	6165.493	6165.493	6165.493
Cash, bank	6.086	6.086	6.086	6.086	6.086
Cash surplus, finance available	9415.197	11313.050	13210.910	15108.770	17006.620
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	16340.730	18189.550	20038.380	21887.210	23736.030
Equity capital	780.000	780.000	780.000	780.000	780.000
Reserves, retained profit	12490.440	14339.260	16188.090	18036.910	19885.740
Profit	1848.826	1848.826	1848.826	1848.826	1848.826
Long and medium term debt	0.000	0.000	0.000	0.000	0.000
Current liabilities	1221.464	1221.464	1221.464	1221.464	1221.464
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	1221.464	1221.464	1221.464	1221.464	1221.464
Equity, % of liabilities	4.773	4.288	3.893	3.564	3.286

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ECONOMIC ANALYSIS

Foreign Cashflows at Adjusted Exchange Rates in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects

	preliminarily adjusted PV			factor	adjusted present values		
	at 0 %	at 10.00 %	at 20.00 %		at 0 %	at 10.00 %	at 20.00 %
f o r e i g n cashflow:							
net cashflow, operation	-41444.05	-22573.45	-14423.03	1.00	-41444.05	-22573.45	-14423.03
sales revenue, incl. tax	122671.30	56065.54	30595.83	1.00	122671.30	56065.54	30595.83
other income	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indirect effects,benefit	....	....	....	....	....	....	....
cash outflow, operation:							
fixed investment	2306.92	2343.74	2300.17	1.00	2306.92	2343.74	2300.17
net working capital . .	-0.00	2276.00	2279.13	1.00	-0.00	˜276.00	2279 13
operating costs	161808.50	74019.25	40439.57	1.00	161808.50	74019.25	40439.57
materials	161808.50	74019.25	40439.57	1.00	161808.50	74019.25	40439.57
unskilled labour . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
supervision & skilled	0.00	0.00	0.00	0.00	0.00	0.00	0.00
taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indirect effects, costs	....	....	....	....	....	....	....

Local Cashflows at Adjusted Market Prices in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects

	financial present values			factor	adjusted present values		
	at 0 %	at 10.00 %	at 20.00 %		at 0 %	at 10.00 %	at 20.00 %
local cashflow :							
net cashflow, operation	319307.90	145306.70	78888.19	1.07	341596.00	155075.70	83979.95
sales revenue, incl. tax	368057.50	168234.40	91820.73	1.00	368057.50	168234.40	91820.73
other income	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indirect effects,benefit	....	....	....	....	....	....	....
cash outflow, operation:							
fixed investment	268.25	441.74	478.01	1.00	268.25	441.74	478.01
net working capital . .	0.00	444.18	454.44	1.00	0.00	444.18	454.44
operating costs	26193.32	12272.81	6908.34	1.00	26193.32	12272.81	6908.34
materials	22088.08	10231.67	5680.41	1.00	22088.08	10231.67	5680.41
unskilled labour . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
supervision, skilled	4105.24	2041.14	1227.93	1.00	4105.24	2041.14	1227.93
taxes	22287.99	9769.00	5091.76	0.00	0.00	0.00	0.00
indirect effects, costs	....	....	....	....	....	....	....

Total Cashflows at Adjusted Market Prices in 1,000 U.S. DOLLARS

Economic Analysis excluding indirect effects

	financial present values at 0 %	at 10.00 %	at 20.00 %	factor	adjusted present values at 0 %	at 10.00 %	at 20.00 %
total cashflow :							
net cashflow	277863.90	122733.20	64465.15	1.08	300151.90	132502.20	69556.91
net indirect effects . .							
total cash inflow . . .	490728.80	224299.90	122416.50	1.00	490728.80	224299.90	122416.50
total cash outflow . . .	212865.00	101566.70	57951.42	1.00 >=	190577.00	91797.72	52859.65
taxes	22287.99	9769.00	5091.76	0.00	0.00	0.00	0.00
flow of funds:							
net flow of funds . . .	-847.08	1082.87	1744.15	1.00	-847.08	1082.87	1744.15
total funds, inflow . .	3821.46	3535.19	3337.65	1.00	3821.46	3535.19	3337.65
equity	780.00	780.00	780.00	1.00	780.00	780.00	780.00
subsidies, grants . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . .	3041.46	2755.19	2557.65	1.00	3041.46	2755.'9	2557.65
total funds, outflow . .	4668.54	2452.32	1593.50	1.00	4668.54	2452.32	1593.50
interest	1627.08	1168.40	903.03	1.00	1627.08	1168.40	903.03
repayment	3041.46	1283.93	690.47	1.00	3041.46	1283.93	690.47
dividends distributed	0.00	0.00	0.00	0.00	0.00	0.00	0.00
net flow, foreign funds	-1104.48	524.05	1076.53	1.00	-1104.48	524.05	1076.53
foreign funds, inflow .	2768.12	2526.07	2359.16	1.00	2768.12	2526.07	2359.16
equity	195.00	195.00	195.00	1.00	195.00	195.00	195.00
subsidies, grants . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . .	2573.12	2331.07	2164.16	1.00	2573.12	2331.07	2164.16
foreign funds, outflow .	3872.60	2002.01	1282.63	1.00	3872.60	2002.01	1282.63
dividends distributed	0.00	0.00	0.00	0.00	0.00	0.00	0.00
debt service	3872.60	2002.01	1282.63	1.00	3872.60	2002.01	1282.63
interest paid .	1299.48	926.10	711.85	1.00	1299.48	926.10	711.85
loan repayment .	2573.12	1075.91	570.79	1.00	2573.12	1075.91	570.79

financial rate of return (market prices) 161.66 %

economic rate of return (prelim.adjust) 165.93 %

Total Cashflows at Adjusted Exchange Rates in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects

	preliminarily adjusted PV			factor	adjusted present values		
	at 0 %	at 10.00 %	at 20.00 %		at 0 %	at 10.00 %	at 20.00 %
total cashflow :							
net cashflow	300151.90	132502.20	69556.91	1.00	300151.90	132502.20	69556.91
net indirect effects . .	....	....	....	....	....	....	....
total cash inflow . . .	490728.80	224299.90	122416.50	1.00	490728.80	224299.90	122416.50
total cash outflow . . .	190577.00	91797.72	52859.65	1.00	190577.00	91797.72	52859.65
taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00
flow of funds:							
net flow of funds . . .	-847.08	1082.87	1744.15	1.00	-847.08	1082.87	1744.15
total funds, inflow . .	3821.46	3535.19	3337.65	1.00	3821.46	3535.19	3337.65
equity	780.00	780.00	780.00	1.00	780.00	780.00	780.00
subsidies, grants . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . .	3041.46	2755.19	2557.65	1.00	3041.46	2755.19	2557.65
total funds, outflow . .	4668.54	2452.32	1593.50	1.00	4668.54	2452.32	1593.50
interest	1627.08	1168.40	903.03	1.00	1627.08	1168.40	903.03
repayment	3041.46	1283.93	690.47	1.00	3041.46	1283.93	690.47
dividends distributed	0.00	0.00	0.00	0.00	0.00	0.00	0.00
net flow, foreign funds	-1104.48	524.05	1076.53	1.00	-1104.48	524.05	1076.53
foreign funds, inflow .	2768.12	2526.07	2359.16	1.00	2768.12	2526.07	2359.16
equity	195.00	195.00	195.00	1.00	195.00	195.00	195.00
subsidies, grants . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . .	2573.12	2331.07	2164.16	1.00	2573.12	2331.07	2164.16
foreign funds, outflow .	3872.60	2002.01	1282.63	1.00	3872.60	2002.01	1282.63
dividends distributed	0.00	0.00	0.00	0.00	0.00	0.00	0.00
debt service	3872.60	2002.01	1282.63	1.00	3872.60	2002.01	1282.63
interest paid .	1299.48	926.10	711.85	1.00	1299.48	926.10	711.85
loan repayment .	2573.12	1075.91	570.79	1.00	2573.12	1075.91	570.79

financial rate of return (market prices) 161.66 %
economic rate of return (prelim.adjust) 165.93 %
economic rate of return (econom.prices) 165.93 %

Absolute Efficiency Test - 1 in 1,000 U.S. DOLLARS
Economic Analysis at Market Prices, excluding indirect effects

	grand total	total constr.	total produc.	.construction... 1991	1992	production 1993	1994
value of output, O	490095.40	0.00	490095.40	0.00	3644.80	9112.00	29416.80
material input, I+MI	186591.80	2713.12	183878.70	2713.12	2360.16	4403.30	14039.63
investment, I	2695.29	2713.12	-17.83	2713.12	743.48	815.57	2996.97
operation, MI	183896.50	0.00	183896.50	0.00	1616.69	3587.73	11042.67
net domestic VA	303503.60	-2713.12	306216.80	-2713.12	1284.64	4708.70	15377.17
repatriated payments	3872.60	92.82	3779.78	92.82	185.64	185.64	379.02
net national VA	299631.10	-2805.94	302437.00	-2805.94	1099.00	4523.06	14998.15
national wages	4105.24	0.00	4105.24	0.00	202.50	252.50	280.79
social surplus	295525.80	-2805.94	298331.80	-2805.94	896.50	4270.56	14717.36

present values at	20.00 %
PV, net national VA	69019.59
PV, national wages	1227.93
PV, unskilled labour	0.00
PV of social surplus	67791.66

relative efficiency of:		
	capital invested, E(C) :	11.58
	foreign exchange, E(FE) :	1.46
	skilled labour, E(L) :	56.21

Absolute Efficiency Test - 1 in 1,000 U.S. DOLLARS
Economic Analysis at Market Prices, excluding indirect effects

	1995	1996	1997	production 1998	1999	2000	2001
value of output, O	37379.60	37379.60	37379.60	37379.60	37379.60	37379.60	37379.60
material input, I+MI	15146.22	13970.79	14166.79	13970.79	13970.79	13970.79	13970.79
investment, I	1175.43	0.00	196.00	0.00	0.00	0.00	0.00
operation, MI	13970.79	13970.79	13970.79	13970.79	13970.79	13970.79	13970.79
net domestic VA	22233.38	23408.81	23212.81	23408.81	23408.81	23408.81	23408.81
repatriated payments	355.81	332.60	309.40	286.20	262.99	239.79	216.58
net national VA	21877.57	23076.21	22903.41	23122.62	23145.82	23169.03	23192.23
national wages	280.79	280.79	280.79	280.79	280.79	280.79	280.79
social surplus	21596.78	22795.42	22622.63	22841.83	22865.04	22888.24	22911.45

present values at	20.00 %
PV, net national VA	69019.59
PV, national wages	1227.93
PV, unskilled labour	0.00
PV of social surplus	67791.66

relative efficiency of:		
	capital invested, E(C) :	11.58
	foreign exchange, E(FE) :	1.46
	skilled labour, E(L) :	56.21

Absolute Efficiency Test - 1 in 1,000 U.S. DOLLARS
Economic Analysis at Market Prices, excluding indirect effects

	production					
	2002	2003	2004	2005	2006	2007
value of output, O	37379.60	37379.60	37379.60	37379.60	37379.60	-633.33
material input, I+MI	14166.79	13970.79	13970.79	13970.79	13970.79	-6141.28
investment, I	196.00	0.00	0.00	0.00	0.00	-6141.28
operation, MI	13970.79	13970.79	13970.79	13970.79	13970.79	0.00
net domestic VA	23212.81	23408.81	23408.81	23408.81	23408.81	5507.95
repatriated payments	0.00	0.00	0.00	0.00	0.00	1026.12
net national VA	23212.81	23408.81	23408.81	23408.81	23408.81	4481.82
national wages	280.79	280.79	280.79	280.79	280.79	0.00
social surplus	22932.03	23128.03	23128.03	23128.03	23128.03	4481.82

present values at	20.00 %
PV, net national VA	69019.59
PV, national wages	1227.93
PV, unskilled labour	0.00
PV of social surplus	67791.66

relative efficiency of:	capital invested, E(C) :	11.58
	foreign exchange, E(FE) :	1.46
	skilled labour, E(L) :	56.21

Foreign Exchange Effect in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects
100 units foreign CU = 100.00 units local CU

	grand total	total constr.	total produc.	.construction... 1991	1992	production 1993	1994
total foreign inflow . .	125439.40	1742.00	123697.40	1742.00	1011.07	2423.34	7907.25
equity capital	195.00	195.00	0.00	195.00	0.00	0.00	0.00
subsidies, grants . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . . .	2573.12	1547.00	1026.12	1547.00	105.31	150.78	553.05
exports	122671.30	0.00	122671.30	0.00	905.76	2272.56	7354.20
indirect effects	....	....	....	....	....	....	....
total foreign outflow .	167988.00	2195.82	165792.20	2195.82	2124.54	4022.82	12890.93
royalties	0.00	0.00	0.00	0.00	0.00	0.00	0.00
equipment	2306.92	2103.00	203.92	2103.00	675.13	764.02	2802.18
imported materials . . .	161808.50	0.00	161808.50	0.00	1263.77	3073.16	9709.74
repayment loans & overd.	2573.12	0.00	2573.12	0.00	0.00	0.00	193.38
other repayments	0.00	0.00	0.00	0.00	0.00	0.00	0.00
repatriated wages . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dividends paid	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interests	1299.48	92.82	1206.66	92.82	185.64	185.64	185.64
indirect costs	....	....	....	....	....	....	....
net foreign exchge flow	-42548.54	-453.82	-42094.72	-453.82	-1113.47	-1599.48	-4983.66
import substit'n effect	245364.40	0.00	245364.40	0.00	1822.40	4556.00	14708.40
net forgn exchge effect	202815.90	-453.82	203269.70	-453.82	708.93	2956.52	9724.72

present values at	20.00 %
foreign exchange flow .	-13908.17
net forgn exchge effect	47300.11

PHOTOVOLTAIC MODULES

Foreign Exchange Effect in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects
100 units foreign CU = 100.00 units local CU

	production						
	1995	1996	1997	1998	1999	2000	2001
total foreign inflow . .	9561.88	9344.90	9344.90	9344.90	9344.90	9344.90	9344.90
equity capital	0.00	0.00	0.00	0.00	0.00	0.00	0.00
subsidies, grants . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . . .	216.98	0.00	0.00	0.00	0.00	0.00	0.00
exports	9344.90	9344.90	9344.90	9344.90	9344.90	9344.90	9344.90
indirect effects	....	....	....	....	....	....	....
total foreign outflow .	13768.65	12646.09	12818.88	12599.68	12576.47	12553.27	12530.06
royalties	0.00	0.00	0.00	0.00	0.00	0.00	0.00
equipment	1099.36	0.00	196.00	0.00	0.00	0.00	0.00
imported materials . . .	12313.48	12313.48	12313.48	12313.48	12313.48	12313.48	12313.48
repayment loans & overd.	193.38	193.38	193.38	193.38	193.38	193.38	193.38
other repayments	0.00	0.00	0.00	0.00	0.00	0.00	0.00
repatriated wages . . .	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dividends paid	0.00	0.00	0.00	0.00	0.00	0.00	0.00
interests	162.43	139.23	116.03	92.82	69.61	46.41	23.20
indirect costs	....	....	....	....	....	....	....
net foreign exchge flow	-4206.77	-3301.19	-3473.98	-3254.78	-3231.57	-3208.37	-3185.16
import substit'n effect	18689.80	18689.80	18689.80	18689.80	18689.80	18689.80	18689.80
net forgn exchge effect	14483.03	15388.61	15215.82	15435.02	15458.23	15481.43	15504.64

present values at	20.00 %
foreign exchange flow .	-13908.17
net forgn exchge effect	47300.11

Foreign Exchange Effect in 1,000 U.S. DOLLARS
Economic Analysis excluding indirect effects
100 units foreign CU = 100.00 units local CU

	production					
	2002	2003	2004	2005	2006	2007
total foreign inflow . .	9344.90	9344.90	9344.90	9344.90	9344.90	0.00
equity capital	0.00	0.00	0.00	0.00	0.00	0.00
subsidies, grants . . .	0.00	0.00	0.00	0.00	0.00	0.00
loans & overdraft . . .	0.00	0.00	0.00	0.00	0.00	0.00
exports	9344.90	9344.90	9344.90	9344.90	9344.90	0.00
indirect effects	-----------	-----------	-----------	-----------	-----------	-----------
total foreign outflow .	12509.48	12313.48	12313.48	12313.48	12313.48	-4502.65
royalties	0.00	0.00	0.00	0.00	0.00	0.00
equipment	196.00	0.00	0.00	0.00	0.00	-5528.77
imported materials . . .	12313.48	12313.48	12313.48	12313.48	12313.48	0.00
repayment loans & overd.	0.00	0.00	0.00	0.00	0.00	1026.12
other repayments	0.00	0.00	0.00	0.00	0.00	0.00
repatriated wages . . .	0.00	0.00	0.00	0.00	0.00	0.00
dividends paid	0.00	0.00	0.00	0.00	0.00	0.00
interests	0.00	0.00	0.00	0.00	0.00	0.00
indirect costs	....	....	....	....	....	....
net foreign exchge flow	-3164.58	-2968.58	-2968.58	-2968.58	-2968.58	4502.65
import substit'n effect	18689.80	18689.80	18689.80	18689.80	18689.80	0.00
net forgn exchge effect	15525.22	15721.22	15721.22	15721.22	15721.22	4502.65

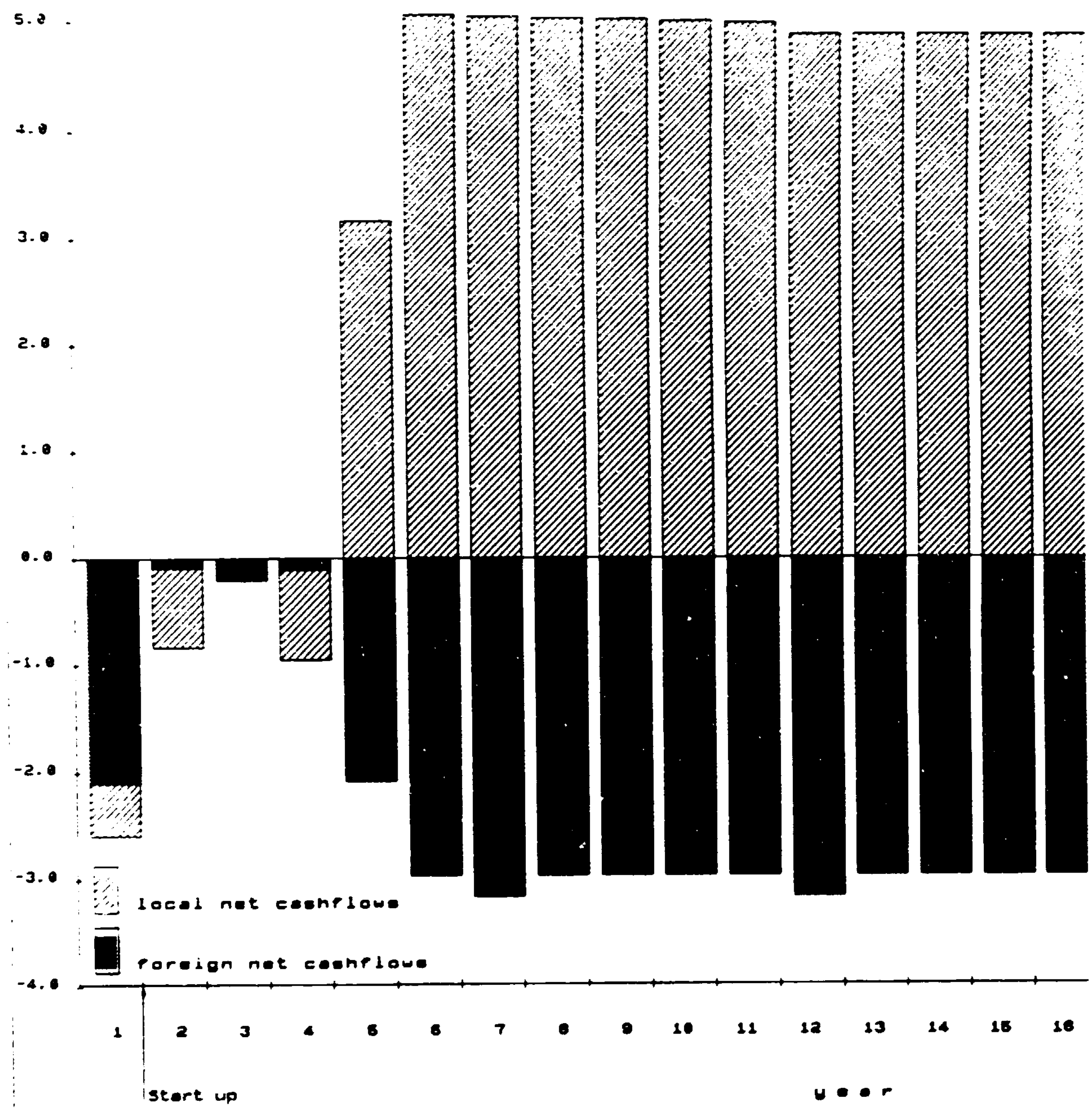
present values at	20.00 %
foreign exchange flow .	-13908.17
net forgn exchge effect	47300.11

PHOTOVOLTAIC MODULES

GRAPHICS

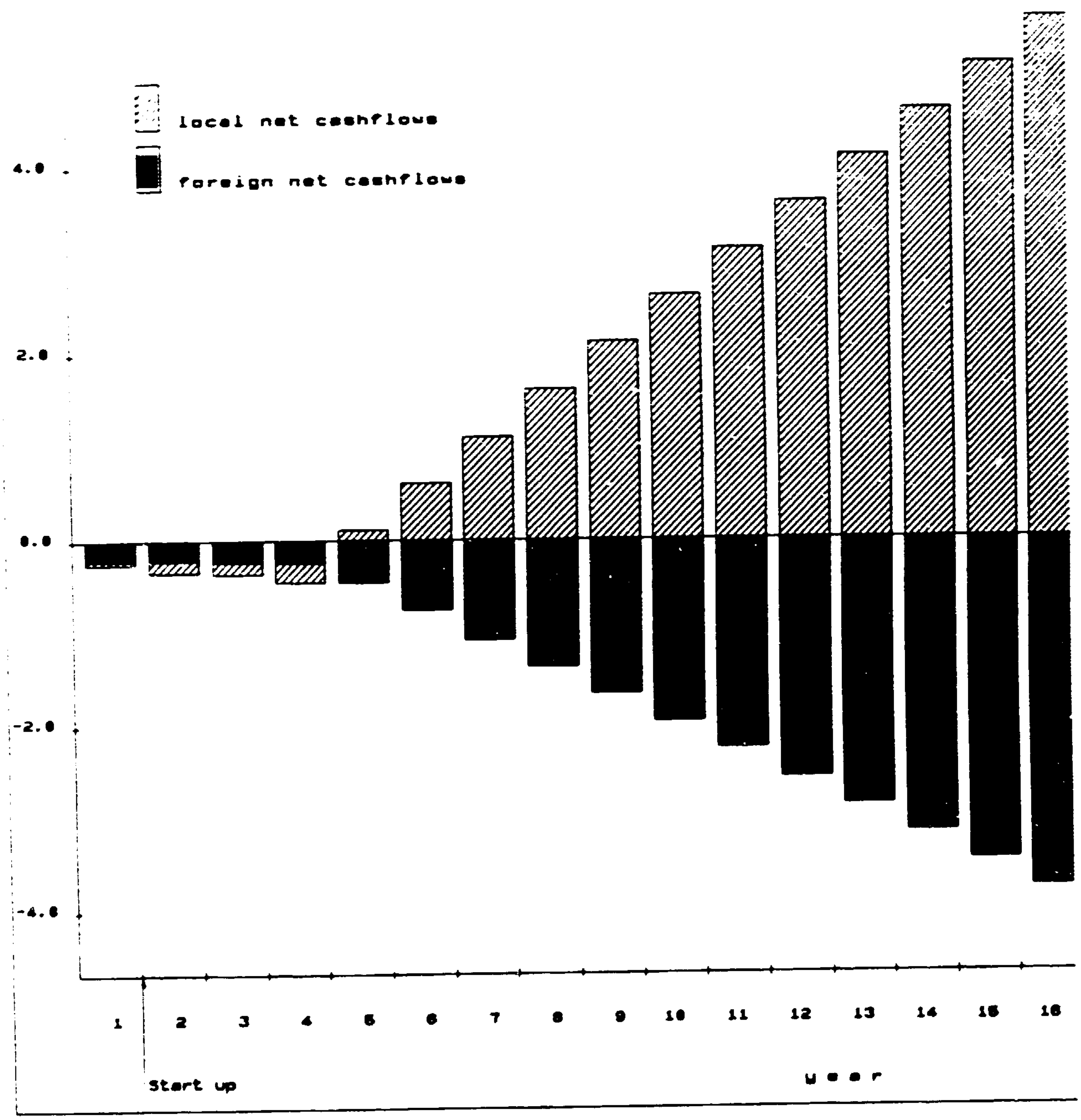
Annual CF, operations

10^3 1,000 U.S. DOLLARS



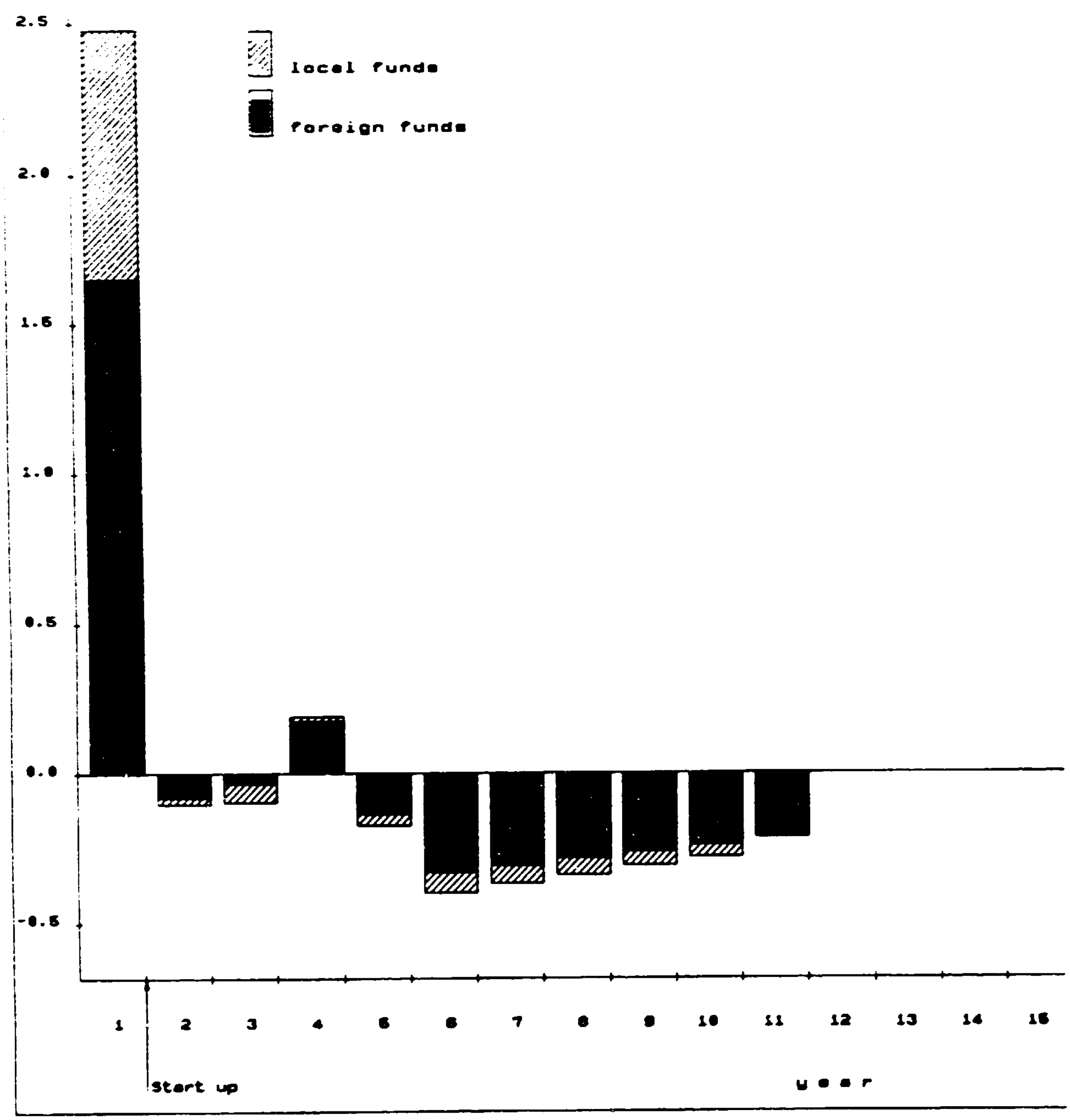
Accumulated CF, operations

10^4 1,000 U.S. DOLLARS



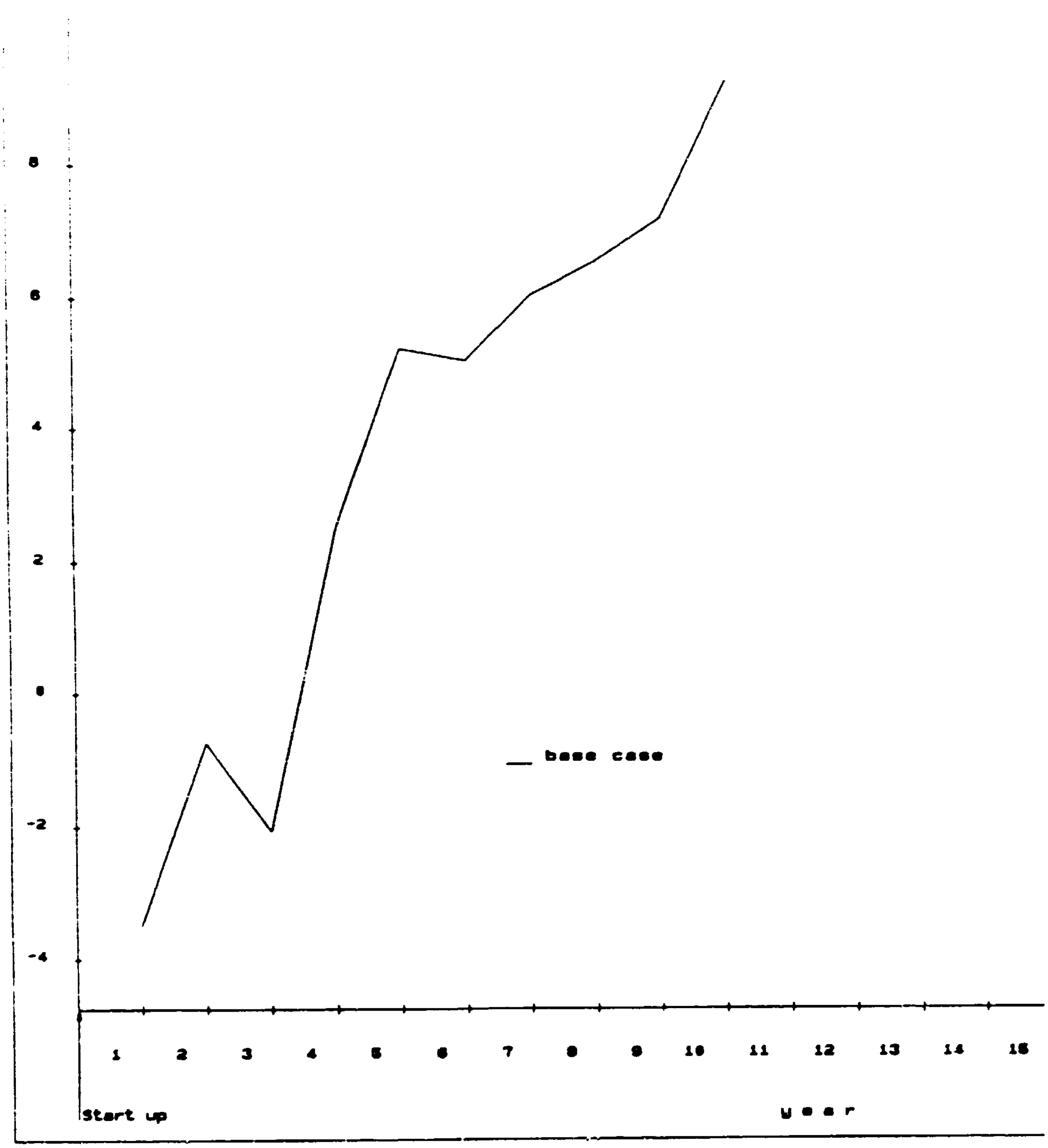
Annual flow of funds (finance)

10^3 1,000 U.S. DOLLARS

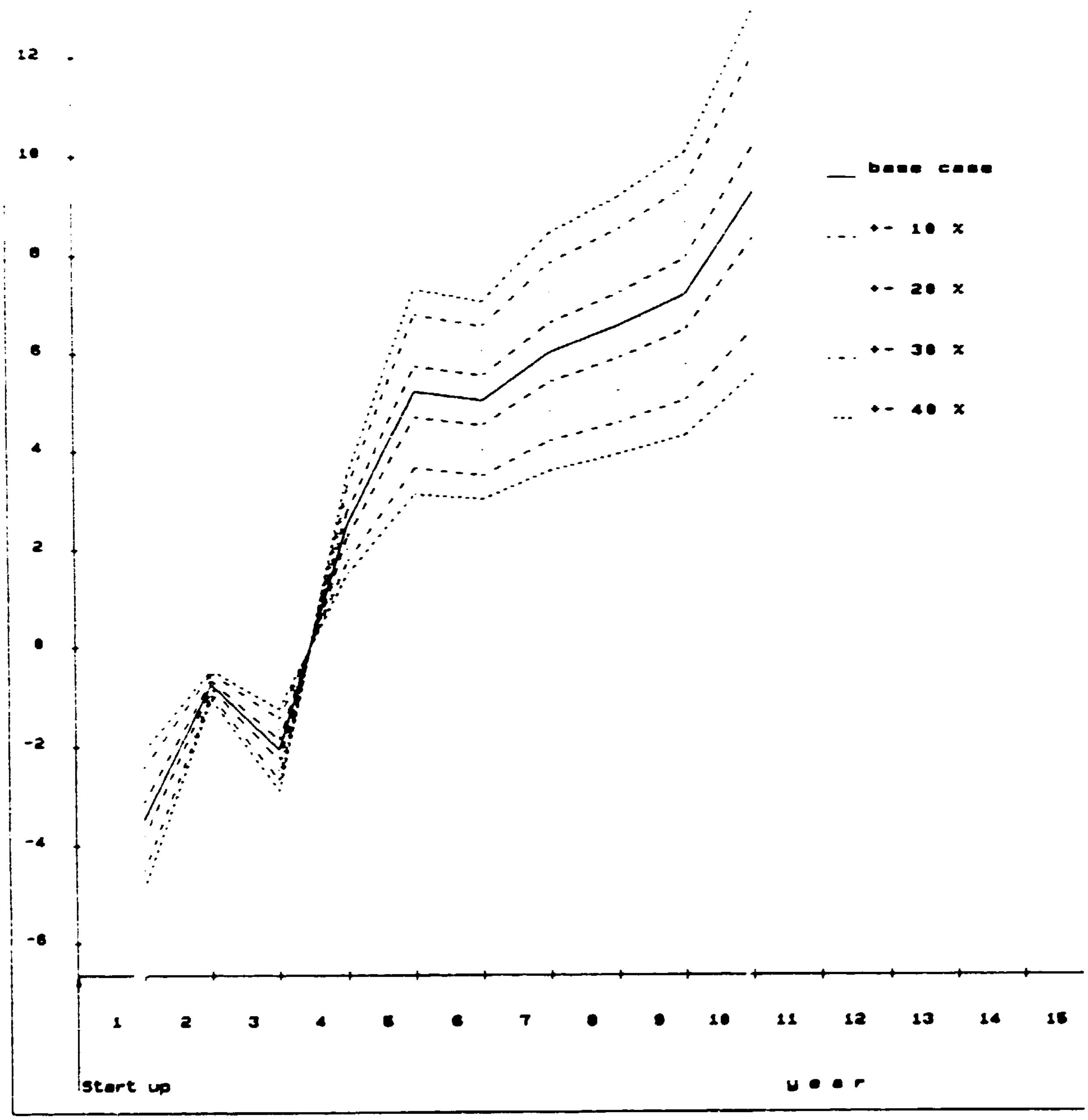


Debt Service Ratio, by year

net cashflow/debt service

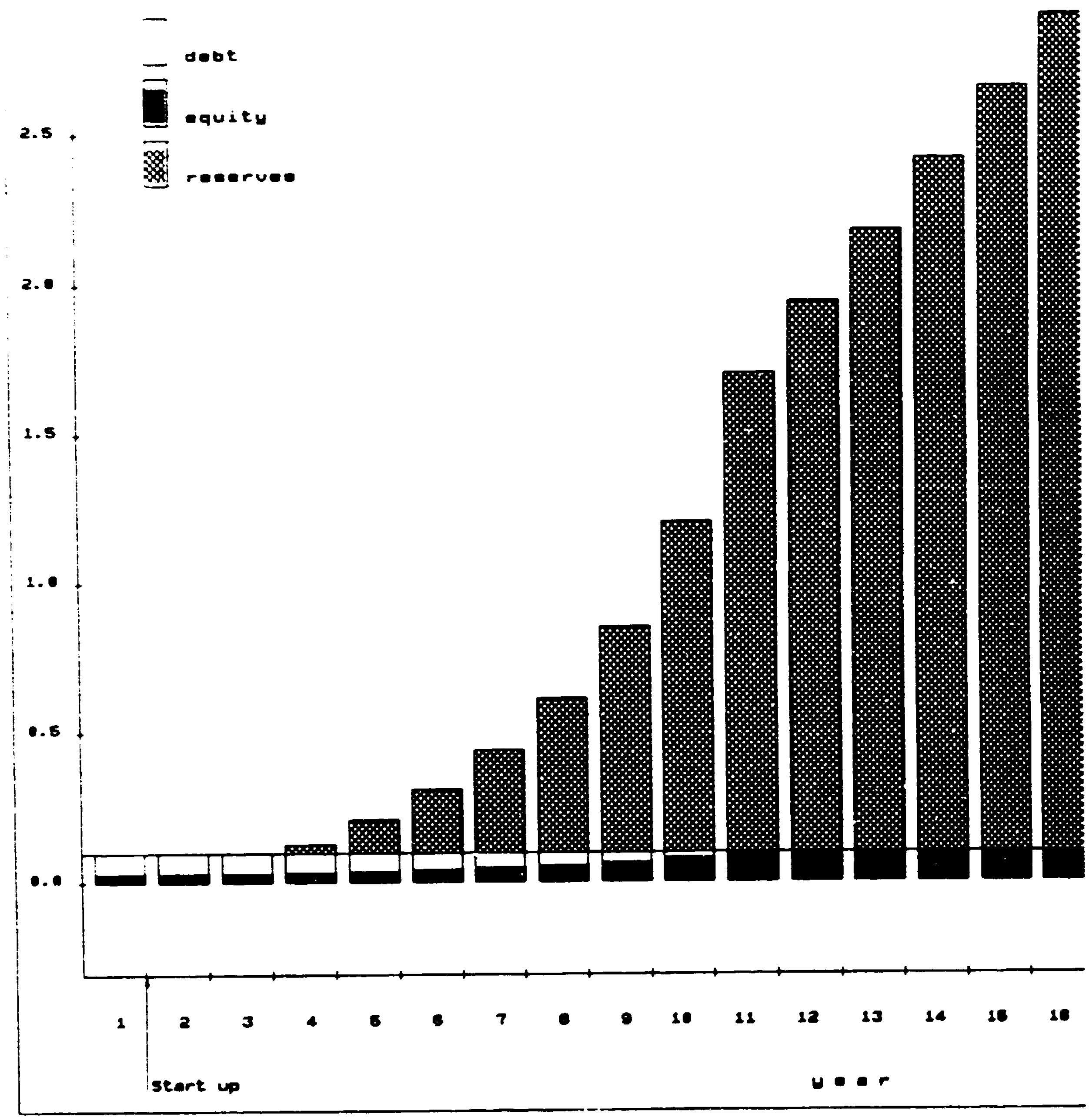


Debt Service Ratio, by year net cashflow/debt service	variation of the net cashflow



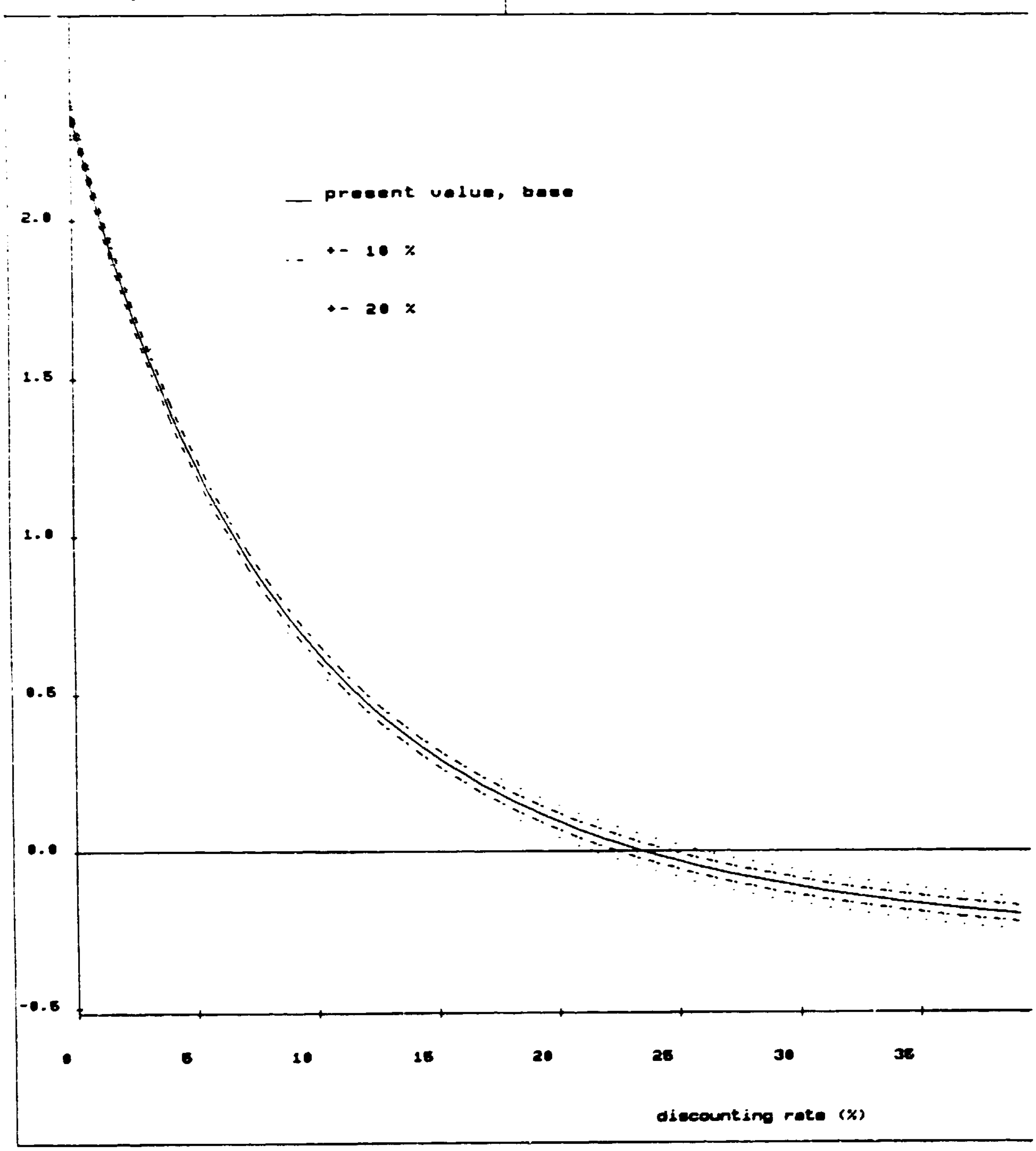
Debt/Equity Ratio, by year

10^3 ratio in (%)

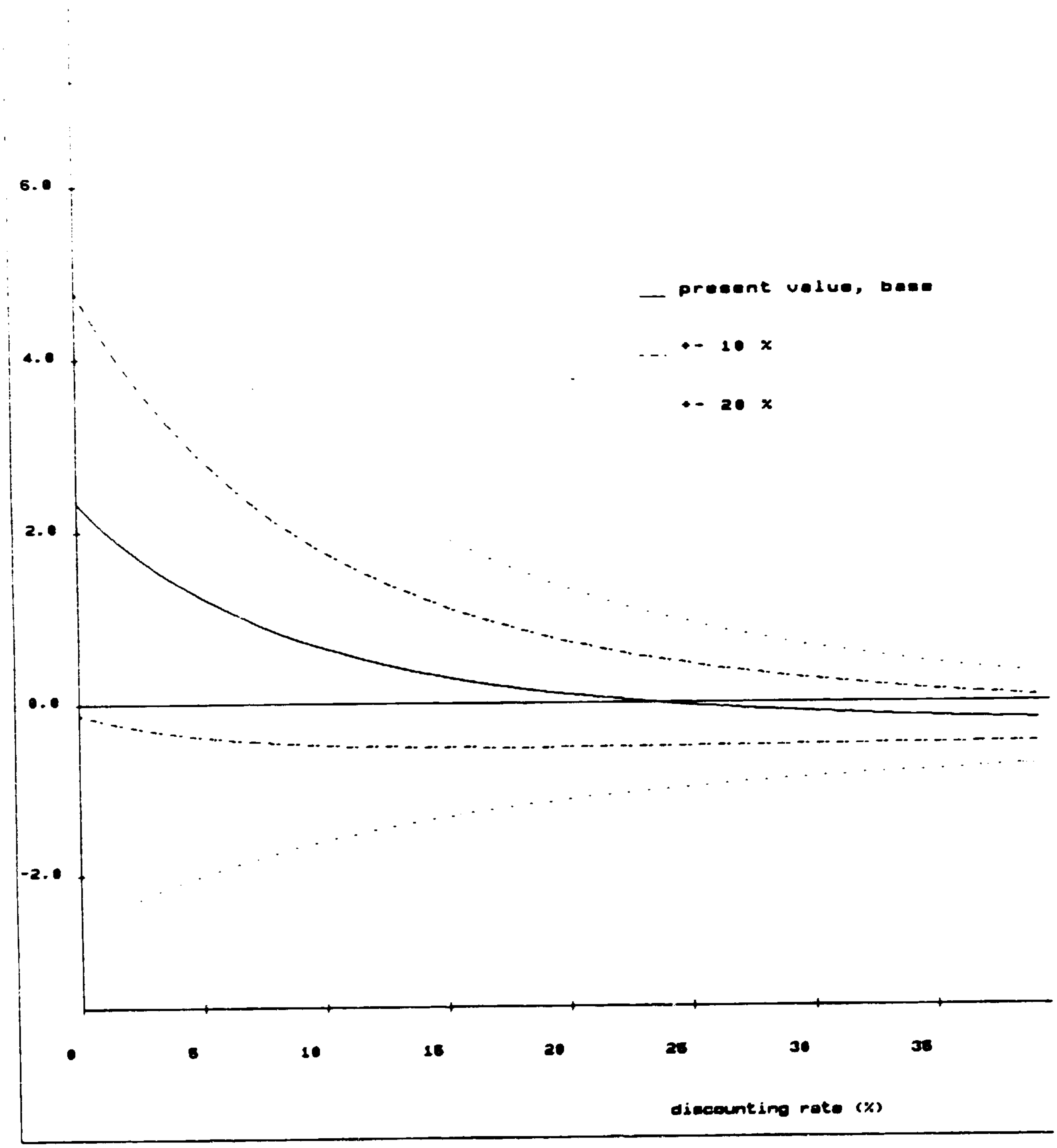


Discounted CF, Investment | var. of initial investment costs

10^ 4   1,000 U.S. DOLLARS



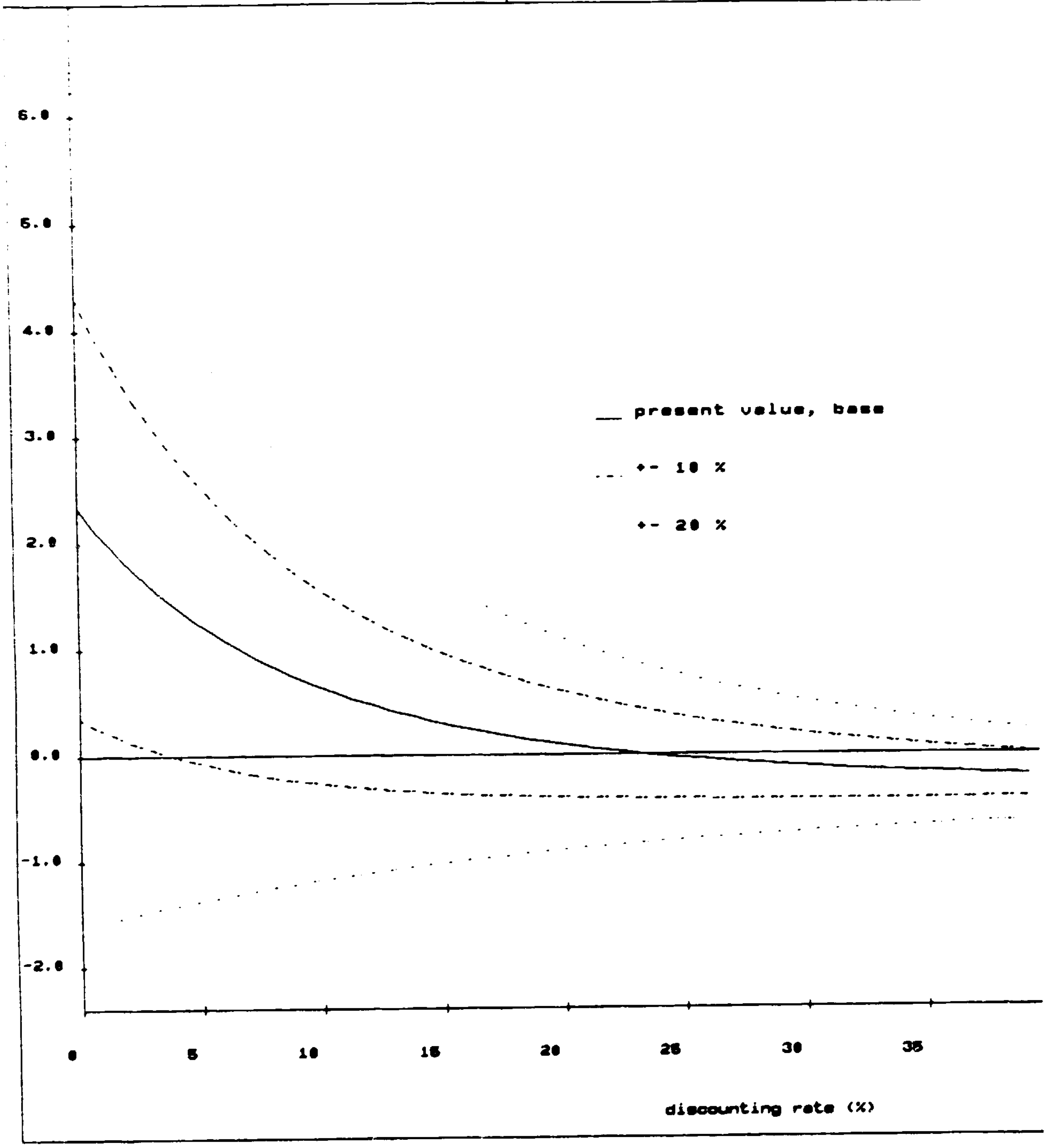
Discounted CF, Investment	variation of sales prices
10^ 4 1,000 U.S. DOLLARS	



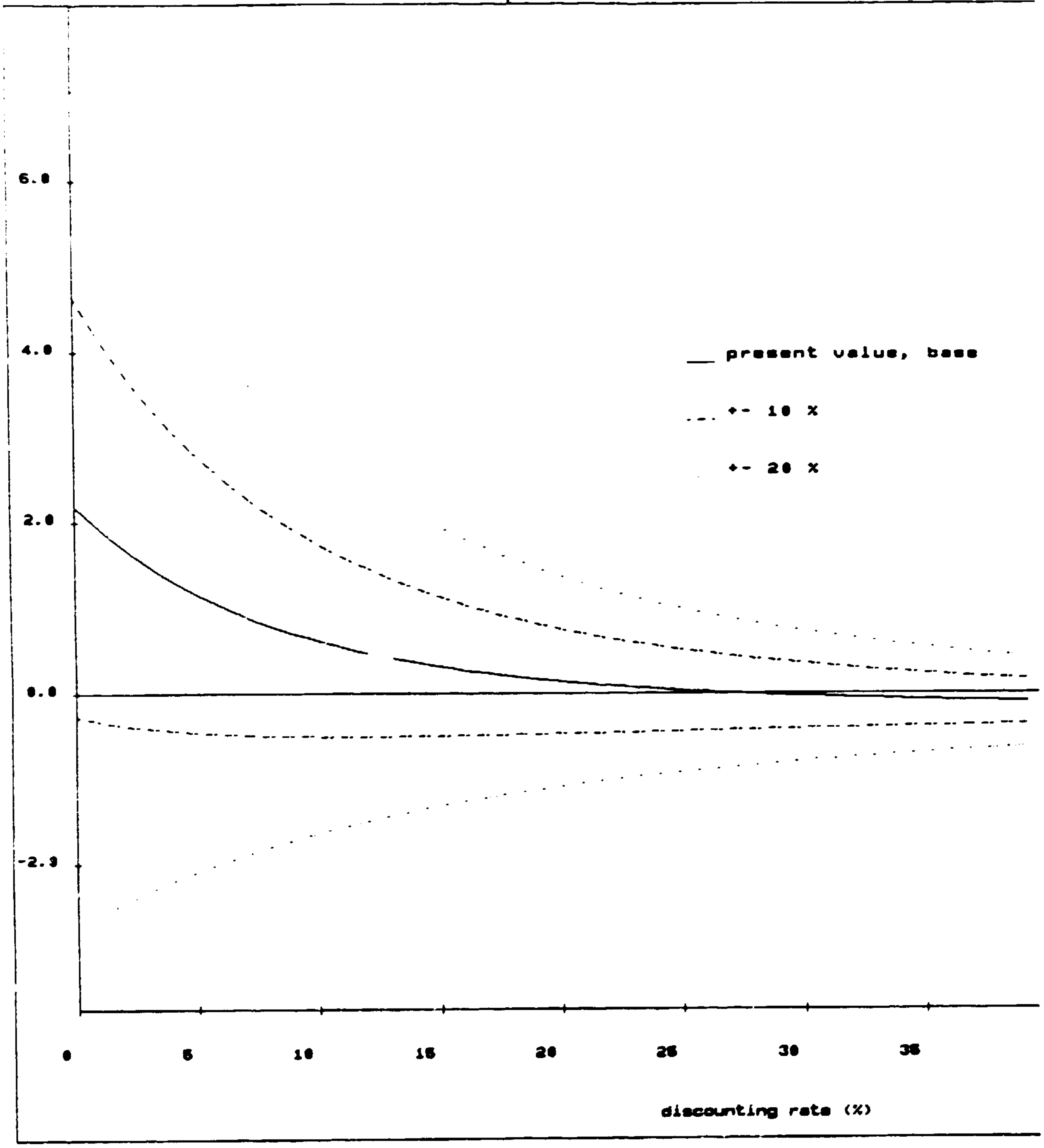
Discounted CF, Investment

variation of operating costs

10^ 4 1,000 U.S. DOLLARS

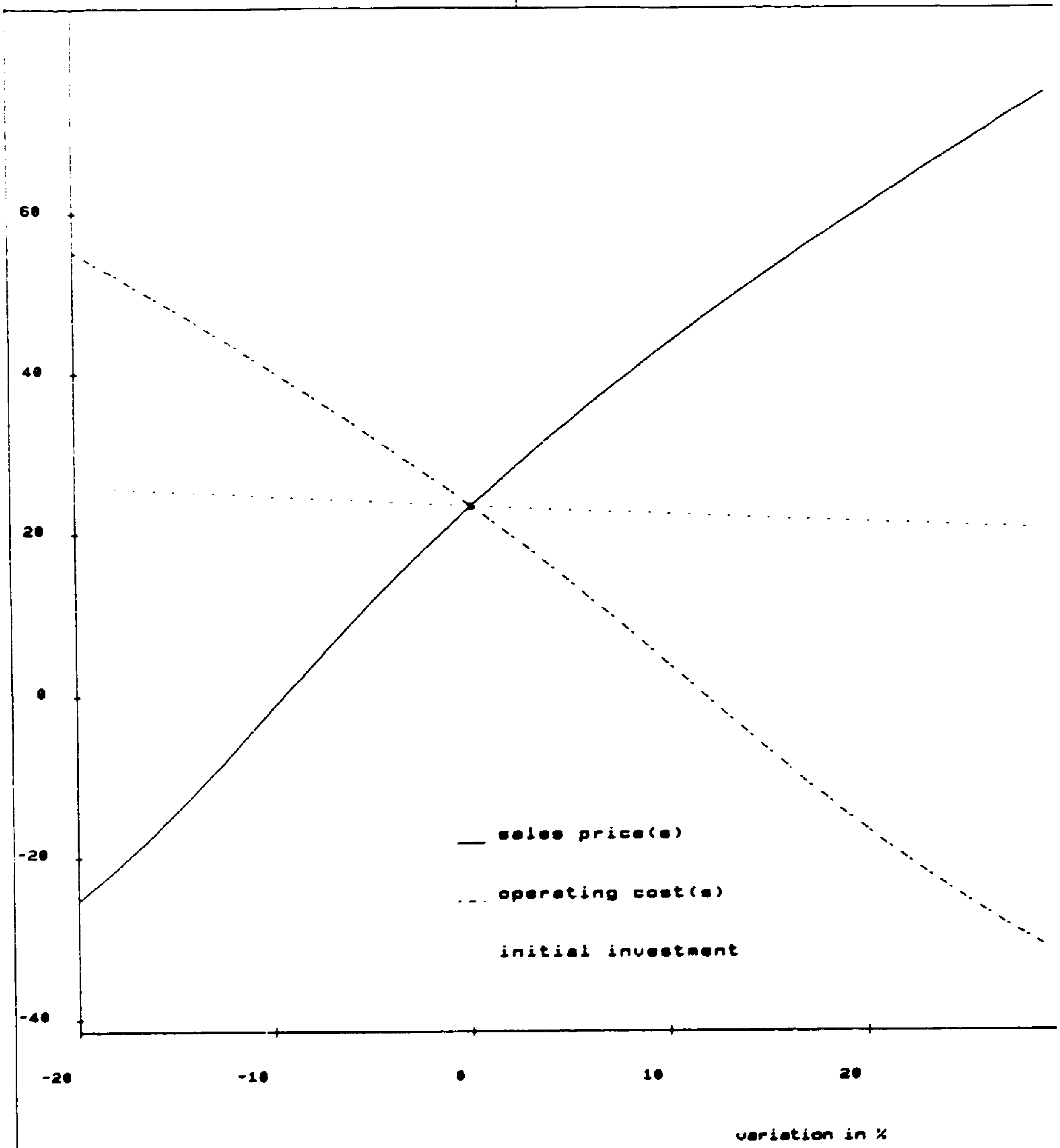


Discounted return on NetWorth	variation of total sales prices
10^ 4 1,000 U.S. DOLLARS	

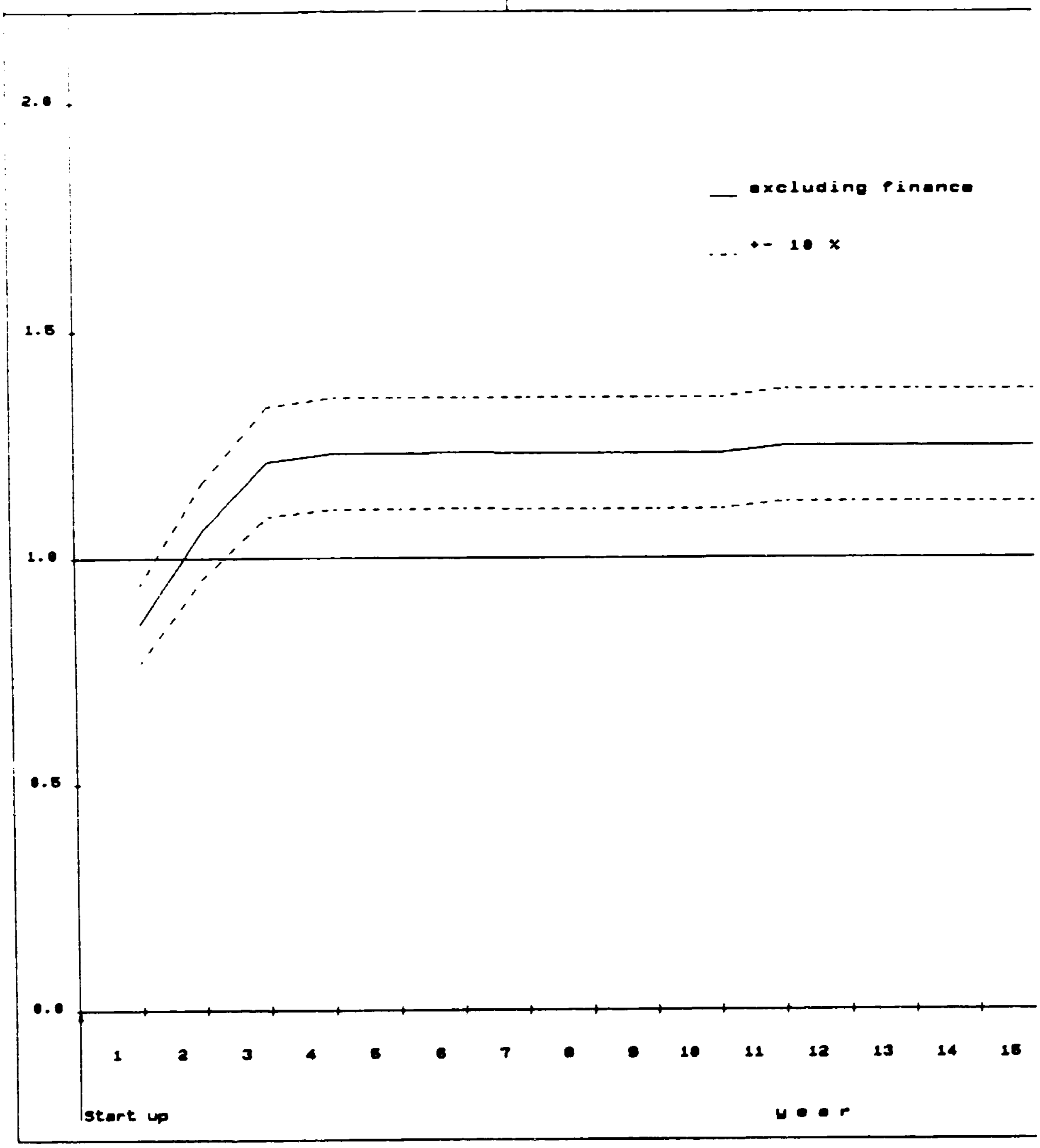


Sensitivity of IRR

internal rate of return

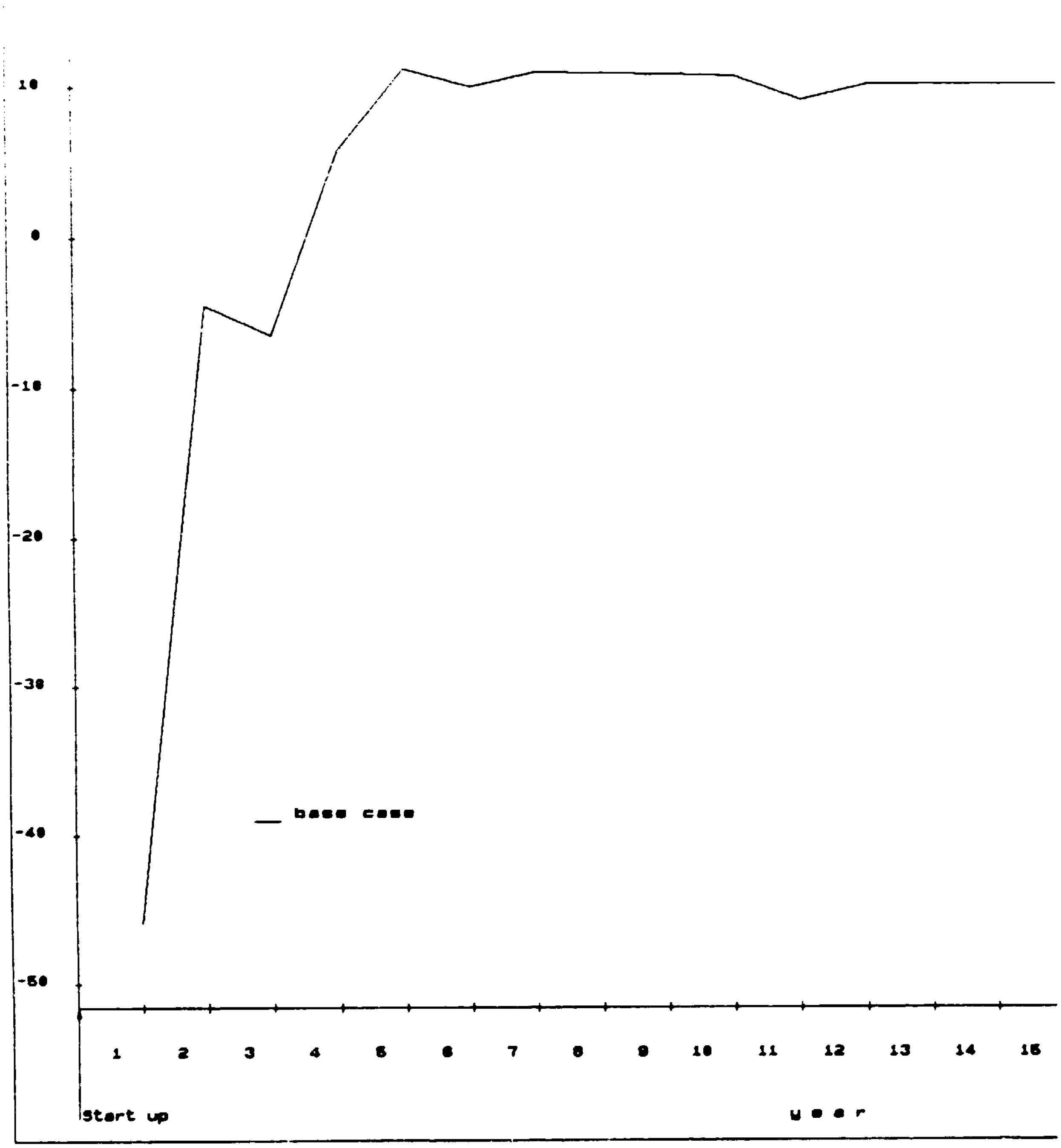


Fixed Costs Coverage Ratio variable margin/fixed cost	variation of sales prices



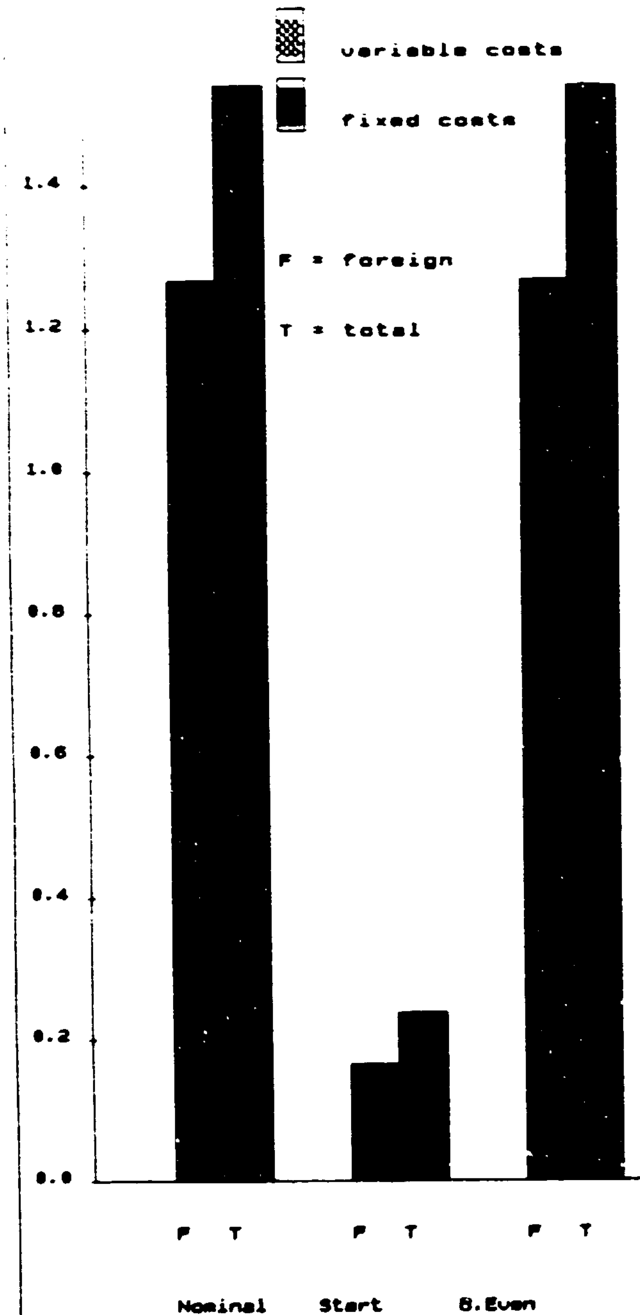
Net Cashflow / Total Sales

ratio in (%)



Structure of Production Costs

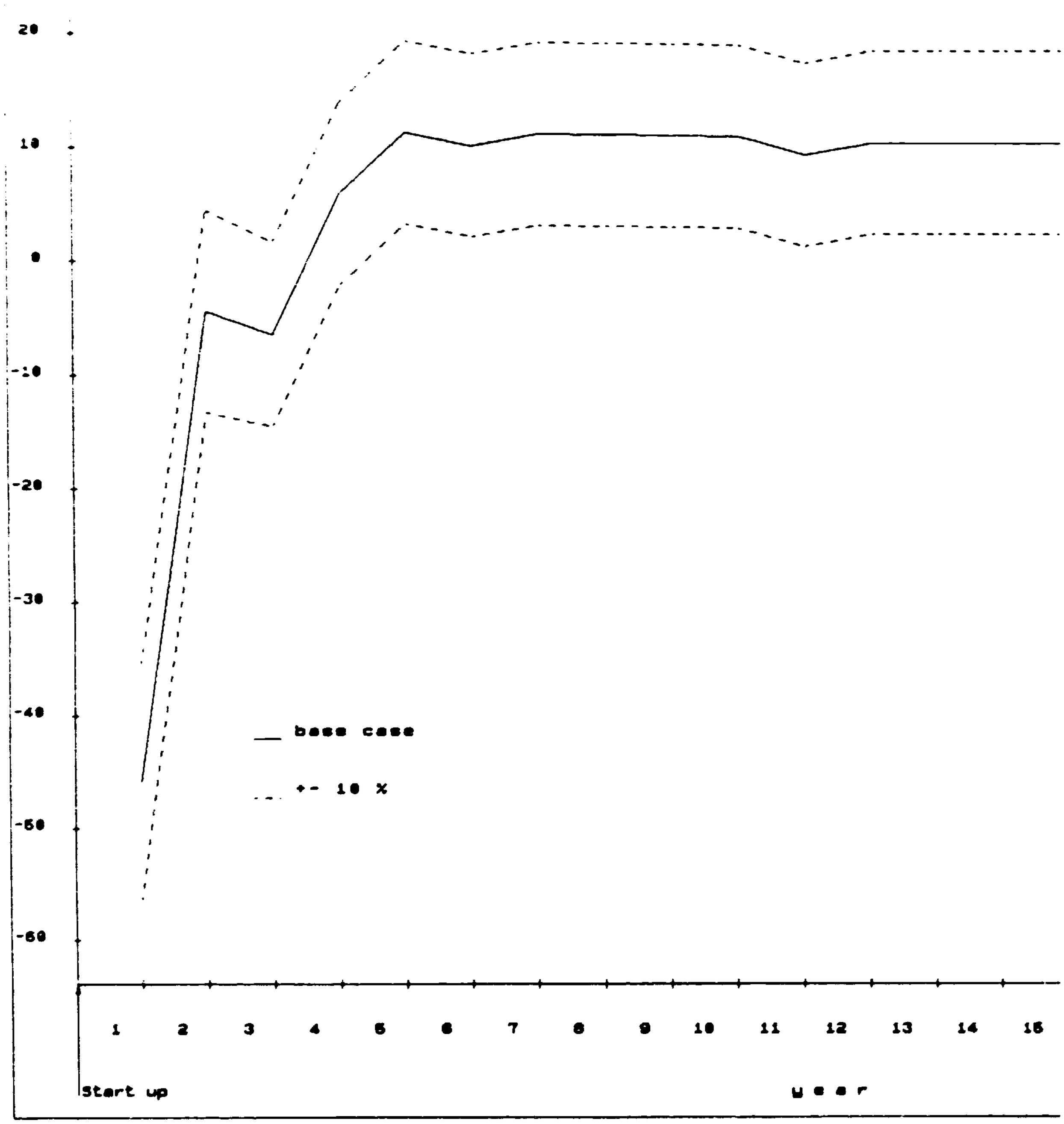
10^ 4 1,000 U.S. DOLLARS — for 6th production year



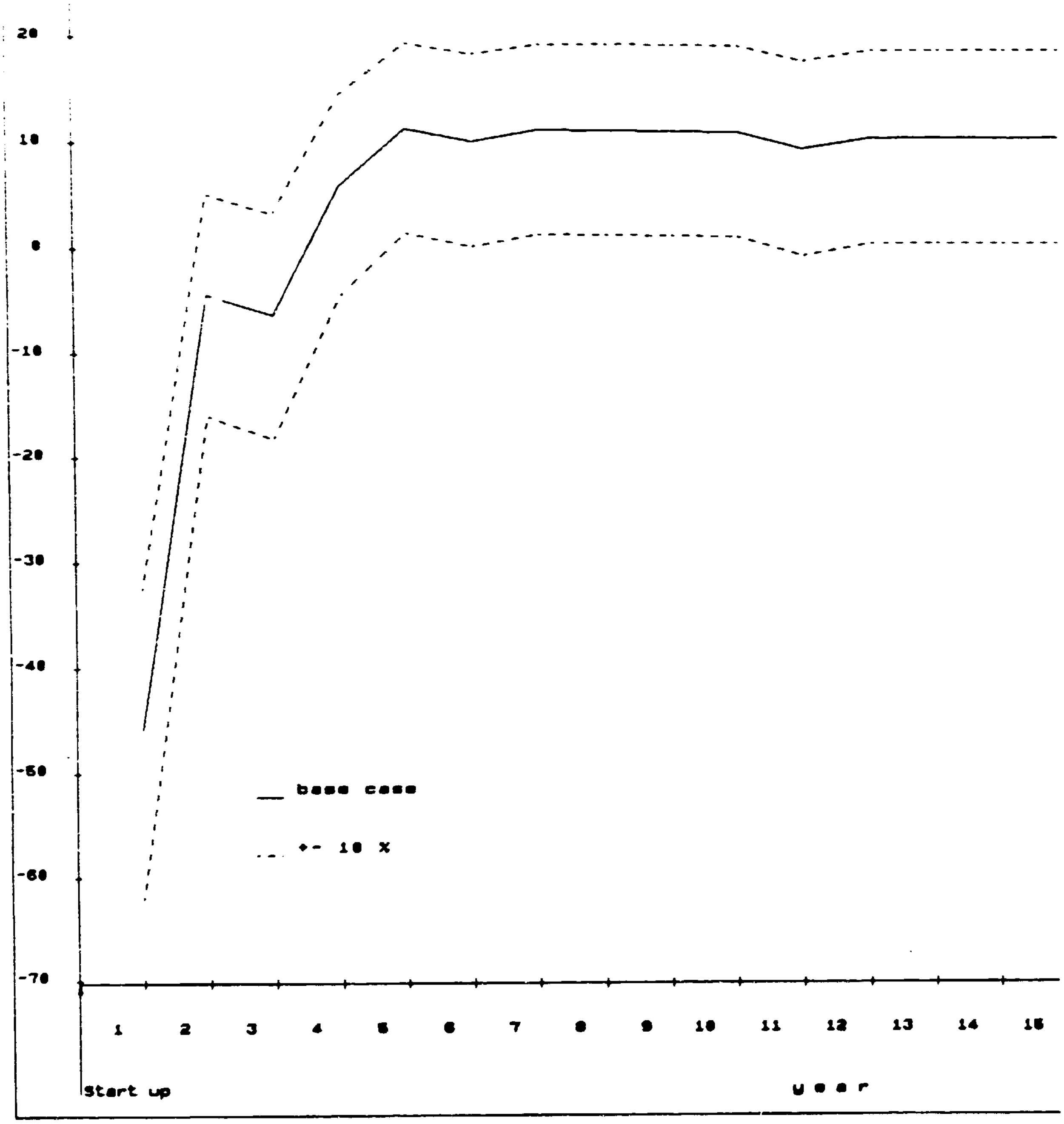
Nominal	Start up	
79.34	50.04	raw material
13.91	8.78	other RM
0.00	0.00	utilities
0.16	0.13	energy
1.13	4.63	labour
0.13	0.04	maintenance
0.66	2.31	spares
1.92	13.68	overheads
1.04	9.49	depreciation
1.13	10.11	interest
100.00	100.00	Total Prod C.

production level

Net Cashflow / Total Sales ratio in (%)	variation of operating costs

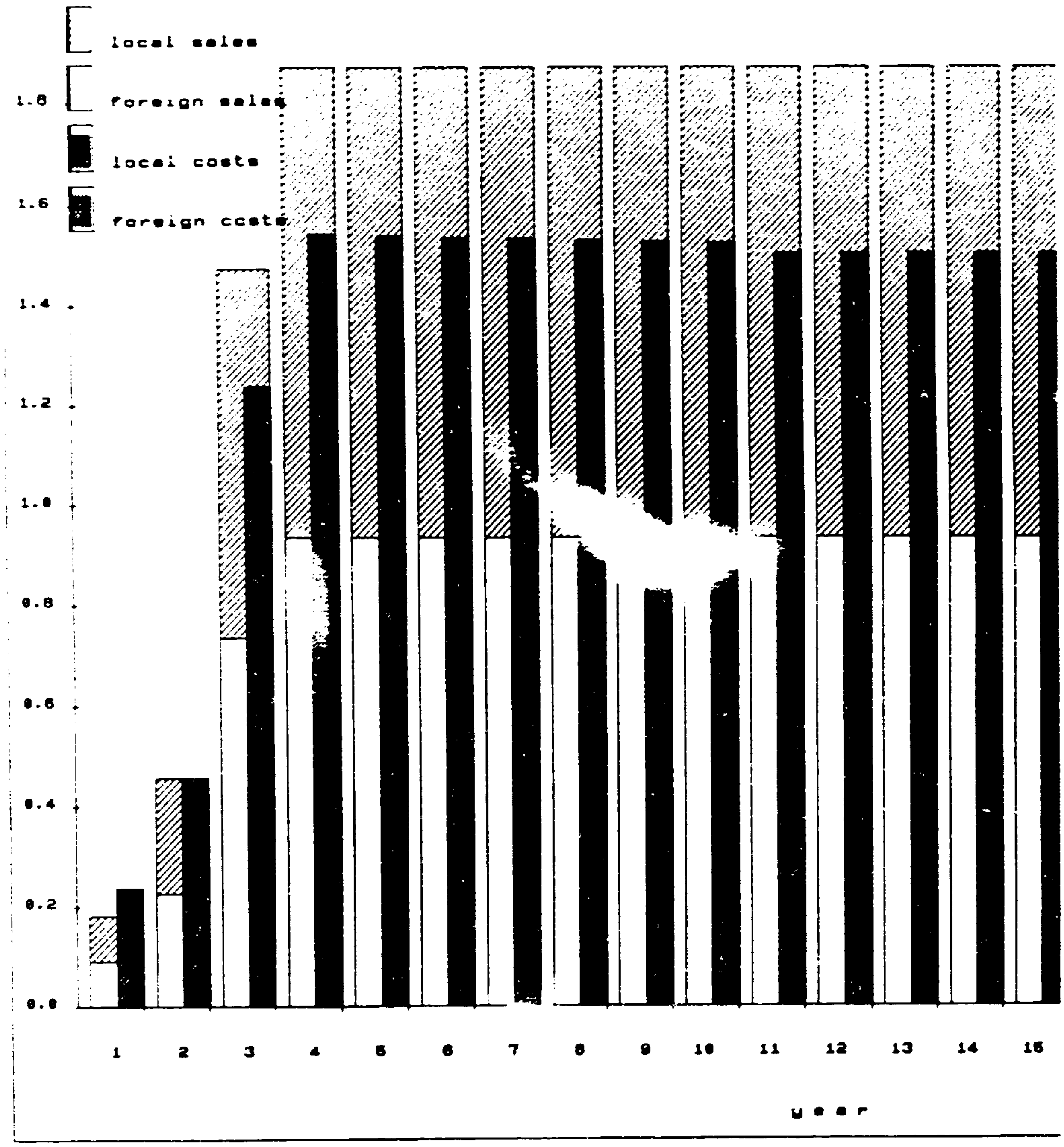


Net Cashflow / Total Sales ratio in (%)	variation of sales prices net of sales tax



Total Sales & Production Costs

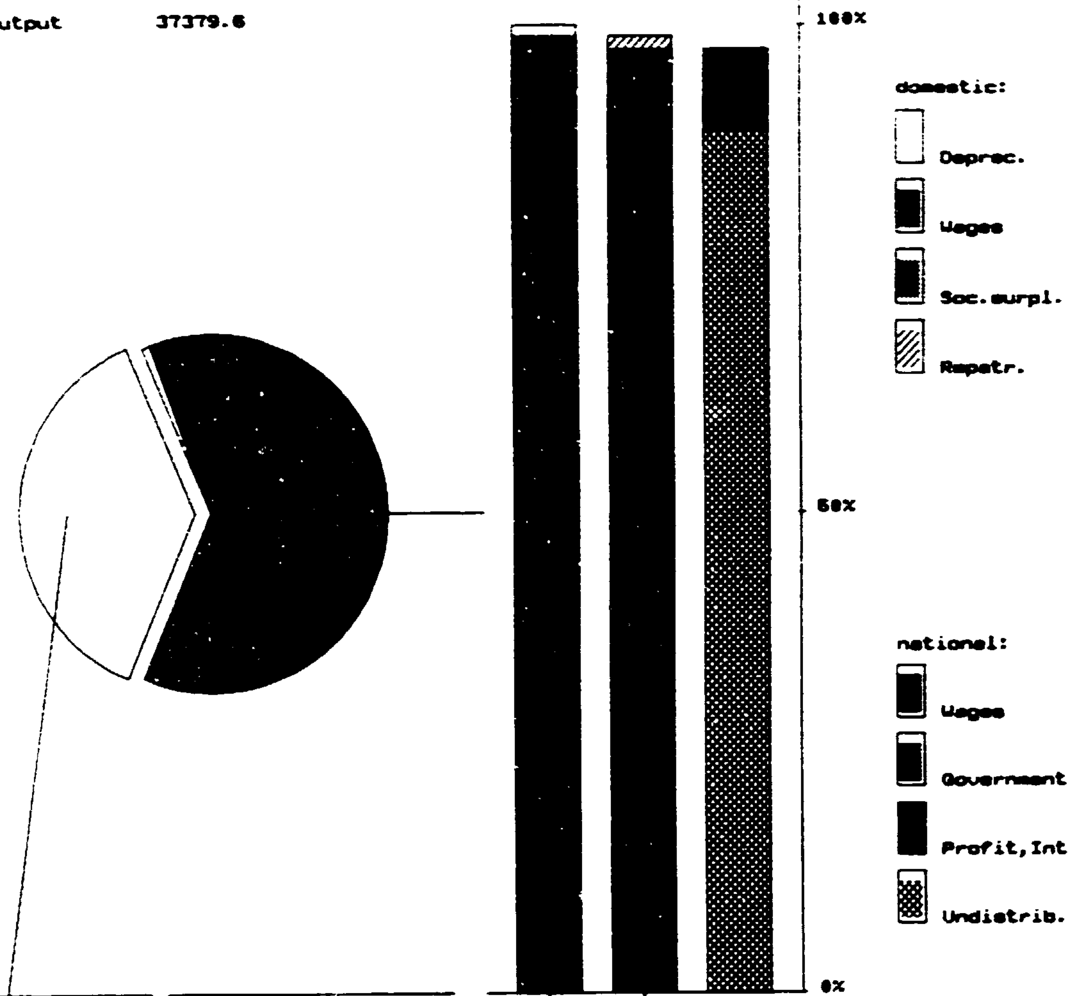
10^4 1,000 U.S. DOLLARS



Structure of value added	
million us dollar	for 5th production year

production year: 5

value of output 37379.6



Material		Gross domestic		
Input (M)	37.4%	Value added	62.6%	
	13970.8		23408.8	

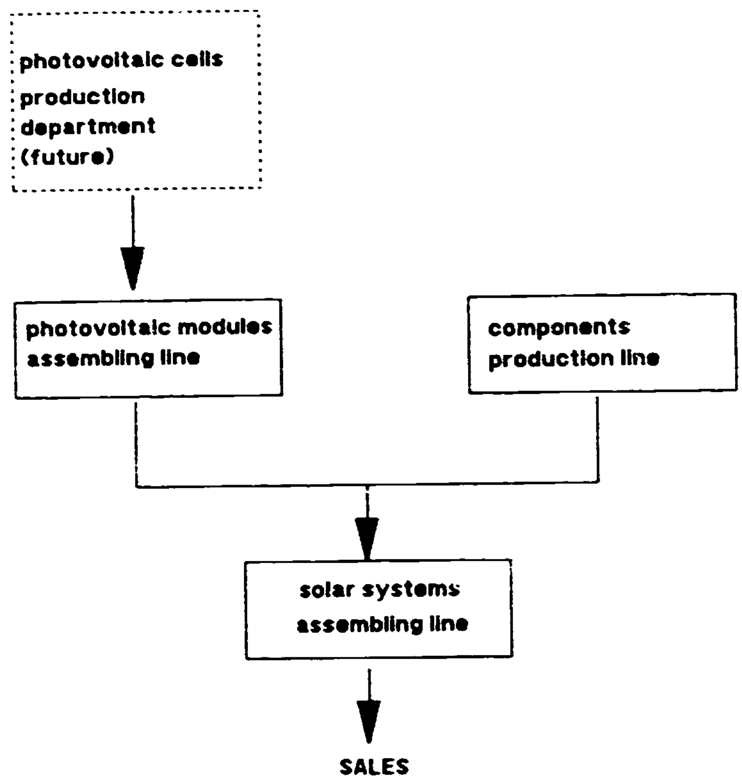
Net National Value Added

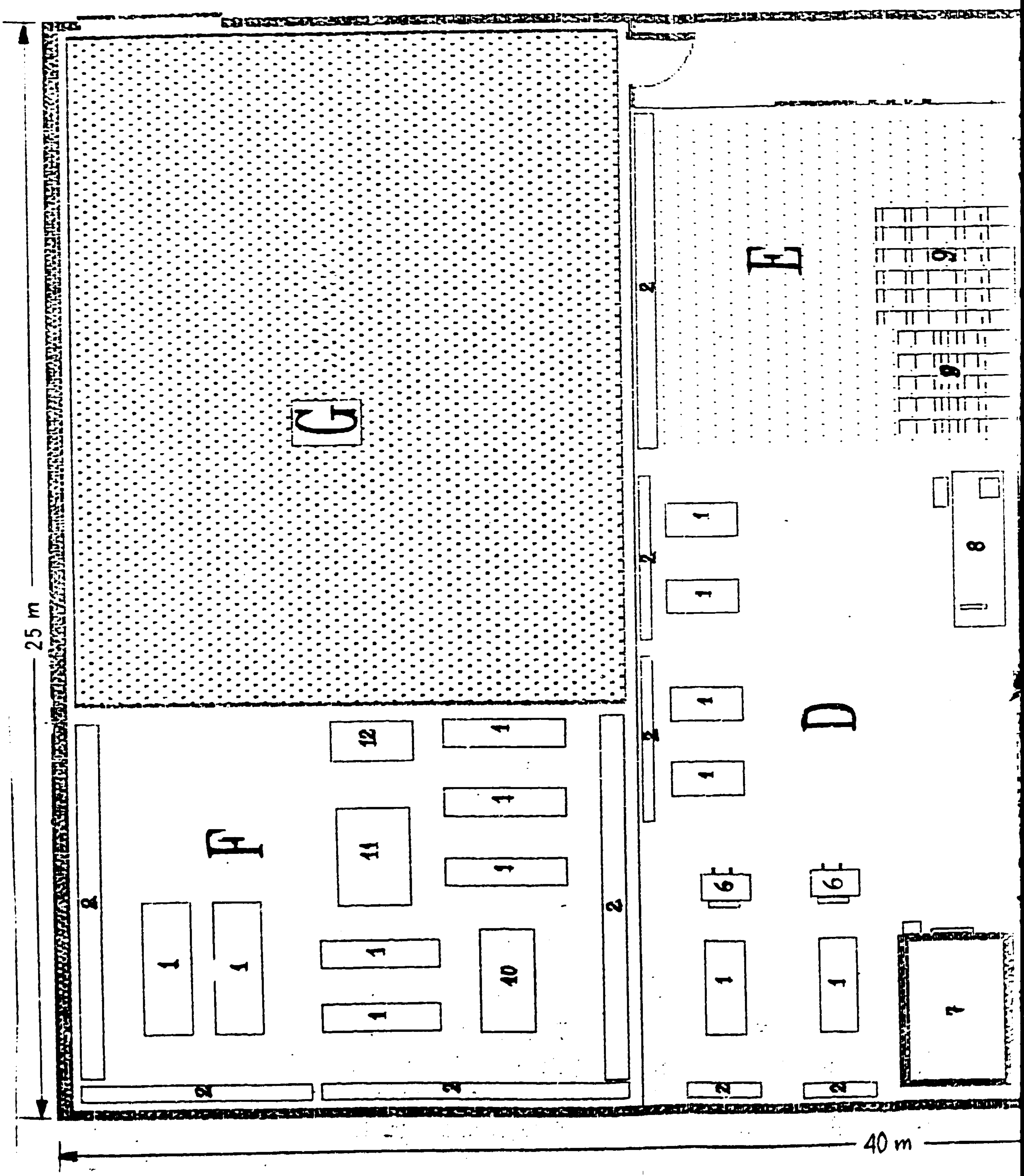
Net Domestic Value Added

Gross Domestic Value Added

DRAWINGS

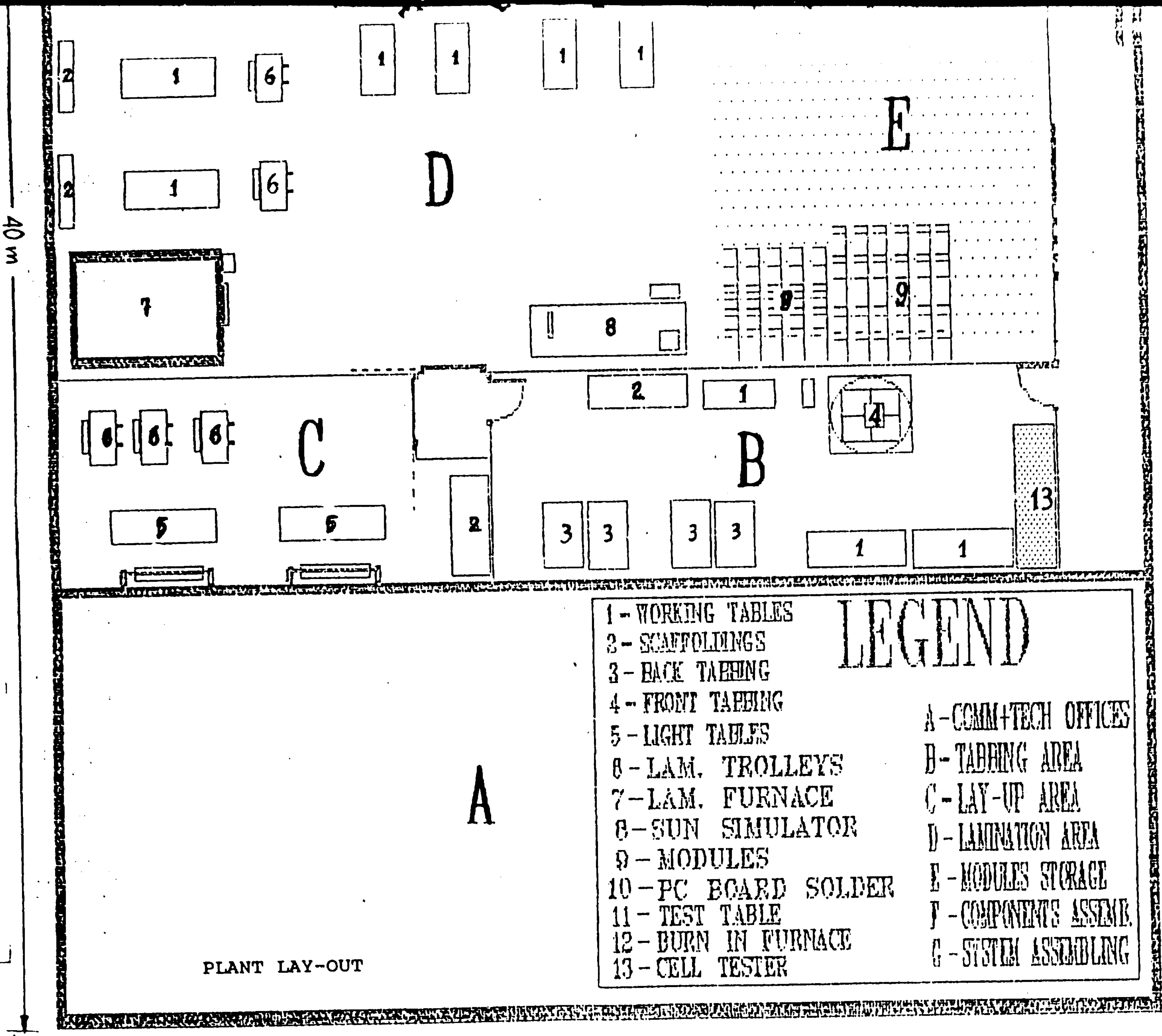
Production flow diagram





SECTION 1

SECTION 2



PLANT LAY-OUT

baldo & c.

ANNEXE I

LIST OF MAJOR SOLAR P.V. SYSTEMS

ALREADY SOLD BY ECOLOGICAL DESIGN

REGISTER OF SOLAR ENERGY INSTALLATIONS NAME OF COMPANY : ECOLOGICAL DESIGNS (PVT) LTD.

SITE	DISTRICT	INSTALLATION			COMMENTS ON PERFOMANCE
		NATURE	DATE	CAPACITY	OPERATIONAL/NON OPERATIONAL/ CONDITION UNKNOWN
e.g 1. Dambowera Farm	Bindura	PV Lights for Holiday Cottages	September 1988	400 W	Operational
Mr Mupasu	Masvingo	2 light system	22.3.89		
Mundoro Sec. School	Masvingo	4 light system	28.3.89		
Murdyi	Masvingo	3 light system	4.5.89		
Mr M. Rushwaya	Masvingo	4 light system	19.1.90		
Mr Mapindu	Bikita	5 light system	24.1.90		
Zadock Musipambi	Chivu	4 light system			
Mr Hwena	Masvingo	4 light system	23.2.90		
Mr Dauramanzi	Gutu	3 light system	7.3.90		
Mr Marava	Zaka	5 light system	9.5.90		
D.D.F.	Masvingo	5 light system	11.5.90		
One plus one	Masvingo	8 light system	28.5.90		
Mr E.D. Chipatp	Zaka	4 light system 3xH40,1NG20,2AH Batteries	23.7.90		
Mr Moyce	Zaka	2xLH 15,1x LH12			
Mr F. Mageza	Masvingo	2 light system	2.8.90		
Mr Nyamadzawo	Harare	A19 Bowl lights	16.8.90		
Zimbabwe Sun Hotel	Kariba	5x LH12 lights	30.8.90		
Mr Guni	Harare	18 light system	6.9.90		
Mr Bruford	Harare	2x 8 light systems 8 light system	6.9.90		
Teletronics	Harare	A19 Bowl lights 2x NG6 charge cont. 1x H45 PA			
Mr Chagwiza	Gutu	1x H40, 1x NG6 1x S119,1x battery			
Clive Kay	Kadoma	1x NG6,4x Brick imp.			

N.B : You are required to make detailed comments on a seperate sheet of paper where necessary.

REGISTER OF SOLAR ENERGY INSTALLATIONS   NAME OF COMPANY :..ECOLOGICAL DESIGNS (PVT) LTD.....................

SITE	DISTRICT	INSTALLATION			COMMENTS ON PERFOMANCE
		NATURE	DATE	CAPACITY	OPERATIONAL/NON OPERATIONAL/ CONDITION UNKNOWN
e.g 1. Dambowera Farm	Bindura	PV Lights for Holiday Cottages	September 1988	400 W	Operational
Mr A. Chimuti	Chivu	4x light system	25.10.90		
Sanyati safari	Harare	1x NG8, 1x H45, 4x AT9, 1x Battery			
Mr Burdett	Kariba	1x NG8 1x Battery			
Solar Products	Harare	1x LH20, 5xAT9, 3xS119			
R. Nyamadzawo	Harare	4x AT9, 4xS119			
Mr E. Wamambo	Masvingo	2xLH18 Solar Bulbs	4.5.90		

N.B : You are required to make detailed comments on a separate sheet of paper where necessary.

REGISTER OF SOLAR ENERGY INSTALLATIONS NAME OF COMPANY : ECOLOGICAL DESIGNS (PVT) LTD

SITE	DISTRICT	INSTALLATION			COMMENTS ON PERFOMANCE
		NATURE	DATE	CAPACITY	OPERATIONAL/NON OPERATIONAL/ CONDITION UNKNOWN
e.g 1. Dambowera Farm	Bindura	PV Lights for Holiday Cottages	September 1988	400 W	Operational
Solar Products	Harare	4x S119 Bulbs 4x 9w bulbs 3x AT9 lights 5x S119 lights 10x 4120 20x AT9 9w lights 30S119 lights	15.11.90		
Mr. Chibadza	Harare	4 light system	15.11.90		
Cooltech	Kadoma	4S119,1xNG8,1xH45 1 battery	16.11.90		
Mr Fasho	Masvingo	1x H45,1xNG8,2x S119 1x719 battery	23.11.90		
Teletronics	Harare	5x H45,10xNG8	26.11.90		
Mr Gangat	Masvingo	5x S119,1xNG8,1x200 AH battery	26.11.90		
Teletronics	Harare	1x JB 3	30.11.90		
Gudehue Frense	Murombezi	1x H55	30.11.90		
Teletronics	Harare	5x NG8	10.12.90		
Solar Products	Harare	20x S119, 10xH45 5x NG8 4x LH 20 lantern	11.12.90		
Teletronics	Harare	5x H45	11.12.90		
Mr P. Mupunga	Gutu	4 light system	14.12.90		
Clive Kay		2 batteries deltech	14.12.90		
One Plus One	Masvingo	14 S119,4x AT9 250w Inverter	20.12.90		
E.D. Chipato	Zaka	1 deep fridge 8 light system	14.1.91		

N.B : You are required to make detailed comments on a seperate sheet of paper where necessary.

REGISTER OF SOLAR ENERGY INSTALLATIONS

NAME OF COMPANY : ECOLOGICAL DESIGNS (PVT) LTD

SITE	DISTRICT	INSTALLATION			COMMENTS ON PERFOMANCE
		NATURE	DATE	CAPACITY	OPERATIONAL/NON OPERATIONAL/ CONDITION UNKNOWN
e.g 1. Dambowera Farm	Bindura	PV Lights for Holiday Cottages	September 1988	400 W	Operational
Solar Products	Harare	6xS119, 12xAT9, 4xH45, 4x JB2 4x H45, 10x LH20, 25x AT9w, 100 S119	16.1.91		
Chipato	Masvingo	4x S119	18.1.91		
Dombwera	Bindura	12 light system	22.1.91		
Teletronics	Harare	20x LH 20, 20 lanterns 20x NG6, 5 timer switch 5x NG8, 125 bowl lights	22.1.91		
N.R.Z.	Bulawayo	1x Helios solar power supply system	30.1.91		
Solar Products	Harare	1xMx2, 2xAH 200 batteries, 2x F/glass boxes	1.2.91		
Cooltech	Kadoma	1x H60, 1xNG6, 2AH200 batteries, aust inverter	5.2.91		
Mr Muderi		2x S119 Globes	8.2.91		
Mr Donald	Kariba	2x H60, 1xNG13, 1xJB2 2x 200 AH, 3xS119 4x LH20, 3xAT9 1x lantern	14.2.91		
One plus one	Masvingo	3x S119, 4x S119, 1x AT9, 2x batteries	19.2.91		

N.B : You are required to make detailed comments on a seperate sheet of paper where necessary.

bdldo &c.

ANNEXE II

TENDER OF NATIONAL RAILWAYS OF ZIMBABWE

NATIONAL RAILWAYS OF ZIMBABWE

Code No
83-29-6410

SUPPLIES BRANCH

P.O. Box 1990
BULAWAYO
Telegrams: "RAILSUPPLY"

Telephone 363111 Ext 3241
TELEX "SUPMAN" 33045 ZW
TENDER ENQUIRY
NOTICE NUMBER **6543:2741**

TO: CHAIRMAN TENDER BOARD

Date: **8 March** 19**90.**

Tenders are invited for the supply of the articles enumerated below :-

1. Tender documents can be obtained from the Supplies Manager, National Railways of Zimbabwe, Africa House, Bulawayo
2. Correspondence Relating to Tender notices must not have Tender Enquiry Notice Number quoted on the envelope and should be addressed to Supplies Manager, P.O. Box 1990 Bulawayo (Telex 33045 Supman ZW).
3. Tenders will close at 10:00 hours on the date below and will be opened on that date at that time in the presence of Bidders who choose to attend
4. **Tender Quotations must be submitted to:** The Secretary, Government Tender Board, P.O. Box 8075, Causeway Harare or Fifth Floor Forum House, 57 Samora Machel Avenue, Harare, Zimbabwe (Telex 22662 ZW Tender).
5. Tender Quotations in sealed envelopes must be endorsed on the outside with the abovementioned Tender Notice Number and closing date. Tenders submitted by telegraph must state clearly therein the Tender Enquiry Number, name of the Tenderer, the service offered and the amount and must be despatched in time for delivery by 10,00 hours on the closing date, and the confirmation of the Tender must be posted not later than the closing date
6. Tenders which are not received by 10.00 hours on the closing date whether by hand, post or telegraph, will be treated as late Tenders and disregarded
7. The country of origin and /or manufacture must be stated in every Tender
8. The Administration of the Railways does not bind itself to accept the lowest or any Tender and reserves the right to select any Tender in whole or in part and shall not be obliged to give any reason for the rejection of any Tender or the acceptance thereof.

The Regulations overleaf shall be binding on all Tenderers.

Closing Date: 17 MAY 1990

SUPPLIES MANAGER:

ITEM NO.	DESCRIPTION	UNIT	QTY	RATE EACH
	SOLAR: POWER SUPPLY UNITS:			
1.	Solar Power Module to Supplement Charging of 24 Volt Battery Bank. To CSE's Spec. 1/90: Solar Cells. (N.R.Z. CODE 43-86-5005)	No.	28	
2.	Solar Power Module For D.C. Track Circuit Application To CSE's Spec. No. 2/90 Solar Cells. (N.R.Z. CODE 43-86-5007)	No.	200	
	Earliest delivery must be quoted.			
	BASIS: It is Mandatory For All Zimbabwean Based Tenderers To Quote On An F.O.R. ZIMBABWEAN STATION BASIS.			
	•Failure to supply the above details could jeopardise the acceptance of your offer.			
	706350 and 706751 STOCK 10 WARD BULAWAYO			

NATIONAL RAILWAYS OF ZIMBABWE

TENDER SPECIFICATION REFERENCE : "TSE 1/90 : SOLAR CELLS"

SPECIFICATION FOR THE SUPPLY OF SOLAR VOLTAIC POWER MODULES FOR 24 VOLT BATTERY BANK BETWEEN BULAWAYO AND VICTORIA FALLS

1) INTRODUCTION

This specification covers the Railway Administration requirements for the supply of 28 solar voltaic modules to be used as detailed in Paragraph 4.

2) TECHNICAL INFORMATION

One complete copy of the following instruction manuals must be submitted with your offer.

2.1. Technical description of the equipment detailing the technology used by the manufacturer in constructing the photo voltaic cells and advantages associated with the technology chosen.

2.2. Installation methods, maintenance techniques and operating instructions including related tests and adjustments.

2.3. Component list of all parts associated with the equipment.

2.4. Wiring and circuit diagrams.

3) ENVIRONMENTAL SPECIFICATION

3.1. Each complete module shall be 100 % waterproof.

3.2. The Tenderer shall specify the temperature range over which each complete module is guaranteed to operate whilst meeting the specifications detailed in this document.

3.3. Within the parameters of operation specified by this document the complete solar cell module shall not undergo any form of expansion or contraction which will affect the performance of the solar cell module when mounted.

3.4. The module shall be able to withstand continuous cycling of temperature as would be encountered by sunlight interruptions due to clouds in conjunction with fluctuations of ambient temperature caused by wind.

3.5. The module shall be able to withstand sudden cooling such as would be encountered by a heavy downpour of rain on a hot day. Tenderers shall give full details of the parameters under which each complete module is tested to meet this requirement.

3.6. Each complete module shall be hail resistant to a minimum particle energy of 10 joules.

3.7. Each complete module shall be reasonably able to withstand the effects of stone throwing (railway ballast) by vandals.

3.8. The surface of the light absorbing face of each complete module shall be smooth and not conducive to the accumulation of dust or other opaque matter which will reduce the efficiency of the device.

3.9. It is imperative that a full description of the nature of tests performed to ensure each complete module meets the above environmental specifications be submitted detailing the results and parameters under which each complete module will operate.

REGULATIONS

1. The date of commencement and completion of delivery must be specified in the Tenderer's offer. Protracted deliveries may be rejected as unresponsive. Terms of delivery, F.O.B., C & F and other trade terms, commonly referred to as incoterms shall have meanings assigned to them by the current edition of the International Rules for the Interpretation of the Trade Terms published by the International Chamber of Commerce, Paris.

2. Prospective Tenderers requiring any clarification on matters relating to this Tender may contact the Supplies Manager at the mailing address indicated on page 1 of this document provided such communication is done prior to the closing date of this Tender. Such communication shall not in any way interfere with the confidentiality of nor divulge information prejudicial to other prospective competitors in this Tender. The National Railways of Zimbabwe shall have the right to disqualify any Tenderer as a result of a breach of this Regulation.

3. Except in special circumstances where a waiver is granted Tenders shall be expected to remain valid for a period of 90 days from the closing date and during this period no Tenderer may withdraw its bid.

4. Tenderers must ensure that Goods and /or services offered conform to those advertised and that where standards mentioned in the technical specifications have been superceded the latest issued by the concerned institution shall apply.

5. The administration of National Railways of Zimbabwe reserves the right to enter into a formal contract with the provision of a surety (such surety not to exceed 10% of the full value of the contract) with the successful Tenderer, should it be deemed necessary. In exceptional circumstances both Tender security and performance security may be required and this will be specified in the Tender requirements.

6. Failure to comply with the above regulations will result in the rejection of Tender.

4) GUARANTEE

4.1. Each complete module must be guaranteed for twelve months from the date it is put into operating service.

4.2. After eleven months operating service a selected number of complete solar cell modules will be removed from site and tested in accordance to the environmental specifications which cover the particular module.

4.3. Should any module fail the environmental tests conducted within twelve months operating service, then the tenderer shall agree to replace each complete solar module without any additional costs to NRZ including freight and duties.

5) CONSTRUCTION

5.1. It is preferred that all mounting arrangements be provided by NRZ. The Tenderer is to submit all the necessary details required for manufacture of the mounting arrangements such that the solar modules will operate to specification.

5.2. If it is deemed necessary by the Tenderer, the Tenderer may supply the mounting arrangements in addition to the solar modules. In this case the Tenderer is to submit complete details of the proposed mounting arrangements and to clearly state why it is preferred to provide them instead of their being manufactured by NRZ.

5.3. Should NRZ provide the complete mounting arrangement then the successful Tenderer is invited to inspect and approve complete structure, at no cost to NRZ, to ensure the terms of guarantee as detailed in section 4 of this document are effective.

5.4. The letters N.R.Z. with the manufacturers serial number are to be incorporated into each complete module such that removal of the letters/serial number will destroy the module. Tenderers are requested to submit full details on the method adopted to achieve this requirement.

5.5. The construction of each complete module shall be such that the device can be removed/replaced with ease.

5.6. Tenderer is to supply full details of the electrical connections to each complete solar module. The electrical connections must be enclosed with a cover which requires a spanner or screwdriver to facilitate its removal. The incoming cable must have a clamping mechanism to enable it to be securely held in place.

6) 24 VOLT BATTERY BANK : ELECTRICAL REQUIREMENTS

6.1. A solar cell module is required to supplement the charging of a 24 volt 135 AH Nife cell battery bank.

6.2. The batteries are presently charged by diesel generators via 24 volt rectifiers rated at maximum charge current of 9 amps.

6.3. The diesel generators are operated for about 6 hours a day in 2 hour periods.

6.4. The continuous current drain from the batteries is rated at about 7 amps.

6.5. The voltage versus current characteristic curves at different temperatures and illumination intensities must be provided.

6.6. The maximum open circuit voltage and short circuit current of each solar module at maximum solar radiation must be stipulated.

4.7 The number of cells per module in series/parallel configuration must be stipulated.

7) COMPLIANCE

A detailed complete schedule of compliance to every part of this specification must be submitted.

It must be noted that the compliance to the technical parts of the specification must where applicable be quantified with reference to results derived from specific tests and not supported by reference to a general document used for advertising purposes.

Failure to abide by this requirement alone may result in the rejection of the Tender.

8) Tenderers are to stipulate the delivery period for supply of the complete quantity of solar modules to Bulawayo, Zimbabwe on receipt of an official N.R.Z. orders.

9) Tenderers are required to submit a breakdown of costs pertaining to their respective quotations as follows:-

9.1. Cost of modules detailing percentage of foreign currency content required.

9.2. Freight costs for delivery to Bulawayo, Zimbabwe.

10) Tenderers are requested to submit their offers pertaining to this specification complete and not combined with any other offer related to the supply of photo voltaic solar modules.

11) All queries pertaining to this tender must be submitted directly to the following, quoting file reference 30:7032:01.

CHIEF SIGNAL ENGINEER
10TH FLOOR
NEW RAILWAY HEADQUARTERS
P.O. BOX 504
BULAWAYO
ZIMBABWE

Telex No. 33173 NRZ ZW
Telephone No. 363651, Bulawayo