OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

January 1986

RESTRICTED

ENGLISH

2) Ethiopia.

DEMONSTRATION PROGRAMME ON THE USE OF INDIGENOUS BIOMASS RESOURCES FOR MEETING ENERGY NEEDS

RP/RAF/85/627

ETHIOPIA

Technical Report *

Mission 16 November to 14 December 1985

Prepared for the Government of Ethiopia

by the United Nations Industrial Development Organization

acting as executing agency for United Nations Development Programme

Based on the work of Mr. M. Sayeed

Consultant in establishment of small, developmental steel fabrication facilities

United Nations Industrial Development Organization

Vienna

* This document has been reproduced without formal editing.

Transmittal

Camp

Addis Ababa
December, 1985

The Executive Secretary
Ministry of Mines & Energy
Ethiopian National Energy Committee
Gov't of Provisional Military of
Socialist Ethiopia
Addis - Ababa.

Attention: Dr. Eng. Ghebru Woldegiorgis

Dear Sir,

Ref.: Ethiopian National Energy Committee, Addis Ababa
UNIDO Ref. RP/RAF/85/627/11-52/32.1.I

1. I have the pleasure in submitting this report. It serves the purpose of a terminal report of M. Sayeed.

2. As mentioned on the title page of this report has not been cleared with the UNIDO, which does not, therefore, necessarily share the views presented.

3. I commend implementation of the suggestions made here-in for the establishment of this important Developmental Steel Fabrications Facilities (Workshop) - Cum - Training Centre.

Thanking you,

Yours truly,

(Mohammad Sayeed)
UNIDO CONSULTANT

Abstract

Ethiopian National Energy Committee – Addis Ababa – Ministry of Mines & Energy is located in Addis Ababa. It is to be equipped with a varied assortment of machinery and equipment such as:-

1. Machine Shop
2. Sheet Metal & Welding Shop
3. Foundry Shop
4. Engineering Design Office
5. Mantle Manufacturing Unit.

A wide range of products for manufacture has been identified through conducting surveys and visits. An important recommendation made includes settling-up of the above mentioned engineering shops.

A good workshop needs the support of the above mentioned shops for the effective and sucessful implementation of the varied engineering item – manufacturing programmes for energy sector development.

In view of the present limitation of energy sector, it is not practical to introduce specialized engineering methods and procedures.

The chief objective of the mission was to identify the energy producing equipment and tools, accessories including selection of machinery, equipment, attachment, production tools, raw-materials for the establishment of workshop and to recommend improvement, where appropriate and to prepare outline plans for further long term development. Recommendations has been made on the page 7 concerning the production of varied items and the list of machinery, equipments, etc. for energy sector development and future UNIDO assistance.

Following are the total capital requirements for the facility:

1.	Machinery and equipment		US$ 64,127.00
2.	Additional machinery and equipment		24,088.00
		Total	US$ 88.215.00
3.	Attachments, production tools. accessories. instruments, raw materials, consumable items, etc.		30,548.35
4.	Shops buildings		55,500.00
5.	Office furniture and equipment		5,750.00
		Grand Total	US$180,013.35

Report On Developmental Steel Fabrication Facilities
(Workshop) - Cum Training Centre
Addis Ababa - E t h i o p i a

C o n t e n t

A n n e x e s

List Of Tables
Contents

I. Introduction

The energy sector (ENEC) is attached to the Ministry of Mines and Energy and engaged in the supply of fuel for domestic and industrial sectors through fabrication and manufacture of various types of domestic stoves, biogas digester, charcoal kiln, briquetting plant, etc. at one of the Fabrication Shops, Addis Ababa.

With a view to identify specific areas where assistance was needed, the energy sector (ENEC) recommended to make a study for establishment Developmental Steel Fabrication Facilities (workshop) to achieve the following objectives:

1. To identify equipment such as domestic stoves, charcoal kilns, gasifirs, bio-gas digesters, bio-gas using appliances and gas mantles which need to be developed (fabricated, tested, modified, etc.) to facilitate wide-spread deplayment of bio-fuel technology in Ethiopia.

2. To investigate the potential for fabrication of items identified in paragraph 1 in existing workshops and steel fabrication facilities in Addis Ababa.

3. To identify tools, and equipment needed for the fabrication of items identified in paragraph 1. To determine any additional tools and equipment needed for a bio-fuel centre workshop facility; e.g. welding equipment, gas cutting equipment, friction and cut-off saws, hand power tools (drills, grinders, etc.), hand tools.

4. To prepare a requisition list of all items of equipment required for the bio-fuel centre workshop facility.

For the manufacture of parts, components, attachments and production tools such as dies moulds, jigs, fixtures, machine - attachment, and wide range of parts, domestic stoves, bio-gas digesters, charcoal kilns, bio-gas using appliances, etc. The need for setting up machine shop and Sheet Metal & Welding Shop recommended including Foundry Engineering, Design Division and Mantle Making Section.

.../7

The main object of this project to modernize their production methods and processes for turning out quality products and developing new and existing items for fabrication and manufacture under the improvement programmes to meet the accute shortage of domestic and industrial fuels in both rural and urban areas in Ethiopia.

After the establishment of the above shops, the transfer of technology will be easier for assimilation at that time through training on-the-job in the related fields.

Visits were made to various government departments, agencies, industrial enterprises and energy workshops to assess the existing industrial potential and facilities in order to manufacture the variety of items (identified) for the energy sector.

Productivity

The setting up of Engineering Workshop and training on-the-job of the technical personnel is expected to go along way towards improvement of fabrication and manufacturing processes and cost reduction, products development and improvement in the productivity.

II. Recommendation:-

A good workshop needs the support of a good machinshop including Sheet Metal and Welding shop; Foundry shop together with a Design office to serve the needs of the centre.

After having identified the new products, processes, equipment, appliances, instruments and other accessories, etc. The following divisions to be established to cope with the situations.

To assist the Developmental Steel Fabrication Facilities (workshop) - Cum - Training Centre, which is for fabrication and production of varieties of items, through:-

(a) Establishment of Machine Shop for production of tools such as moulds, dies, jigs, fixtures, attachment, spare parts used in the

manufacture of different types of domestic cooking stoves, valves, biogas using accessories and manufacture of wide range items such as stove - body, Air Regulator, Gas Injector - Cum - Cook, Fixing Nut, Lamp Cook with handle, Hinge, Top Plate Reflector, Chimney, Gas Regulator Needle, Components and wind mills, and Mantle Lamp.

Training of skilled and new workers in the field of machine - tool engineering.

(b) Establishment of Sheet Metal and Welding shop for fabrication of biogas digester, structures, Domestic cooking stoves, Biogas water heater, cooker's frames, cutting of m.s. sheets to sizes, bending sheets to size, Charcoal Kiln, Briquetting Plant, wind-mills, etc.

Training of skilled and new workers for up-grading their skills and technical knowledge in the field of welding technology.

(c) Setting up Foundry Shop for production of cast iron Biogas cookers, water heater, stoves, Biogas using domestic appliances, moulds and varieties of items and casting of gun-metal parts including aluminium accessories etc.

Training of skilled and new workers in the retated fields.

(d) Setting up of Engineering Design Division for developing design, and assist in design of moulds, dies, production tools, such as jigs, fixtures, spare parts including redesign of biogas-using appliances, cooking and baking stoves, water heater, etc.

Training of designers and draughtsmen in the field of design and draughting.

III. ACKNOWLEDGEMENTS

1. This mission has been a great success in every respect. Preparation of this terminal report in such a short time would not have been possible without prompt cooperation and help extended by all the persons who have participated in the study. These are listed at Annex

2. Special gratitude is expressed for the following who have greatly assisted in this study.

I.	Mr. Yaheya Mohammed	- Mechanical Engineer
II.	Mr. Tekola Shimelis	- Agricultural Engineer
III.	Mr. Siltan Abraha	- Civil Engineer
IV.	Mr. Kidane Workeneh	- Chemist
V.	Mr. Afework Wogayehu	- Economist
VI.	Mr. Abebe Irgetie	- Assist. Agricultural Engineer

3. The draft contents of this report were discussed with the following top executives at the Ministry of Mines & Energy (EMEC). Their comments are greatly valued.

i) Dr. Eng. Ghebru Woldeghiorghis - Executive Secretary

ii) Mr. Omer Mohammed Getta - Senior Economist

4. The opportunity to work with UNIDO who funded this study is greatly appreciated. The help and guide-lines receivedfrom the following executives of the Engineering Industries Sections, Division of Industrial Operations at the UNIDO Headquarters at Vienna needs special mention.

i) Mr. Delos - Head of Eng. Industrial Section

ii) Mr. R. Williams, Industrial Development Officer and back stopping Officer at the project.

5. Miss Abrehet Gebreselassie has assisted in the typing and cyclo-styling of the report and deserves thanks for her neat and fast work.

6. It is difficult to name each individual who helped in completing this assignment in a record time. They particularly include executives and engineers and also the car drivers and administrative staff at the ENEC.

(Mohammad Sayeed)

Addis Ababa - Ethiopia
December 1985

Annex - I

List of machinery, equipment, attachment and tools required for the establishment of Developmental Steel Fabrication Facilities (Workshop) Cum - Training Centre, Addis Ababa.

S.No.	Description of Machinery/Equipment	Quantity	Approximate CAP Value in US$
	(A) Machine Shop		
1	Gap Bed Lathe Max. Swing over bed 450 mm. Max. distance between centre 1500 mm. Elec. Motor 4 kw 50 cycle 3 phase 1450 RPM.	1 unit	3,000.00
2	Geared Head Lathe Height of Centre 300 mm. Max. length of work piece 1400 mm. - 2800 mm. Swing over bed (for Gap Type Lathe 200mm.) Swing over bed 615 mm. Max. turning length 1210 mm. - 2610 mm. Elec. Motor 10 kw 50 cycle 3 phase 1450 RPM.	1 unit	2,500.00
3	Turret Instrument Lathe Max. bar dia 16 mm. Spindle to Turret Face Max. 300 mm. Height of Centre 100 mm. Elec. Motor 0.55 kw/1.5 kw 50 cycles 3 phase 710 to 2770 RPM.	1 unit	2,200.00
4	Shaping Machine Max. cutting length 500 mm. Max. Ram stroke 500 mm. Max. distance, lower edge of ram to table 385 mm. Elec. Motor 4 kw 50 cycles 3 phase 1420 RPM.	1 unit	4,300.00
5	Power Hacksaw Machine Max. Diameter of work 220 mm. Elec. Motor 1.5 kw 50 cycles 3 phase 1430 RPM.	1 unit	750.00

.../2

S.No.	Description of Machinery/Equipment	Quantity	Approximate C&F Value in US$
6	Bench Drilling Machine Drilling Capacity 15 mm. Max. Spindle Travel 100 mm. Max. Height of spindle Head Adjustment 300 mm. Max. distance between lower face of spindle to surface of work table 430 mm. Number of spindle speed 8 Range of spindle speed 320-2900 RPM. Area of work-table 350x350 mm. Rated Power Motor 0.75 kw. Rated RPM of Motor 890 RPM.	1 unit	1,444.00
7	Double Ended Grinding Machine Capacity: 8" Grinding Wheel 8" dia. Elec. Motor 1.5 kw RPM 1420	1 unit	535.00
8	Pillar Drilling Machine Drilling capacity: 1½" dia. Spindle traverse: 140 mm. Max. distance between spindle Base - 1156 mm. Table working surface: ϕ335 mm. Elec. Motor 1 HP 50 cycles 3 phase 1425 RPM.	1 unit	675.00
9	Universal Milling Machine working surface table 48"x 11⅝" table Swivels right or left 45° Longitudinal Traverse 32" Cross 10" Vertical 16" Max. distance to table 16" Arbor dia. 1" - 1½" with universal dividing Head 5" Capacity, and back dividing attachments and 10" Rotary table change gears and universal vise.	1 unit	10,400.00
10	Double Ended Tool & Cutter Grinding Machine Elec. Motor 0.5 kw RPM 2800 Capacity: Grinding Wheel 6" dia	1 unit	500.00
11	Surface Plate Size 3'-0"x2'-0"	1 unit	215.00
	T o t a l		23,519.00

.../.

S.No.	Description of Machinery/Equipment	Quantity	Approximate C&F Value in US$
	(B) Sheet Metal & Welding Shop		
1	Sheet Shear (Guillotine Shear) Cutting thickness 0.6-3 mm. Cutting width 1200 mm. Elec. Motor 3 hr speed 1000 RPM	1 unit	1,550.00
2	Open Back Inclinable Power Press Capacity: 60 tons Elec. Motor 7.5 hr 1500 RPM Opening in table: Left to Right 450 mm. Front to Back 310 mm. Diameter 400 mm.	1 unit	5,000.00
3	Oxygen and Acetyline Gas Welding Set	1 unit	315.00
4	Electric Arc Welding Set (Plant Motor Generator) 320 Amp. AC/DC Complete with accessories	1 unit	938.00
5	Sheet Metal Three-Roll Bending Machine Complete with all standard Accessories consisting of: Specifications:- Max. size of sheet bent (for steel) with ultimate strength of 25 kg/sq.mm.), mm. thickness 5, width 1500, minimum bend radius, mm. 150 Bending speed, m/min. 7 Electric Motor and starters operated at 400/440 volts, 3 phase, 50 cycles, A.C Standard Accessories:- Electrical equipments A set of V-Belts Lubrication systems A set of change tools.	1 unit	3,115.00
6	Oil-fired oven type annealing and hardening furnace Specifications: Operating at 1800°F (1000°C) size of the chamber	1 unit	3,225.00

.../4

S.No.	Description of Machinery/Equipment	Quantity	Approximate C&F Value in US$
	12" wide, 9" high 18" long with No. 2 oil burner and fan blower (Air pressure 16-18 W.C. complete with Thermo-couple and pyrometer). size of oil burner Size of Burner - - - - - - - - No. 2 Capacity per hour gallons - - - 1-6 Dia. of oil connection ins. - - $\frac{1}{8}$" Dia. of Air connection ins. - - 2" Air pressure ins. - - - - - - - - 16-18 W.C. Pyrometer Indicator and Automatic Controller Range 0-700°C Calibrated for Chromal - alumel with thermo-couple, complete with thermo-couple PC/A. 10-$\frac{1}{2}$, Compensating lead C.431-230 Volt, single phase 50 cycles A.C.		
7	Hardness Testing Machine (Rockwell Principle) Complete with proportional weight for 60 kg, 100 kg and 150 kg tests accessory case containing:- 1" ball penetrator, diamond cone $\frac{16}{}$ penetrator, small table with raised centre flat table, two Vee tables, three test blocks and spare balls.	1 unit	375.00
8	Flexible Shaft Hand Grinding Machine Equipped for grinding awkwardly placed spots the manufacturing dies, drilling holes, polishing, cleaning tubes, etc. The machine is to be equipped with Electric Motor operating on 3 phase alternating current 220/380 volts, 50 cycles. Holding capacity of collect chuck. 3 mm. to 8 mm. diameter. High speed Steel Medium cut Rotary Files (to be used for smooth machining of material such as: Cast iron, steel, brasses, copper and aluminium).	1 unit	650.00
9	Portable Hand Drilling Machine	1 unit	158.00
10	Air Compressor Air cooled, two stage type 30 Compressor Driven by 400/440 Volts 3 phase, 50 cycle, mounted on a 24"x72" Horisontally Air.	1 unit	4,062.00

S.No.	Description of Machinery/Equipment	Quantity	Approximate C&F Value in US$
11	Resistance Spot Welder Specification: Rating KVA Max. efficiency, welding 25 minimum 120 Primary Voltage V. 220/380 Primary current A. 115/66 Duty cycle, percent 20 Thickness of low-carbon Steel sheets to be welded, mm. Nominal 1.5+1.5 Maximum 3+3 Welding current A. 8100 Regulating Range of open Circuit secondary I. 8-3, 6 Voltage, V. 1,75-3 Nominal Range open circuit Secondary Voltage V. 3.14-3-3 Number of regulation ranges - 8 Electrode length, mm - 250 Regulation ranges, of electrode length mm 200-400 of horn opening (clearance) mm 130 - 220 of electrode force for nominal electrode length, kg 60-300 maximum working stroke of upper electrode for nominal electrode.	1 unit	2,812.00
	T o t a l		22,200.00
	(C) Foundry Shop		
	1. 1-Ton capacity cupola with charging platform, fire - brick lining, blower and blower motor (the cupola will be designed and fabricated at the local workshop).	1 unit	5,500.00
	2. Oil-fired crucible Tilting Furnace. capacity: 300 lbs Brass, 100 lbs Aluminium (The furnace will be designed & manufactured at one of the local workshop).	1 unit	938.00
	3. Core Oven size 60" high x 42" wide x 42" deep, suitable for working temperature upto 400°C. (The coreoven will be designed and made at one of the workshop).	1 unit	315.00

.../6

S.No.	Description of Machinery/Equipment	Quantity	Approximate CAF Value in US$
	4. Handle with shanks 100 lbs capacity (Hand Ladle will be designed and fabricated at one of the workshop, Addis Ababa.	4 units	350.00
	5. Grinding Machine Double Ended (10" dia x 3")	1 unit	625.00
	6. i) Moulding Box Big 50 pairs ii) Moulding Box Small 50 pairs		550.00
	T o t a l		8,278.00
	(D) Engineering Design & Drawing Office for:		
	- Developing design of product and production toolings		
	- Reducing manufacturing costs by redesign of production tools and precision spare parts and components		
	- Training of designers and draughtsmen for up-grading their knowledge & skills to meet the requirements of the centre		
	- Selection and specification of materials for economical and quality manufacture of various items		
	- Reducing the maintenance costs by designing and redesigning machine-aids, attachment, equipment, etc.		
	- Developing national technological capabilities in design & equipment to meet local manufacturing programmes		
	Drawing Equipment & Instruments		
	(1) Standard size of Drawing Board complete with accessories	2 units	500.00
	(2) Drawing and Draughting Instruments	2 sets	130.00
	T o t a l		630.00

S.No.	Description of Machinery/Equipment	Quantity	Approximate C&F Value in US$
	(E) Mantle Production Section		
1	Mantle Making Machine for Bio-gas lamp complete with accessories (In door and out door single mantle 100 CP Lamp)	1 unit	6,500.00
	T o t a l		6,500.00
	Grand Total		64,127.00

Additional List of Machinery/Equipment for Developmental Steel Fabrication Facilities Workshop-cum-Training Centre

1. Universal grinding machine (for machine shop), 1 unit approx. — US$ 5,000.00

   Specifications:

Distance between centres	1,000 mm
Swing	300 mm
Max. grinding diameter	150 mm
Capacity steady rest	10-100 mm
Max. load between centres	125 kg
Total stroke of wheel head	255 mm
Wheel (outside dia x width x inside dia)	305x50x127 mm

2. Electric arc welding set, 1 unit — US$ 938.00
   (Plant motor generator for sheet metal and welding shop)

   320 amp. AC/DC complete with accessories

3. Armature testing apparatus, 1 unit — US$ 450.00
   (for Maintenance Department)

   Specifications:

   To detect the following faults:

   - winding short circuits
   - broken windings
   - fault connections of the winding
   - winding earth faults
   - electric supply at 200/220 volts, 60 cycles, 1 phase, A.C.

4. Open back inclinable power press, 1 unit — US$ 3,500.00
   (for Sheet Metal and Welding Shop)
   Capacity 30 tons
   Elec. motor 4.5 kW 1,500 RPM

5. Open back inclinable power press, 1 unit — US$ 6,750.00
   (for Sheet Metal and Welding Shop)
   Capacity 100 tons
   Elec. motor 12.75 kW 1,500 RPM

6. Sheet bending machine, 1 unit — US$ 3,250.00
   Forming 90° shape (for Sheet Metal and Welding Shop)

   Specifications:

   Max. size of sheet bent (for steel with ultimate strength of 45 kg/sq.mm)
   Thickness 4 mm
   Width 1,500 mm
   Elec. motor, starter and control operated at 380 volts, 3 phase, 50 cycles, A.C.

7. Universal tool and cutter grinder, 1 unit — US$ 4,200.00
(for Machine Shop)

Specifications:

Speeds (approximate)	3,500-6,000 RPM
Grinding wheel, work-head	320- 600 RPM
Between centres	24"
Feed to table	24"
Work-table	38"
Wheel-head cross feed	9 1/4"
Hole in workhead spindle	No 4 - Morse
Vertical movement of head	9 1/4"

Total US$24,088.00
==========

Annex - II

List of Attachment, Production Tools, Accessories and Measuring Instruments and Consumable Items.

Description of Engineering Production Items	Quantity	Approximate C&F Value in US$
(I) Description of Attachment		
1. Drill Chuck with key and Morse Taper No. 3 shank, capacity $\frac{1}{4}$" to $\frac{1}{2}$", $\frac{1}{8}$" to $\frac{3}{4}$" to 1"	2 each	115.00
2. Bench Vice 4"	4 Nos.	64.00
3. Tool Maker's V-Blocks, Parallel Clamps	2 each	70.00
4. Set of tool holders	6 Nos.	85.00
5. Emery wheel dresser	1 No.	25.00
6. Quick Acting Drilling Vice Specifications :-	2 Nos.	150.00
Vice length - 240 mm. Base width - 140 mm. Height - 90 mm. Width of Jaws - 80 mm. Complete with hardened Jaw liners		
7. Machine Vices Specifications :-	2 Nos.	140.00
Clamping capacity 10 to 60 mm. dia shafts Vice width - 210 mm. Length - 365 mm. Height - 170 mm. Jaw width - 100 mm. Complete with hardened Jaw Linings		
	Total	649.00
(II) Description of Production Tools and Accessories		
1. Two lips and three lips end mills, sizes- 4 mm., 6 mm, 8 mm, 10 mm, 12 mm, 16 mm for milling machine	4 each	650.00
2. Cutters of different sizes for milling machine	4 each	450.00
3. Carbide tiped right hand turning tools and boring tools for lathe	6 each	120.00
4. a) High speed Tool Bits with 10% cobalt sizes $\frac{5}{16}$" sq.x 4", $\frac{1}{8}$"sq.x 4", $\frac{1}{2}$"sq.x4" $\frac{5}{8}$" sq.x 4"	6 each	240.00
b) High speed Round ⌀ 10 mm.x 4"	6 Nos.	40.00

.../9

Description of Engineering Productions Items	Quantity	Approximate C&F Value in US$
5. Centre Drill 1.5 to 2.5 mm.	4 each	48.00
6. Involute Spur Gear Cutters High speed steel 20° Pressure Angle		
Size — Standard dia — Hole — Form No. of Cutter		
6 DP — do — 1" — 1 - 4		
7 DP — do — 1" — do —		
8 DP — do — 1" — do —	4 Nos in each DP	
9 DP — do — 1" — do —		
10 DP — do — 1" — do —		
11 DP — do — 1" — do —		
12 DP — do — 1" — do —		
14 DP — do — 1" — do —		
16 DP — do — 1" — do —		
18 DP — do — 1" — do —		
Total Nos. of Cutters	40 pieces	900.00
7. Side and Face Milling Cutters High speed steel		
Dia. in inch — Width face in inch — Hole in inch		
3" — 3/8" — 1"	4 each	
3" — 1/2" — 1"	"	
4" — 1/2" — 1"	"	
4" — 3/8" — 1"	"	
4" — 7/8" — 1"	"	
Total Nos. of Cutters	20 pieces	500.00
8. High speed Steel End Mills for Key Slots		
Cutter Dia in mm. — Cutter Width in mm. — Shank Dia in mm. — Over all length in mm.		
4 — 1 — 6 — 50	4 Nos. each	150.00
4 — 1.5 — 6 — 50		
	Total	3,098.00

Description of Engineering Production Items	Quantity	Approximate C&P Value in US$
(III) Description of Measuring Instruments:-		
1. Radius Gauges 1 to 7 mm.	1 each	25.00
7 to 15 mm.	1 each	28.00
2. Screw Pitch Gauges, metric & inch	2 each	35.00
3. Inside Micrometer (Metric adjustable)	1 each	55.00
4. Outside Micrometer (Metric adjustable)	1 each	55.00
5. Calipers 6" - 12" (Inside)	3 Nos.	15.00
6. Surface Gauge 12" spindle	2 Nos.	10.00
7. Steel Square	2 Nos.	10.00
8. Calipers (Outside) 6"x12"	3 Nos.	15.00
9. Dividers 3" & 6"	3 each	25.00
10. Depth Gauge 6"	2 Nos.	30.00
11. Marking Gauge 6"	2 Nos.	25.00
12. Height Gauge 400 mm.	1 No.	35.00
13. Knife Edge Try Square 2" & 4"	2 each	20.00
14. a) Dial Indicator (0.01)	2 Nos.	50.00
b) Dial Indicator (0.002)	2 Nos.	55.00
15. Bevel Protactor	1 No.	65.00
16. Outside Micrometer (Complete with liner Locking Device) Range Measuring Faces Reading 0 - 1" Carbide 0.001	2 Nos.	54.00
	Total	607.00
(IV) Raw Material Requirement(Imported Materials)		
A. 1. Pig Iron - 5 tons @ 125/- per ton		625.00
2. Hard Coke - 4 tons @ 50/- " "		200.00
3. Refractries (Fire-bricks)		2,250.00
B. 1. Cast Iron Srap 5 ton @ 75/- per ton		375.00
2. Lime-Stone 2 tons @ 20.125		56.25
3. Graphite, Bentonite, Molasses, Linseed Oil, Blacking, etc.		1,500.00
4. Fire-wood, Oil		2,250.00
5. Consumable stores like: cotton waste, Nails, wires, water - buckets, etc.		2,175.00
C. Non-Ferous Metal		
1. Aluminium 164kg. @ $1/- per kg.		164.00
2. Zinc 30kg. @ $0.85 "		25.50
3. Copper 25kg. @ $2.00 "		50.00
4. Tin 2kg. @ $5.30 "		10.60

Description of Engineering Production Items	Quantity	Approximate C&F Value in US$
D. 1. Studs, Bolts, Nuts, Washers, Pins, etc.		250.00
2. Galvanised Steel Pipes $\frac{1}{2}$" dia 600m. in length		980.00
3. Galvanised Steel Pipes 1" dia 600m. in length		1,902.00
4. Galvanised Steel Pipes $\frac{3}{4}$" dia 600m. in length		1,422.00
5. P.V.C. Pipes $\frac{1}{2}$" dia 600m. length		600.00
6. P.V.C. Pipes $\frac{3}{4}$" dia 600m. length		648.00
7. Mild Steel Sheets 1 mm.x 2000 mm.x 1000 mm. 7.2 kg/sq.m. 100 pcs. = 1400kgs.		1,400.00
8. Mild Steel Sheets 1.5 mm.x 2000 mm.x 1000mm. 10.8kg/sq.m. 50 pcs. = 1080kgs.		1,053.00
9. Mild Steel Sheets 2.5 mm.x 2000 mm.x 1000mm. 14.4kg/sq.m. 150 pcs. = 4320kgs		4,055.00
10. Mild Steel Sheets 2.5 mm. 2000mm.x 1000mm. 18.0kg/sq.m. 100 pcs. = 3600 kgs.		3,528.00
	Total	25,519.35
(V) Description of Consumable Items:		
1. Straight Grinding Wheels ϕ100x12x20 m.m. bore (for Tools & Cutter Grinding Machine)	6	125.00
2. Hack-Saw Blades 18"x1$\frac{1}{4}$" x $\frac{1}{16}$" 6 TPI	12 Doz. each	
3. a) Arc Welding Electrodes ϕ2.5 mm. & ϕ 4 mm.	4 gross each	
b) Sheffield needle file 4"	6 sets	550.00
c) Diamond needle files set	1 set	
4. Oil stones	2	
5. Files - 3 cornered, flat, round and half round	6 each 6 each	
6. Twist Drills $\frac{1}{12}$" to 1"		
	Total	675.00
Grand Total		30,548.35

Annex - III

Participants in the study (reference list of persons met in Addis Ababa and who participated in the study)

1. Executives at the Energy Sector:-

1.01.	Mr. Yaheya Mohammed	- Mechanical Engineer
1.02.	Mr. Tekola Shimelis	- Agricultural Engineer
1.03.	Mr. Siltan Abraha	- Civil Engineer
1.04.	Mr. Kidane Workneh	- Chemist
1.05.	Mr. Afework Wegayehu	- Economist
1.06.	Mr. Abebe Ergete	- Assist. Agricultural Eng.

2. Ministry of Mines & Energy
Ethiopian National Energy Committee (ENEC)

2.01.	Dr. Eng. Ghebru Woldeghiorghis	- Executive Secretary
2.02.	Mr. Omar Mohammed	- Senior Economist

3. Un Agencies

3.01.	Mr. Michael Priestly	- R.R. UNDP Addis Abeba
3.02.	Mr. Kadress Vencatachellum	- Deputy Rep. of UNIDO
3.03.	Mr. Mazhar Ali	- Assist. R.R. (Administration)

4. Division of Industrial Operations, UNIDO, Vienna

4.01.	Mr. M. Delos	- Head of Engg. Industrial Section
4.02.	Mr. R. Williams	- Industrial Development Officer and Substantive Officer.

Annex IV

Job Description For Technical Expert
(Production - Cum - Industrial Engineer)

Project	:	In Socialist Government Of Ethiopia
Post Title	:	Technical Expert in Production & Industrial Engineering
Duration	:	11 months (possibility of extension)
Date required	:	October 1986
Duty Station	:	Addis Ababa, with travel within the country
Purpose of Project	:	To assist the Ministry of Mines & Energy (ENEC) of - - - - - - - - - Government of Socialist Ethiopia. In establishment of various shops of Developmental Steel Fabrication Facilities (Workshop) - Cum - Training Centre, for manufacture and fabrication of different types of bio-gas cooking stoves, water-heater, charcoal kiln, bio-gas using appliances and accessories, bio-gas digesters, etc. Training of personnel in related fields.
Duties	:	In coordination with the Ethiopian National Energy Committee, the expert will specifically be expected to:

1. Prepare layout of various shops (Machine Shop, Sheet Metal & Welding Shop, Foundry Shops including Design & Mantle Mfg. Section) as well as assistance in installation and commissioning of machinery & equipment for the shops proposed.

2. Assist in design, development, rectification, fabrication of varieties of items used in bio-gas equipment and accessories & other engineering items for energy sector.

3. Assist in the production of spares, accessories, production tools, Jigs, fixtures, machine-aid, etc.

4. Impart training to engineers, technicians, supervisory and technical personnel of the ENEC to keep them abreast with the latest techniques of production.

5. Assist in the areas of production processes, standardisation of operation, selection of materials, processes, sequence of operations, time and material estimating and cost of production.

The expert will also be expected to prepare a final report setting out the mission findings and recommendations to the government for further action.

Qualification : Mechanical Engineer with 15-20 years of practical and relevant experiences in the fields of Machine and Tools Shop; Sheet Metal & Welding & Foundry shop including Industrial Engineering & Training.

Language : E n g l i s h

Back-ground Information : To alleviate the current, accute shortage of domestic fuel in both rural and urban areas in Ethiopia, The Ethiopian National Energy Committee (ENEC) is to develop the country's bio-fuel resource potential. Areas of particular interest includes:-

- Anaerobic digestion of human, animal and food processing waste (biogas generation);
- Gasification of wood and charcoal;
- Improved domestic stoves;
- Improved domestic water heater;
- Charcoal production from agricultural wastes;

- Combustion of agricultural wastes;
- Briquetting of wooden/saw dust and other agricultural wastes, etc.

It is proposed that the Developmental Steel Fabrication facilities (workshop) - Cum - Training Centre is to be established under ENEC. Such a centre would be composed of facilities for machining, fabrications, casting, and testing.

This projects would utilize the proposed centre for achieving the following objectives:-

- Fabrication/modification of equipment, accessories, etc.
- Casting of domestic stoves, accessories, spare parts, components, attachments, gas mantle parts such as body and related parts,
- Improving quality of products,
- Training of the personnel in the related fields.

The centre needs technical assistance in execution of r ndation made by UNIDO Consultants towards imports of machinery, equipmer d production tools, etc. for the establishment of Developmental Steel Fabrication Facilities (Workshop) - Cum - Training Centre enabling it to fabricate and manufactures of various items identified, installation and commissioning of machinery and equipment, training the people on the job and starting prod ction with improved techniques.

Annex - V

Training Abroad

The ENEC Management should deploy technical personnel for training overseas and in-plant with the manufacturers and suppliers of equipment. The training of supervisory and technical staff as well as new workers should be carried out in some of the engineering enterprises at home as well as abroad prior to arrival of new machinery and equipment at the centre, so as to enable them to do the work and handle tools, equipment, jigs, fextures, dies, etc. They should in particular, receive training in the following fields:-

1. Machine & Tool Shop
2. Sheet Metal and Welding Shop
3. Foundry Shop
4. Inspection & Quality Control
5. Engineering Design & Drawing Office.

Annex - VI

MANPOWER REQUIREMENTS

	Technical	Nos. of Persons Required
1.	Mechanical Engineer (Machine Shop, Foundry, Sheet Metal & Welding Shop)	1
	Total	1
2.1	Asst. Mechanical Engineer (- do - - do -)	1
2.2	Foreman (Machine Shop)	1
2.3	Skilled workers	2
2.4	Semi-skilled	1
2.5	Unskilled workers	2
	Total	7
3.1	Foreman (Sheet Metal & Welding Shop)	1
3.2	Skilled workers	3
3.3	Semi skilled workers	2
3.4	Un-skilled workers	2
	Total	8
4.1	Foreman (Foundry Shop)	1
4.2	Moulder - Cum - Cupola Operator	1
4.3	Moulder (Skilled)	1
4.4	Moulder (Semi-skilled)	1
4.5	Un-skilled workers	4
	Total	6
5.1	Maintenance Foreman	1
5.2	Skilled workers	2
5.3	Un-skilled	1
5.4	Electrician	1
	Total	5

Annex - VI

MANPOWER REQUIREMENTS

	Technical	Nos. of Persons Required
6.1	Designer (Engineering Design Division)	1
6.2	Draughtsman	1
6.3	Tracer	1
	Total	3
7.1	Mantle Making Machine Operator	1
7.2	" " " Asst. Operator	1
	Total	2
	Grand Total	32

Annex - VII

Analysis Of Steels Used For Tools

Composition of Steels used for Tools:

(i)	Tungsten High Speed Steel:	C 0.60 to 0.75, Mn 0.15 to 0.40, P 0.03 S 0.03, Si 0.15 to 0.40, Cr 3.00 to 4.50 Va 0.75 to 1.50, W 17.00 to 19.00
(ii)	Carbon Tool Steel:	C 1.00 to 1.10, Mn 0.15 to 0.35, P 0.025 S 0.025, Si 0.35
(iii)	Carbon Die Steel:	C 0.80 to 0.90, Mn 0.45, P 0.025, S 0.025
(iv)	Oil Hardening Non-deforming	C 0.85 to 0.95, Mn 1.05 to 1.25, P 0.025, S 0.025, Si 0.20 to 0.35, Cr 0.40 to 0.60, Va 0.25, W 0.40 to 0.60
(v)	Low-Tungsten Chrome-Vanadium:	C 1.15 to 1.25, Mn 0.20 to 0.35, P 0.025 S 0.025, Si 0.20 to 0.35, Cr 0.35 to 0.50 Va 0.15 to 0.25, W 1.30 to 1.75
(vi)	Chrome-Vanadium Steel:	C 0.15 to 0.25, Mn 0.50 to 0.80, P 0.04, S0.04, Si 0.10 to 0.20, Cr 0.80 to 1.10, Va 0.15 to 0.25
(vii)	Carbon Steel:	C 0.50 to 0.63, Mn 0.60 to 0.90, P 0.04, Si 0.15
(viii)	Carbon Die-Block Steels:	C 0.55 to 0.65, Mn 0.50 to 0.70 P 0.04, S 0.04, Si 0.15 to 0.30

(ix)	Chrome Vanadium Steel:	C 0.45 to 0.55, Mn .50 to 0.80, P 0.04, S 0.04, Cr 0.80 to 1.10 Va 0.15 to 0.20
(x)	Low-Tungsten Alloy:	C 0.40 to 0.50, Mn 0.15 to 0.35 P 0.025, S 0.025, Si 0.15 to 0.35 Cr 1.25 to 1.50, Va 0.15 to 0.25, W 2.00 to 3.00
(xi)	High-Carbon High-Chromium:	C 1.45 to 1.70, Mn 0.20 to 0.40, P 0.03, S 0.03, Si 0.20 to 0.40, Cr 11.0 to 12.50, Va 0.15 Co 0.40 to 0.60, Mo 0.70 to 1.00
(xii)	Cobalt High Speed Steel:	C 0.65 to 0.75, Mn 0.25 to 0.35 P 0.03, S 0.03, Si 0.20 to 0.40, Cr 4.00 to 4.25, Va 0.90 to 1.10, W 17,00 to 18.00, Co 4.50 to 5.00, Mo. 0.40 to 0.50
(xiii)	Chrome-Vanadium:	C 0.65 to 0.75, Mn 0.10 to 0.30, P 0.03, S 0.03, Si 0.25 to 0.35 Cr 0.70 to 0.90, Va 0.15 to 0.25
(xiv)	Silicon-Molydbenum Steel:	C 0.45 to 0.55, Mn 0.30 to 0.50, P 0.02, S 0.02, Si0.80 to 1.10, Mn 0.40 to 0.60

Table – 1

SPECIFICATIONS FOR ELECTRODES

AWS Classification	Current	Polarity	Characteristics	Practical Uses	Tansile Straight	Elongation in 2 in. P.C.	Amperage Dia.	Range Current
E-4510	D.C.	Straight	Some oxide precipitation. Deposit sets up high	Build-up casting repair used as filler rod, ornamental iron work	40,000 to 55,000	5	$\frac{3}{32}$, $\frac{1}{8}$ $\frac{5}{32}$, $\frac{3}{16}$	45 – 65 85 – 120 110–120 120–210
E-6010	D.C.	Reverse	Deep penetration metal freezes rapidly. Used for vertical & over-head welding. Very verstile	Heavy fabrication. Bridge-work. Pipe welding	60,000 to 75,000	20 – 28	$\frac{3}{32}$, $\frac{1}{8}$ $\frac{5}{32}$, $\frac{3}{16}$	40 – 80 75 –130 100 –175 135 –250
E-6011	A.C. D.C.	Alternating current reverse or straight	Deep penetration.can be used to replace. AWS E 6010	Sasme as AWS E 6010	60,000 to 75,000	20 – 26	$\frac{1}{8}$, $\frac{5}{32}$ $\frac{3}{16}$, $\frac{1}{4}$	80 –130 120 –180 135 –250 200 –300
E-6012	A.C. D.C.	Alternating current Straighter reverse	For poor fit-up jobs. Slag easily removed. Penetration moderately good. Slow freezing deposit. Low splatter. Welds easily.	Poor fit work. Sheet metal work. Farm machine repair. Auto repair. Vertical down welding	60,000 to 75,000	20 – 24	$\frac{3}{32}$, $\frac{1}{8}$ $\frac{5}{32}$, $\frac{3}{16}$	35 – 80 75 –125 110 –175 135 – 250

AWS Classification	Current	Polarity	Characteristics	Practical Uses	Tansile Straight	Elongation in 2 in. P.C.	Amperage Dia.	Range Current
E-6013	A.C. D.C.	Alternating Current, straight or reverse	Smooth bead, Low splatter. Arc stable penetration moderate. Easy slag removal	Sheet-metal Welding. Metal furnitures. Light plate welding	60,000 to 75,000	20 - 25	$\frac{3}{32}$, $\frac{1}{8}$ $\frac{5}{32}$, $\frac{3}{16}$	45 - 85 65 -175 110 -200 135 - 225
E-6020	A.C. D.C	Alternating current straight or reverse	Deep penetration. High current necessary. Smooth weld. Easy slage remolval. High rate of deposit	Flat & horizontal welding. Boiler work. Heavy fabrication. Girder fabrication	60,000 to 75,000	26 - 32	$\frac{1}{8}$, $\frac{5}{32}$ $\frac{3}{16}$, $\frac{1}{4}$ $\frac{5}{16}$	90 - 150 125 - 200 175 - 275 225 - 375 300 - 450

Electrode Specifications:- The accompanying table - 1 gives specifications for various electrodes. The classification for mild steel electrodes is used. In this system the letter E signifies electrode and the first two numbers following the letter the tensile straight.

The current ranges are approximate and cover a wide field for each type of electrode. This range is necessary because of the different welding procedures employed by different operators, the condition of the welding equipment, the thickness of the metal to be welded and the conditions under which the welding is being done.

The tensile straight of a steel bar is its resistance to being pulled apart if the pull is applied to each end of the bar. It is usually designated in pounds per square inch of the cross-section of the bar. Elongation is the elastic limit. When the elastic limit has been passed, a bar will break. The ductility of a metal is that property which permits it to stretch or bend.

Current Requirements:- It is impossible to give exact formulas for determining the amount of current necessary for a particular weld. There are many variables in this problem, but experience will enable you to develop the knowledge required to make the proper decisions.

To the number of pounds of usefully deposited metal per hour should be added 25 per cent to cover splatter loss and the portion of the electrode held in the electrode holder which is necessarily thrown away.

Table - 2

Gas Tungsten - Arc (TIG) Welding Of Aluminium

Material Thickness (in.)		Type of Weld	Tungsten Electrode Diameter (in.)	Filler Rod dia. (in.)	Nozzle size ID (in.)	Shielding Gas C F H	Welding Current A C - HF(A)	Number of Passes	Travel speed (IPM)
3/64	0.046	Sq.groove	1/16	1/16	1/4	19	40 - 60	1	16
1/16	0.063	Sq.groove	3/32	3/32	5/16	19	70 - 90	1	11
1/16	0.063	Fillet	3/32	3/32	5/16	15	70 - 90	1	9
3/32	0.094	Sq.groove	3/32	3/32	5/16	19	90 -110	1	11
3/32	0.094	Fillet	3/32	3/32	5/16	16	95 -115	1	9
1/8	0.125	Sq.groove	1/8	1/8	3/8	20	115 -135	1	11
1/8	0.125	Fillet	1/8	1/8	3/8	19	120 -140	1	10

Contd. Table 2

Material Thickness (in.)		Type of Weld	Tungsten Electrode Diameter (in.)	Fillet Rod dia. (in.)	Nozzle size ID (in.)	Shielding Gas C F H	Welding Current A C - HF (A)	Number of Passes	Travel speed (IPM)
3/16	0.187	Fillet	5/32	5/32	7/6	25	180 - 200	1	10
3/16	0.187	Vee groove	5/32	5/32	7/16	25	160 - 180	2	11
1/4	0.250	Fillet	3/16	3/16	1/2	30	230 - 250	1	10
1/4	0.250	Vee groove	5/32	5/32	7/6	30	200 - 220	2	9
3/8	0.375	Fillet	3/16	3/16	1/2	35	250 - 310	2 - 3	

Table - 3

Inches Per Pound Of Filler Or Braze

Electrode Wire

Wire Diameter		Metal or Alloy									
Decimal inch	Fraction inch	Aluminium	Bronze Aluminium 10%	Bronze Silicon	Copper (deox)	Copper Nickel	Magnisium	Nickel	Steel Mild	Steel Stainless	Flux-Cored Steel Electrodes
0.020		32,400	11,600	10,300	9,800	9,950	50,500	9,900	11,100	10,950	-
0.025		22,300	7,960	7,100	6,750	6,820	34,700	6,820	7,680	7,550	-
0.030		14,420	5,150	4,600	4,360	4,430	22,400	4,400	4,960	4,880	-
0.035		10,600	3,780	3,380	3,200	3,260	16,500	3,240	3,650	3,590	-
0.040		8,120	2,900	2,580	2,450	2,490	12,600	2,480	2,790	2,750	-
0.045	$\frac{3}{64}$	6,410	2,290	2,040	1,940	1,970	9,990	1,960	2,210	2,170	2,375
0.062	$\frac{1}{16}$	3,382	1,120	1,070	1,020	1,040	5,270	1,030	1,160	1,140	1,230
0.078	$\frac{5}{64}$	2,120	756	675	640	650	3,300	647	730	718	996
0.093	$\frac{3}{32}$	1,510	538	510	455	462	2,350	460	519	510	640
0.125	$\frac{1}{8}$	825	295	263	249	253	1,280	252	284	279	346
0.156	$\frac{5}{32}$	530	189	169	160	163	825	162	182	179	225
0.187	$\frac{3}{16}$	377	134	120	114	116	587	115	130	127	-
0.250	$\frac{1}{4}$	206	74	66	62	64	320	63	71	70	-

LAYOUT OF SHOPS

I MACHINE SHOP

1. Gap Bed Lathe
2. Geared Head Lathe
3. Turret Instrument Lathe
4. Milling Machine
5. Shaper
6. Double Ended Grinder
7. Power Hacksaw
8. Surface Plate
9. Bench Drilling Machine
10. Pillar Drilling machine
11. Work Bench

II FOUNDRY SHOP

1. Oil-fired furnace
2. Core Oven
3. Handle with Shanks
4. Grinding Machine

III SHEET METAL & WELDING SHOP

1. Sheet Shear
2. Power Press
3. Oxygen & Acotylene Welding Set
4. Electric Arc Welding Set
5. Furnace
6. Bending Machine
7. Hardness Tester
8. Grinder
9. Spot Welder

IV. TOOLS & MATERIAL STORE ROOM

V. DESIGN & DRAWING OFFICE

VI. MANTLE MAKING SECTION

VII. MAINTENANCE SECTION