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

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

08766

Distr.
LIMITED

ID/WG.293/39
16 March 1979

ENGLISH

United Nations Industrial Development Organization

Workshop on Fermentation Alcohol for Use as Fuel and Chemical Feedstock in Developing Countries

Vienna, Austria, 26 - 30 March 1979

FERMENTATION - SECOND WAY FOR UTILIZATION OF VEGETABLE SOURCES*

by

Kurt Schreier**

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Managing Director, Vogelbusch Ges.m.b.H., Mautner Markhof-Gasse 40, 1110 Vienna, Austria

id.79-1976

with

08766

Distr.
LIMITED

ID/WG.293/39/Add.1
28 March 1979

ENGLISH

United Nations Industrial Development Organization

Workshop on Fermentation Alcohol for Use as Fuel and Chemical Feedstock in Developing Countries

Vienna, Austria, 26 - 30 March 1979

FERMENTATION - SECOND WAY FOR UTILIZATION OF VEGETABLE SOURCES*

by

Kurt Schreier**

ADDENDUM

The following pp. 1 - 4 (Figure 1 - 4) should be added to the above paper as pp. 17 - 20.

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Managing Director, Vogelbusch Ges.m.b.H., Mautner Markof-Gasse 40, 1110 Vienna, Austria

id.79-2676

Figure 1

COST INFLUENCING FAKTORS.

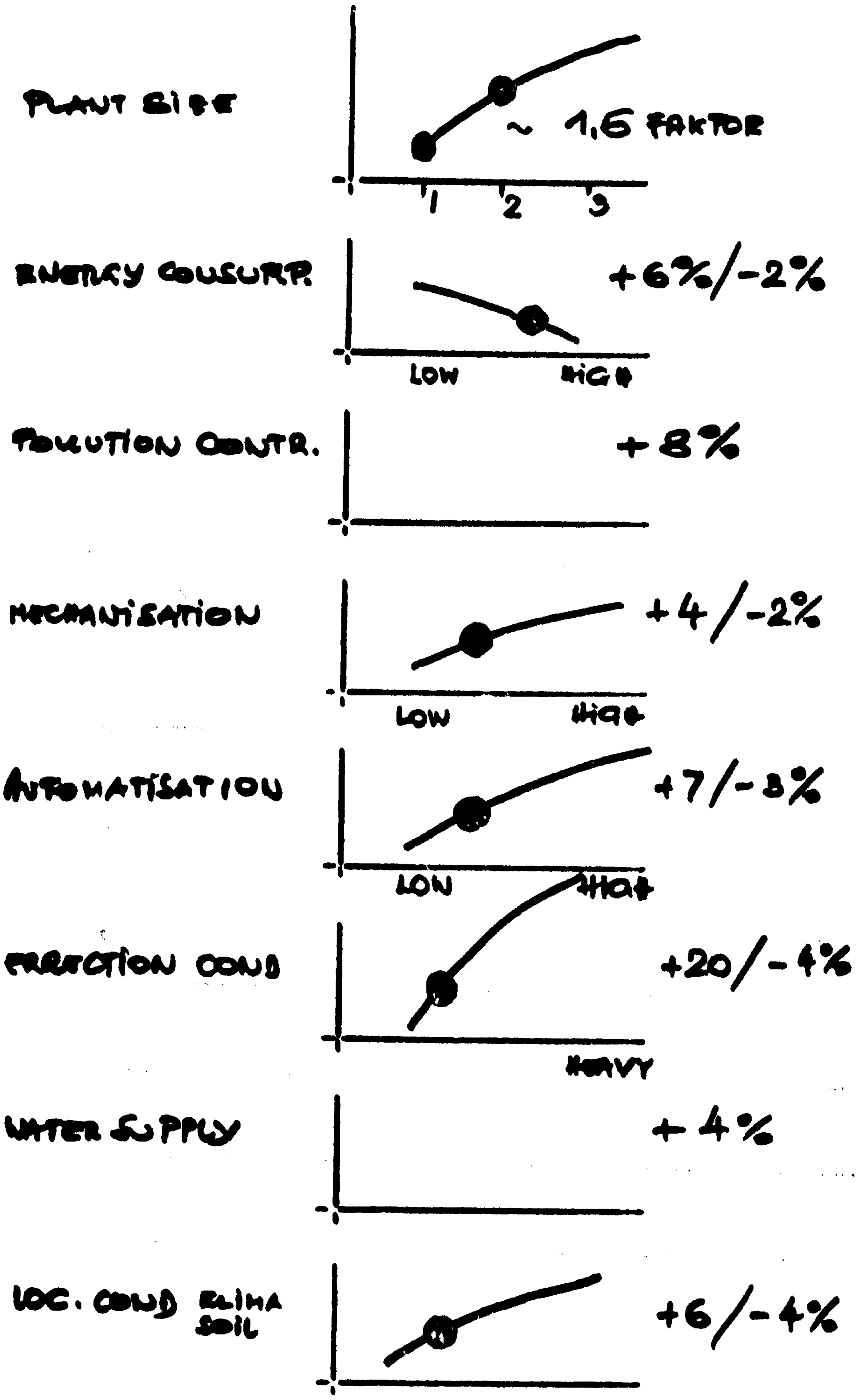


Figure 2

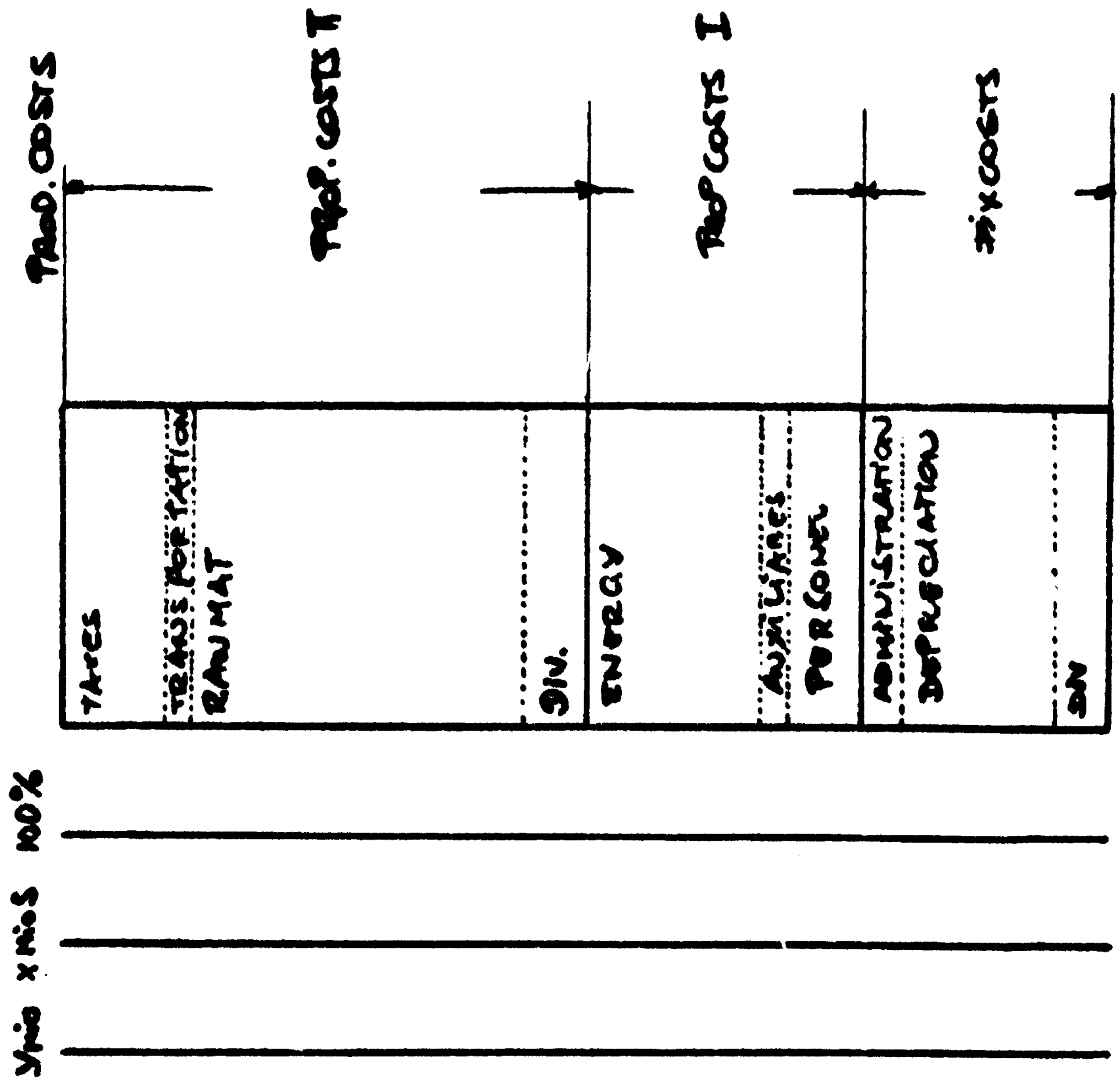
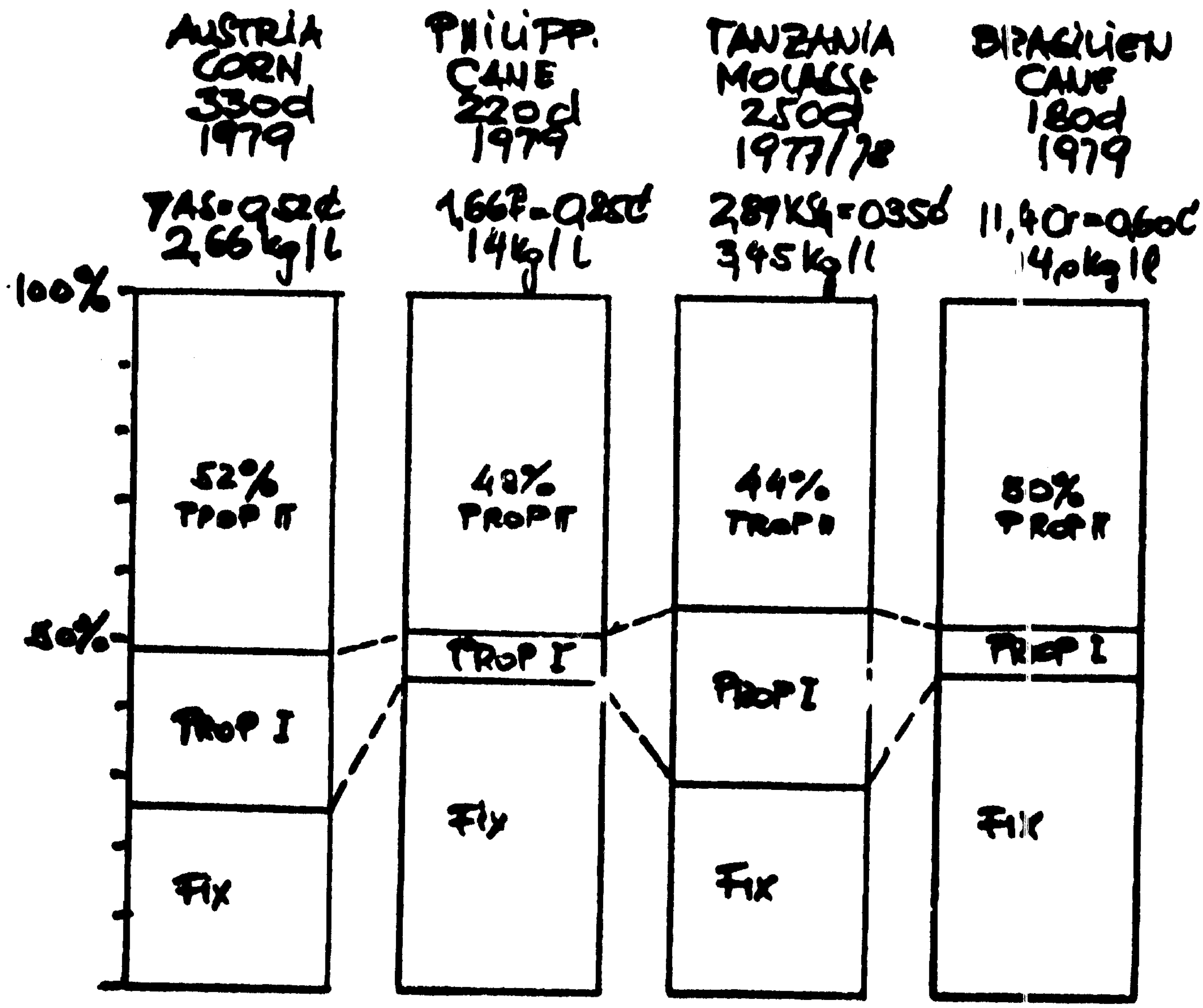
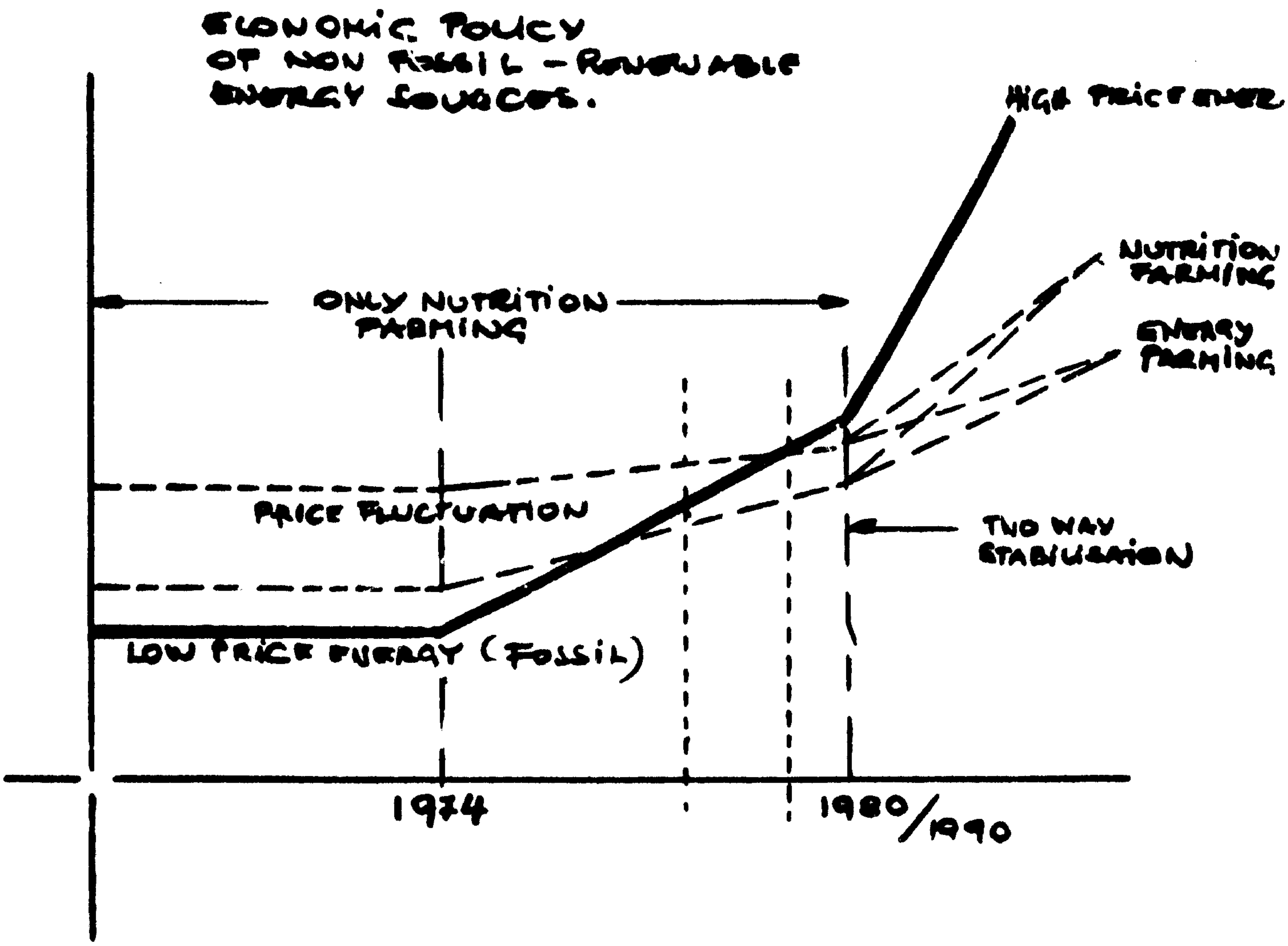

PROD. COSTS
PROP. COSTS II
PROP COSTS I
FIX COSTS
TRANSPORTATION
RAW MAT
ENERGY
PERSONNEL
ADMINISTRATION
DEPRECIATION
100%

Figure 1



BASIS FOR COMPARISON:
CAP: 120.000 l/d.

Figure 4


ECONOMIC POLICY
OF NON FOSSIL - RENEWABLE
ENERGY SOURCES.
HIGH PRICE ENER
NUTRITION FARMING
ONLY NUTRITION FARMING
ENERGY FARMING
PRICE FLUCTUATION
TWO WAY STABILISATION
LOW PRICE ENERGY (FOSSIL)
1974
1980/1990

FERMENTATION - SECOND WAY FOR UTILIZATION OF VEGETABLE SOURCES

The application of the technical microbiology to disclose new nutrition and energy sources is not only an alternative to the prevailing agricultural and industrial techniques, it is, as already stated several times on other occasions, a compelling necessity for the further development of our society, which is caused not only by the fact that the use of microorganisms brings an automatical combination of the problems of supply and removal and by this, gain of products from a real "cyclic process" with the sun as primary energy supplier.

Before I want to discuss briefly the ways of solution which are given for realization of these thoughts as well as the basic conditions, I generally want to state as introduction to the theme "energy alternative":

With the exception of the nuclear energy, the use of geothermic and the tides, all energy forms available today are based on the sun as primary energy supplier. (See Annex 1)

A considerable distinguishing mark of two groups of possible energy transformation is that one group is transformed towards utilization of kinetic energy forms (hydro-electric plants, wind-electric plants, heat collectors, solar cells and electrical energy resulting from them), whereas another group can be counted to the potential energy, i.e. energy storage resp. storable energy.

The biggest energy source which is still at our disposal represents the potential energy sources formed in the prehistory by solar energy, i.e. the fossile fuels: carbon, oil and gas which are used today.

The essential contribution of the plant to the future energy supply consists in the fact that, besides of the possible constant renewal of the plants, solar energy is stored in these plants, too, and that this solar energy can be transformed by the technical microbiology in aerobic or anaerobic processes to another potential energy form. This makes, similar to the carbohydrates, an energy form available which can be stored for a time as long as you wish. That means that the energy form gained from solar energy through the plants is, in its technical and technological spectrum of application, equal resp. similar to that of solid, liquid and gaseous conventional energy suppliers.

May I cite a paragraph from a paper by Prof. Schmidt from the Technical University Vienna as example of the dimensions of "advanced energy sources":

"The annual production of biogene dry substance on the world surface is estimated to be 160 milliard tons. Counting a medium calorific value of 18,4 kJ/kg, it corresponds to an energy quantity of about 3×10^{21} J per annum; assuming a possible utilization degree of 33 %, there results a usable energy quantity of about 10^{21} J per annum. This figure must be reduced by the energy value of direct and indirect food production, which is estimated to be about 4×10^{19} J per year, and the energy demand necessary for the production and processing of the biomass, amounting to about 50 % of the gross energy quantity. Therefore, the actual usable potential for energy supply is about 5×10^{20} J per year.

As comparison to this figure: The global energy consumption is about 2×10^{20} J per annum."

Annex 2 shows these figures in their quantitative relation for a better survey. From this graphic you can see that the utilization of the biomass is not only a possible, but also a realistic, if not the absolute solution.

As an actual example for the process technique I want to explain in more details the realization of power alcohol plants

a) using waste products as raw material

b) for energy production in so-called autonomous units.

A. Utilization of Waste Products resp. By-Products

The utilization of waste products by fermentation processes is put in the first line to show the simple combination of these technologies, which can be done without any special problems, in already existing plants of the agro-industry.

First of all, I want to state with all emphasis that the combination of biochemical processes in existing agro-industry complexes must be seen in all its technical and economic consequences not only from the point of energy production, but simultaneously from the point of environmental protection for even those existing plants. For this reason, you must not expect from this variant, neither such large energy quantities which have a decisive influence on the total energy balance of a country, nor an energy production with high efficiency. In spite of this, such units take within a plant or agro-complex a high position, because they close the recycling circuit of so-called "open plants". This high position is given not only from the point of kinetics or charge of environments, but finally such a plant represents also an economic factor under the condition that you consider all integrated aspects concerned.

Within the frame of the Brazilian alcohol programme, a large number of existing sugar mills were enlarged by such units, wehre the capacities of these units range from 60.000 to 600.000 l alcohol per day.

Another proof that this way is the right one is the fact that for example in Europe, recently a quite serious interest was shown to process the whey from dairies to power alcohol.

The energy balance of such plants will be discussed in detail in connection with the so-called autonomous plants.

B. Autonomous Plants

Quite another situation as described above you will find at the plants which are erected with the purpose of energy production. (On this place I only want to mention that the logical consequence to the unit for the energy production from plants is the energy plantation.) Such plants show also for the energy production a favourable economical situation which is still improved by the fact that in autonomous units all components of the plant are processed to final products without remainder. Autonomous plants are incorporated in existing agricultural structures resp. agricultural structures to be created,in such a way that not only full environmental protection is guaranteed, but that also by recovery of slops and ashes all mineral components for growth which are extracted from the soil by the plants, are recycled.

According to the experiences gained during the last years, we have developed standardized plants. The standard sizes of these plants are 120.000, 240.000, 360.000 and 480.000 l alcohol per day, whereby the conception of the plants allows an enlargement to these capacities step by step.

The dimensions of these plants, their combination into relative agricultural structures, their influence on the infrastructure of a country, bring not only for the economic system of single regions or countries positive social aspects of considerable importance. I do not think to be wrong saying that such plants can prepare the way for new social structures as well as structures of society aoutside of urban regions. Ladies and gentlemen, I take the liberty to demonstrate to you the level of technique of various types of power alcohol plants by means of some figures, graphics and pictures which are taken from concrete projects (details about the development of the power alcohol programme in Brazil are given on another occasion of this Workshop).

1. Energy balance of an autonomous <u>power alcohol plant</u>

In Annex 3 is compared the energy contents of the raw material with that of the single final products:

As raw material is used sugar cane, the considered final products are alcohol, feed stuff and fertilizer.

The necessary process energy is gained from bagasse. The balance shows that the process runs with surplus energy, that means that, besides of the mentioned final products, surplus energy is gained in form of electrical energy resp. process heat.

From the balance you can see that 50,2 % of the energy contents of the plants can be definitely gained, whereby 45,8 % of the total energy of the plants are produced in form of potential energy (37,6 % as fuel, 8,2 % as fertilizer and feed stuff) and 4,4 % of the total energy in form of kinetic energy (electricity resp. steam). See also Annex 4 and 5.

(In this energy balance we have shown also the figures of a non-autonomous plant. In these figures you will see some deviations which result from the fact that for the chosen example molasses is taken as raw material. With molasses, the fermentation process can be run with higher concentrations, the resulting higher alcohol concentration in the mash brings a reduction of the energy necessary for distillation, rectification, dehydration and evaporation of the slops. On the other hand, if no surplus steam is available from the existing sugar mill, a considerable quantity of energy in form of fuel stuff must be led to the process.

2. Structure of a power alcohol plant

As already mentioned, we have developed a modular principle for the erection of autonomous plants. This technique provides: a cane acceptance and crushing line which capacity can be doubled by adding another roll press so that the plant itself can be erected as twin-unit. This juice producing line is followed by a pre-concentration unit according to the capacity of a fully equipped crusher line. The fermentation is run continuously in a multi-tank system; these tanks are arranged in such a way that an enlargement to the desired capacity can be reached by adding another fermenter. Distillation, rectification and dehydration are designed as 120.000 l units and can be run, according to the capacity, in parallel operation. The same is valid for slops concentration and boiler station.

3. Pictures

The pictures according to Annex 6 show details and general views of various types of plants.

Summarizing I want to conclude the development on the field of power alcohol as follows:

The plants have reached by now a very high level of technique and operation safety. Numerous plants with 600.000 to 700.000 l alcohol production per day are already in operation. The energy balance resp. the efficiency of such plants is already so high that an economic "energy production" is possible. However, I would like to express my conviction that a further improvement of the efficiency can be reached to a limited extent by an increase of the yield, however in a large scale by reduction of the energy input which is the goal of our work. A further aim of our work is the utilization of other raw materials instead of sugar cane in autonomous plants with similar economical results, like the plant described. These raw materials are other sugar containing plants and starch plants, from the latter especially maize and cassava.

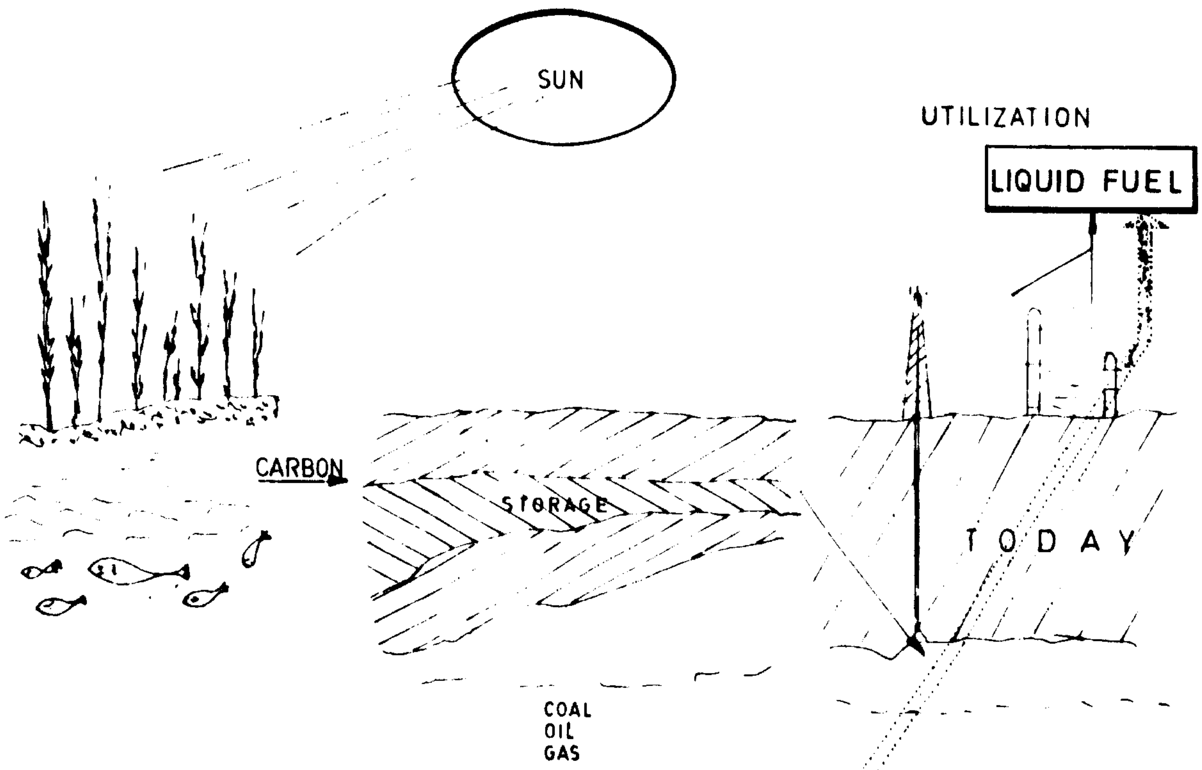
Besides of the utilization of sugar and starch containing "energy plants", another object of our works is the use of cellulose. The theoretical possibilities of the transformation of cellulose to pentose and hexose are known and can be (resp. have been realized in general also from the technical point of view). The work still to be done comprises the improvement of the economical aspects of these processes, especially the development of the hydrolysis process to a cyclic process where the agent used for the hydrolysis is used continuously in a closed circuit.

From our experiences we believe that the following timetable is realistic for the application of various raw materials for power alcohol production: During the next decade, the majority of these plants will be operated on sugar cane basis. Plants for utilization of starch will find a rising interest. We are sure that rhe application of hydrolysates cannot be expected in large scale in this period. With a high probability hydrolysis processes will be available first with highly concentrated acids and only then the development of a hydrolysis process with enzymes or a combined acid-enzymes process will be successfully concluded.

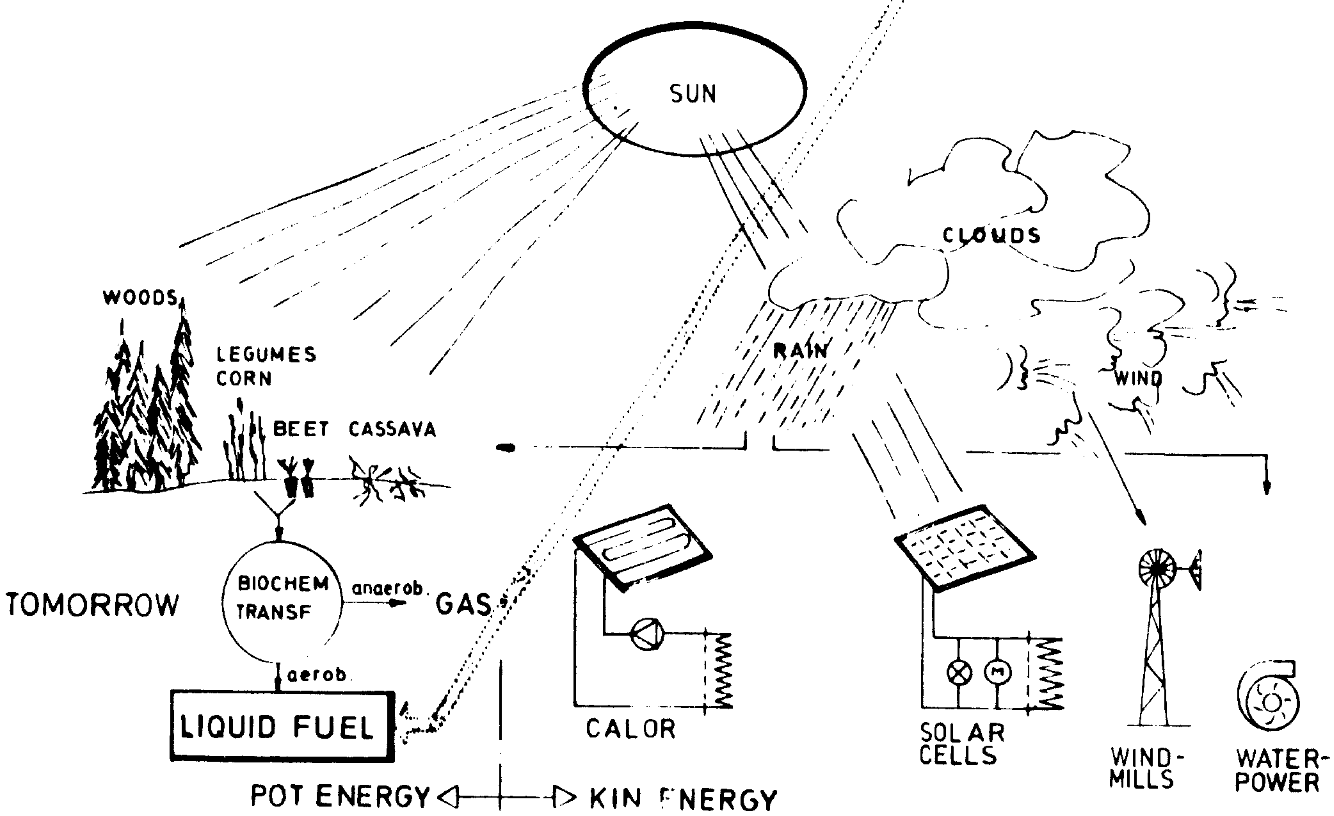
Annexes

Annex 1

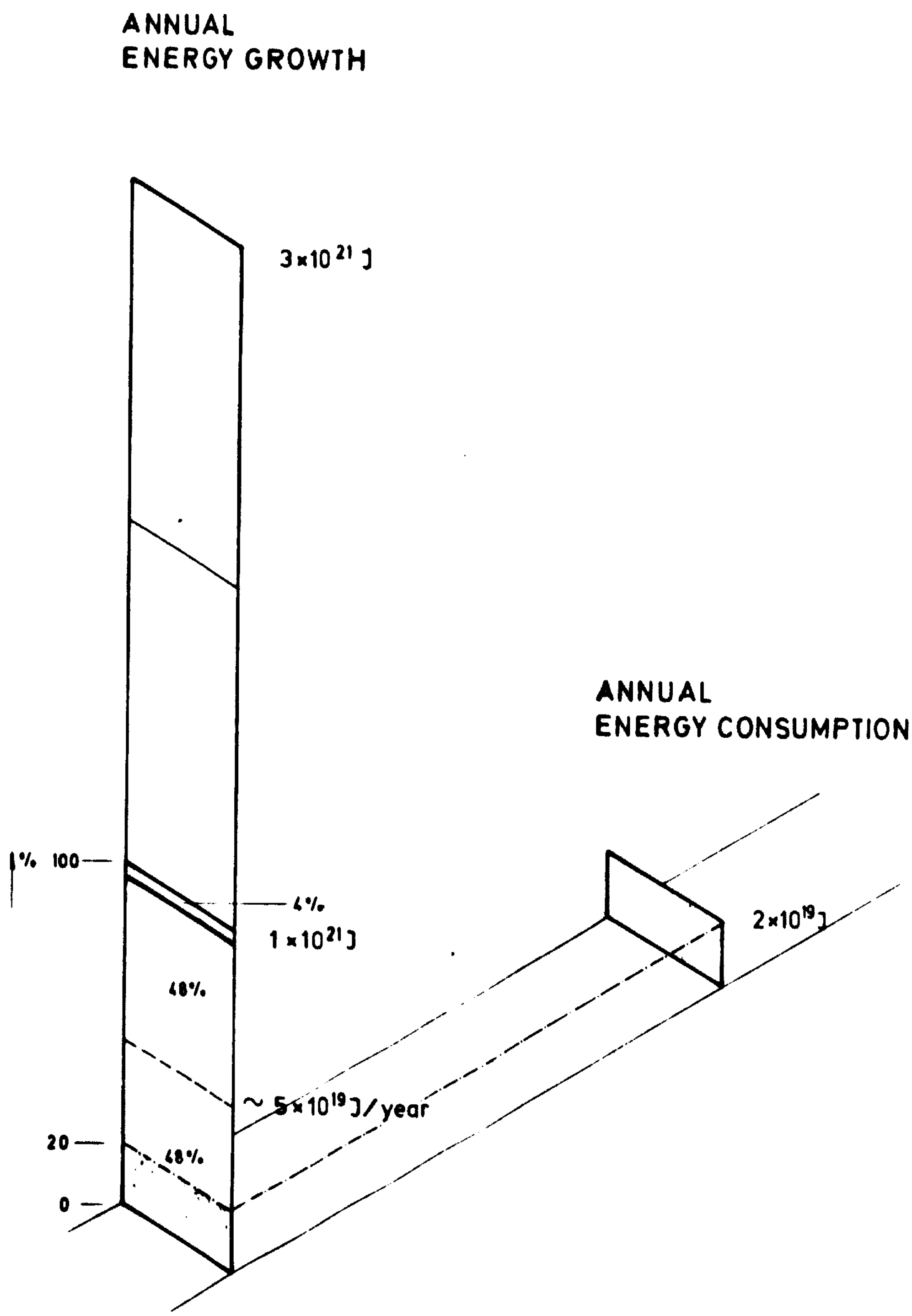
CONVENTIONAL ENERGY SOURCES



ADVANCED ENERGY SOURCES

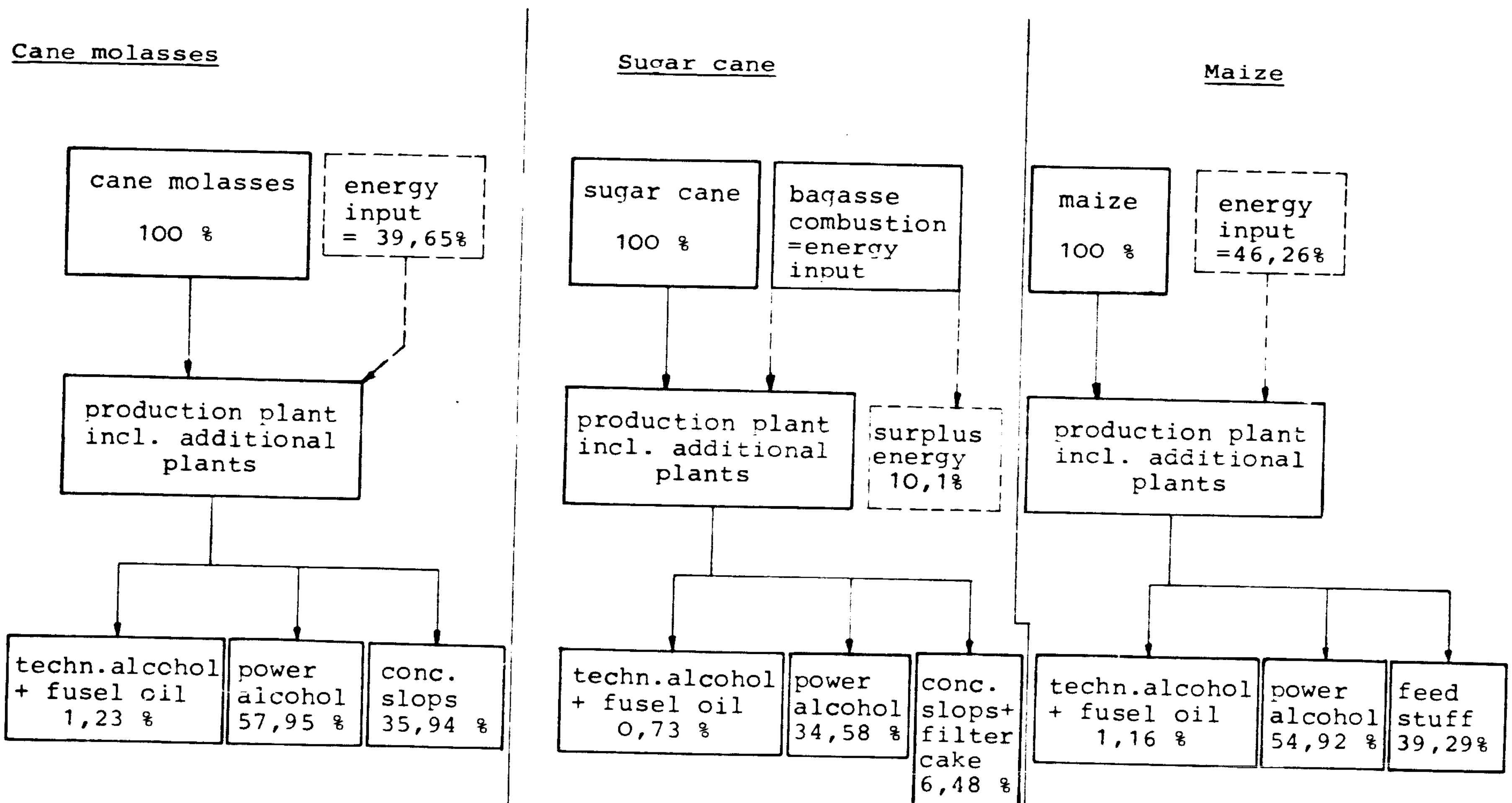


Annex 2


ANNUAL
ENERGY GROWTH
3×10^21 J
1% 100
4%
1×10^21 J
48%
~ 5×10^19 J/year
20
48%
0
ANNUAL
ENERGY CONSUMPTION
2×10^19 J

Annex 3

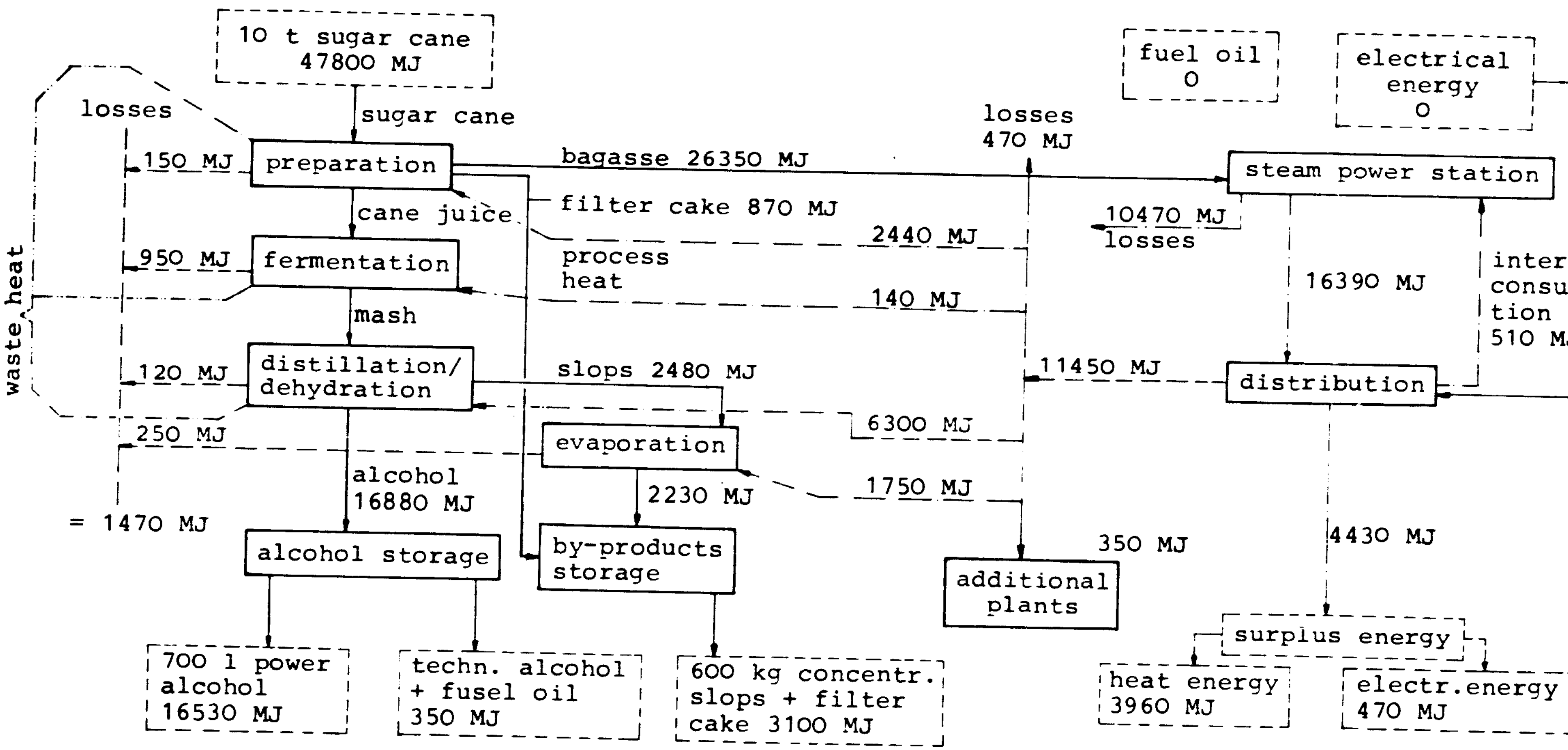
Energy Balance



Remarks:
1. All plants refer to the upper calorific value of the materials.
2. in normal process in the distillation/dehydration plant
3. a) cane molasses: concentrated slops with 58 % DMS
   b) sugar cane: concentrated slops (60 %) + filter cake (17 %), concentrated to 38 % ca. in total
   c) maize: feed stuff, concentrated to 40 % DMS

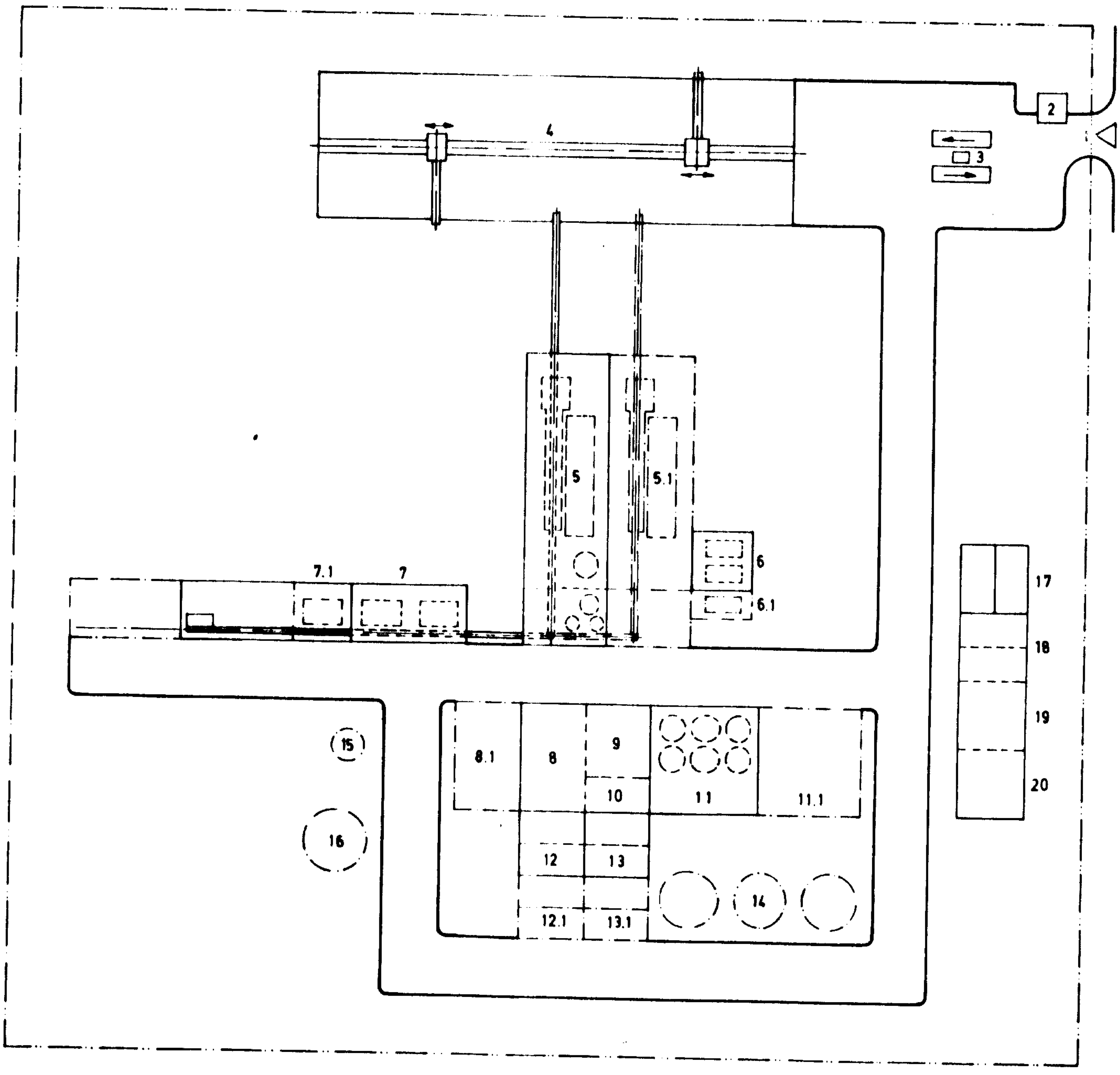
Annex 4

ENERGY BALANCE



Annex 5 a

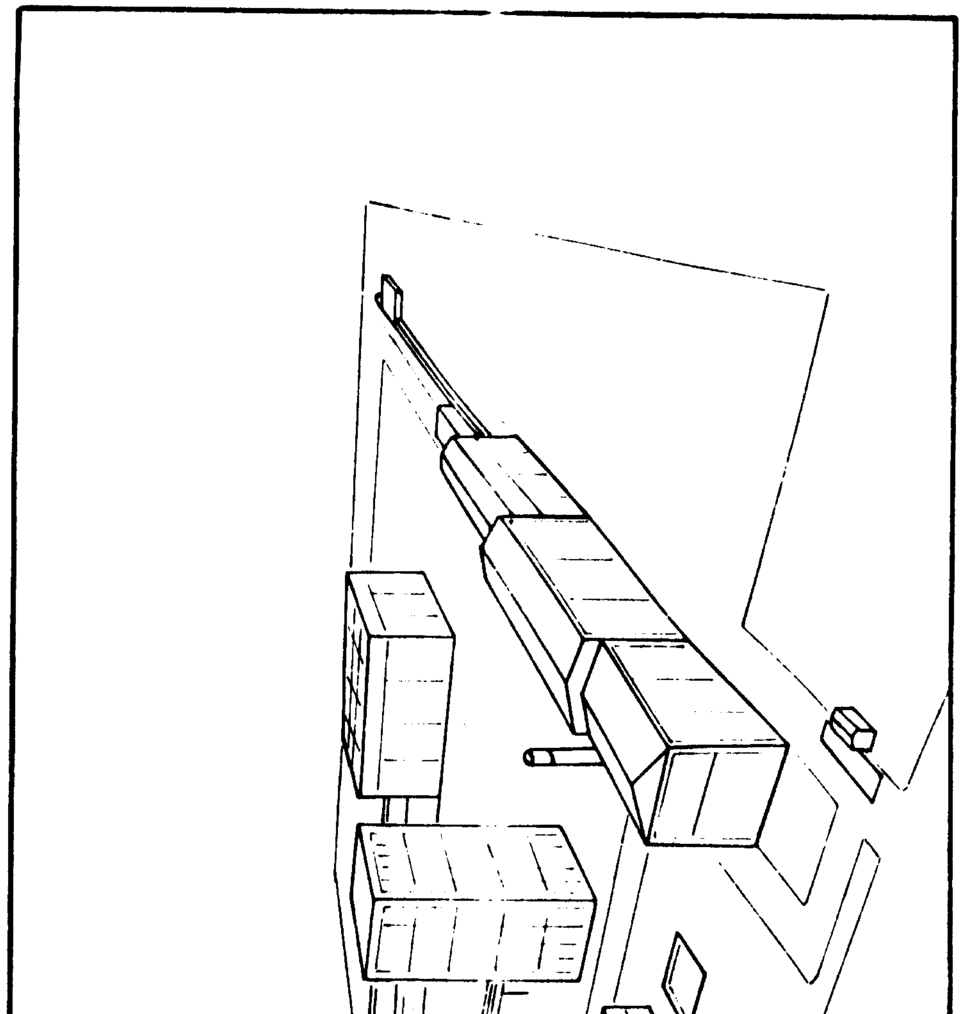
GENERAL LAY OUT



Legend

1 main entrance
2 porter
3 weigh bridges
4 acceptance of sugar cane
5 cane mill
5.1 extension
6 electric power station
6.1 extension
7 boiler
7.1 extension
8 juice treatment
8.1 extension
9 nutrients storage
10 machine room
11 fermentation station
11.1 extension
12 evaporation plant
12.1 extension
13 distillation plant
13.1 extension
14 alcohol tanks
15 fuel tanks
16 concentrated vinasse tank
17 administration
18 spare parts repairing shop
19 social and sanitary rooms
20 laboratory

Annex 5 b



General view

G-83

80.02.04