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EVALUATION OF WOOD RESIDUES AS AN ENERGY SOURCE FOR FOREST INDUSTRIES *

by

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CONTENT

Introduction

At the present time four thousand million people consume 6.3 thousand million tons of fossil oils or their equivalent. The consumption per capita amounts in the U.S.A. to 8.2 tons, in Europe 3.5 tons and in the developing countries 0.3 tons. There is still a big difference between the developed and the developing countries although in the latter the need for heating is insignificant. Conservative estimates project a world population of 6.5 thousand million people in the year 2,000 consuming probably some 17 thousand million tons of oil equivalent. At that time it has to be considered that approximately three thousand million people will live in countries - or nearly the half of the world's population - which have no oil resources of their own. Thus, in the remaining 21 years up to the end of the century, ways will have to be found in order to increase the supply of energy of the developing countries up to three or four times the present consumption. Even in Europe there will be an enormous difference between unrestrained demand and feasible supply (Annex 1).

Conventional fuels - mostly of the fossil type - are becoming scarce. It is expected that the tension between supply and demand pressures on the global energy market will lead to a marked increase in the cost of purchased energy. This would lead, as well, to a rise in the share of energy costs in total production costs and thus provide a strong incentive for energy conservation measures and the use of biomass - derived energy. The utilization of biomass as a source of energy cannot fill the gap between demand and available energy but could contribute greatly in resolving the world-wide problems of energy. In any case local supply of biomass - waste or primary products - would favour the decentralized energy supply of enterprises, farms and villages in the near future. For the lower heating values of various residues of vegetal plants which are available for energy generation at many places, particularly in developing countries refer to Annex 2.

1. Wood as an energy souroe

Sinoe the early period of man, wood was normally used as building material and fuel. During the past century, however, the use of wood as direct fuel has been largely reduced by the fossil fuels (coal, mineral oil and natural gas). Only for the poor in developing oountries, both urban as well as rural, wood is actually the principal source of energy for cooking and for keeping warm. In these countries an estimated 86 per cent of all the wood consumed annually is used as fuel. The estimated use of wood for energy in 1971 (Annex 3) in the developing world, indicates according to regions, the share of energy generated by wood of total energy forms 6 per cent in the near East, 20 per cent in Latin America, 29 per cent in Asia and the Pacific and up to 66 per cent in Africa. The share in Europe is estimated from nil to five per cent, except in Finland with more than 20 per cent. But on the other hand the use of wood in the industrial sector of Europe as paper, panels, furniture, etc., has been increased in such a way that more than half of the demand has to be covered by imports. With the industrial prooessing of wood, bark, saw dust and residual pieces increase in considerable quantities and are locally conoentrated whioh could be processed for power supply. The patterns of energy input in forest industries and in the total manufacturing sector is compared for different countries (Annex 4). The share of wood-based fuel in many countries is so low - in Germany 0.2 per cent - that they do not have to be reported in the official statistics. However, following an E.C.E. study, about half the available residues, after deduction of those used as raw material, is utilized as a souroe of energy, at least in Europe, as well as in USA, i.e. 12 to 13 million m^3 of primary wood-processing residues, during the years 1974-1976. The energy flows in the forest industries during the mid 1970's in the E.C.E. region appear in Annex 5.

Wood is not an important direct souroe of energy in general and cannot be more than a supplementary source in developed countries as in the E.C.E. region and the U.S.A. However, this has to be stated only without really far reaohing measures as the allocation of very large areas of fertile land to energy plantations. In developing countries the situation is changing. In Brazil ten per cent of the total gasoline utilized is already substituted by alcohol generated from biomass and the share next year is expected to reach twenty per cent.

For the forest industries, however, wood is an important source of energy. In the E.C.E. region wood residues, including liquors, cover more than 25 per cent of energy input to the forest industries as a whole. However, there is a larger potential of fuel wood, about 2 ½ times as much as the energy consumption of the mechanical wood - processing sector. This means, there is self-sufficiency in the wood-processing sector apart from scarce availability of residues in several industrial centres. In developing countries there is no doubt of self-sufficiency within the forest industries and wood-processing industries. A sawmill for example needs only one third of its own waste for its energy supply and the other two thirds could be used for heat generation or energy supply to other installations.

The higher utilization of wood waste as a source of energy could lead to competition between demand of raw material for pulp and paper and demand for energy. Thus, higher prices would favour the development of other potential sources of wood energy as silvicultural thinnings, logging residues, non-merchantable biomass from forest land clearing, and "energy plantations" of quick - growing trees or shrubs, cultivated exclusively as a source of biomass energy. However, the desirability and the decision about using more wood residues to produce energy depends on a wide range of factors but basically on the following criteria:

- quantity and type of fuel wood available;
- co-production between electric power generation and heating;
- energy required and the fluctuation of demand during day and night;
- surplus supply of energy to adjacent industries and townships;
- combination of on-site and public electrioity supply.

There are excellent conditions in the wood industry with respect to residues serving as alternative energy resources. Not only residues from sawmills could be used but also those from veneer plants and other wood-processing factories (refer Doc. ID/WG/296/10). Even the residues normally left in the forest should be considered in this connexion as an alternative energy resource.

2. Stationary power generation with fuel wood

2.1 Waste energy balance of steam-power generation

The first approach to a power generation of waste should be the drawing up of a waste-energy balance. Considering lumber production from tropical hardwoods with an average air-dry density of 0.87 % metric tons per m^3, the annual cutting volume of the sawmill should be 94,000 m^3 of logs. The breakdown of products and waste material based upon material flow in the sawmill follows:

		products m3	waste m3
1.	Input log yard	94,000	
2.	Waste log yard		5,000
3.	Logs < 8 m	83,500	
4.	Logs > 8 m	5,500	
5.	Total (3) + (4)	89,000	
	Output sawmill		
6.	Timber > 8 m	2,500	
7.	Timber < 8 m	15,000	
8.	Lumber for green shipping	12,000	
9.	Lumber for drying	15,000	
10.	Total timber (6) + (7)	17,500	
11.	Total lumber (8) + (9)	27,000	
12.	Total output (10) + (11)	44,500	
13.	Waste sawmill		45,200
14.	Losses by drying 600 m^3		
15.	Input planer mill	5,300	
16.	Waste planer mill		1,100
17.	Output planer mill (15) - (16)	4,200	
18.	Input dry lumber sorting and up-grading	9,100	
19.	Waste from up-grading		800
20.	Dry lumber products shipment (17) + (18) - (19)	12,500	
21.	Green lumber and timber products shipm. (6) + (7) + (8)	29,500	
22.	Total shipment mill (20) + (21)	42,000	
23.	Total waste and losses (in m3) (2) + (13) + (14) + (16) + (19)		52,700
24.	Total waste in metric tons (23)-(14)x0,87		45,300
25.	Recovery in % = (22) : (1) x 100 =	45	
26.	Relation timber : lumber (10) : (11)	40 : 60	
27.	Relation timber length > 8m : < 8m = (4):(3) = 6 : 94		
28.	Relation green timber and lumber : dry lumber shipment (8) + (10) : (20)	70 : 30	

There will be a yearly shipment of 42,000 m3 squared timbers and lumber, which represents a recovery of approximately 45 % of the input. During the processing operations waste occurs at several production sites as indicated below:

- log yard	5,000
- sawmill	45,200
- planer mill	1,100
- upgrading	800
Total waste m^3	52,100

Thus the total annual wood waste amounts to 52,100 m3 of solid wood. The average moisture content has been assumed to be 35 % in relation to the bone-dry weight. Considering an air-dry density of the sawn logs of 0.87% metric tons per m^3 or 1.02 % metric tons per m^3 with a moisture content of 35 % the 52,100 m^3 of solid wood are equivalent to: 52,100 m^3 x 1.02 metric tons per m = 53,200 metric tons.

The energy requirements for steam-power generation could be assumed to be 100 kg of solid wood waste at 35% moisture content per 36 kwH electric power as an average value of the power equipment normally used in forest industries. The annual production of electric power could be thus calculated as follows:

$$\frac{53{,}200 \text{ metric tons x } 36 \text{ kWh}}{0.1 \text{ metric tons}} = 19{,}100 \text{ mwh/year}$$

Considering a specific steam consumption of 12,5 kg per kWh generated, the total steam requirements per year could be estimated at:

19,1 MWh/year x 12,500 metric tons/MWh = 240,000 m.t.

On the other hand the installed capacity of the power plant and that of the power consumers needs could be estimated as follows:

logyard	70 kW
sawmill	1,650 kW
drying kilns	190 kW
planer mill and remanufacturing	600 kW
water supply	130 kW
work shops	130 kW
power plant and lighting	730 kW
town requirements (300 dwellings for 1500 people)	2,500 kW
	6,000 kW

An assumed peak load of 4.2 MW has been taken for the size of the power generation equipment. Average loads may be estimated at 3200 kW during the two 8 hour shifts on working days, 1400 kW during the non-working days, and 600 KW during the night hours.

Consequently the power demand in MWh per year can be calculated as follows:

274 days x 16 h = 4384 h x 3200 kW = 14,000 MWH/year
91 days x 16 h = 1456 h x 1400 kW = 2,000 MWH/year
365 days x 8 h = 2920 h x 600 kW = 1,800 MWH/year
17,800 MWH/year

This results in a positive waste-energy balance with an availability of 19,100 MWh/year agains a demand for energy of 17,800 MWh/year. These estimates are valuable for steam-power generation.

It should be mentioned that the heat demand for wood drying would be covered by the heat frcm the waste steam.

2.2 Waste-energy balance from gas power generation

The waste-energy balance for gas-power generation is still more favourable due to the higher electrical energy output of approximately 65 kWh from 100 kg of solid wood waste based upon an average moisture content of 35 per cent. This means that in this case the annual production of electric power could be calculated as follows:

$$\frac{53{,}200 \text{ m.t. x } 65 \text{ kWh}}{0.1 \text{ metric tons}} = 34{,}580 \text{ MWh/year}$$

Thus, only half of the energy potential of the waste from the sawmill would be needed to cover the power demand despite the fact that a supply of about 40 per oent from the power production goes to the township. The heat demand for wood drying could be covered by the heat from the cooling water of the gas-engines, which oould be obtained with a temperature ranging from 80°C to 120°C.

We have seen that from the total annual heat potential from the wood waste of:
53,200 metric tons x 9.2 GJ/metric tons x 0.2777 WMh = 135,900 MW
only about 25 per oent could be converted to eleotric power at best, i.e. about 34,580 MWh; another 75,000 MWh or 270 GJ could be recycled or used in a co-production arrangement for heating purposes. In the best of the cases about 80 per cent of the total energy input from the wood waste could be used in industrial processes. This very high efficiency to be obtained in an electric power - heat co-production represents a large economical advantage in comparison with other systems such as power generation by diesel engines and by the centralized big power plants from the public power supply, where the efficiency is below 30 per cent in the first oase and between 30 per cent and 40 per cent in the latter.

3. Electric power generation

In the past the diesel engine was the solution for power supply of forest industries and especially night loads in those isolated factories which did not work around the clock. But considering the high ideal oil prices and with every indication of further increases in the near future, all normal power production in forest industries should be based on wood waste as fuel.

4. Power generation by steam turbine

Based upon a capacity of 6 MW in the discussed sawmill, normally only a turbine would have been taken into consideration. However, the following points call for more detailed discussion of alternative solutions in this case. The steam power plant must be able to run for many hours below the average load, i.e. in the night hours with only ten per cent of the sized capacity. A sub-division of the installed capacity of 6 MW only into two plants will, therefore, not be possible considering 3 MW as a minimum economical size of a steam turbine. The power generation unit should be divided into four units or more, each one with 25 per cent capacity and 1.5 MW - alternators or less. A typical wood fuel steam boiler plant is shows in Annex 6.

5. Power generation by steam motor

Steam motors are more suitable for power generation units of 1.5 MW or less, due to their flexibility in relation to steam pressure and possible expansion. Also, their robust construction and lower requirements of water treatment and maintenance indicate certain advantages for steam power generation in developing countries. Annex 7 contains a power plant with steam motors coupled with the co-production of heat for several industrial purposes.

6. Evaluation of alternative of steam power generation

In this particular case the demand for process steam for drying purposes, etc. is very low, so that a high percentage of steam cannot be utilized as process steam and must be condensed for the recycling of the water. This offers the possibility of using turbines, which make better use of steam between atmospheric pressure and vacuum, whilst steam motors make better use of the steam pressure between boiler pressure and atmospheric pressure. In addition such exhaust steam turbines are not as delicate as the high pressure part of small turbines. Furthermore, the greatest advantage of such a combination between turbine and engine is the possibility to make use of the flexibility of the modular steam motor, which leaves open the possibility of variation of the quantities and pressures of the process steam as required in the future. Annex 8 shows the layout of such a power plant.

7. Power generation by gasification - gas engine

In a wood gasification plant the solid fuel filled into gasifier casings or gasification tanks is distilled into charcoal and finally gasified to lean gas. Motors or engines running with lean gas produced from wood waste will convert up to 30 per cent of the heat supply from the gas into mechanical or electrical energy. About 15 per cent are lost through general radiation, the remaining 55 per cent escape with the cooling air or the cooling water or with the exhaust gases. In stationary plants, particularly in plants for greater energy gain, such as power stations, the waste heat could be used effectively for both drying and heating processes. The exhaust gases are clean and do not contain any noxious materials polluting the environment. They may even be used directly for drying and heating by simply adding air to them. Annex 9 demonstrates a gasification and gas engine power generation plant. The capital costs of such a plant would be about 15 to 20 per cent lower than those of a steam power generation plant. Annex 10 shows this type of power plant.

8. Mobile power generation from fuel wood

Furthermore the utilization of gas power in vehicles is very interesting today. There is an old technology from the time before and during the last World War in Europe, which has now been adapted to today's requirements, especially in developing countries without their own sources of liquid fuel. (Refer Annex 11 as an example).

One kilogram of wood with a 20 to 25 per cent moisture content will yield about 2.3 m^3 of generator gas, meaning that e.g. one liter of petrol could be replaced by 2.5 to 3 kg of wood, and one liter of diesel oil by 3 to 3.5 kg of wood. With oven-dried wood chips the latter relation could be reduced to 2.5 to 3 kg of wood for the equivalent of one liter of diesel oil, or 0.2199 British Imperial Gallons.

There exists a real opportunity to produce oven-dried wood chips utilizing the waste heat of the cooling equipment and of the exhaust of the power station to be installed. The wood waste for the production of chips for gasification would be available in quantities of about 100,000 m^3 of solid wood per year on the logging sites of the discussed sawmill where the waste occurs from the crowns, branches and heart-rotted stems of the felled trees during the normal logging activities. The chips would be produced by a mobile chipper driven by a gas engine and hauled by trucks to the mill for drying and upgrading. The volume of 100,000 m^3 per year of solid waste from the logging sites corresponds to 75,000 metric tons of dried wood chips with an equivalent of 25,000,000 liters or 5,500,000 British Imperial gallons per year of liquid fuel for combustion pruposes.

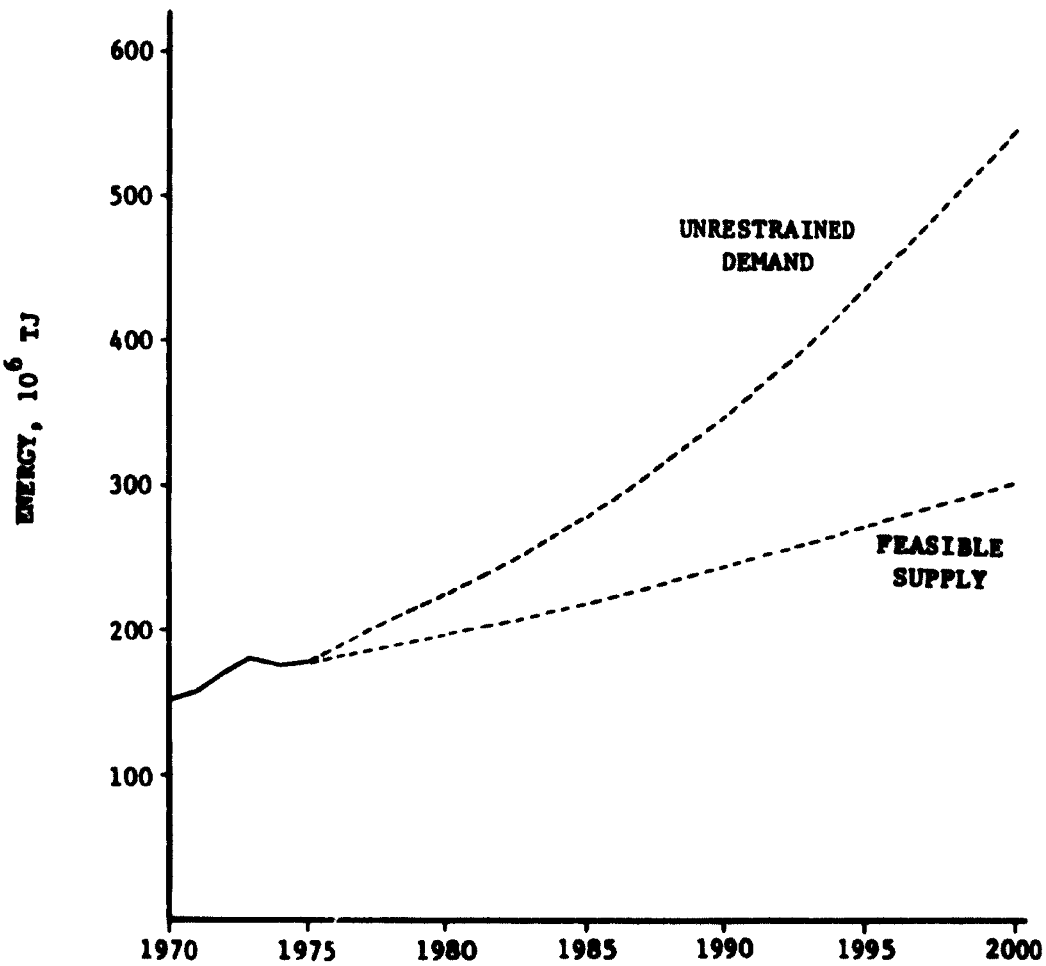
The additional equipment for gas-fuel generation for a normal vehicie with an engine of 150 to 200 hp costs about 25,000 US$. The oosts of the wood fuel with an equivalent of one liter diesel oil would not be higher then US$ 0.10, or US$ 0.46 for the equivalent of one British Imperial gallon of diesel oil. This is a competitive cost for fuel and interesting from the point of view of saving foreign exchange.

9. Cost relations on power generation systems

Considering very different situations in each case, the costs of electric power generated by steam range approximately from 0.05 to 0.10 US$/kWh on the assumption that the wood waste has been delivered to the plant free of cost. The comparison of cost calculations of electric power generated by wood-gas engines and diesel-guel engines, working under similar conditions appears in Appendix 12 . The power costs of wood gas are US$0.10 per kWh and of diesel fuel US$ 0.15 per kWh under certain assumptions made. If the diesel-fuel price rises - nowadays a common fact - the relation of 2 : 3 between the two cost calculations will move more and more favouring the wood-gas generated power.

ANNEX 1

ENERGY USE PROJECTION FOR THE ECE REGION



ANNEX 2

LOWER HEATING VALUE AND COMPOSITION OF VARIOUS WASTE MATERIALS

Material	MJ	BTU approx.	Volatile parts %	Water %	Ash %
Wood (green)	9.2	8,700	45	37	0 - 1.5
Wood (air dry)	15.6	14,800	60	15 - 20	0 - 1.5
Flax	16.5	15,600	80	12	0 - 5
Paper	14.8	14,000	70	6	6
Bark (pressed)	5.9	5,600	32	60	1.5 - 4
Peat (dry)	11.6	10,400 to 12,000	38 - 40	37 - 45	1 - 2
Pith	8.4	8,000	45	50	2 - 3
Sisal, Agave	14.3	13,600	64	11	22
Bamboo	15.9	15,100	68	11	4
Cotton Husks	13.9	13,200	79	9	12
Cacao Husks	13.9	10,800 to 15,600	65	8 - 9	7 -23
Coconut Husks	16.0	12,800 to 17,600	70	11 - 24	1 - 4
Straw Dust	14.3	13,600	60	8	2
Coffee Husks (dry)	6.6	6,280	29	65	1
Rice Husks	12.2	11,600	56 - 58	9	18 -20
Tobacco Dust	12.7	12,000	45	5	40

1 Megajoule (MJ) = 10^6 Joule
947.8 BTU = 0,2388 Mcal = 0,2777 kWh

1 Gigajoule (GJ) = 10^9 Joule

1 Terajoule (TJ) = 10^{12} Joule

ANNEX 3

Estimated Use of Wood for Energy in 1971

	Consumption of wood Fuel		Energy from wood Fuel	
	Total	per caput	Coal Equiva-lent2	Percent of total Energy3
	Million m^3	Million m^3	Million tons	
Asia and Pacific:				
Southeast Asia and Pacific	278	0.91	92	62
South Asia	267	0.38	88	43
China and other Asia	148	0.18	49	9
TOTAL	693		229	29
Near East	13	0.15	4	6
Africa:				
North Africa	55	0.50	18	41
West Africa	110	0.92	36	75
East Africa	117	1.14	39	75
TOTAL	282		93	66
Latin America:				
Central America	33	0.36	11	9
South America	199	1.03	66	29
TOTAL	232		77	20

ANNEX 4

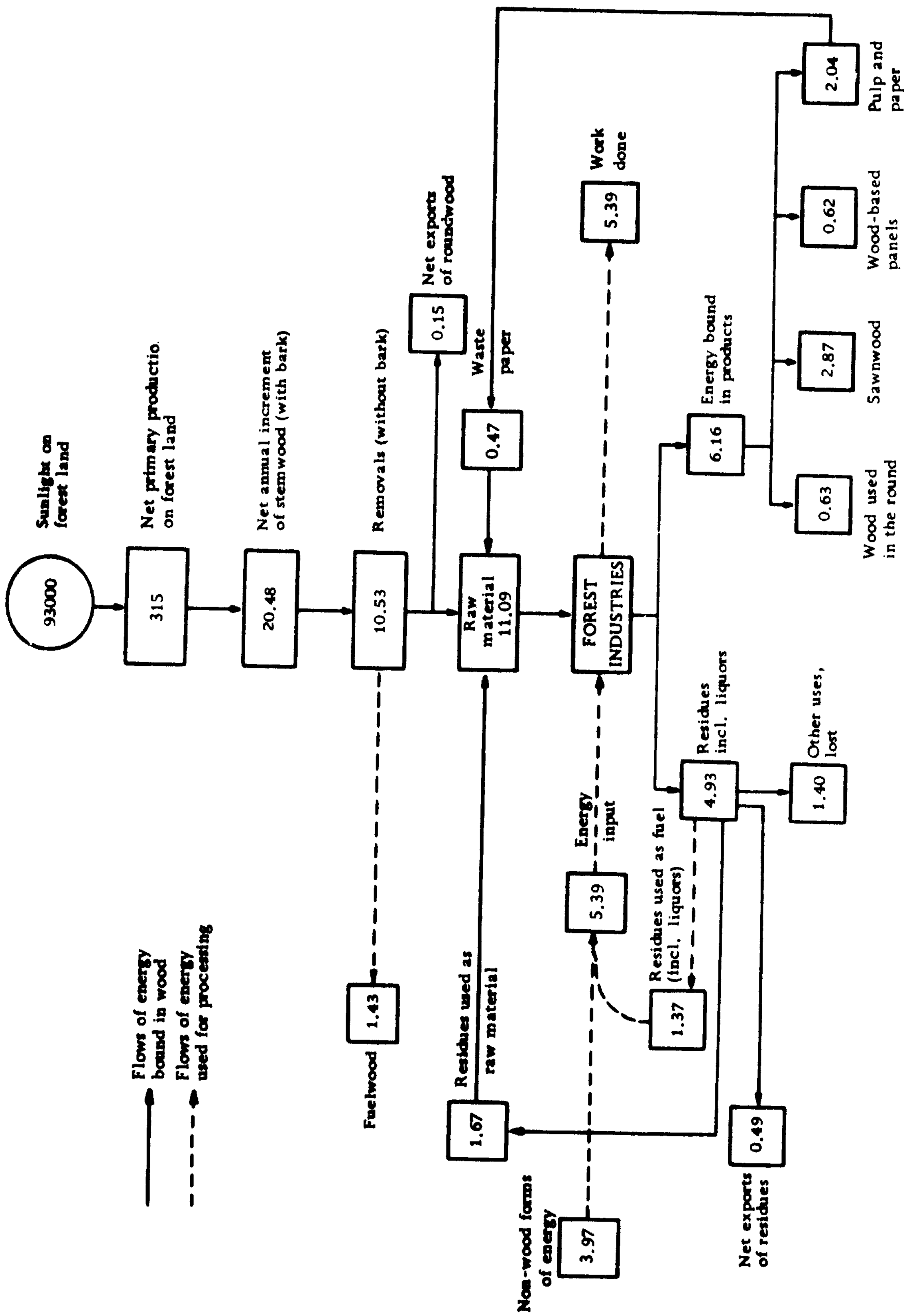
Trend of Energy Input in Forest Industries and in Total Manufacturing Sector, 1971-1972 **

(% of recorded total energy input)

	Coal-based	Oil-based	Gas	Wood-based	Other	Net purchase of electricity
Austria:						
-manufacturing	21.5	29.7	30.3	0.9	0.1	17.5
-pulp + paper	11.2	31.2	34.2	8.9	0.3	14.2
-mechanical wood-processing	1.0	45.9	7.9	4.3	-	40.9
Finland:						
-manufacturing	4.7	21.5	-	22.7	18.3	32.8
-pulp + paper	3.0	12.8	-	11.8	31.1	40.5
-mechanical wood-processing	0.6	16.6	-	15.4	40.0	27.9
France:						
-manufacturing	28.2	32.5	-	..	-	39.8
-pulp + paper	5.8	45.5	8.0	..	-	40.7
-mechanical wood-processing	..	..	..	..	-	..
Germany, Fed.Rep. of:						
-manufacturing	22.5	32.6	26.9	-	-	18.1
-pulp + paper	12.0	57.6	19.7	-	-	10.7
-mechanical wood-processing	5.0	49.7	7.4	-	-	37.9
Hungary:						
-manufacturing	0.1	-	-	-	0.1	99.8
-pulp + paper	0.3	12.2	-	-	0.2	87.3
-mechanical wood-processing	46.6	11.0	-	-	0.1	42.4
Norway: *						
-manufacturing	0.4	20.7	-	-	0.6	78.3
-pulp + paper	-	41.5	-	0.2	1.0	57.3
-mechanical wood-processing	-	42.5	-	0.6	2.8	54.1
Sweden:						
-manufacturing	7.7	43.1	0.1	1.5	-	47.7
-pulp and paper	-	43.1	-	4.0	-	52.8
-mechanical wood processing	-	42.9	-	2.8	-	54.3
USA:*						
-manufacturing	13.1	9.9	44.4	..	3.2	29.3
-pulp + paper	18.8	29.4	33.8	-	1.8	16.2
-mechanical wood-processing	4.2	11.8	35.6	-	19.2	29.3
Yugoslavia:						
-manufacturing	41.1	25.0	..	-	-	33.9
-pulp + paper	61.4	9.8	-	-	-	28.8
-mechanical wood-processing	28.1	27.6	-	-	-	44.3

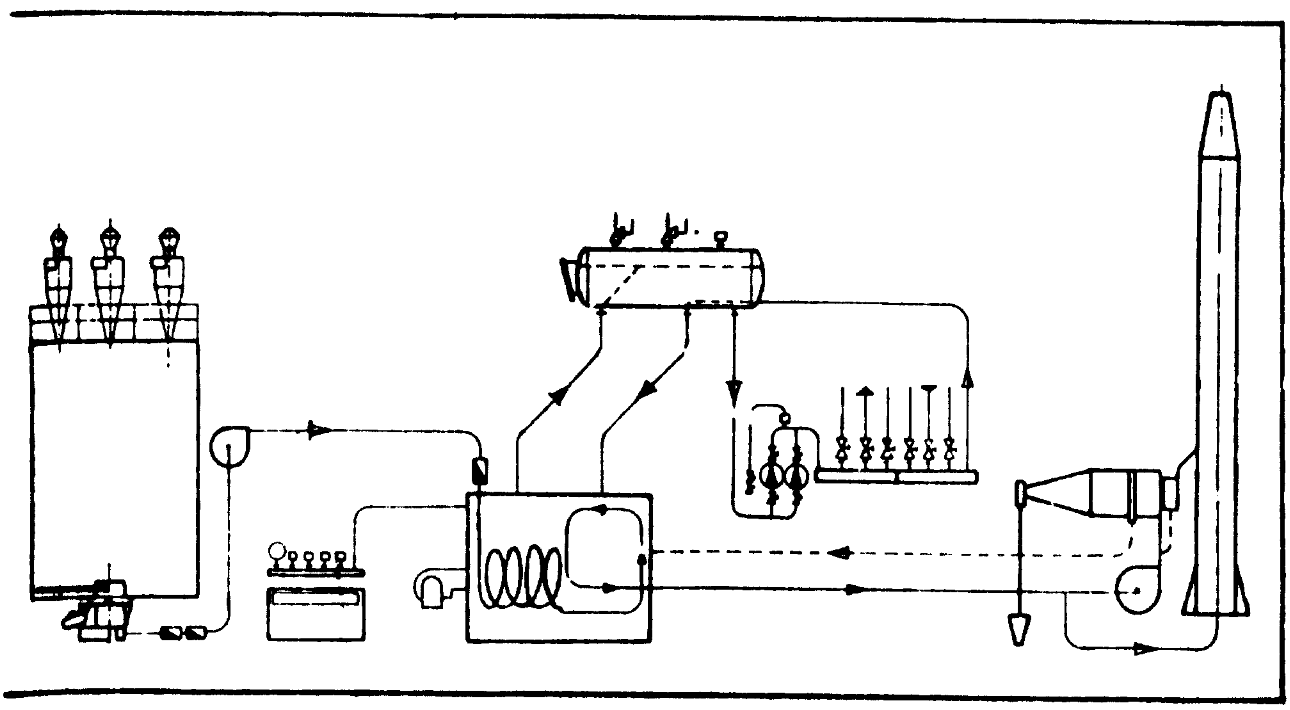
* year 1971
** Source: ECE statistics

ANNEX 5



Energy flow in the forest industries ECE region in the mid-1970s (10^6 TJ)

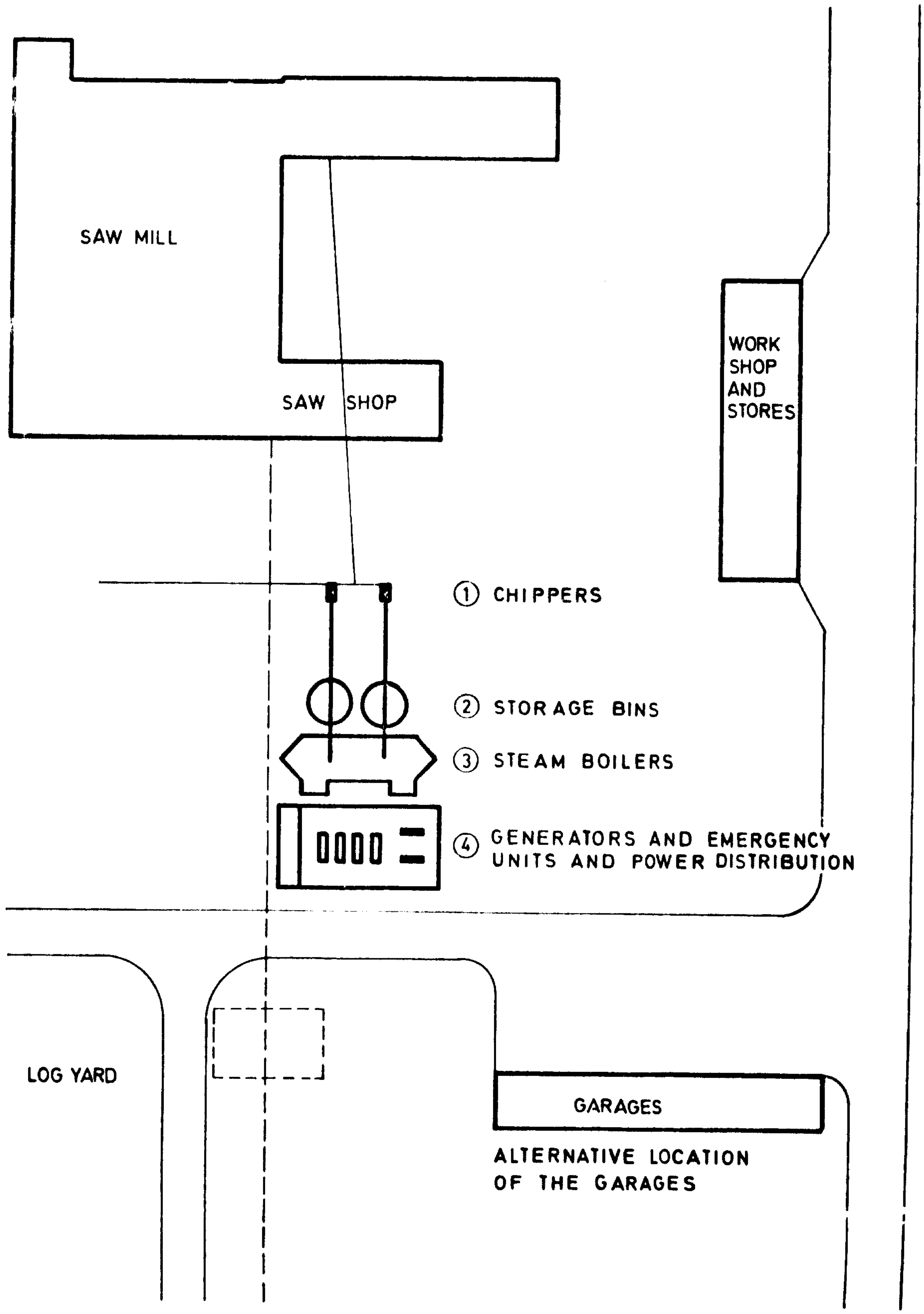
ANNEX 6



Wood fuel steam boiler plant

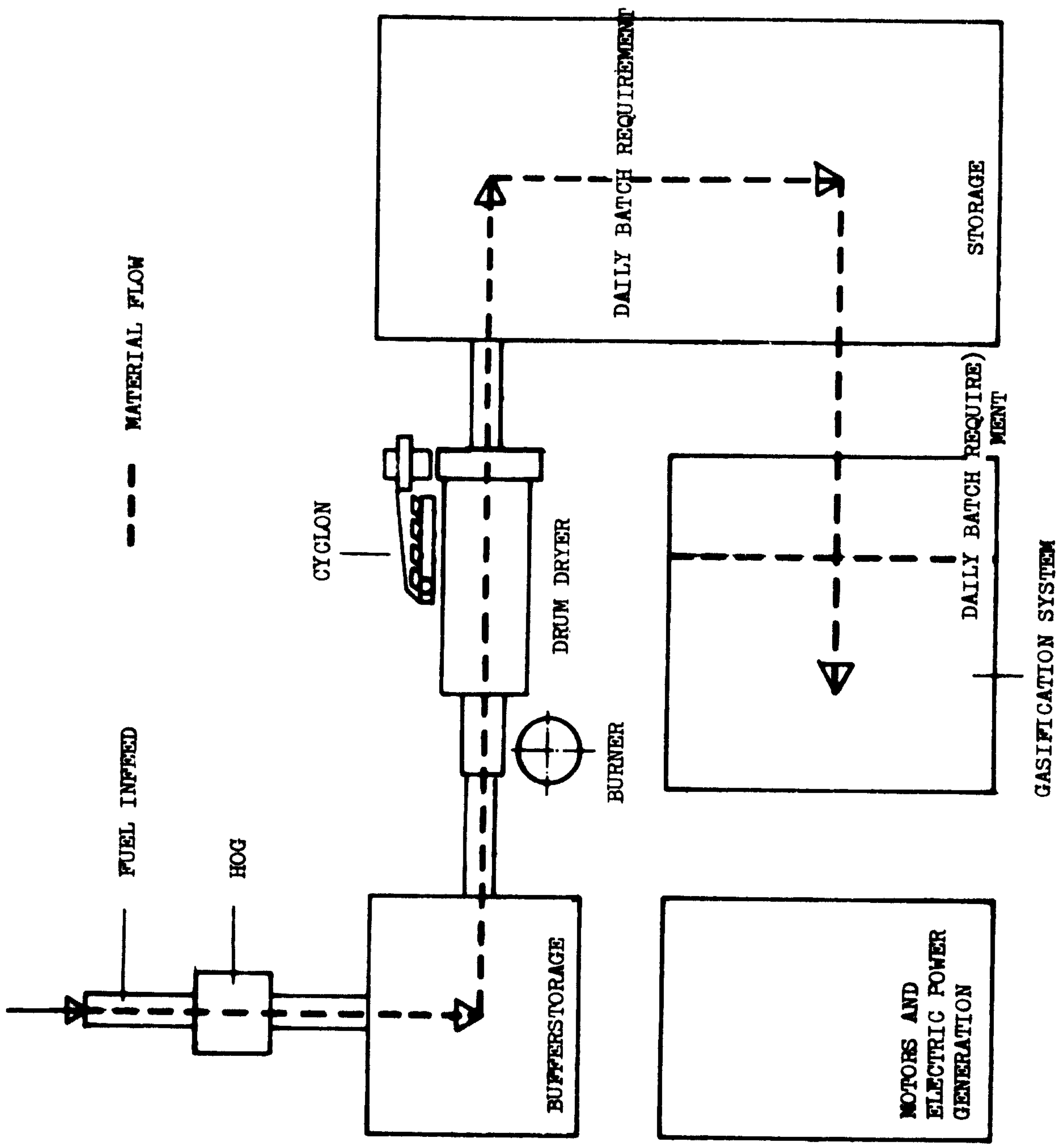
ANNEX 7

STEAM - POWER STATION

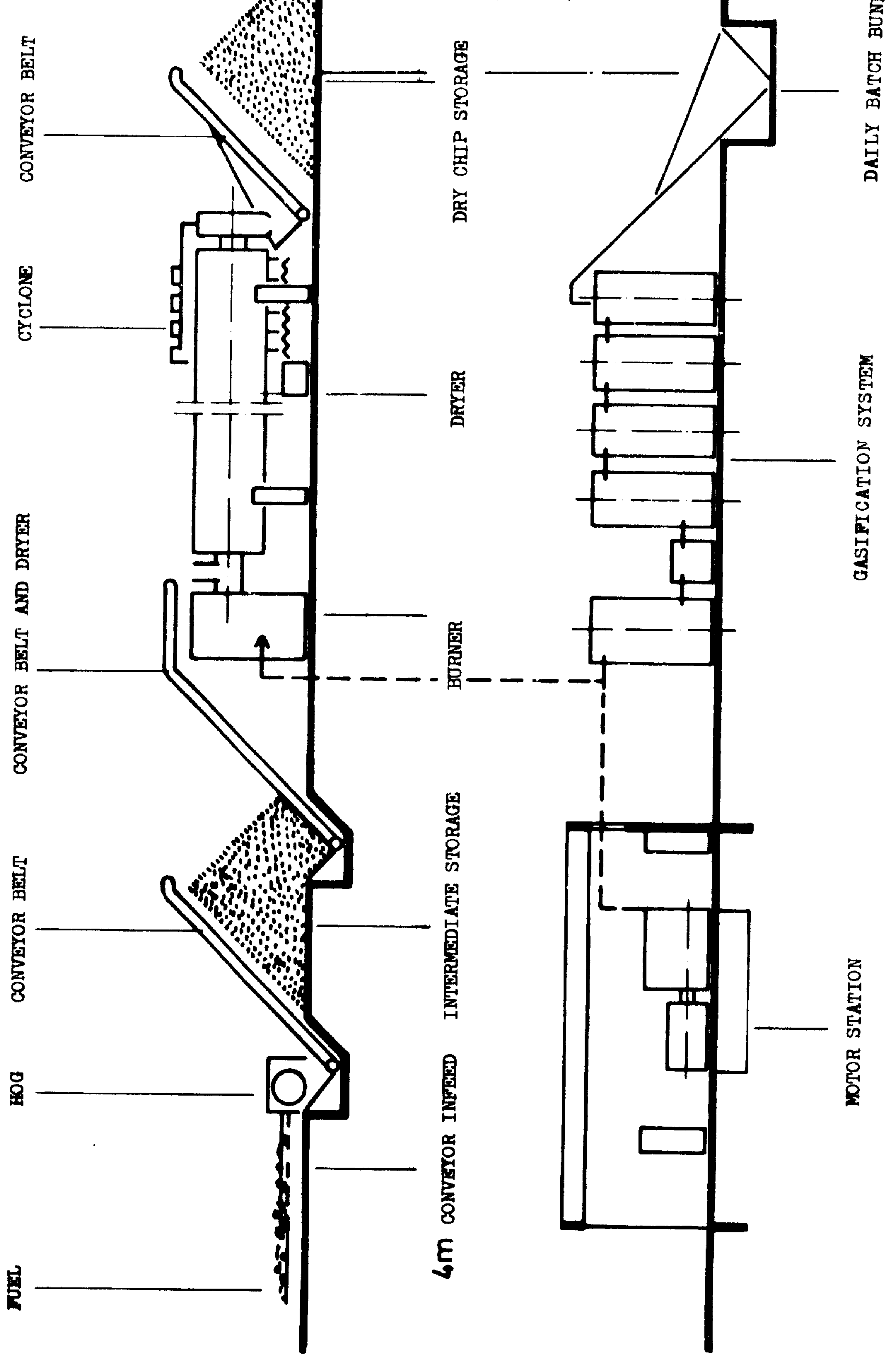


ANNEX 8

Power Generation by Gasification

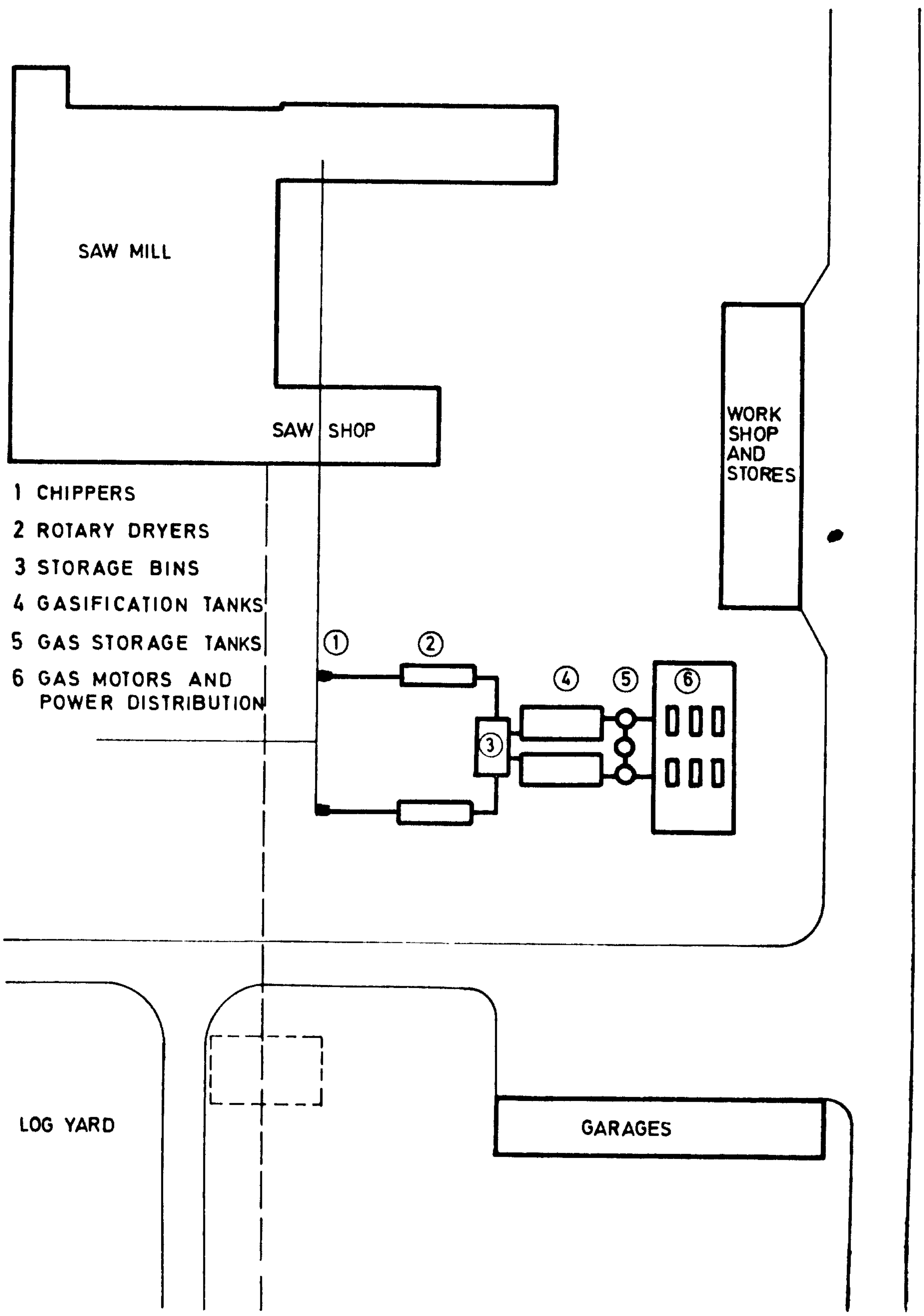


ANNEX 8 (contd.)

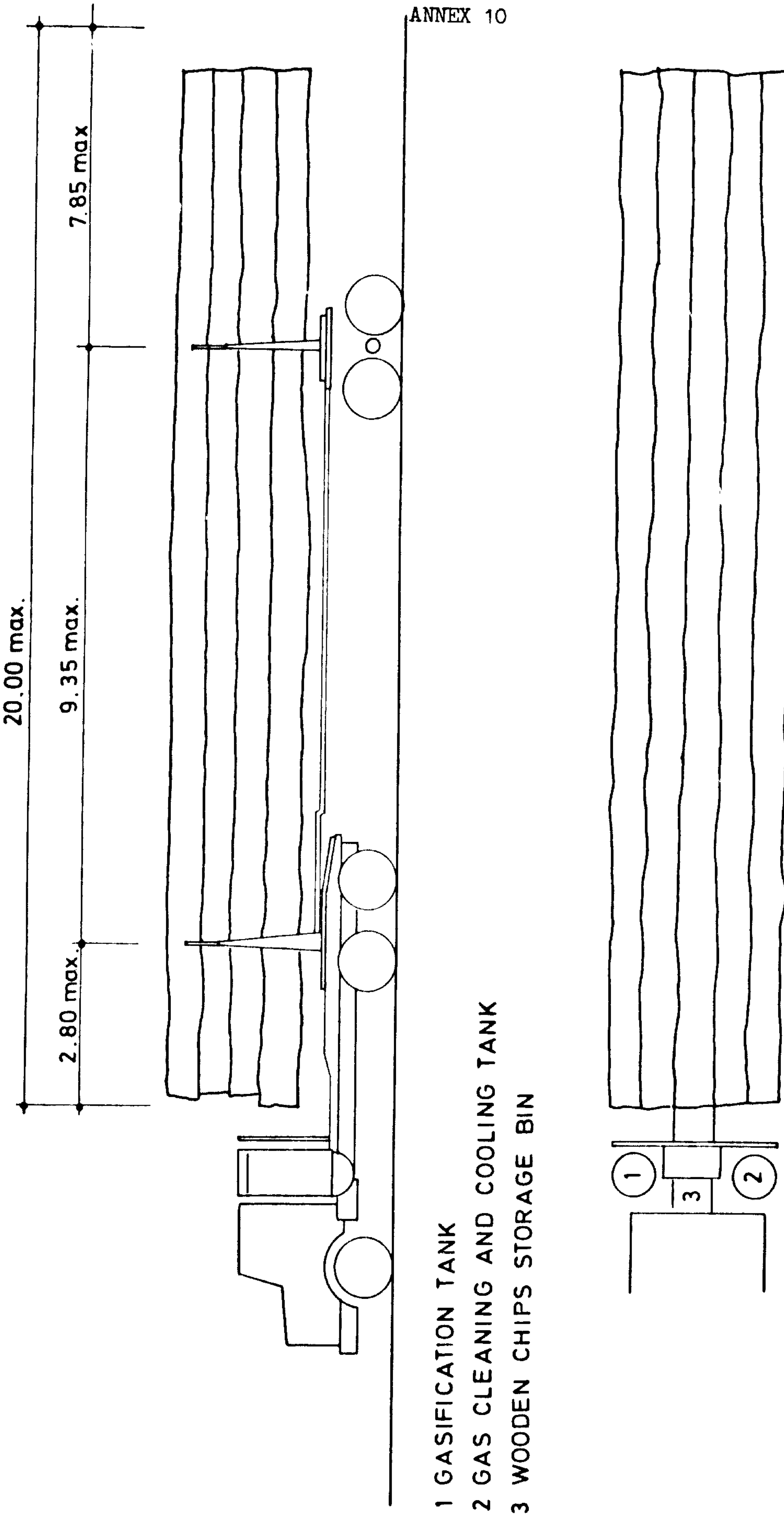


ANNEX 9

GAS - POWER STATION



ANNEX 10



LOGGING TRUCK WITH WOOD-GAS FUEL COMBUSTION

ANNEX 11

Comparison of Cost Calculation of small Power Plants:

Assumptions:

80 KW installed capacity

Operations conditions:

250 days x 8 h = 2.000 h x 80 KW x 0.8 load factor = 128,000 KWh

250 days x 6 h = 1,500 h x 80 KW x 0.5 load factor = 60,000 KWh

100 days x14 h = 1,400 h x 80 KW x 0.5 load factor = 56,000 KWh

---

350 days x14 h = 4,900 h x 80 KW x 0.622 load factor = 244,000 KWh

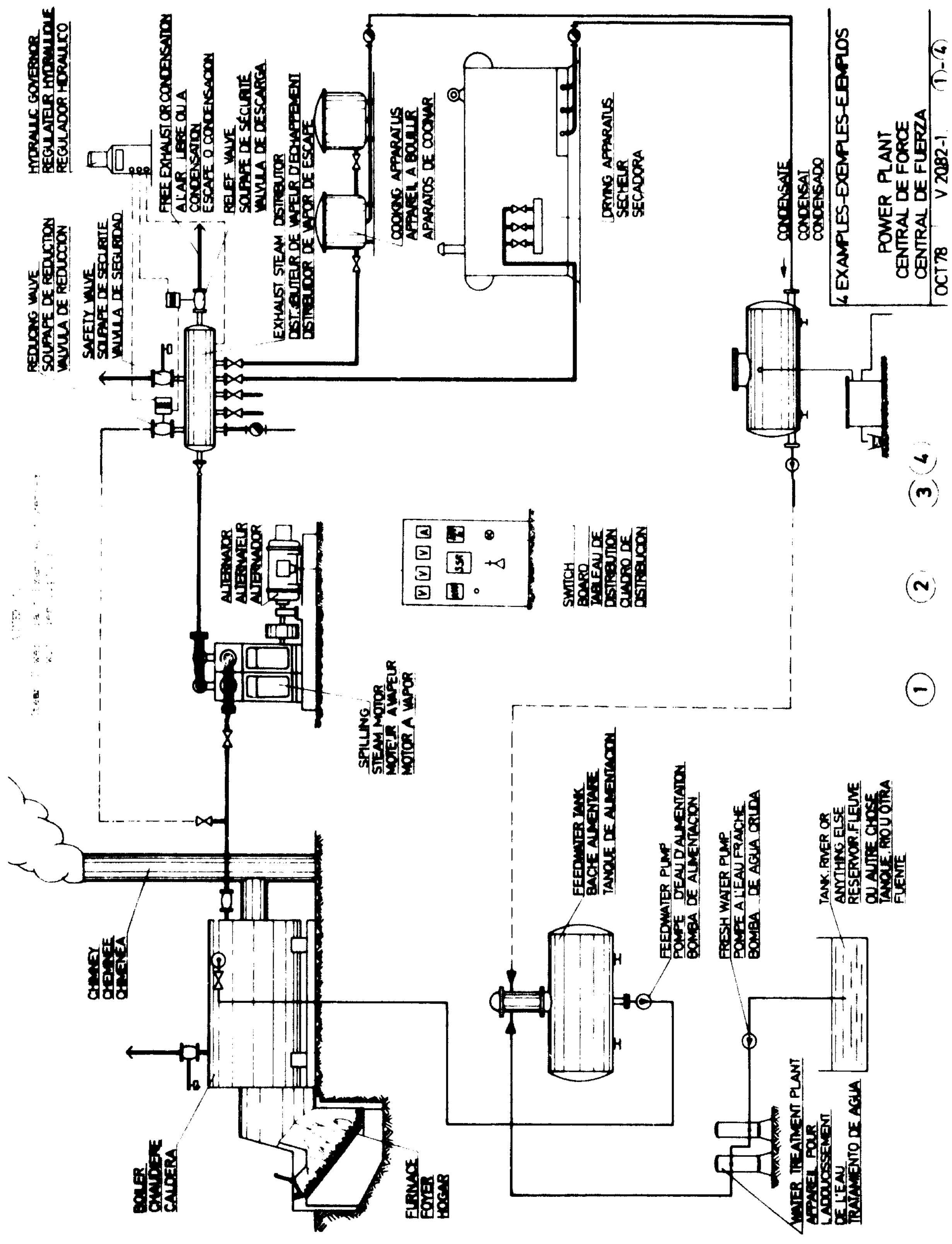
Operation time to overhaul:

diesel fuel motors	15,000 h = 3.25 years
wood-gas motors	30,000 h = 6.25 years
gasifier plant	50,000 h =1o.00 years

Cost calculations in US$		Wood-gas motor		diesel-fuel motor
Investment costs (FOB European port):				
motor with generator 100 KWh		35,705.00		29,778.00
gasifier plant		36,600.00		——
Total investment costs		72,305.00		29,118.00
Depreciation:				
motor and generator	15.38% =	5,491.40	30.72% =	8,959.60
gasifier plant	10.00% =	3,660.00		—
Total depreciation		9,151.40		8,959.60

ANNEX 11 (contd.)

	Wood-gas motor	Diesel-fuel motor
Wages:		
Motors 360 days, 14x9,26 US$	1,823.60	1,823.60
Gasifier 360 days, 14 x 5.26 US$	1,893.60	—
Total wages	3,282.20	1,823.60
Maintenance and repair:		
Motors, 4% of investment	1,428.20	1,164.70
Gasifier, 2% of investment	732.00	—
Total maintenance + repair	2,160.20	1,164.70
Fuel costs:		
10.677 % load factor)		
diesel-fuel		
244,000 x 0.225 x 1		
0.9 x 0.95 x 0.75		
= 85,614 kg x 0.26 US$/kg	—	22,530.00
Lube oil:		
1 % of 85,614 kg		
= 856 kg x 316	2,703.00	2,703.00
Waste preparation:	4,663.20	—
Summary of costs:		
Depreciation	2,151.40	8,959.00
Wages	3,787.70	1,893.60
Maintenance + Repairs	2,160.20	1,164.70
Diesel-Fuel	—	22,530.00
Lube-oil	2,703.00	2,703.00
Waste preparation	4,663.20	—
	22,465.00	37,250.30
Electric power cost:		
Wood-gas motor	0.092 US$	
Diesel-fuel motor		0.15 US$



HYDRAULIC GOVERNOR
REGULATEUR HYDRAULIQUE
REGULADOR HIDRAULICO
FREE EXHAUST OR CONDENSATION
A L'AIR LIBRE OU A CONDENSATION
ESCAPE O CONDENSACION
RELIEF VALVE
SOUPAPE DE SÉCURITÉ
VALVULA DE DESCARGA
EXHAUST STEAM DISTRIBUTOR
DISTRIBUTEUR DE VAPEUR D'ECHAPPEMENT
DISTRIBUIDOR DE VAPOR DE ESCAPE
REDUCING VALVE
SOUPAPE DE REDUCTION
VALVULA DE REDUCCION
SAFETY VALVE
SOUPAPE DE SECURITE
VALVULA DE SEGURIDAD
COOKING APPARATUS
APPAREIL A BOUILLIR
APARATOS DE COCINAR
DRYING APPARATUS
SECHEUR
SECADORA
CONDENSATE
CONDENSAT
CONDENSADO
4 EXAMPLES-EXEMPLES-EJEMPLOS
POWER PLANT
CENTRAL DE FORCE
CENTRAL DE FUERZA
OCT'78 V 2082-1 1-4
ALTERNATOR
ALTERNATEUR
ALTERNADOR
SWITCH BOARD
TABLEAU DE DISTRIBUTION
CUADRO DE DISTRIBUCION
SPILLING STEAM MOTOR
MOTEUR A VAPEUR
MOTOR A VAPOR
1
2
3
4
CHIMNEY
CHEMINEE
CHIMENEA
FEEDWATER TANK
BACHE ALIMENTAIRE
TANQUE DE ALIMENTACION
FEEDWATER PUMP
POMPE D'EAU D'ALIMENTATION
BOMBA DE ALIMENTACION
FRESH WATER PUMP
POMPE A L'EAU FRAICHE
BOMBA DE AGUA CRUDA
TANK, RIVER OR ANYTHING ELSE
RESERVOIR, FLEUVE OU AUTRE CHOSE
TANQUE, RIO U OTRA FUENTE
BOILER
CHAUDIERE
CALDERA
FURNACE
FOYER
HOGAR
WATER TREATMENT PLANT
APPAREIL POUR L'ADOUCISSEMENT DE L'EAU
TRATAMIENTO DE AGUA

Explanations to the "Steam Power Plant Examples" in Annex 12

Example 1:

The life steam from the boiler is sent to the steam motor which, equipped with an extension shaft and a pulley, can drive machineries of all kinds, e.g. rice-mills, saw milling equipment, paper machines, compressors, etc. The exhaust steam of the steam motor is blown to the open air. This solution works economically based on conventional fuels whenever the local electricity prices are relatively high, or based on locally available non-conventional fuels, e.g. rice husks (hulls), wood residues, nut shells etc., even when the local prices for conventional fuels and/or electricity are relatively low.

Example 2:

Same conditions and requirements as per example 1 but with the difference that an alternator is directly coupled to the steam motor so that the mechanical energy is converted to electric energy for driving electric motors and/or for lighting purposes.

Example 3:

Same conditions and requirements as per examples 1 and 2 but with the difference that the power plant is equipped with an exhaust steam condensing plant, which is necessary in all those areas and regions where sufficient quantities of water are not available for feeding the boiler.

Example 4:

This is the most economic solution for all those industries which have a considerable demand in process heat besides its electric energy requirements. The so called co-generation principle applied in this solution means that the steam coming from the boiler is utilized first of all for generating electric energy by means of the SPILLING steam motor alternator set whilst the exhaust steam of the steam motor is sent to the processing plant for heating, drying, cooling (absorbtion), cooking and sterilising purposes. Thus up to 80% of the fuel cost can be recovered in form of electric energy and process heat. If in addition locally available residues can be burnt the electric energy and heat will be obtained at almost no cost!

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