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CONSULTATIVE COMMITTEE

UNIDO

UNITED NATIONS

REPUBLIQUE FRANÇAISE

15795-E

(1 of 3)

ENERGY UTILIZATION OF AGRO-FOOD INDUSTRY BY-PRODUCTS

NOVEMBER 1984 - LILLE (FRANCE)

Part 1

SESSION REPORT

CONSULTATIVE COMMITTEE

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REPUBLIQUE FRANÇAISE

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NOVEMBER 1984 - LILLE (FRANCE)

Part 1

SESSION REPORT

A/B

This seminar has been made possible by the organization and active participation of:

- services of the United Nations Industrial Development Organization (UNIDO)
- the Ministry of Foreign Affairs (United Nations and International Organization Board) (France)
- the Ministry of Industry and Foreign Trade (France)

with the assistance of:

- the Regional Council of Nord-Pas-de-Calais (Lille)
- the Agence Française pour la Maîtrise de l'Energie (AFME) (French Agency for Energy Management)
- the Agence pour la Coopération Technique, Industrielle et Economique (ACTIM) (Technical, Industrial and Economic Cooperation Agency) (France)
- the Agence Nationale pour la Recupération et l'Elimination des Déchets (ANRED) (French Agency for the Recovery and Removal of Waste)
- the Centre Français du Commerce Extérieur (CFCE) (Foreign Trade Board)

The minutes of the proceedings of the seminar were written by Mrs Françoise Mas, AFME consultant, with the assistance of UNIDO's French office.

The foreword was written by Mr Yves Lambert of the AFME.

FOREWORD

The Consultative Committee on the use of agro-food by-products as sources of energy met in Lille (France) from 12 to 16 November 1984. Set up on the initiative of France and the United Nations Industrial Development Organization (UNIDO), this Committee was one of the first in the world to put into practice the recommendations of the Programme of Action laid down at the United Nations Conference on new and renewable energy sources, held in Nairobi in August 1981.

This meeting of the Consultative Committee had been planned since 1983 with the following theme: "Energy Utilization of Agro-food Industry By-products". The theme appeared the most fitting, given the need to embrace the transfer, adaptation and application of new technologies and to accelerate the use of biomass resources for the production of energy, without losing relevance for the largest possible number of less developed countries (LDCs).

Purpose

- to identify and promote those investment projects involving the conversion of agro-food by-products into energy for which earlier studies had demonstrated economic and technical advantages;

- to determine the possibility of carrying out feasibility studies into those of the projects mentioned above whose technical feasibility has been demonstrated by pilot plants;

- to determine the possibility of further development (process and installation studies) with a view to setting up demonstration plants in those areas where the industrial application of the techniques appears justifiable.

Preparation

In preparation for this meeting, France responded to the initiative of her Ministry of Foreign Affairs (United Nations and International Organizations Board) to seek the participation of representatives from various organizations:

- the Agence pour la Coopération Technique, Industrielle et Economique (ACTIM) (Technical, Industrial and Economic Cooperation Agency) (France)

- the Agence Française pour la Maîtrise de l'Energie (AFME) (French Agency for Energy Management)

- the Agence Nationale pour la Recupération et l'Elimination des Dechets (ANRED) (French Agency for the Recovery and Removal of Waste)

- the Centre Français du Commerce Extérieur (CFCE) (Foreign Trade Board)

- the Regional Council of Nord-Pas-de-Calais (Lille)

- the Ministry of Industry and Foreign Trade (France)

- the Cooperation and Development Board of the Ministry of Foreign Affairs.

UNIDO (Vienna) assisted in the preparation of this meeting through the very close collaboration of its Paris office. UNIDO took the responsibility of informing all Member States of the United Nations as to the theme and timing of the meeting, in an effort to gauge interest in the subject and to request preliminary details of the projects that might be of relevance to the Committee.

In this way it was possible to make a preliminary selection of some twenty countries and to discuss their projects or proposed projects with them. France and UNIDO sent representatives to most of these countries to make an overall survey of the projects, and to make a preliminary analysis of their technical and economic aspects.

At the same time, the AFME commissioned the French consultancy group, SEMA, to produce a summary report on the use of the various agro-food by-products as sources of energy

Participants

In an effort to combine discussion of these projects with a chance of arousing interest from potential contractors and financing institutions, the Committee invited the following three types of representative to take part in the meeting:

- overseas nationals with direct involvement in the project(s) presented by their countries; representatives of public-sector or private-sector industry or civil servants responsible for the development and promotion of the use of biomass as an energy source;

- representatives of French industry and financing institutions able to respond to the technical, economic and financial questions raised by project initiators;

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- representatives of official French organizations. UNIDO, other organizations of the United Nations, and the World Bank.

The Meeting

The Nord-Pas-de-Calais Region (France) offered to organize and to meet the costs of organizating the meeting, and to cover travel expenses for representatives from developing countries. The meeting of the Consultative Committee was held in Lille from 12 to 16 November 1984.

Presentations of the different technical subjects and of the projects themselves were of very high quality, and provided opportunities for the participants to meet each other and discuss the possibility of working together in various areas.

The Consultative Committee was the first Committee of its kind, and, through the active participation of representatives of the worlds of industry and finance, will have made it possible to sow the seeds of fruitful cooperation in the agro-food sector and in the use of by-products from agro-food industries as sources of energy. Indeed, alongside the plenary assemblies of the Committee, an exhibition was organized with the participation of about a dozen industries, and conference rooms were made available for smaller meetings.

Results

Summary reports dealing with the different conversion processes, examples of earlier projects and the potential of each by-product were distributed during the meeting and were later circulated more widely. These reports can now be updated as and when the projects initiated by the Consultative Committee materialize.

Indeed, several of the projects presented to the Consultative Committee are now nearing completion, as a result of bilateral or multilateral financing arragements.

The speeches given during the Lille seminar were of considerable interest, and, in accordance with the wishes of UNIDO, are reproduced below in the full minutes of the proceedings.

ABBREVIATIONS

ACTIM	Agence pour la Coopération Technique, Industrielle et Economique
AFME	Agence Française pour la Maîtrise de l'Energie
ANRED	Agence Nationale pour la Récupération et l'Elimination des Déchets
BFCE	Banque Française du Commerce Extérieur
BNP	Banque Nationale de Paris
CCCE	Caisse Centrale de Coopération Economique
CEA	Commissariat à l'Energie Atomique
CEEMAT	Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropicale
CEMAGREF	Centre du Machinisme en Génie Rural et des Eaux et Forêts
CFCE	Centre Français du Commerce Extérieur
CIRFI	Centre International de Recherche sur le Financement des Investissements dans les Pays en Développement
CTFT	Centre Technique Français Tropical
EDF	Electricité de France
EEC	European Economic Community
FAC	Fonds d'Aide et de Coopération
FAO	Food and Agricultural Organization
GEST	Groupe d'Echanges Scientifiques et Technologiques
IEMVT	Institut de Recherche sur l'Elevage et de Médecine Vétérinaire des Pays Tropicaux
INRA	Institut National de Recherche Agronomique
MRE	Ministère des Relations Extérieures (Ministry of Foreign Affairs)
NUOI	Direction des Nations Unies et des Organisations Internationales
NPC	Nord-Pas-de-Calais
UNIDO	United Nations Industrial Development Organization

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PART SIX: ECONOMIC AND FINANCIAL ASPECTS

INTRODUCTION

WELCOME AND OPENING SPEECH

by Mr Noël Josephe, Chairman of the Regional Council of Nord-Pas-de-Calais

Ladies and Gentlemen,

It is a great pleasure for me to welcome you to the Region of Nord-Pas-de-Calais and to Lille, capital of Flanders.

It is a great honor for me to open a meeting that brings together such a large number of eminent people from all over the world, from throughout the nation and from every corner of the region.

First I would like to offer an especially warm welcome to the 36 official representatives and delegates from overseas countries, some of whom have traveled great distances to be with us here today. Twenty of you are from Africa, 7 from South America, and 9 from Asia.

Leaders of the many countries that you represent (whose national flags are symbolically flying in this conference hall) are responsible for a large proportion of the population of our planet.

It is thus a great pleasure for me that your countries have accepted the invitation made jointly by France, UNIDO and the Nord-Pas-de-Calais Region to take part in this detailed discussion of a theme so vital as the role of energy in investment projects in the agro-food sector.

I would like to offer my sincerest thanks to you, and to your respective governments, to have come to our region to take part in this meeting.

I am also very conscious of the fact that several senior international civil servants have paid us the honor of being present at this meeting, and, in particular:

- Mr Larre, Director of the Industrial Office of the United Nations Environment Program;

- Mr Faidley, as representative of the United Nations Food and Agriculture Organization in Rome, who is in charge of coordination of the "Energy and Environment" program;

- Mr Hadj-Sadok, Director of New and Renewable Energy Sources at the United Nations in New York.

I would now like to thank the initiators and co-organizers of this event:

- Mr Pierret, Director of the United Nations and International Organizations Board at the French Ministry of Foreign Affairs, and Mr Biraud, Head of the Economic Division;

- UNIDO (Vienna), represented by Mr Maung, Director for the Chemicals Industry, and Mr Baum, Consultant and former Director for Energy and Raw Materials at the United Nations in New York;

- Messrs Jeanroy and Gonbert, Director and Deputy Director of UNIDO's office in France;

- Mr Lejeune, Deputy Director of the Agence pour la Coopération Technique, Industrielle et Economique (ACTIM);

- Mr Chartier, Scientific Director of the Agence Française pour la Maîtrise de l'Energie (AFME);

- Mr Mettelet, Deputy Director of the Agence Nationale pour la Récupération et l'Elimination des Déchets (ANRED).

I would also like to thank representatives of companies and financing institutions, and particularly those from the Nord-Pas-de-Calais Region, for their clear determination to take an active part in today's proceedings.

Might I finally take this opportunity of thanking the regional concillors and the many persons that have demonstrated their personal interest in this meeting by their presence at this opening session.

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To have been called upon to open this meeting of the Consultative Committee is thus a great personal honor, but it is also a great privilege for the region I represent. We feel privileged for two basic reasons:

- It is the first time that the Consultative Committee has organized a meeting with participants from several continents and in so doing it has taken on genuinely worldwide dimensions.

- It is also the first time that UNIDO and a national government have accepted the challenge of harnessing the vital force of a regional community to organize an event of this magnitude within that community.

I would like therefore to pay particular respects to the representatives of the French government and of UNIDO, and to thank them for having chosen the Nord-Pas-de-Calais Region to host, and, to a large extent, to organize this meeting of the Consultative Committee.

In response to such a show of confidence, the Regional Council and its various departments have, as you will no doubt be aware, left no stone unturned to ensure the success of this meeting. My personal feelings are that the far-reaching relevance of the meeting and the quality of its participants are already a guarantee of its success.

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When our region offered to organize this meeting, we did of course have a number of well-founded and objective arguments to put forward.

Our first attribute -- and the presence here today of a large number of company directors from the region is living proof of this -- is the fact that the Nord-Pas-de-Calais is one of France's very top regions in the agro-food sector. Our leading position in this sector is not only a result of our agricultural production, but also because of the quality and dynamism of our industrial companies and our engineering and service industries.

Secondly; the Nord-Pas-de-Calais Region has already enjoyed a close working relationship with the French office of UNIDO.

Here I am making particular reference to the work we have carried out with the delegates of various countries, for example from Senegal, who organized an official visit of elected representatives and representatives of regional industries in early 1984.

Finally, organizing the Consultative Committee meeting in Lille was an opportunity that the Regional Council intended to seize in an effort to make very considerable progress in two directions:

- Firstly, the strengthening of our collaboration with the French office of UNIDO. In this respect, I am delighted to see that the six delegates currently posted to the Paris office are among the overseas representatives we are welcoming today.

I cannot resist taking this opportunity to express my pleasure in welcoming the two delegates from the Peoples' Republic of China, and in pointing out that my pleasure is all the more acute for having led, hardly two weeks ago, an official visit to China of elected representatives, industrialists and engineers from the region, in order to sign the twinning charter with the municipality of Tianjin, and to consolidate cooperation agreements for the exploitation of its mineral resources.

- Secondly, this meeting is an opportunity for us to develop cooperation, and particularly industrial cooperation, between regional companies or organizations and partners in less developed countries.

In addition to the work that has been carried out by the region, mention should be made of the joint action that has been taken with Algeria, and, more recently, with Cameroon.

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Politically speaking, we wish to develop those of our activities that involve decentralized cooperation. These activities fit into a broader framework whose basic principles I should like to outline here.

The first point involves the coordination between cooperation in which the region intends to become involved, and the policy of international cooperation followed by central government.

The Regional Council's position in this respect is quite clear: the region should not compete with central government, but should either work in association with it, or, and in the majority of cases, act in an autonomous and complementary fashion.

In this area, our field of activities is vast.

As an institution, the region is particularly well prepared -- in terms of operational capabilities, for example -- to respond to the needs that are increasingly often expressed by communities in developing countries: regions, provinces, or large urban areas.

An adequate response can very often only be found through local partners such as chambers of commerce, companies, universities, research centers, specialized training institutes, etc.

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I would now like to discuss another side of the question, devoting rather more time to this aspect since it is likely to be of greater interest to the overseas representatives with us here today.

This aspect involves the cooperation policy of the Nord-Pas-de-Calais region, and more particularly its approach to development-related problems and its conception of its relationship with its overseas partners.

In a few moments Mr Pierret, Director of the United Nations and International Organizations Board at the Ministry of Foreign Affairs, is to outline the main features of France's international cooperation policy. I will thus restrict my comments to those points that seem to me to be essential.

How can a Regional Council such as ours -- and here I am referring to the political forces that make up the Council -- fail to identify with the sentiments expressed by the President of France at Cancun, and pledge unconditional support for the principles for action outlined by the Head of State on that occasion?

To illustrate this point, I should like simply to quote the closing words of that speech by Mr François Mitterand: "My conclusion is that as far as France is concerned, we must endeavor to bring more unity to this world of ours, while paying the closest repect to the diversity of its component parts."

In this respect also, the Regional Council's position is quite clear. I would like to use this opportunity to stress the fact that the Nord-Pas-de-Calais Regional Council has always considered this meeting of the Consultative Committee as an excellent chance to further the North-South dialog, in admittedly limited proportions, but in concrete terms and in the knowledge that it will serve as a valuable example for future action.

I would add that, by acting in this way, the region is conscious of following the path laid down by the United Nations Conference on new and renewable energy sources, held in Nairobi in August 1981. The region is eager to take this opportunity of contributing to the implementation of the guidelines set forth by that Conference.

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I would now like to mention our own conception of cooperation, particularly industrial cooperation, with our partners from overseas.

The mainstays of the policy of the Nord-Pas-de-Calais region in this respect are as follows:

- The Regional Council intends to call upon the participation of companies in the region in the support of new industrial projects by handling our partners' requests for:

  - professional training

  - adaptation of products and processes

  - support for industrial technology transfer.

- The region will give priority to those industrial projects that stress the importance of:

  - linking industry with agriculture

  - meeting local requirements

  - integrating the project in the relevant sector of activity.

- Finally, the Regional Council is motivated by two major concerns:

  - Industrial relationships must be mutually beneficial. Industrial policies must thus be profitable for the foreign country involved in any cooperation project, yet remain compatible with the interests of companies in the region.

  - Full importance must be attached to the integration of projects in genuine industrial development strategies based on the priority objectives of partner countries.

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At the beginning of my speech, I intentionally used a very powerful term -- "vital" -- to describe the theme of this seminar.

Indeed, here we have an exceptional opportunity of examining together the possible solutions to such basic problems as food, industrialization, and energy management, as well as the synergy that can exist between the various aspects of these solutions.

I can assure the overseas representatives here today that the French companies they will have the chance to meet and speak with -- and particularly those from the Nord-Pas-de-Calais region -- have in their midst some of the most competent and experienced experts in matters connected with energy management and the different techniques for using agro-food by-products as sources of energy.

I am personally very well aware -- as of course is the entire Nord-Pas-de-Calais region -- of the energy problem. For one year I chaired the government-sponsored Long Term Energy working party, and I was particularly struck by the very size of the stakes involved in this problem, from technological, industrial and economic viewpoints, but especially in its human dimension.

I am sure we will all agree on the importance of the the humanitarian aspects underlying the questions you are going to examine at this seminar.

Let me quote just one example: the problem of the use of woodfuel and the very rapid desertification of millions of hectares that it leads to. Thus, at this time, the very existence of millions of human beings is increasingly jeopardized by the need to meet even basic energy needs.

I have no hesitation in emphasizing the responsibility of rich and developed countries in the face of these dire problems of hunger and poverty.

My dearest wish is that we can, over the coming days, work together to pinpoint ways of establishing genuine food security throughout the world on a durable basis.

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I wish you a pleasant stay in Lille, a city full of life, as you will discover, that is more than ready to you offer you the warmest of welcomes.

I am convinced that this week will be extremely enriching for you, and will be a source of hope for the success of your respective projects.

I declare this meeting of the UNIDO Consultative Committee open.

SPEECH BY MR ALAIN PIERRET

Director, United Nations and International Organizations Board,
Ministry of Foreign Affairs (France)

Mr Chairman,

It is my honor, on behalf of the French government, to thank you for your region's generous welcome on this occasion. This seminar is one of the most original events ever organized by a Member State of the United Nations in conjunction with a specialized institution, with a view to consolidating solutions to a problem that concerns the countries of the North as well as countries of the South: the rational and efficient use of energy.

I would also like to thank representatives of the United Nations Industrial Development Organization, who will be able to explain in greater detail the reasons behind the choice of theme for this seminar, and who have been very closely involved in the preparation of this important occasion.

Finally, I wish to offer especial thanks to the participants that have come from all over the world to prove to us that energy problems concern each and every one of us, and to help us improve our understanding of their needs in this sector.

Ever since petroleum has ceased to be considered as an essential and sometimes almost exclusive source of energy, the mobilization of the resources required to implement projects and programs involving new and renewable energy sources has been one of the principal questions examined on various occasions at intergovernmental level.

The Nairobi meeting of the United Nations conference on new and renewable energy sources held in August 1981 was an opportunity to broach the subject and to lay down a Program of Action, the implementation of which has since been regularly reviewed by the Committee at its two-yearly meetings.

I should like to take this opportunity of outlining the standpoint that France has adopted on this matter of great concern to international organizations. I should also like to demonstrate to you the originality of the Consultative Committee that is meeting this week in your city. In this way, I shall indicate the directions that we feel ought to be taken to ensure the success of an energy management strategy within the broader context of industrial development.

One of the keystones of the Nairobi Program of Action was the need for national and regional planning initiative to attach priority to energy requirements by mobilizing existing financial resources as efficiently as possible, and by economizing both currency reserves and physical resources when availability is limited. Since the question concerns developing countries, a multilateral approach was clearly the most suitable response, and it was of particular interest to utilize the resources offered by United Nations Funds such as the UNDP and its special energy account. It will not, be possible, however, in the face of the continuing worldwide crisis we are experiencing, to generate significant levels of new resources. Nevertheless, the idea of North-South cooperation could be applied in concrete terms in this area through the transfer of knowhow and the improvement of resources already existing in a large number of countries.

France has naturally attached great importance to these principles, which have played a constant role in the formulation of her own policy on cooperation and development.

One of France's earliest projects in this respect was the Programme Sahel - Energies Nouvelles launched in 1976. Since then, national institutions such as the Fonds d'Aide et de Coopération, the Caisse Centrale de Coopération Economique and the Treasury Department itself have provided significant amounts of State aid.

At the present time, we are striving to master the energy problem in all its known dimensions. France has thus shown considerable interest in setting up energy projects in urban as well as rural areas, in Africa, Asia and Latin America, involving not only direct bilateral cooperation but also participation in the implementation of projects financed through multiple sources and by institutions with regional vocations such as the Asian Institute of Technology in Bangkok, whose solid reputation is now well proven.

It transpired, however, that existing models required lengthy and costly procedures and that they did not allow for sufficient accuracy in the identification of needs. Aiming to further the application of the Nairobi Program of Action, France took the initiative of proposing to organize consultative meetings at national level, regional level (as defined by the United Nations) and worldwide level. All competent bodies within the United Nations system were invited to take the necessary steps to offer effective assistance in preparing this original approach to joint action, and in ensuring the eventual success of this action.

The basic tenet of the Consultative Committee is the idea of technical assessment of needs and subsequent identification of priority projects. Consultative meetings are thus one of the essential stages in the process if mobilizing resources, and they aim to encourage joint action in order to promote and support programs linked to energy management.

The principal role of a Consultative Committee such as the committee that is meeting here is to bring those in charge of development in a wide selection of countries into contact with partners that are in a position to help them implement clearly defined projects.

Participation is voluntary. Everyone is free to participate, and it is for that reason that we can already gauge the success of this meeting by the very large number of delegates present. However, it will not be possible to accurately measure the success of the seminar until a year or two from now, when the projects discussed this week have materialized in concrete terms.

Although this Committee is meeting today in France, we should not lose sight of its regional and international context. The major contribution of the United Nations Industrial Development Organization and the knowledge this organization is offering to share with us will thus undoubtedly add a very tangible dimension to the debates that are to follow.

This process of mobilization of resources is equally original. Depending on the types of project and on the actual conditions under which each project is proposed, one can call upon bilateral or multilateral financing institutions, or else seek financing from the national resources of the countries that wish to put their new energy schemes into practice. Coordination of these various sources of financing will be a result of the contacts made this week or on subsequent occasions, as well as the resources of the countries involved.

I must again stress the fact that the Consultative Committee has not been set up for arbitrary reasons. On the contrary, it is the consequence of a consensus of opinion reached after lengthy reflection and is based on a wish to adopt a joint approach to shared problems and thereby reach valid results. The long preparation that has gone into this meeting is proof of the fact that this type of occasion cannot be improvised, and that its success depends on lengthy and detailed discussion. In this respect, visits by consultants have played a very positive role in shaping a considerable number of projects.

It is thus fair to hope that our Committee will reach constructive conclusions which can form the basis of action taken under the aegis of other organizations, particularly the United Nations Regional Economic Commissions, and which can lead to concrete results in terms of the industrialization of the Third World, in accordance with the spirit of the Lima Declaration and Plan of Action that marked UNIDO's Second General Conference in 1975.

The reflection undertaken by the Committee leads me to ask the following question: which directions should be given priority in the adoption of a strategy for the use of new sources of energy, and for energy management in general within the context of industrial development?

In our opinion, no policy on the use of energy resources can be successful unless it is part of an global energy planning program, and unless it is integrated into development projects. On this basis, it has transpired that agro-food industries constitute a privileged sector for a tangible approach to new and renewable energy sources.

Energy management must figure in all energy projects, whether they involve urban areas or rural areas. These projects can be linked to all manner of other projects, involving construction industries or the health sector, for example. A biomass strategy has already been laid down, and will be the subject of much of the debate that is to follow. This strategy is a good demonstration of the need to ensure transition in matters of energy. Similarly, the study of woodfuel and reforestation of village areas is an essential element of this strategy. France has appointed a coordinator of these various aspects of the problem, and has thereby demonstrated the interest she attaches to this development strategy.

The importance of training should also be emphasized. An especial effort is required in this area, and France has very extensive experience in the transfer of technology.

The financing of preliminary investments and technical assistance is already part of the responsibility of several bodies in the United Nations system, and it is for that reason that no new financial committment is needed to lay down a genuine energy management strategy. The proposals to promote investment through the creation of an energy subsidiary within the World Bank Organization were vigorously supported by my country, not only by relevant bodies at national level, but also by the President of the Republic himself at the North-South conference in Cancun.

In conclusion, as the Nairobi Program of Action emphasizes, it is first and foremost for individual countries to assume the major responsibility of developing their new and renewable energy sources and to mobilize their national savings to this effect.

I wish to thank you, Mr Chairman, for your kind attention to these few observations, and I would like to reiterate my sincere wish that this Consultative Committee may fulfil the expectations of all those who have been involved in its preparation, and that the subsequent report submitted to the United Nations Committee for New and Renewable Energy Sources may be considered as a fruitful and genuinely helpful contribution.

SPEECH BY MR MYNT MAUNG

Director for Industrial Development (Chemicals Industry), United Nations Industrial Development Organization (Vienna)

Mr Chairman, Ladies and Gentlemen,

On behalf of the Executive Director of UNIDO, Mr Abdel Rahman Khane, and on my own behalf, I should like to welcome you to this meeting of the Consultative Committee on energy production and the manufacture of by-products from industrial waste in the agro-food sector, organized by UNIDO in collaboration with the French government and with the assistance of the ACTIM, the AFME and the regional council of Nord-Pas-de-Calais.

I am very happy to be here in Lille and to have the opportunity of meeting you and making your acquaintance. This week's seminar is an exceptional occasion in that it is bringing together representatives of the French government, who are our hosts today, representatives of French organizations involved in the production of energy from biomass, and leaders of the Nord-Pas-de-Calais regional council, who have been kind enough to offer us the hospitality of their famous and historical city of Lille.

Present among us are delegates of very high standing from all over the world, and, if they have all arrived, thirty-three representatives of twenty-five developing countries. Also present are representatives of French industry specifically involved in the development and use of new techniques for producing and utilizing energy from biomass. We also welcome representatives from certain international development banks and other organizations within the United Nations. It is this breadth of interests that makes the meeting a unique gathering.

Before I embark upon the theme of this meeting of the Consultative Committee, I should like to say a few words about UNIDO and about our activities in the field of cooperation. For those of you who are unfamiliar with our organization, UNIDO is the United Nations Industrial Development Organization. Our headquarters are in Vienna, and, to date, we are still part of the United Nations headquarters in New York, although we are about to become an autonomous, specialized organization with the same status as the FAO in Rome or UNESCO in Paris.

UNIDO's mission as stated in its charter is to provide assistance to developing countries in their efforts to industrialize. One of the principal means of attaining this objective is through technical cooperation activities that we carry out at the request of the governments of developing countries. These activities involve cooperation projects, or technical assistance projects as they are sometimes called, and include the transfer of knowhow by individual experts or consultancy firms, training programs (in the form of grants or study leave arranged for professionals from the developing countries concerned, or in the form of group courses organized in those countries or abroad), and the supply of basic equipment ranging from laboratory supplies to small-scale pilot factories used for running experiments on new technical processes, and including test and quality control equipment.

In other words, our cooperation activities are based on the preliminary investment stage of projects. The financing needed for these cooperation activities comes from the United Nations Development Fund (UNDF), which supplies 70% of all the financing that UNIDO has available for this activity, the United Nations Industrial Development Fund (UNIDF) which was created after the Lima Conference and is made up of voluntary donations from donor States from the developed world as well as the developing world, the Special Industrial Services, the Regular Technical Assistance Program (PR Fund), and finally the Trust Fund, set up by certain developing countries for the provision by UNIDO of the technical assistance they require, and paid for by the beneficiary government.

I will speak again later about our technical cooperation activities, and will quote examples of the use of biomass as a source of energy. For the time being, however, I would like simply to point to two important features of these different sources of financing: it is always granted in the form of aid and not in the form of loans. This aid is always either in the form of contributions "in kind" or in hard currency, usually local currency, allocated by the State or by the public-sector organization involved in the technical cooperation project.

Aside from these technical cooperation activities, UNIDO implements an extensive program of investment promotion, about which Mr Jeanroy of the Investment Promotion Service will speak to you presently. In view of this program, we have set up a number of investment promotion offices in the capital cities of several industrialized countries, such as Paris, Brussels, Bonn, New York, Tokyo, and, more recently, Warsaw.

Let me now return to the theme of this seminar. The need for such a meeting of the Consultative Committee came to light during the Nairobi Conference on new and renewable energy sources held in August 1981, and it may be of use for me to remind you now of certain passages from the minutes of that meeting.

The United Nations Conference on new and renewable energy sources held in Nairobi in August 1981 accepted the idea that "the development of new and renewable energy sources involves a large number of different measures ranging from support actions, including the integration of new and renewable energy sources into general energy planning strategies at national level, and preliminary investments, to capital investment commitments for projects and programs.

"Support actions involve integrating new and renewable energy resources, among other things through the strengthening of the institutional infrastructure of the country concerned, the gathering of data, instruction and training, research, development, demonstration, etc., while preliminary investment includes feasibility studies, design programs, engineering, etc.

"Demand for financing for this type of action or activity is already considerable, and will increase in the coming years, particularly in response to the implementation of the Nairobi Program of Action.

"In addition to financing for support actions and preliminary investment activities, the promotion of capital investment financing for new and renewable energy sources in developing countries is of considerable importance."

Concerning the mobilization of the financial resources needed to implement the Nairobi Program of Action for the development of new and renewable energy sources, the Conference called for "prompt, specific action, in order to finance support actions and preliminary investment and investment activities outlined in the preparation program for projects."

The report of the Conference also specifies that "during the United Nations Conference on new and renewable energy sources held in Nairobi, several countries expressed their willingness to release additional resources to finance the development and utilization of new and renewable energy sources. In order to favor increased financing and to encourage joint financing of new and renewable energy sources, the Conference recommends that, at worldwide, regional or subregional level, multilateral and bilateral donors and the relevant beneficiary countries should, wherever appropriate, plan to hold consultative meetings aimed to facilitate concerted action in this field, while remaining aware of the need to avoid unnecessary repetition and taking full account of national plans and priorities. These consultative meetings should discuss priority areas as defined by the Nairobi Program of Action, and should involve in particular the financing of the promotion of research, demonstration and development of new and renewable energy sources."

To summarize, the theme of the meeting can be defined as follows:

- to identify and promote investment projects for the conversion into energy of agro-food by-products and waste and other usable substances, these projects having been shown to be technically and economically viable by earlier studies;

- to identify opportunities of carrying out feasibility studies (analysis of cost/socio-economic benefit) into the projects of the region concerned, when the technical feasibility has already been proven by a pilot or demonstration plant, or by a reliable development study;

- to identify opportunities for new development work, including process and design studies, and leading to the installation of pilot or demonstration plants in the area where the use of a technique that has been proven at industrial level seems promising.

We might have been too ambitious to expect so much from this meeting, but it is better to be too ambitious than not at all. We are all aware that it is very difficult to identify and prepare investment projects in the field of biomass-derived energy, when most of the capital earnings are generated by energy savings or by other advantages such as reduced pollution. The difficulty is not specific to this field, but exists as soon as industrial investment in developing countries is involved.

To illustrate this point, I would like to quote the reports of a number of international development aid and financing institutions. The Center for Industrial Development of the European Economic Commission (EEC) in Brussels has stated that "one of the main obstacles to industrial cooperation between the ACP countries (Africa-Caribbean-Pacific) and EEC industry is the lack of well documented industrial projects that are supported by the competent local public-sector or private-sector bodies. It is not always possible for the Industrial Development Center, with its relatively small staff, to visit the countries concerned in order to identify and consolidate projects."

Another example is provided by the conclusions of a working party examining the activities of the private sector in the Caribbean, where it is stressed that "the under-development of the private sector in the Caribbean was not a result of the lack of resources to finance the activities of the private sector, but rather of the absence of projects liable to attract such financing." There are many examples of this type, but I shall restrict myself to one further quotation, taken from the 1982 Annual Report of the Development Financing Corporation of the Netherlands (FMO), which points out that "this paradoxical situation, where a considerable need for financial resources exists alongside an abundance of those same resources, is chiefly the result of three problems. This became clear, for example, during the first consultative meeting on industrial financing held in Madrid in 1982 under the auspices of UNIDO. On that occasion, the attention of participants was drawn firstly to the major gap that exists in information on financing and investment opportunities between sources of financing on one hand and the State and industry on the other. The second problem is the lack of viable, well prepared investment projects. Development banks are clearly not prepared to finance projects that appear to be neither technically or economically viable, nor socially acceptable. The third problem that is commonly referred to is the serious insufficiency of the means available to cover political and economic risks."

The meeting of the Consultative Committee is not a customary exercise to promote investment, but rather a joint experience and a joint effort on the part of the French government and UNIDO to bring industrial investment projects to light and to raise the quality of such proposals in order to enhance their chances of finding financing.

We are convinced of the need from the very outset to bring together potential partners from developing countries and industrialized countries, in order to favor permanent dialog and allow for the preparation and financing of viable industrial projects that are to the advantage of all the parties involved.

I wish to stress the fact that this approach is just one of the ways of attempting to bring to light industrial investment projects in the relatively new field of supporting developing countries in their efforts to realize their full potential in the production and utilization of biomass-derived energy. If it is successful, it can be used again, when the time comes, with another group of countries, and with reduced expenditure in terms of both time and money.

As you know, we at the United Nations can only act as catalysts by bringing together the two parties concerned, and, if I may use another chemical metaphor, by setting off a reaction between potential partners in the developing countries on one hand and French industries and financing institutions on the other. Once it has been set off, I hope, this reaction will continue without us.

In conclusion, I should like to thank the French government, the ACTIM, the AFME and the authorities of the Nord-Pas-de-Calais region for agreeing to cooperate with UNIDO to organize this Consultative Committee meeting, and for their generous financial support without which this meeting could not have taken place. I am sure that the delegates from developing countries have come to make a large number of interesting propositions, and thus I propose that we all get down to work.

Thank you for your attention.

SPEECH BY MRS TERESINA MARTINET

Head of Department, Renewable Energy Sources and Rational Use of Energy, Ministry of Industry and Foreign Trade (France)

Mr Chairman, Ladies and Gentlemen,

On behalf of Mr Malvy, Secretary of State for Energy, and on my own behalf, I should like to say how happy I am to be present at this first meeting of the Consultative Committee on the use of agro-food by-products as sources of energy.

I should like to say a few words about the approach we wish to adopt with developing countries in this field.

As Mr Pierret reminded us in his speech, France at the Nairobi Conference, and again during the World Energy Conference in New Delhi, expressed a wish to set up the Consultative Committee on new and renewable energy sources, and has taken an active part in the organization of this seminar.

The Ministry of Industry and Foreign Trade, and the Secretary of State for Energy have a deepseated belief in the generalized necessity of increasing international cooperation through providing assistance to developing countries in the energy sector.

This financial and technological assistance aims -- in various different ways, depending on the local context -- to contribute to a durable increase in the independent energy capacity of developing countries. In terms of bilateral cooperation, energy is a priority sector if we are to respond to the wishes of those countries.

Objectives in this field are quite plain:

- Growth in demand must be palliated through the more rational use of available energy. This goal cannot be attained without energy planning and relevant training.

- All national energy resources must be used as quickly as possible. This objective involves the use of industrial waste from the agro-food sector, which is the field of competence of this Committee.

It would be a mistake to think that only heavily industrialized countries need to use their energy rationally. Indeed, if national energy resources are not sufficient to meet requirements, and if energy independence becomes a prerequisite for development, less industrialized countries should approach the energy question in exactly the same way.

France can contribute substantially to the achievement of these objectives.

Since the first oil shock in 1973, we have been forced to take action to reduce our own energy dependence.

This action has had positive results: by introducing energy-saving measures and developing national energy production, we have succeeded in increasing our energy independence from 22.5% in 1973 to close to 40% by September 1984. These results illustrate the steady progress we have made towards reaching our objectives, namely 50% independence by 1990.

The advances we have made in techniques and materials, and the experience of the past 10 years of research, development and application must be passed on, to save the developing countries precious time, and to allow our industries to utilize and adapt the knowhow they have succeeded in acquiring.

As an example, I should like to refer to the particularly encouraging results achieved in the wines and spirits and dairy sectors, agro-food industries that have managed to utilize their waste products in this way and have thereby witnessed a considerable reduction in their energy bills.

The principal results will be outlined in the presentations that are to follow, by representatives of agencies set up by the French government in order to implement this ambitious program. In the French plan, agro-food industries figure in the priority program N°5, and the dynamism they have demonstrated is an encouraging example for further action in energy management.

Energy problems encountered within France are clearly not the same as those faced by the developing countries. On the other hand, the problems encountered by our overseas departments and territories are more similar, since, in terms of climatic conditions and local resource availability, they have much in common with developing countries. Industry and government have worked intensively to solve the energy problems of these regions, by adapting technology as well as equipment and materials to these new conditions.

This experience, Ladies and Gentlemen, gives us grounds to believe that the capabilities we have acquired over the past 10 years are particularly applicable to the current problem, and we hope in this way to contribute to the successful use of local energy sources as a way meet the energy requirements of developing countries.

SPEECH BY MR GERARD BIRAUD

Head of Economic Section, United Nations and International Organizations Board, Ministry of Foreign Affairs (France)

Mr Chairman, Ladies and Gentlemen,

As head of the department that has directed the preparation of this seminar over the past 18 months, I can state that our concept of the meeting has been subject to continuous change and development, particularly under the influence of those who have worked towards the accomplishment of the task in hand.

Despite all these changes and developments, and despite the fact that we have a tight schedule, as you can see in your program of events, I personally feel that we are embarking today upon a kind of adventure.

As Mr Maung said earlier, "This is a unique gathering". It is the first of its kind; it is entirely new and original.

Before I attempt to define what this seminar is, or what we hope it will be, I should like to say -- and this is perhaps an easier task -- what it will not be:

- In spite of the presence here today of representatives of a large number of governments, this meeting is not an intergovernmental conference aiming to negotiate and adopt resolutions on "faits accomplis", since the areas we are dealing with are developing very rapidly. Neither are we aiming to reach a compromise between necessarily diverse interests. Although this meeting will give us the opportunity of enriching many areas of our scientific and technological culture, it is not a scientific congress, and we should not expect it to mark a decisive step in the progress of man's knowledge of techniques for the production of energy from agro-food by-products.

- Although it has brought together various suppliers of technology, particularly industrial companies and engineering firms, offering various promising projects (many of which are exhibited on the stands that you will be able to visit more fully over the coming days), this gathering is not a trade fair where each exhibitor attempts to show off his own goods while pretending to ignore the qualities of his neighbor's.

- Neither is it, as United Nations jargon would have it, a "pledging conference", that is, a conference where financial contributions are announced, and where the success of the conference is gauged by calculating the total financial committment and comparing it with the figures hoped for. A number of national and international banks and financing institutions are represented here today, but I am sure that they have not come to finalize any immediate committments.

- Neither is it a political meeting. Yet the presence of a number of personalities from the world of politics -- our Chairman and a number of elected representatives -- is a fair demonstration of the extent to which the subjects we will be debating together are of central importance -- as our Chairman Mr Josephe has pointed out so well -- both in terms of solidarity and in terms of the industrial development that is our common future.

If our Consultative Committee does not exactly fit any of the traditional categories of meeting, it nonetheless has something in common with all of them, and constitutes a class of its own that is the result of a lengthy process of evolution.

The idea of Consultative Committees was adopted by the Nairobi Conference on the basis of a concept of consultation that has been introduced to the United Nations system in a quite original manner by UNIDO itself. For several years now, this organization has at regular intervals selected various themes of discussion, and has invited industries, representatives of governments and of other organizations and associations involved in industry, from both industrialized countries and developing countries, to participate, with a view to promoting industrial projects and the industrialization of developing countries by identifying mutual fields of interest among participants.

My department wished to follow this model of a very open meeting aiming to favor the emergence of projects, and to apply it to the development of forms of energy whose viability has suddenly become apparent as a result of the massive price increases that have taken place over the past ten years, a viability we had tended to overlook in our countries in the 30 or 40 years since the war and the shortages it provoked.

However, we felt it was essential to avoid at all costs a repetition of the general statements on new and renewable energy sources that have already -- quite justifiably -- filled the columns of our magazines and been extensively covered by other media in the press and by speeches at other conferences.

With the full agreement of the UNIDO Secretariat, we have thus resolutely directed this meeting towards "the field", as it were. Agro-food industries, whose importance is of strategic importance in so many developing countries, particularly those with an energy deficiency, appeared to us to be a preferential area of application for energy production.

Mr Biraud then described how the seminar program had been drawn up with a view to combining discussion of two types of problem:

- technical processes of energy production

- agro-food processes.

This week's proceedings will include introductory presentations to clarify certain simple points of theory, in an effort to ensure a minimum level of basic understanding of the subjects under discussion, and in the knowledge that nobody can have in-depth knowledge of all the specialized fields concerned.

The other basic element of this week's proceedings will involve actual projects or proposed projects presented to us by representatives of developing countries. These projects constitute the theme of our meeting today. It is fair to hope that tomorrow they will be the tangible proof of the success of this week's proceedings.

The meeting will provide an opportunity for these representatives to meet the men and women involved in the industries that are developing and utilizing the equipment and processes we shall be discussing. They will also meet representatives of the regional, national and international financing institutions that can play an essential role in the realization of their projects..

The physical organization of this conference center and the timing of our agenda have been devised by our hosts in an effort to optimize contacts between French professionals and participants from developing countries. Each representative of French industry has been allotted a very short period of session time to introduce him- or herself, but the real discussions and contacts will clearly take place on a bilateral basis.

Mr Biraud then proceeded to introduce individual overseas participants.

Before closing, I should like, as head of the department that has directed the preparation of this seminar, to thank all those persons whose contribution has made this meeting possible:

- financial assistance, that has broadened the scope of the meeting far beyond our initial hopes;

- human, intellectual, organizational and material assistance, with everyone assuming their respective roles, without losing sight of the complementarity that was involved.

The basic tasks were shared by three organizations:

1) The Nord-Pas-de-Calais Regional Council, whose Chairman opened this meeting in such a perspicacious manner, was responsible for all the material and organizational aspects of the meeting, down to the minutest details upon which the success of such event depends. Here I would like to thank all those who have worked with and for the Regional Coucil and to congratulate our hosts on the exemplary way in which they have succeeded in arousing the interest and involvement of the professions concerned.

2) The ACTIM (Agence pour la Coopération Technique, Industrielle et Economique) was in charge of the administration and financial management of this event, and, in particular, worked with the Secretariat of UNIDO in the recruitment of participants from developing countries. The general mandate of the ACTIM is to organize contacts between French and overseas professionals in an effort to favor technical and industrial exchanges.

3) The AFME (Agence Française pour la Maîtrise de l'Energie) assumed the substantial and delicate responsibility of devising the technical program of this seminar. The AFME is responsible for research, development, demonstration and information related to areas covered by national and international energy policies, and is involved in energy management, the development of new and renewable energy sources and economies of raw materials.

   The ANRED (Agence Nationale pour la Récupération et l'Elimination des Déchets) has worked in association with the AFME. The ANRED is a State-run industrial and commercial organization operating under the supervision of the Minstries of Environment, Industry and Budget. Its mandate is to protect the environment from waste-related pollution, and to further economize raw materials and energy through the use of waste generated by producers and consumers.

In conclusion, I would like to stress the importance of the role played by the French office of UNIDO, in both the conception of the meeting and the choice -- which today seems to have been more judicious than ever -- of the Lille area as a venue for this event.

Finally, we thank the various French government agencies that have been willing to become involved in the team of organizers which we were called upon to direct.

SPEECH BY MR ANDRE LEJEUNE

Deputy Director, Agence pour la Coopération Technique, Industrielle et Economique (ACTIM)

Mr Chairman, Ladies and Gentlemen,

I will use the short time allotted to the organization which I represent to speak to you about the role played by that organization in the preparation of this meeting, and to give you a rough outline of the action that the ACTIM would be able to take to contribute to the tangible follow-up of the contacts that will be made throughout this week between future partners from France and overseas.

First of all, however, I would like to indicate briefly who or what we are. The ACTIM is a non-profit organization under the supervision of the Ministry of Finance and Budget and the Ministry of Industry and Foreign Trade. Its board of directors is made up of ministerial representatives (50%) and representatives elected by our 320 member companies (50%). We are represented in your countries by our embassies' trade consultants

Our goal is to organize contacts between French and overseas professionals in order to favor international exchanges of industrial technology. The ACTIM implements bilateral technical cooperation programs on behalf of its supervisory Ministries and participates in conjunction with the Ministry of Foreign Affairs in the implementation in France of the multilateral technical cooperation programs of a number of international organizations, including UNIDO.

Let me illustrate our activities with some statistical information:

- The ACTIM has existed since 1958. Since that time it has received more than 50,000 managers and specialists visiting France from abroad and sent more than 15,000 experts on detachment overseas.

- The agency has a staff of 200 in France.

- Its budget is in the order of FF 90 million.

The role played by the ACTIM in the organization of this meeting was as follows:

The ACTIM has been involved in the preparation, financing and organization of this Consultative Committee meeting, as part of its technical cooperation program.

For more than twenty years, at the request of the Ministry of Foreign Affairs, the ACTIM has acted as an executive and supervisory agency for the training programs undertaken in France by a number of specialized United Nations international organizations. This role has engendered a particularly close and amicable relationship with the industrial operations service of UNIDO.

It was thus in an atmosphere of close collaboration that overseas participants for this seminar were sought. Two parallel circuits were set up: UNIDO sent invitations to some thirty countries, while the ACTIM circularized our Embassies abroad in an effort to enable those persons most directly concerned by the themes of the meeting to liaise with the offices of the UNDF and local government agencies and take part in this seminar. At this stage, I would like to thank the Nord-Pas-de-Calais region, which has done everything in its power to approach the French companies concerned by the projects liable to be presented to the seminar in an effort to identify the overseas representatives that it would be of interest to have among us this week.

Through these concerted efforts, and thanks to the countries and institutions that have covered fully or in part the travel and living expenses of their representatives, we are happy to have a larger attendance than was initially expected. Further, we have great pleasure in welcoming among us delegates from UNIDO's Paris office, whose experience in industrial cooperation will be highly valuable if our work together is to be a success.

Those of you who have been in contact with the ACTIM over the past few weeks, either by letter or by telex, may have the impression that the ACTIM is a sort of travel agency, that has worked with varying degrees of efficiency depending on the ease with which you have obtained your preparatory dossier or tickets, or on whether you have been met at the airport or at your hotel. It is true that in the division of physical tasks among the French organizers, our role in the eyes of those of you who come from developing countries has been to a certain extent one of conference managers. This is an important role, and we are extremely eager to perform it as efficiently as possible. The ACTIM will be represented throughout the meeting, and, for some of you, in the days following the meeting also, as I had the opportunity of pointing out during the dinner of welcome offered by the region. Mrs Kremer, whom you already know, will be available to help you arrange your return to your respective countries.

Having mentioned these practical points, I should like to say a word about the technical cooperation activities in the energy field in which we are involved under the aegis of UNIDO and with the collaboration of the Ministry of Foreign Affairs and the AFME. Together we have organized for three consecutive years a seminar on energy management in the cement industry.

Within the same multilateral framework, a seminar is starting today in Metz on energy savings in the iron and steel industry. In the context of bilateral cooperation, a seminar is to be held in January 1985 with the collaboration of the Rhone-Alpes region, dealing with energy efficiency and the use of new energy sources in the agro-food industries of the Mediterranean countries.

I would like to make one incidental remark here to point out that the ACTIM has for a number of years put into practice a policy aimed to involve the regions of France, and has set up branch offices in the Rhone-Alpes region, the Midi-Pyrénées region and the Aquitaine region. I hope that this event, for which the Nord-Pas-de-Calais region has made outstanding efforts, will help strengthen the still sporadic links that we enjoy with your region, Mr Chairman.

To return to our activities in technical cooperation, I would like to quote the operations that have been carried out with the AFME and the ANRED in Central America, Cuba and Colombia, in the field of new energy sources, and the collection and processing of industrial and municipal waste.

These few examples illustrate the importance of energy problems in the programs implemented by the ACTIM, and consequently shed light on the role we could play in the follow-up to this seminar.

At this stage, I can say that the ACTIM is able to act in several different ways, and, provided it has obtained the agreement of its supervisory authorities, the ACTIM's action can contribute to the solution of various problems arising before or after the execution of a project.

Action to be taken before the project is implemented basically involves technical identification studies and other studies aimed to allow French and overseas partners to specify their industrial cooperation procedures more accurately. Action to be taken after the project is implemented includes the training of staff involved in industrial cooperation agreements.

We would like these activities to be integrated into the joint financing arrangements set up by international organizations, cooperation and development agencies, departments of the Ministry of Foreign Affairs, Technical Ministries and by the Nord-Pas-de-Calais region.

Be that as it may, if the technical opinion of the AFME or the ANRED is positive, the ACTIM will endeavour to deal with all your requests, whether they are from the countries represented here or from French companies, since we, like all the organizers, wish to see in the short and medium term, as many tangible results come out of this seminar as possible.

SPEECH BY MR PHILIPPE CHARTIER

Scientific Director, Agence Française pour la Maîtrise de l'Energie (AFME)

Mr Chairman, Overseas Representatives and Representatives of international organizations, Ladies and Gentlemen,

My first task is to give you a brief outline of the Agence Française pour la Maîtrise de l'Energie.

As you know, France is a country where everything of importance must exist in writing. Thus, the simplest way of explaining what the AFME is or does would be to summarize briefly what was written in its constitution when the agency was founded.

"The mandate of the Agence Française pour la Maîtrise de l'Energie is to implement the national energy management policy, that is, to handle all activities of research, development, demonstration and information in the energy sector. This mandate covers the rational use of energy, and new and renewable energy sources."

Another clause specifies the Agency's partipation, and in particular its financial participation, in the drawing up and implementation of international cooperation agreements.

The French government set up the institution in 1982, for three reasons, which I think it is important to mention here today.

- The first reason is that energy is by far the largest single factor in France's balance of trade deficit, representing in 1984 a total of 185 billion francs (20 billion dollars).

- The second reason is that our country has followed a new regional policy since 1982, and that the energy problem is central to this new policy.

- The third reason is that France follows an policy of active cooperation with the Third World, and that energy problems and how to solve them are important factors in this cooperation.

The technologies utilized by the Agency and the processes it seeks to promote (methanization, alcohol fermentation, combustion and gasification) are highly relevant to this seminar.

Rather than discuss each of these processes in detail, I would refer you to the concrete examples to be found in the technical dossier you have with your seminar documents, which provide a much clearer picture of our involvement in this sector.

However, I would like to devote some time to one of these processes: methane production. I have chosen to speak to you about this process because I consider it a good example of the contribution that biotechnology can make in the energy sector. Moreover, since the beginning of the oil crisis, I have been specifically interested -- in other capacities than that of scientific director of the AFME -- in the emergence of this new technology.

France has been deeply involved in this area since 1976. In 1983, 1984 and 1985, the AFME alone has spent 35 million francs ($4 million) on research into and assistance for the installation of the first industrial methanization units.

This constant and considerable involvement has made it possible, among other things, to produce a high-quality industrial product. I would like to mention the names of a number of industrial companies that have now reached a high enough standard to hold positions in the international market:

- AIR LIQUIDE, DEGREMONT and SGN in the agro-industrial sector;

- BERTIN, BIOMAGAZ and SATEC in the livestock waste sector;

- VALORGA in the household waste sector.

I should point out that since 1976 we have been working hand in hand with the ANRED, since these problems of methanization are closely related to pollution control as well as to the actual production of methane.

Not only have we managed to develop a high-quality industrial product, but we have also succeeded in setting up a technical and scientific evaluation network that is second to none in the world.

Here I wish to mention the Institut National de la Recherche Agronomique, and its Lille laboratory, which is most probably one of the world's leading applied research facilities working in the methane field, as well as professional institutions.

Another important point: I do not think that we at the AFME were in any way surprised at the decision to hold this seminar in the Nord-Pas-de-Calais region. The Nord-Pas-de-Calais region is one of the most dynamic of our regional partners, and it is certainly one of the most ready to accept new technologies.

Throughout this conference, you will be able to approach representatives of the Agence Française pour la Maîtrise de l'Energie, and in particular representatives of the internatioanl relations department directed by my colleague Mr Devin, and representatives of our Nord-Pas-de-Calais regional delegation, directed by Mr Radanne.

I should also like to take this opportunity to say that energy problems in industry, and in the agro-food sector in particular, will also be the subject of a major conference to be held in Paris from 20 - 22 November, where more than 150 industrial companies will be exhibiting their equipment.

As time is short, I will conclude this brief overview by wishing success to the projects that will undoubtedly materialize as a result of this meeting.

SPEECH BY MR MICHEL AFFHOLDER

Director, Agence Nationale pour la Récupération et l'Elimination des Déchets (ANRED)

The Agence Nationale pour la Récupération et l'Elimination des Déchets is, like the AFME, a public institution set up to implement government policy in its own field, namely, the field of waste.

This policy is based on two important concerns:

- protection of the environment;
- economic factors, involving the rational use of resources and the recovery of energy and raw materials from waste products that would be lost were these waste products to be discarded regardlessly.

I will simply quote a few figures to illustrate the Agency's activities.

About 100 persons currently work for the ANRED, of whom two-thirds are engineers and specialists.

The Agency has an annual budget of around 100 million francs.

Its mandate is to favor the recovery and removal of waste. It fulfils this role in several ways:

- Firstly, the Agency provides technical assistance to all parties wishing to combat waste problems, by suggesting solutions that involve producing less waste, making use of or recovering this waste, or, if this is impossible, removing the waste so as to reduce the negative effects it may have on the environment.

  With its team of specialists and its information and documentation center, the ANRED seeks to enhance knowledge of the field through its publications and expert advice.

- Secondly, the ANRED participates actively in actual projects -- not ordinary projects for the collection and processing of waste, but those projects that involve innovative techniques, and that involve technological risks or risks linked to the specific nature of the waste and to the market development of the raw materials which this waste is meant to replace.

The ANRED acts in close liaison with other public-sector establishments:

. the AFME, of course, in all areas involving the use of waste as energy sources and the recovery of raw materials from this waste, and, more recently,

. French regional authorities, with which the Agency has signed contracts for joint action in promoting the utilization of waste, or, failing which, the removal of this waste.

At international level, we have not as yet been involved to any significant extent. We are a relatively young establishment that has so far been working to achieve a level of competence at national level, and which has been involved in a large number of projects within France itself.

We have nonetheless begun to develop our international involvement, and have received representatives from abroad who have shown interest in France's activities in waste processing. We have provided these representatives with documentation and useful addresses, we have organized visits, and we are determined to further develop this aspect of our activity.

In conclusion, I would like to say that you will have the opportunity of meeting a number of ANRED representatives, who will be called upon to speak at various working sessions during this seminar.

NAME	POSITION	PROJECT
Mr Rosman Argentina	Vice President, Bank of Santa Fé SANTA FE	Production of alcohol from sugarcane in the Province of Santa Fé
Mr Trepp Bolivia	Project Director, Consultora Nacional (CONNAL SRL) LA PAZ	Production of fertilizers by anaerobic fermentation of agro-industrial waste
Mr Beltran Colombia	Director General, National Educational Foundation for the Development of Agriculture and Livestock Breeding BOGOTA	Pilot farm for integrated pig and cattle production using agricultural waste
Mr Konan David Ivory Coast	Technical Director, SODEPALM-PALMINDUSTRIE ABIDJAN	Installation of industrial prototype for biogas production from palm oil mill waste
Mr Traore Ivory Coast	Société Ivoirienne de Technologie Tropicale (I2T) ABIDJAN	Gasification plant operating on parchment coffee
Mr Sery Gale Ivory Coast	Director for Agro-food Industries, Ministry of Industry ABIDJAN	Utilization of wood waste in industry
Mrs Toka Djegba Ivory Coast	Directorate for Agricultural Planning and Modernization and Utilization of Agricultural Products and By-products, Ministry for Rural Development ABIDJAN	Production of energy (gas) from forest clearance by-products

NAME	POSITION	PROJECT
Mr Tutor Sanchez Cuba	Specialist in Project Analysis and Development, State Committee for Economic Collaboration CIUDAD DE LA HABABA	Production of biogas and organic fertilizers in livestock centers
Mr Pou Dominican Republic	Head of Technological Coordination Bureau, National Commission for Energy Planning (COERNER) SANTO DOMINGO	National "forestry farms" program for woodfuel production
Mr Khalek Egypt	Chairman and Chief Executive, United Group CAIRO	Urban waste treatment by composting
Mr Issembe Gabon	Deputy Director for Research, Ministry of Agriculture LIBREVILLE	Pilot plant for methanization of poultry droppings (electricity + incubator heating)
Mr Camara Guinea	Engineer, General Directorate for Agro-food Industries, Ministry of Agriculture CONAKRY	Utilization of sugarcane by-products (Koba)
Mr Singh India	Director, Bio-energy Division, Non-traditional Energy Sources Department, Ministry of Energy NEW DELHI	Utilization of bio-energy (by-products of rice, sugarcane, etc.)
Mr Soeriaatmadja Indonesia	National Coordinator, Biomass Energy Technologies, Aide at the Ministry of State for Population and the Environment JAKARTA	Utilization of by-products from the tapioca industry

NAME	POSITION	PROJECT
Mr Jones Kenya	Adviser on Energy Conservation and Fuel Oil Replacement, Ministry of Energy and Regional Development NAIROBI	Combustion of cashewnut shells
Mrs Razafindrakoto Madagascar	Head of Programming, Directorate for Programming and Financing, Ministry for Livestock and Animal Production, Water Resources and Forests ANTANANARIVO	Use of biogas at community level
Mr Rivet Mauritius	Principal Assistant Secretary, Ministry of Energy and Internal Communications PORT LOUIS	Electricity production from bagasse
Mr Baharunden Malaysia	Director, Raw Materials Processing Department, Federal Land Development Authority (FELDA) KUALA LUMPUR	Methanization of liquid waste from oil palm mills for electrification of rural areas
Mr Zabi Morocco	Secretary General, Comité de Développement des Energies Renouvelables (CDER) MARRAKECH	1) Methanization + composting of abattoir waste (Marrakech) 2) Methanization of slurry (SODEA farm near Marrakech) for electricity production
Mr Forte Mozambique	Chief Executive of the State-run company BOROR MAPUTO	Installation of gas generator-electricity generating units operating on coconut shells

NAME	POSITION	PROJECT
Mr Shah Pakistan	Technical Officer, Appropriate Technology Development Organization, Ministry of Science and Technology KARACHI	Biogas-compost project using livestock breeding waste
Mr Cisse Senegal	Director for Energy, Ministry for the Development of Industry and Craftmaking DAKAR	1) Incineration of household waste (Dakar) 2) Methanization of abattoir waste
Mr de Alwis Sri Lanka	Head of Agricultural Development Department, National Research and Development Center EKALA, JAELA	Production of coconut fiber briquettes
Mr Nindie Tanzania	Research Engineer, Energy Conservation Department, Organization for Industrial Research and Development DAR ES SALAAM	1) Pilot plant for ethanol production from sugar molasses 2) Reduction of deforestation by utilization of peat and improvement of charcoal ovens
Mrs Suvachittanont Thailand	Researcher, Energy Research Division, Thai Institute of Scientific and Technological Research (TISTR) BANGKOK	Demonstration plants for pyrolysis of rice husks
Mr Maherzi Tunisia	Directorate of Design and Development, Entreprise Tunisienne d'Activités Pétrolières (ETAP) TUNIS	Biogas production from animal excreta in poultry production

AGRO-FOOD INDUSTRIES AND THEIR BY-PRODUCTS

Summary report of speech delivered by Mr Vellaud
Head of Organic Waste Department, Agence Nationale pour la Récupération et l'Elimination des Déchets (ANRED)

1 - BY-PRODUCTS FROM AGRO-FOOD INDUSTRIES, AGRICULTURE AND LIVESTOCK BREEDING

Several categories of by-product must be distinguished before the technologies that should be adopted to utilize these by-products can be identified:

. Liquid effluent from agro-food industries contains not only organic matter and suspended solids of animal or vegetable origin, but also waste derived from the raw materials used by these industries (soil, etc), and, in certain cases, chemical substances.

Certain liquid by-products are generated by a component of the raw materials that is not utilized in the manufacture of the finished product: for example, whey accounts for 60 - 75% of the total weight of processed milk.

Livestock breeding produces liquid excreta (slurry) or solid excreta (manure) in considerable quantities: 2 billion tons in the United States, 1.7 billion tons in India, and 350 million tons in France.

Certain agro-food industries produce several categories of by-product from the same raw material. The sugarcane industry, for example, produces bagasse, mash, molasses, and, in some cases, slop. During harvesting, terminal clusters (tops) can also be collected for use in animal feeds.

. Harvesting residues and waste from the processing of crops include dry waste products with varying characteristics.

In cotton cultivation, for example, followed by the processing of seeds for production of cottonseed oil, various by-products are formed: bunch refuse (stalks), leaves, cotton dust, hulls and linters.

In the major rice-producing countries in Southern and South-East Asia, straw, husks and bran make up more than 300 million tons of rice-crop residues.

The coffee processing industry produces dry waste in the form of husks (12% water content) as well as pulp and mucilages (80% water), and there are thus various different methods of producing energy from these by-products.

These few examples of by-products from agro-food industries, crop production and livestock breeding demonstrate the basic characteristics of the substances under consideration:

- the waste is organic;

- very considerable quantities are involved;

- the substances are perishable and must thus be used quickly or stored (increased costs);

- storage is sometimes necessary because of seasonal production;

- water content is often high leading to drying and transportation problems;

- the waste is often scattered over a wide area (crops) and collection costs are thus considerable.

It is even more important to utilize by-products if their presence constitutes a serious pollution problem. Using chemical oxygen demand (COD)* as a measure of pollution, it has been calculated that in Malaysia, the leading producer of palm oil, untreated effluent from oil production plants causes 25% more pollution every day than the country's entire population of 13 million.

2 - ENERGY PRODUCTION FROM ORGANIC WASTE

Processes of energy production from by-products can be divided into two categories on the basis of the water content of these by-products. Dry processes are suitable for by-products with low water content, while wet processes are applicable to by-products with high water content.

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* Chemical oxygen demand (COD) is a measure of concentration and degree of oxidation of dry matter content.

2.1 - Dry processes

- Combustion with excess air (incineration) is the most common form of combustion, and was without doubt the earliest method of energy production to be adopted. The energy produced through incineration is generally converted into electricity, but it is also used directly as a heat source.

- Gasification, or combustion in controlled atmosphere, involves the conversion of a solid fuel into a gas (or occasionally into a liquid). The quality of the gas depends on the reagent gas that is used in its production (air, O_2, H_2, CO CO_2). The production of lean gas (with air as the reagent gas) is of particular interest to us here. Lean gas is utilized to produce heat or mechanical energy.

- Pyrolysis involves heating organic matter to high temperatures (500 to 100°C) over a period of several hours in an air-free environment. The process produces gas, burning oil and carbon black, but is relatively poorly suited to heterogenous substrates, such as by-products from agro-food industries.

- Carbonization in air-free environments is chiefly used to produce charcoal for domestic and industrial purposes.

- Conversion under pressure or 'hydrocarbonization' involves converting organic matter into burning oil or gas by subjecting it to high levels of temperature and pressure. To date, this process has not been used on waste products.

2.2 - Wet processes

- Methane fermentation makes it possible to convert organic matter into biogas composed chiefly of methane CH_4 (60 to 95%) and carbon dioxide CO_2 (5 to 40%). In simple terms, two populations of bacteria are involved in the process: acidogenic bacteria, which hydrolyze the organic matter into simple compounds, and methanogenic bacteria, which convert these compounds into methane.

  Several types of fermentation unit exist, with continuous or batch input of organic matter. These facilities produce biogas and a methanized substrate that must be dealt with either by manuring or by dumping after further aerobic purification.

Well managed methanization makes it possible to reduce pollution, generate electricity, and stabilize waste products (reduced odor).

Alcohol fermentation requires preliminary treatment of the lignocellulose or carbohydrate matter to free the carbon chains. The organic matter then undergoes enzymic hydrolysis to produce, in particular, fuel substitutes (gasohol).

The process of converting biomass into methanol (synthetic gas) cannot be classified as a wet process, and requires further research. This research is currently being carried out in a number of demonstration plants and will continue in further units currently under construction (bringing the total number of demonstration plants to around 10).

3 - OTHER USES OF BY-PRODUCTS

The use of agro-food waste products as sources of energy is the theme of this Committee. It should not be forgotten, however, that these by-products can be put to other uses:

- nutrition for animals or humans

- fertilizers and organic soil improvers.

Here I should like to stress the importance of each of these respective uses -- food, fertilizers and energy -- and the need for waste producers to compare the different uses before adopting the solution that is best suited to his particular case.

PART ONE

PROCESSING TECHNIQUES

Summary reports of speeches

METHANIZATION OF INDUSTRIAL WASTE IN THE AGRO-FOOD SECTOR

Summary report of speech delivered by Mr Dubourguier, Food Science Center, Institut National de la Recherche Agronomique (INRA Villeneuve d'Ascq)

1 - POLLUTION CONTROL BY METHANIZATION

Over the last decade, remarkable progress has been made in the anaerobic treatment of industrial waste in the agro-food sector.

Methanization as a means to reduce pollution has several distinct advantages over aerobic treatment:

- reduced energy expenditure;

- reduced sludge production;

- good maintenance of biological activity during prolonged periods of shut-down.

When sources of low-temperature heat are available, methanization can be used to recover 90 - 95% of the energy potential of organic matter. Despite very high levels of efficiency in removing carbon, methanization is most often used merely as a preliminary stage of pollution control. Organic nitrogen in particular continues to be present in the form of ammonia, and residue must either be spread as manure or reprocessed (aerated lagooning, activated sludge, etc.)

2 - THE METHANIZATION PROCESS

Complete methanization of organic matter requires the symbiotic association of three main types of bacteria: hydrolitic and fermentative, acetogenic, and methanogenic strictu sensu.

When waste matter contains significant proportions of insoluble cellulose compounds, polymer hydrolysis is a major problem since bacterial enzymes have little effect on these substances.

When handling liquid waste with low suspended solids content, the low rate of growth and biological activity of the acetogenic and methanogenic populations that must cohabit makes the process highly sensitive to excessive organic matter loading.

The use of methanization on an industrial scale is thus subject to the following conditions:

- The choice of technology must be well suited to the waste to be treated and the circumstances under which the plant is to operate. Industrial processes are continuous, and allow for high levels of concentration of methanogenic sludge to be maintained in the reactor, even when hydraulic residence time is very short.

- A balance must be maintained between acidogenic phase and methanogenic phase.

- The process must be seeded and started up correctly.

3 - TECHNIQUES

3.1 - First-generation techniques

These techniques are still in use, and include anaerobic lagooning, the mixer-digester, and the aerobic contact process.

Industrial experience gained over three years of operation of a 5,000 m3 digester installed in a vegetable canning plant has demonstrated the feasibility of the contact process with a maximum load of 4 kg COD/m3/day. Treatment efficiency is 85% for biogas production of 2.4 m3/m3/day (of which 55% is methane).

Nevertheless, recycling sludge by settling is of limited efficiency in summer periods. In the French sugar industry, the IRIS process is still employed. Maximum loads are between 2 and 4 kg COD/m3/day.

3.2 - Second-generation techniques

These techniques differ from first-generation techniques in that they allow for greater sludge retention efficiency. They are based on adhesion, trapping or granulation.

Methanogenic sludge concentration is such that loads can reach more than 10 kg COD/m3/day. To date, the anaerobic sludge blanket is the only form of this technique to have been introduced on an industrial scale. In sugar manufacture, loads of 8 kg COD/m3/day have produced 3 m3/m3/day of gas, with hydraulic residence times of less than 24 hours.

4 - CONCLUSION

Second-generation techniques open new horizons for the application of the methanization process. At this time, the most promising research involves the development of highly active biofilms, particularly in fluidized beds, which would make it possible to handle loads of more than 20 or 30 kg COD/m3/day.

COMBUSTION AND GASIFICATION

Summary of speech delivered by Mr Molle, Head of the Energy Division, CEMAGREF (Centre du Machinisme en Génie Rural et des Eaux et Forêts)

1 - INTRODUCTION

Biomass is not like any other fuel, even if it has been in use for thousands of years.

Firstly, importance should be attached to the high quality of biomass as a source of energy. It has a heat value of around 4,000 kcal, which is approximately half as much as that of petroleum products.

The first technical problem encountered with biomass is its high volatile matter content (volatile solids index). When volatile solids are given off (above a certain temperature in gasification and combustion), that process itself is exothermic and machinery is liable to clog and malfunction.

Ash poses another problem, since it fuses at relatively low temperatures and is liable to form clinker and clog equipment at operational temperatures in combustion or gasification.

The last disadvantage is not, in my opinion, a real problem. Agro-food waste often has high moisture content, but it is possible to reduce this content from 90 - 95% to 60 -70% by mechanical treatment before recovering heat at relatively low temperatures in the combustion and gasification process, which would make it possible to reduce the moisture content to the 20% needed with current systems.

Attention should also be paid to the very high chemical reactivity of biomass and to the near-total absence of sulfur.

2 - HEAT PRODUCTION

A wide variety of equipment exists in France today for burning biomass. Machinery can be categorized in terms of the particle size of the biomass with which they operate:

- The PILLARD burner for fine sawdust. Sawdust is an excellent fuel when burned in suspension in the same way as pulverized coal.

- The PILLARD kiln, used for biomass of rather larger particle size, such as pressed grape pomace, grape seeds, etc. The kiln has a separate chamber into which the biomass fuel is injected and where the flame develops vertically (top to bottom).

- The fluidized-bed gas generator (PILLARD and CREUSOT LOIRE). This equipment has the major advantage of being capable of burning both sawdust and paper briquettes. It can thus handle a wide range of particle sizes, but can only operate at high power levels (more than 10,000 th/hr).

A concrete example of heat production in the agro-food sector is provided by the Grand Manusclat project in the South of France, that has received subsidies from the Agence Française pour la Maîtrise de l'Energie. Under this project, elephant grass is burned in a gas generator to produce gas that is then burned to provide heating for glasshouses and for drying fodder.

This project is an example of a well integrated agro-food industry meeting energy needs as well as crop production requirements.

Technologies for heat production in agro-food industries exist for almost all situations.

3 - PRODUCTION OF MECHANICAL ENERGY

One of the oldest techniques for producing mechanical energy involves combustion, followed by the compression of steam, which is then decompressed in a turbine.

3.1 - The boiler/turbine technique

This conventional technique is used at high power levels, particularly by the world's sugarcane plants, as a means of disposal of bagasse, which is tremendously bulky. To date, however, the efficiency of this system has been poor, and investment costs have been high.

The appearance of new RATEAU steam turbine techniques which can be used in the 1 MW - 3 MW - 5 MW power range (high power levels for the production of mechanical energy), has brought down the power threshold for profitability of boiler/turbine systems. The first application of this technique was in a wood-fired power plant in the Philippines.

3.2 - The Gas generator/engine technique

For smaller units (a few hundred kW to a few MW) a series of techniques exist, that can be divided into two main categories:

- CREUSOT LOIRE gas generators (CEMAGREF license) operate on the principle of recycling gas so as to remove tar and keep gas clean at engine intake. This technology is being developed on granular biomass such as wood or coconut shells (1 MW pilot plant installed in Valenciennes, France).

  The motors used in the gas generator/engine technique are available from all manufacturers of diesel engines, that can operate on lean gas.

- Back-flow gas generators (used during the Second World War) are built by several manufacturers (CHEVET, PILLARD, etc.). These units are highly simple and must use substances with large particle size (to allow for gas circulation through the biomass). However, power levels cannot exceed 300 kW if problems of tar formation are to be avoided.

- Fluidized-bed gas generators with higher power levels are currently under development for use with engines, but further research is required despite the progress that has been made.

4 - UTILIZATION OF EXCESS BY-PRODUCTS

It is an extremely frequent occurrence, if not the general rule, for the quantity of waste available to be very considerably greater than the needs of the agro-food industry in question. What can be done in this situation?

One very widely used process is granulation. It should be pointed out, however, that any modification of the particle size of ligneous matter is a very long and difficult process.

4.1 - Granulation

Several types of press can be used to granulate ligneous biomass, including the following:

- Extrusion presses, producing compressed, cigar-shaped pieces of a few millimeters in length; these presses consume large quantities of energy and the extrusion dies wear rapidly.

- Ram presses can be used to obtain slightly larger pieces than extrusion presses, but costs are higher.

The fact that the substance to be treated is ligneous matter makes the process more difficult. It is thus relatively common to carbonize all this biomass, and to extract the charcoal dust from the gas by a simple cyclone process. Charcoal is not ligneous, and is thus easier to granulate.

Several types of granulation process can be suggested for this "vegetable charcoal":

- External worm-gear presses can be used to produce small balls of vegetable charcoal at a rate of 500 t/day (equivalent to 1,500 to 2,000 t/day of waste).

- Plate granulators mix vegetable charcoal dust and form round lumps with 3% binding agents. These lumps are fairly solid, but not sufficiently solid for use in gas generators, and they can be difficult to preserve.

- Extrusion presses for vegetable charcoal produce high-density pellets and consume less energy than extrusion presses for ligneous biomass.

In the future, charcoal is likely to be far more widely used throughout the world than it is at present: for low power requirements, the use of charcoal makes it possible to reduce investments and maintenance requirements considerably.

4.2 - Carbonization

As we have seen, it is more profitable in certain cases to use biomass in the form of charcoal. However, we have not discussed the ways in which charcoal can be obtained. This technology will be discussed in greater detail later, but I should like to mention it to you briefly here.

- The traditional method of charcoal production is carbonization in charcoal stacks or pits, which is not a very efficient process.

- A more recent method involves the use of vertical, cylindrical kilns, where wood is introduced at the top, and the charcoal recoverd at the base, with reverse-flow circulation of gases. This solution reduces wood consumption considerably.

- A new technology developed by CREUSOT LOIRE makes it possible to carbonize substances with large particle sizes, and at the same time to reduce the size of the charcoal units.

- PILLARD has developed a horizontal rotary kiln for producing charcoal dust from palm-nut shells, cotton hulls, coffee husks, groundnut shells, rice husks, bagasse, etc.

CONCLUSION

In conclusion, I should like to make a remark about the possible future uses of this waste.

Research is underway into the removal technologies for ash contained in vegetable charcoal, one-half of this ash occurring in the form of calcite. Removal of this ash would make it possible to produce low-ash charcoal (0.3 - 0.5% ash) which could then be used directly in motors.

ALCOHOL FERMENTATION

Summary report of speech delivered by Mr Cagnot of SEMA Energie

1 - BREAKDOWN OF EXPERIENCE ABROAD

To date, priority has been given to gasohol programs with favorable technical and economic results, carried out in the following areas:

- remote regions:
  - . completely landlocked countries, such as Zimbabwe, Malawi and Paraguay
  - . large countries with areas at least 1,000 km from the coast, such as Brazil, where the possibility of exporting molasses is low, and the cost of importing petroleum products is high;
- countries with a strong wish to achieve energy self-sufficiency through the use of extensive domestic sugar resources (Brazil, Philippines, Kenya, etc.) but where economic results of programs are more variable and where macroeconomic or socio-political factors constitute part of the justification for a program, alongside the basic criterion of remoteness, which is a microeconomic aspect.

Projects that are likely to develop in the short term underscore these criteria: Mali, Zimbabwe, East Zaire. All these programs operate on molasses from sugar production, or, as is the case in Brazil, also on sugar juice. Programs operating on molasses from sugar production have so far produced the best results, in that they are extensions of the sugar production process itself and do not have to integrate all the costs of an independent industrial project. The use of cassava is currently being examined, in an aim to ensure operation of the facility outside the sugar season (for example in Malawi), but research is not yet complete.

Today, the principal means of using the alcohol is still in the form of 10 - 25% anhydrous alcohol mixed with gasoline. Other major uses include hydrous alcohol used directly in special engines and 1 - 4% anhydrous alcohol mixed with diesel oil. These uses are fairly well developed, but a number of specific difficulties still exist.

The main problems, aside from the need for a favorable local context, are linked to the difficulties that arise during the start-up period.

2 - COST BREAKDOWN OF A STANDARD GASOHOL PROJECT

If a gasohol project is to be an overall success, the cost price of ethanol must be lower or only slightly higher than the pre-tax cost price of conventional fuels. The existing distribution network must also overcome certain problems linked to tolerance of the new product.

Analysis of a standard cost breakdown sheds light on two types of key factor:

- factors directly linked to the scale of the project: distillery investments, selling price of molasses;

- factors linked to local conditions: cost of local imports of conventional fuels, local utility price of molasses, links between sugar facility and distillery, the capacity to overcome problems encountered with the new product, alcohol transportation costs, etc.

Other factors can help optimize the program, especially if the price of ethanol is close to that of imported fuels: technical design of the distillation unit and means of financing and management.

3 - MAIN SOLUTIONS FOR THE DESIGN OF A DISTILLATION UNIT

The choice of technical options is based on several objectives:

- to minimize cost price of ethanol by maximizing production capacity and reducing investment;

- to match the product to the needs of the market, by selecting a realistic range of production;

- to adopt simple technical solutions that are suited to a small distillery located in a remote area (robust design, easy operation and low maintenance);

- to treat waste by selecting a process for utilizing slop that is suited to local conditions.

These objectives make it possible to optimize, in particular:

. links between sugar facility and distillery;

. degree of instrumentation of the unit;

. production period.

4 - CASE STUDY

A study was led by two teams from the SEMA group into a alcohol fuel project in the Rwanda-Burundi-East Zaire region.

4.1 - Objective

The objective of the project is to replace a proportion of imported automobile fuel with ethyl alcohol.

Raw materials used in this project are molasses from sugar production (current production: 4,000 tons). Ninety percent of the molasses are not re-used and are dumped in Lake Tanganyika.

After modifications are made to the sugar production facility, yearly production will be 11,500 tons, which will allow for production of 32,000 hectoliters of ethanol per year (200 hectoliters per day).

4.2 - Location

The region chosen for the project is highly suitable, since it is particularly remote: it is located at the same distance (2,000 km) from the two ports handling petroleum imports, and from the two existing refineries.

The project thus has a key economic advantage: distance.

4.3 - Project costs

The breakdown of costs that establish the price of the ethanol produced includes two major items:

- Distillation costs, representing 93% of the total costs of the project (investment, purchases of molasses, other inputs, purchases of energy, labor, etc.);

- Subsequent blending, distribution and transportation of alcohol and alcohol fuel, representing 7% of total costs.

In view of this breakdown, the following factors must subsist:

- low purchase price for molasses;
- low investment;
- rationalization of other operational parameters;
- optimization of alcohol transportation-utilization system;
- high cost of petroleum products.

Under this project, low-price molasses can be obtained because there is no local market of any interest: the region is too remote to export these products.

Investment, however, cannot be reduced, since the two solutions that would have made this possible cannot be put into practice:

1) It is impossible to maximize capacity because no further raw materials are available.
2) Reducing investment costs for a given level of annual production by producing alcohol throughout the year (and not only during the sugar season) is not a profitable solution.

To rationalize the other parameters of production, it is preferable to adopt lagooning rather than methanization as a method of waste treatment, and to optimize the range of production (alcohol fuel and industrial alcohol) to maximize added value.

To optimize the alcohol transportation-utilization system, it was decided to opt for production of anhydrous alcohol (99.3% alcohol) that can be blended (10 - 25%) with gasoline and used in regular gasoline engines without modification. The complete technical infrastructure required to use unblended hydrous alcohol in special engines led us to reject this solution.

4.4 - Conclusion

The results of the cost breakdown are as follows:

Cost price of alcohol is between $29 and $35 per hectoliter (depending on variables) against gasoline costs at depot of $45 to $55.

These price levels are equivalent to an average saving of 18 - 21%, i.e., 36 - 42% of gasoline prices at depot and yearly savings of $570,000 - $670,000.

Foreign currency savings are also extremely high, representing 25% of the overall investment of $3,750,000, i.e., 45% of the foreign currency component of this investment.

CARBONIZATION AND DENSIFICATION

Summary report of speech delivered by Mr Vaing, Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropicale (CEEMAT)

Despite the measures that have been taken by certain industries in the agro-food sector to utilize their own waste products, large quantities of these by-products are still available. If these substances are left untreated and dumped, they will decompose or, worse, remain as a source of pollution. In rice production, for example, only 20% of the rice husks (the industy's principal by-product) are re-used by the industry.

It is thus appropriate to collect available waste and process it to form stable fuels that can be stored easily and used at a later date in standard incineration or gasification units.

Two solutions can be examined:

- Carbonization, to produce charcoal with high lower heat value (LHV = 7,500 kcal/kg). Charcoal can then be used either in combustion or in gasification, but only 50% of the potential energy in the untreated waste can be recovered.

- Densification by compression, allowing for reduction in volume of the untreated waste: the LVH of the densified product is at least as high as uncompressed biomass, and can reach as much as 3,500 kcal/kg.

1 - TYPES OF CARBONIZATION EQUIPMENT

1.1 - Industrial charcoal kiln (Bonnechaux system kiln by Carbo-France)

This equipment is used for substances with similar characteristics to branches of woodland trees. Depending on the model, 4 - 8 stacked cubic meters of raw material can be converted into 200 - 400 kg of charcoal.

These units are mentioned for guidance only, since they appear unsuitable for most agricultural waste with small particle sizes.

1.2 - Carbonization vessel for cotton stalks (designed and developed by the CEEMAT)

This vessel has been tested with crushed cotton stalks, shrubbery collected in undergrowth, vine tendrils, and maize cob cores.

The vessel is cylindrical and has a volume of 1.5 m3. It can hold 150 kg of raw materials, which will produce 36 kg of charcoal, 2 kg of fines and 0.5 kg of ash. Energy efficiency is around 50%.

The carbonization process lasts about 4 hours, but 10 hours are needed for the equipment to cool before the vessel can be refilled. The unit can be disassembled and transported and has proved to be highly practical for small-scale/individual use.

1.3 - Equipment for converting straw into granulated charcoal

The CEMAGREF (Centre National du Machinisme Agricole, du Génie Rural, des Eaux et Forêts) has designed and developed a process and equipment allowing for easy production of balls of charcoal from straw.

This process has two phases:

- A carbonization phase that is specially designed to handle this low-density, small-particle material;

- Crushing of charcoal followed by briquetting with 2 - 3% binding agent in a rotary drum with low energy consumption.

The equipment produces balls or lumps of 2 - 4 cm in diameter, with a higher heat value (HHV) of 7,500 kcal/kg. The product behaves in the same way as standard charcoal when used in combustion or gasification units.

2 - TYPES OF DENSIFICATION PROCESS AND EQUIPMENT

Densification of products has economic advantages (reduced cost of transportation, handling and storage) and technical advantages (improved performance of equipment that uses the end product).

The following factors must be taken into account in the densification of agricultural waste products:

- level of compression to which product is subjected;

- characteristics of product to be treated (crushed/uncrushed, dried, etc.);

- the use of binding agents (cold process with binding agent, hot process without binding agent);

- type of equipment used:

  . briquetting by compression in a dual-roller system;

  . pelletizing by compression in molds;

  . extrusion by pressing through openings with specific dimensions and shape;

  . pelletizing in a rotary drum;

- physical characteristics of the finished product (particle size, density, moisture content, heat value, etc.).

A large number of manufacturers have developed compression equipment as well as complete fixed or mobile densification units with hourly throughput of between a few hundred kilograms and several tons.

We have tested various types of equipment, and can mention the following:

- 100 - 500 kg/hr range:

  . SACME-MIRBO presses

  . SERMIE presses

  . HUMUS presses;

- > 500 kg/hr range:

  . ALSA MECA fixed units from the Société Industrielle des Forges de Strasbourg;

  . fixed or mobile units from PROMILL.

We believe that densification equipment producing 250 - 500 kg/hr is suited to the socio-economic conditions of certain developing countries.

PART TWO:

APPLICATIONS INVOLVING INDUSTRIAL BY-PRODUCTS IN THE AGRO-FOOD SECTOR

Summary reports of speeches

LIVESTOCK BREEDING AND ABATTOIRS

METHANIZATION OF WASTE FROM INDUSTRIAL LIVESTOCK BREEDING AND ABATTOIRS

Summary report of speech delivered by Mr Cousin, Agence Française pour la Maîtrise de l'Energie (AFME)

1 - Introduction

Subsequent to the series of oil crises, the Government towards the end of the 1970s decided to launch a major Research and Development program in an aim to develop systems of energy production from industrial by-products in the agro-food sector. One of these systems is methanization, and the program sought to develop digesters suited to medium-scale agriculture in an aim to contribute to the reduction of the country's energy deficit.

The AFME and the agricultural profession organized technical follow-up, led and coordinated by the GIDA (Groupement Interinstitut pour l'Etude des Déjections Animales), which today makes it possible to assess the results of operation of more than 60 methanization plants.

2 - THE SITUATION IN 1984

2.1 - Development of methanization

In view of the fact that the cost of energy is now rising relatively slowly, methanization is no longer only a profitable system of producing energy from agricultural waste (provided that biogas resources match the energy requirements of the user), but also as a particularly energy-efficient system of deodorization and pollution control.

Industrial livestock breeding consumes large quantities of energy and is thus the most suitable activity for projects to install plants for treating liquid waste, pig and cattle slurry and poultry droppings in the short term.

For the same reasons, several projects of industrial scale are to be implemented during 1985 to handle abattoir waste.

2.2 - Techniques

The systematic follow-up of projects that the GIDA has carried out over the last three years has provided a basis for a preliminary assessment of the performance and reliability of the systems available.

2.2.1 - Liquid waste

The main difficulties initially encountered were linked to the sizing of equipment, the categorization of the waste to be treated, and the need for a good match between biogas production and the energy requirements of the user concerned.

Today, several industrial companies have reliable equipment treating several thousand m3 of slurry each year and producing several dozen tons of oil equivalent (TOE).*

Biogas is used directly on site in different forms:

- heat energy, replacing natural gas, propane, or, most commonly, domestic fuel oil;

- electricity, using heat recovery generators.

Methanized products are highly suitable for use as manure, since they are relatively odor-free.

2.2.2 - Solid waste

To date, the only units treating solid animal waste are batch-filled installations built by the users themselves. Users appear satisfied with results.

Continuous treatment processes are currently under examination and no information will be available until results are publicized. In France, the profitability of such operations will depend chiefly on the value of the methanized product.

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* 1 TOE = 1.5 tons of coal = 900 m3 of natural gas = 10 4 thermies = 10 7 kcal = 11,628 kWh

2.3 - Development potential outside France

While methanization of liquid waste from large-scale livestock breeding facilities in France is a positive response to energy and environmental problems in France, the methanization of solid vegetable and agricultural waste applied to small-scale livestock breeding activities in the Sahel, for example, can be a significant factor of development.

Such were the findings of the Research and Development program implemented in that region. The program also allowed for:

- the creation of systems based on dual activities (market gardening and cattle grazing), thereby making it possible to produce compost as well as biogas needed for operation of electricity generators;
- energy self-sufficiency, in remote areas, for operation of equipment with high social utility, such as millet mills, vaccine refrigerators or lighting systems;
- woodfuel savings: in this respect, although methanization is clearly of interest in the fight against desertification, a genuine incentives policy was required, since the financial savings brought by the substitution of woodfuel was far from sufficient to cover the investment costs incurred by the user.

3 - AFME SUPPORT FOR THE DEVELOPMENT OF METHANIZATION

A major program aiming to support the adoption of the methanization system will be launched at the end of 1984 and the start of 1985. The program will cover:

. for liquid waste from large-scale livestock breeding activities:

  - financial assistance for pre-feasibility studies allowing for examination of the integration of the methanization plant into the livestock breeding activity concerned;
  - financial assistance for investment allocated to pig breeding facilities with a minimum of 1,000 places and cattle breeding facilities of at least 100 livestock units.

. for solid waste, continued research and development of innovative processes with a view to achieving batch treatment, based on units built by users, or assembled from industrial components. In France today, solid manure is still the most extensive source of agricultural waste suitable for methanization.

INTEGRATED BIOGAS PRODUCTION AND TREATMENT PLANT: A BREAKDOWN

Summary report of speech delivered by Mr Aubart, Chief Executive, BIOMAGAZ

1 - INTRODUCTION

A methanization and treatment station was designed and built by the company BIOMAGAZ in an experimentation center in the Sarthe region of France.

This project has been in continuous operation since 1980, and since that date has extensively modified methods for treating slurry from breeding facilities for pigs, cattle, calves, rabbits, sheep, goats and poultry.

2 - THE INSTALLATION

The station was designed to treat approximately 25 m3 of slurry per day in a digester of 250 m3. At the outset, pig slurry was used. Now 20% of the raw waste is of bovine origin.

2.1 - Input

The slurry has the following characteristics:

- dry matter content: approximately 3%

- volatile solids content: 76%

- chemical oxygen demand (COD): 40 g 02/1

- pH: 7.4.

The unit treats 825 kg of dry matter per day, which is equivalent to 1,010 kg COD.

2.2 - Output

Biotechnological yield is as follows:

- biogas production: 288 m3/day
- proportion of methane (CH4): 67%
- proportion of CO2: 32%
- proportion of H2S: 0.2%.

Higher levels of production were actually achieved during the summer period, since 35 m3 of slurry were treated per day for production of approximately 350 m3 of biogas.

2.3 - Reduction of pollution

Approximate results are as follows:

- 38% reduction of dry matter
- 42% reduction of voltile solids
- 46% reduction of COD
- final product completely odor-free.

3 - ENERGY BREAKDOWN

- The biogas produced is entirely used in an AC generator set, giving a thermal equivalent of 696,000 kWh/year.
- From the energy viewpoint, heat recovered on the exchangers in the generator set is used to maintain a temperature of 35° in the digester, i.e., approximately 300,000 kWh/year.
- Electricity consumed by the equipment (pump, agitator, etc.) is approximately 8,000 kWh/year.
- Net electricity generation is thus 153,000 kWh/year.
- Savings on aerobic treatment of 169,000 kWh/year are made possible by reduction in COD through methane fermentation.

The net annual savings of the installation are thus 314,000 kWh, or FF 140,000.

4 - ADDITIONAL DETAILS

1) It was possible to make savings on lagooning because of the rather special context of the station: it is located at a major animal foodstuffs research center that produces around 100 m3 of waste slurry of all types each day.

   The methanization station treats only 25 m3 of slurry per day, the remainder being sent directly for aerobic lagooning.

   The biogas produced is converted into electricity and then used by surface-mounted areation units.

   The savings made by reductions in COD make it possible to use lower-volume, lower-consumption turbines than were needed previously.

2) Digester output is sent to a slurry separation system that produces 24 m3/day of product with 1% dry matter content, and sludge with approximately 30% dry matter and 21% organic matter.

   In addition to the main product, this liquid/solid separator produces a type of compost that can be spread on the land as manure. In this particular case, the "compost" is sent for lagooning with a significantly lower pollution level than the original slurry.

   In other units, it is also possible to send the compost through irrigation systems for use as fertilizer.

5 - COST BREAKDOWN

In very general terms, the payback time on the investment can be calculated in two distinct ways:

- If the overall cost of the unit is taken into account together with all the auxiliary equipment (approximately FF 1 million), the payback time is around 7 years.

- If the digester alone is taken into account, the payback time is 5 years.

SUGAR PRODUCTION

BY-PRODUCTS OF SUGAR PRODUCTION

Summary report of speech delivered by Mr de la Mettrie,
Agricultural Engineer, SATEC DEVELOPPEMENT

Once sugar has been extracted from sugarcane, the fibrous material that remains (bagasse) is used to supply the processing plant. A quantity of waste (by-products) still remains, however, and can have further uses in the processing cycle.

It is now possible to set up a cane sugar production complex that is almost completely autonomous in terms of energy.

1 - COMPONENTS OF SYSTEM

The products and by-products of the sugar production system are as follows:

- The sugar produced is marketed, and is thus removed from the system. This is the foremost goal of the company.

- Vegetable residue remaining on the land after harvesting decomposes and maintains the water balance of the soil.

- Bagasse, the residue remaining after sugarcane has been crushed in mills to extract juice, is burned in boilers to supply the energy needed for plant operation.

  It should be pointed out that sugarcane contains water that is therefore added to the system. This water is converted into steam during the process, and, after condensation, is a very good source of boiler feed water (limited corrosion).

  Almost one-half of the potential energy of the bagasse can be sufficient for the requirements of the process. The remainder can thus be put to other uses:

  . irrigation of plantations

  . lighting

  . distillation

. refining-agglomeration.

- Molasses, the residue of crystallization of the sugar after separation of sucrose crystals in centrifuges, still contain 50% of fermentable sugars. After fermentation, the distillation of molasses makes it possible to produce 95° - 96° alcohol that can be utilized as fuel in diesel engines in the sugar complex in place of imported diesel oil.

- Slop, a by-product of distillation, is particularly rich in potassium. Slop is considered a highly pollutant effluent, but can be spread over fields as a good quality fertilizer.

- Defecation scum is the residue left behind after clarification of juice subsequent to filtration. In sugar production from sugarcane, juice is clarified by adding lime, and sometimes phosphoric acid, to the raw juice coming from the mills. Scum is particularly rich in P2O5 and CaO, and is a very good fertilizer for sugarcane crops. In general, scum is spread on the fields as and when it is produced at the plant.

- Boiler ash, a residue from the combustion of bagasse, is rich in minerals and can be spread on the fields in the same way as scum and slop.

2 - INPUTS AND OUTPUTS

An analysis of the Atomphere-Soil-Plant-Sugar production-Distillation system in terms of inputs and outputs demonstrates that, aside from the sugar (which is sold), all products involved in any of the stages of sugar production are re-used in the processing cycle.

Sugar and alcohol, made up of the carbon, hydrogen and oxygen that is taken from the atmosphere by photosynthesis, take nothing from the soil.

Bagasse is made up of tissues constituting the original sugar cane fiber and pith, water, and residual juice. Ash formed by combustion of bagasse contains the mineral elements of the sugar cane, which were extracted from the soil by the plant, even if a certin quantity of these elements has been lost with the smoke given off during combustion.

All the elements taken from the soil for the growth of the plant can return to the soil in one of the following forms:

- crop residue

- defecation scum

- distillery slop

- boiler ash.

Our aim here is to shed light on the details of this breakdown from two standpoints: "Energy" and "Matter".

Two case studies will be used to elucidate the real possibilities that are open in this respect to sugar production complexes in remote areas of developing countries.

3 - ENERGY SAVINGS IN A SUGAR PRODUCTION FACILITY

At what level should one intervene in a sugar production complex in an aim to economize energy, minimize the bagasse burned or maximize the steam produced?

The following aspects can be examined:

- ligneous matter content of the cane: agronomic research for selection of cane;

- boilers: installation of triple- and quadruple-effect systems to utilize high-pressure steam to activate turbines, and expanded steam for evaporation and concentration of juice;

- choice of turbines (back-pressure, condensation and bleed) to optimize heat balance;

- choice of process: possibility of recycling expanded steam;

- lagging of ducts: reduction of convection losses;

- careful layout of the different lines in the plant.

4 - TWO CASE STUDIES

4.1 - Borotou sugar production facility (Ivory Coast)

This sugar production facility was designed from the outset to save energy. It utilizes 160 tons of sugarcane and produces 120 tons of steam per hour. Process requirements are only 60 tons of steam, and a choice thus had to be made among:

- electricity generation for irrigation of plantations;
- heating for staff housing and villages;
- use in the distillery;
- use in refining-agglomeration processes.

The distillery has not yet been built, and the refining-agglomeration option was retained.

4.2 - Analaiva sugar production facility (Madagascar)

The TECHNISUCRE consortium made two propositions for this sugar production facility:

1) Re-use of slop, scum and ash by constructing a clay-lined pit and maintaining homogeneity with an agitator, for subsequent spreading on soil using slurry spreading systems.

   This system would avoid a situation where slop is fed into the irrigation system at the perimeter of the plant without knowing exactly what happens in terms of fertilization. Savings would be equivalent to nearly FF 2 million.

2) Installation of a distillery producing 2,200,000 liters of 96° ethanol that could be used directly in an engine (GARO process, or Brazilian process).

METHANE FERMENTATION OF BY-PRODUCTS OF ALCOHOL DISTILLATION FROM SUGARCANE

Summary report of speech delivered by Mr Bories, Enology and Vegetable Technology Station, Institut National de la Recherche Agronomique (INRA), Narbonne (France)

1 - DIFFICULTIES ENCOUNTERED IN THE UTILIZATION OF THIS WASTE

The production of alcohol (rum or ethanol) from sugarcane involves large quantities of pollution. With molasses alcohol, effluent has particularly high concentrations of organic matter and minerals (COD: 60 - 100 g/l), and is thus difficult to treat.

The low ethanol content obtained after the fermentation phase of the process gives rise to significant levels of energy consumption in the distillation phase, and to large quantities of waste products (15 - 20 times the volume of alcohol).

Methane fermentation can be used on these waste products, with the following aims:

- pollution control - energy savings

- production of energy.

However, conventional fermentation techniques (integral mixture, anaerobic contact process, etc.) have only limited performance:

- low load levels (volume)

- long hydraulic residence times, requiring large plant dimensions.

Further, spontaneous inhibition is a relatively common occurrence.

2 - PILOT PLANT IN GUADELOUPE (FWI)

The design of a fixed micro-organism reactor is one method of circumventing biological restraints and improving conditions of processing. The use of new materials (plastics), which had been examined earlier for distillation applications, was adopted for the methane fermentation of molasses slop.

An experiment was run in a molasses distillation plant (Société Industrielle de Sucrerie, Guadeloupe) over two seasons (May 1983 - February 1984).

The methanization plant (Société Générale des Techniques Nouvelles) comprises a 10 m3 reactor using FLOCOR plastic and operating in descending flow.

Wastewater is molasses slop with pollutant levels (COD) of 45 - 65 g O2/l. No pH correction or bacterial environment correction is required. (pH of substrate: 4.5).

2.1 - Figures

After nine months, optimum perfomance obtained on the fixed-bed reactor is as follows:

. load (volume): 14.2 - 20.4 kg COD/m3/day

. residence time: 3.37 - 2.67 days

. productivity: 6.3 - 8.2 m3 biogas/m3/day

. removal rate: COD: 71.3 - 61.9%
BOD5: over 90%

. gasification yield: 392 - 445 l of biogas/kg COD input

. methane content: 55%

. volume of biogas: 21.3 m3/m3 of slop

where BOD5 = biological oxygen demand after 5 days.

The fermentation of molasses slop on a fixed-bed reactor is thus carried out with very high pollutant loads per unit volume and with short retention time.

2.2 - Comparison

Compared with conventional processes, the improvements brought by this technology represent a factor of 3 on the parameters of operation and there is a corresponding reduction in the volume of the installations. Results obtained are at the highest level of performance given in documentation. The detailed follow-up of fermentation parameters (particularly volatile fatty acids) demonstrate the perfect stability of the process (no accumulation of VFAs) at these high levels of performance. Inhibition problems might also be alleviated by the longer retention time of biomass. Purification efficiency is optimum for the type of products to be treated. Biodegradability of methanized residue seems low (BOD/COD ratio less than 0.2).

2.3 - Energy breakdown

The energy breakdown of alcohol production has been calculated. The distillery is characterized by the use of fuel oil for distillation processes (0.33 TOE/m3 of alcohol produced). Methanization of waste supplies 339 m3 of biogas/m3 of pure alcohol, which is equivalent to 0.16 TOE, sufficient to cover 48% of the distillery's energy requirements.

Methanization of cane alcohol distillation waste performed with optimized fermentation technologies is an efficient solution to the dual challenges of pollution control and energy production from waste.

BAGASSE PRODUCTION IN CUBA

Summary report of speech delivered by Mr Dutreux, Commercial Director, CEREX

1 - INTRODUCTION

After consultation with worldwide specialists, the Cuban Government, represented by the Ministry for Sugar Production and the Central Purchasing Organization CIMEX, in collaboration with the company CEREX/SECEM (and their technical associates PROMILL) carried out a study aimed to upgrade the country's sugar industry.

The purpose of this study was:

- In a preliminary phase, to use waste biomass to produce solid fuels and cattle feed, and to replace petroleum products consumed by sugar production facilities with the solid fuel produced.
- Subsequently, to increase production of refined white sugar and to widen the field of application of recoverable by-products (paper pulp, particle board, etc.).

2 - SUGAR IN CUBA

The sugar industry in Cuba can be summarized as follows:

- 30% of the gross national product (GNP)
- 10 million tons of raw sugar per year
- 95% of the country's exports
- 165 production centers
- more than 10,000 engineers and technicians.

3 - THE PROCESS

The boilers of the different facilities operate with large quantities of excess air, which is necessary for the combustion of bagasse with 50% moisture content.

SEREX plans to recover fumes from these boilers and use them to dry all the excess bagasse.

After this drying phase, the process comprises granulation, cooling and packing lines.

4 - CONCLUSION

The bagasse has the follwing characteristics:

Moisture content (%)	15	35	50
LHV (kcal/kg)	3,700	2,700	1,900
Steam production capacity (th/t)	4.38	3.46	2.25
Electricity production capacity (kW/t)	219	178	112
Fuel oil equivalent (t bagasse/t fuel oil)	0.37	0.27	0.19

where LHV = lower heat value.

It will thus be possible to utilize the 8 million tons of excess bagasse produced each year, by converting this matter into solid fuel and electricity for an equivalent of 1,220,000 tons of petroleum or 719 million kW.

If bagasse with moisture content of 15% is available, it can be used in high-pressure boilers to produce white sugar. Imports of 400,000 tons of petroleum products can thus be replaced, and production can be increased.

Seven million tons of sugarcane leaves and flowers can be converted into fuel (1,060,000 TOE) or into cattle feed (3.5 million tons).

GASIFICATION OF SUGARCANE BAGASSE

Summary report of speech delivered by Mr Boillot, Research Engineer, Techniques Nouvelles de l'Energie Division, Electricité de France (EDF)

1 - INTRODUCTION

EDF (French Electricity Authority) has carried out a test program on the utilization of sugarcane bagasse by gasification. This program has made it possible to make use of excess available bagasse in Guadeloupe (FWI) and in Reunion Island (Indian Ocean).

The program had two main aspects: bagasse handling and the gasification process proper.

Further, an economic analysis was carried out alongside this practical program, and demonstrated that the gasification system is only suitable for small-scale units (up to 1 MW), since beyond this level, efficiency is high enough to justify using the boiler and steam turbine system.

2 - BAGASSE HANDLING

Different tests were run on 7 tons of bagasse imported from Reunion Island and 40 tons imported from Guadeloupe.

2.1 - Drying

Drying is essential to lower the moisture content of bagasse containing 50% water to an average maximum of 20 - 25% water.

Rotary kilns were used for this operation. This technique is already widely used by industries to dry different agro-food products.

The kilns were supplied with heat from the exhaust gases of engines generating electricity, or from a associated fore-hearth burning high-moisture-content bagasse.

2.2. - Crushing and pressing

Crushing is usually required prior to pressing, except when a ram press is used. In this case, grill mesh size can be altered to select the particle size of the product.

Average energy consumption is approximately 15 kWh per ton of crushed bagasse.

2.2.1 - Pellet presses

Various tests were run on presses with power levels ranging from 50 - 300 hp, and experiments were carried out using several different compression ratios.

Moisture content and the percentage of slop or molasses used as binding agents were also optimized under test conditions. Results demonstrated that slight variations in bagasse moisture content could lead to complications such as clogging of the press or poor pellet quality.

This type of presses consumes an average of 100 kWh per ton of bagasse with 10% moisture content, to produce pellets with density of 1.2 t/m3.

Depending on the mesh used, pellet diameter can range from 6 - 14 mm, but power consumption increases markedly as the pellet size decreases.

The manufacturer PROMILL FRANCE took part in these tests.

2.2.2 - Ram presses

A 50 hp press was tested with uncrushed bagasse with 10% moisture content. Neither water not binding agents were required.

Average consumption was 70 kWh/ton of bagasse. The process appears appropriate for raw bagasse, because of its fibrous nature.

The briquettes produced are 80 mm in diameter and have density of 1.3 t/m3.

It appears difficult to reduce this diameter without affecting the efficiency of the machine and without increasing its consumption.

The manafacturer SERMIE FRANCE took part in these tests.

2.2.3 - Screw-type presses

An 80 hp press was tested on production of pieces of 300 mm in diameter and with density of 1.2 t/m3.

Regrettably, tests could not be finished due to feed problems: the density of dried raw bagasse was too low (85 kg/m3).

It will nevertheless be interesting to follow the developments of this type of press, given that the particle size of the product is ideally suited to use in gas generators, and in view of its potential economic advantages.

Belgian manufacturers ZIMMER DEBAIFFE took part in these tests.

3 - GAS GENERATORS

All gas generators of all sizes produced in France were tested.

3.1 - Low capacity gas generators

Gas generators are considered to be low capacity if they do not generate more than 100 kW.

In this range of equipment, the market is shared by several manufacturers: CHEVET, TOUILLET, EVRARD (Belgium), DUVANT and PILLARD.

It should be pointed out that gasification of pellets is technically feasible, provided hardness and survivability of pellets are satisfactory.

3.2 - High capacity gas generators

An economic assessment of high capacity gas generators was made alongside the test program, with the following results:

- overall efficiency: 0.4 - 0.66;

- gas composition and energy value vary depending on the technique employed: 3,200 - 5,700 kJ/Nm3;

- ease of handling facilitates the use of pellets.

4 - CONCLUSION

The economic analysis demonstrates that the cost of fuel (pellets or briquettes) is around FF 240 - 400 per ton of bagasse with 10% moisture content.

Electricity generated through gasification using a 600 kW unit is around FF 1.50/kWh for production of 3.2 million kWh.

Electricity costs are FF 1.90/kWh when units with lower power levels (400 kW) are used.

This economic analysis covers the entire system : drying, crushing, handling and electricity generation.

HOUSEHOLD WASTE

EXAMINATION OF THE DISPOSAL OF HOUSEHOLD WASTE

Summary report of speech delivered by Mr Broix, Engineer, Local Communities Division, Agence National pour la Récupération et l'Elimination des Déchets (ANRED)

1 - METHODOLOGY

1.1 - Collection of data

The geographical areas under consideration must be specified before waste can be categorized (household waste, treatment station sludge, industrial waste, etc.).

Different processes can then be examined in the li t of the market potential for products of the treatment cyc (heat, electricity, compost, etc.).

At the same time, it is useful to examine the location of treatment plants and landfills.

1.2 - Assessment and analysis of treatment options

On the basis of the data collected (type of w te, process, location), technicians present a number of options to decision-makers.

These options are studied and preselected by a special committee, and then technical and economic assessments are made of each possible method of treatment before one or two methods are dealt with in greater detail.

2 - CASE STUDY: GREATER ANGOULEME (FRANCE)

The Syndicat Intercommunal du Grand Angoulême (SIGA) in 1973 selected and built a household waste treatment plant based on the principle of accelerated composting (with incineration of non-compostable substances). By 1982, this plant was outdated, and needed to be renovated or replaced.

The methodolgy described above was applied to this project. Results were as follows:

2.1 - Collection of data

Data was collected on the basis of a questionnaire circulated to the various communities affcted by the project. The findings of this questionnaire made it possible to specify the type and quantity of waste to be treated. The principal waste products of the Angoulême conglomeration consist of household waste (33,000 tons/year).

2.1.1 - Waste

A more detailed study was carried out in order to identify other types of waste that could be treated alongside the household waste: industrial waste that could be incinerated (and thus treated if an incineration process was to be adopted), or industrial waste that could be fermented (and thus treated if a composting process was to be adopted).

Treatment station sludge is already treated separately, and investments have already been made for this purpose. This type of waste was thus not considered under this study.

2.1.2 - Location

Three sites were surveyed for the treatment plant: the site where the present treatment station is located, and two other sites with potential openings, particularly for incineration.

The conglomeration considered the present site used for dumping industrial products as the only acceptable location.

2.1.3 - Processes

In 1982, the methanization process was still at the pilot plant stage, and could thus not be considered under this study.

All other processes were applicable to Greater Angoulême: slow or accelerated composting, incineration with or without energy recovery, manufacture of storable solid fuel, and selective sorting of household waste.

2.2 - Assessment of options

Eight options were set out on the basis of the following solutions and forecasts:

- extension of the present plant (increased capacity, additional equipment);

- construction of a new plant to back up the present plant, or to treat all household waste;

- short-term forecast for sizing requirements to 1990;

- long-term forecast for the year 2000.

2.3 - Analysis of options

A special committee requested that a further option be added (incineration with outlets 2 or 3 km from site), and that an additional site be considered. A working party was set up so that meetings could be held more frequently, and decisions made more rapidly.

Lastly; an economic assessment was made of each system, taking into account investment costs, costs of operation and dumping of unusable products, as well as the revenue that might be expected from the same of by-products (heat, compost, fuels or materials). On this basis, treatment costs were calculated in francs per ton.

After a comparative study, technicians proposed three options and decision-makers finally selected the following system: incineration with recovery of energy and sale of steam to a local industry and to a hospital.

3 - METHANIZATION OF HOUSEHOLD WASTE

The first industrial methanization unit was brought into service recently at Voiron, Isère (France).

3.1 - Advantages of the system

Of all the possible systems for making use of household waste, the principle of methanization in a reactor presents the most advantages, since it aims not only to recover energy through the production of biogas, but also makes it possible to produce an organic soil improver from the fermentation residue.

However, a number of serious technical difficulties are encountered with this system. While methane fermentation is particularly well suited to the treatment of waste with high moisture content and high organic matter content (stabilization of treatment station sludge, for example), it is more difficult to apply the process to the treatment of household waste, since this type of waste has relatively low moisture content and homogeneity, and requires very specific sorting and crushing operations.

Further, equipment size must be increased to account for the low proportion of dry matter in the reactor (5 - 30% depending on the process), and this requirement involves higher unit treatment costs.

Similarly, it should be pointed out that energy recovery performance with this process is lower than with other processes, such as incineration. Incineration can bring savings of 100 - 130 liters of fuel oil per ton of waste treated, while methanization allows for recovery of only 30 - 60 liters of fuel per ton of waste treated.

Under these conditions, the economic interest of the system in relation to other techniques of treatment and recovery depends on the following factors:

- local conditions for the use of biogas;
- saleability of compost produced from digester residue (and thus physical and agronomic qualities of this compost);
- operating conditions and reliability of the process.

With regard to these last two factors, much can be learnt from the industrial tests run at the Syndicat Mixte d'Aménagement du Voironnais (SMAV) by the company VALORGA. The VALORGA process has been developed after in-depth research under both laboratory and pilot plant conditions.

3.2 - Description of installation

The SMAV household waste treatment plant consists of a unit for crushing waste and removing scrap iron and glass (capacity: 16,000 tons/year).

One-half of the 8,000 tons of crushed, sorted waste is then treated by conventional aerobic composting, while the other half is fed into a methanization unit on continuous operation, consisting basically of a digester with a steel vessel of 400 m3 capacity.

The methanization unit has been in opertaion for several months, producing around 1,600 m3/day of biogas containing 65% methane (i.e., 1,000 m3/day of CH4 and 4m3/m3 of vessel/day).

3.3 - Conclusion

In an aim to consolidate experience and make a meaningful assessment of the levels of performance that can be expected from this technique, which could undoubtedly broaden the range of possibilities open to communities for the treatement and utilization of their waste products, the ANRED and the AFME (Agence Française pour la Maîtrise de l'Energie) propose to carry out during 1985 a highly detailed technical and analytical examination of the installation with the assistance of VALORGA and the SMAV. This study should make it possible to establish energy and materials breakdowns for the process over this period, and to assess compost quality.

OIL MILLS

PALM OIL MILL WASTE: TYPE AND USES

Summary report of speech delivered by Mr Petitpierre, Agronomic Engineer, Consultant at the European Economic Community

Out of every 1,000 kg of raw material (palm bunches) that are sent to the factory, only 240 kg of processed products (kernels and oil) are obtained. Waste products thus account for approximately 75% of the raw materials.

1 - TYPE OF WASTE

1.1 - Dry waste

There are several types of dry waste, with different utilities:

- fiber (making up the pulp of the fruit): 10 - 13% of the weight of the bunch;
- shells surrounding the kernels: 5% of the weight of the bunch; shell debris: 2.5%;
- bunch refuse (fibrous part of bunches supporting the fruit): 23% of the weight of the bunch.

Overall, 450 tons of waste are obtained from every ton of raw material inputs (bunches).

1.2 - Liquid waste

Each ton of raw material produces 0.8 m3 (approximately 800 kg) of liquid waste. This effluent contains the hot process water that must be added to facilitate separation of oil from raw juice during settling.

Liquid waste includes clarification sludge, sterilization condensate, and water from hydrocycloning and fruit washing.

2 - USE OF WASTE FROM OIL PALM MILLS

Industrial units have a yearly average capacity of 60,000 - 80,000 tons of raw materials (bunches).

Seventy-five percent of the raw materials (45,000 to 60,000 tons) would thus be transported to the mill from a radius of 20 - 30 km for no good reason if the waste materials were not utilized.

2.1 - Fiber

To process one ton of raw materials (bunches), requirements are as follows:

- 400 - 500 kg of low-pressure steam for sterilization and heating;

- 15 - 20 kWh of electricity, which can be generated by a steam turbine requiring 400 - 500 kg of high-pressure steam.

In large-scale units, a high pressure boiler assembly supplies 20 - 23 bar steam to a turbine that generates electricity. At turbine outlet, 3-bar steam is recovered for use in sterilization and heating of the product.

The overall requirement for 400 - 500 kg of steam produced is thus 400 - 500 thermies (th), which can be met exactly by using fiber as fuel in the boilers.

Shells and debris can supply an additional 150 th.

2.2 - Shells

Shells are often not used or little used in large-scale units.

In small-scale oil mills, on the other hand, given the high price levels of turbines compared with total investments required for the plant, there is currently a tendency to propose the following solution: low-pressure boiler supplied with fiber and shells, coupled with electricity generating set operating on lean gas supplied by a gas generator running on shells. This solution makes it possible to save 60 - 80% of the fuel oil formerly used to run the generating set.

Gas generators can also be installed on trucks used to transport the bunches of palms, but this solution has several problems: reduced load capacity of truck, relatively slow amortizement of the investment, risks of breakdown, etc.

2.3 - Bunch refuse

Bunch refuse has been used directly for some considerable time on plantations, where it is burned to produce 2.5 kg of potassium chloride per ton of refuse.

This operation provides 20 - 30% of the potassium requirements of the plantation.

In certain countries, however, such as Malaysia, where the palm oil industry is very highly developed, incinerators lead to problems of atmospheric pollution, and bunch refuse is spread as compost directly in the plantations.

Only 2 - 3% of the total plantation surface area is covered with this compost, but the product contains all the organic and mineral manuring requirements of the crop.

2.4 - Liquid waste

Oil mills produce considerable quantities of liquid waste, as was mentioned above: 64,000 m3 for a mill processing 80,000 tons of bunches per year.

Further, this liquid waste is highly pollutant: a medium-sized oil mill produces as much pollution as a town of 120,000 inhabitants.

In Malaysia, several measures have been taken to combat this problem, which is one of the country's major concerns:

- direct spreading of waste in the plantations: this solution has been adopted for several years, but legislation has now been passed fobidding the practice unless preliminary treatment has been carried out to reduce biological oxygen demand (BOD).

- anaerobic digestion: this bacteriological process can be carried out in two ways:

  . anaerobic lagooning in pools covering 1 - 2 hectares, and with a capacity of 50,000 m3 of effluent: retention times of 70 - 100 days are required to reduce BOD by 95 - 99%.

  . covered or open-air digesters if space is more expensive or unavailable.

Before gas can be produced, however, the use to which it will be put must be known. In the light of this information, covered digesters are not always profitable, while open-air digesters can be used to reduce pollution levels and are less expensive, even if gas cannot be recovered.

Pollution control is a serious problem in Malaysia, but this is not the case in Africa, where the concentration of palm oil mills is considerably lower. It is thus rarely necessary to treat effluent, except in specific cases when there is no river within 10 km of the mill where effluent can be dumped, for example, and when the clay substructure makes lagooning impossible (Nigeria project), or else when the effluent cannot be dumped because of the neighboring fishing grounds (area around Lake Tanganyika).

3 - CONCLUSION

I should like to make two comments to conclude this subject.

Firstly, it is important to remember that the reserves of biomass that are available to industries in the agro-food sector are of much greater interest than agricultural residue scattered over plantations. There are several reasons for this fact: raw materials are concentrated in a single location, a technical environment provides openings for utilizing the biomass, and contact with profit-conscious potential partners will ensure that biomass is not utilized simply for the sake of it.

It is also important to stress that finding a technical solution does not imply that the process is worthwhile. Economic calculations must be made scrupulously, since it is easy, given the narrow margins of profitability involved, to swing rapidly from a forecast of profit to a situation of inevitable loss.

BORA BORA: GASIFICATION OF COCONUT FIBER

Summary report of speech delivered by Mr Lemaitre, Renewable Energy Sources Division, Commissariat à l'Energie Atomique (CEA)

1 - HISTORICAL BACKGROUND

Electricité de Tahiti (EDT) has been involved since 1973 in research aimed to discover new sources of energy in an aim to combat the crisis created by oil price increases.

After making a general assessment of the situation and in view of the high biomass potential of Polynesia, EDT decided to concentrate on gas generators, since these units are suitable for supporting the requirements of a public electricity distribution grid on a medium-sized island.

In 1976, EDT decided to investigate a DELACOTTE type gas generator supplied by the French company ENTROPIE and installed and tested in 1978. Coconut fiber is used as fuel for this unit.

At that time, testing could not be continued due to unfavorable economic conditions, and the test program was only resumed in March 1980.

In October 1982, the "gas generator set" had been in operation, coupled to the distribution grid, for approximately 1,500 hours. The diesel generator had also operated independently with diesel fuel for 14,000 hours.

2 - DESCRIPTION AND PRINCIPLE OF OPERATION OF THE INSTALLATION

The energy production line is made up of the following basic equipment:

- the gas generator and its filtration system

- the electricity generating set.

2.1 - The DELACOTTE gas generator

The purpose of a gas generator is to convert ligneous matter into combustible gas through partial combustion in air.

This gas can be used in engines after filtration (to remove tar, dust, etc.) and cooling.

As the fuel is fed into the gas generator, it is successively distilled (volatile solids, water and tar escape with the fumes), carbonized and gasified. Fumes (and the tar contained therein) are collected and burned. Residual impurities are removed in a cooler-scrubber unit.

2.2 - The electricity generating set

The gas produced is used in a dual-fuel diesel engine.

The cylinders of the engine are supplied with a mixture of air and gas that will not self-ignite. Combustion is obtained through pilot injection of diesel oil.

The advantage of a dual-fuel system is that total injection of diesel oil can be resumed if problems occur in the gas generator (technical problems or disruption in coconut-fiber supply).

On the other hand, operation is not fully independent of hydrocarbons, which are still required for pilot injection.

3 - THE FUEL

Coconut fiber and shells are abundantly available as a fuel in many islands because of copra production activities.

Fiber and shells are purchased from private individuals who deliver them in bags to the power plant. Fiber is stored in hangars with wire-netting walls, where it is protected from the rain and naturally ventilated.

However, in view of the difficulties that can be caused by moisture content of fiber, a simple drying unit is required. This unit is supplied with hot air from the gas cooling fan or from the generating set.

Dry fuel is loaded manually into the gas generator at a rate of 1.5 m3 of fiber (150 kg) per hour. This operation has been simplified this year by the installation of a motorized handling line.

4 - STATISTICAL HIGHLIGHTS

The generating set can supply 190 kW, and generally operates at 160 kW.

The gas generator is capable of supplying a generating set of 250 kW.

The following levels of consumption have been recorded:

- diesel oil: 50 g (0.06 l)/kWh at AC generator output;
- coconut fiber: 1.3 kg/kWh at AC generator output.

These measurements can be compared with diesel oil requirements of approximately 280 g/kWh for a diesel engine of the same power rating.

It can thus be deduced that:

. 1 kg of fiber ≡ 0.225 liters of diesel oil;

. fiber from 1 coconut ≡ 0.160 liters of diesel oil.

The Bora Bora gas generator thus assures average gas production equivalent to 35 l/hr of diesel oil.

MALI: COMBUSTION OF COTTONSEED HULLS FOR STEAM PRODUCTION

Summary report of speech delivered by Mrs Doucet (specialist)

1 - THE HUICOMA COTTONSEED OIL MILL

The case study presented here deals with a succesful French project carried out in a cotonseed oil mill in Mali, where a boiler operating on cottonseed hulls was installed to replace an older oil-fired boiler for the production of process steam.

Mali's cottonseed oil mill (HUICOMA) was built in 1981 and has a processing capacity of 300 t/day. Production can be broken down as follows:

- 60 t/day of neutralized oil for local consumption or export to Europe;

- 90 t/day of cattle cake, chiefly for export markets;

- 150 t/day of hulls, all of which is used as cattle feed in Mali, either directly or mixed with crushed cattle cake.

2 - ENERGY REQUIREMENTS OF MILL

Primary energy requirements of a cottonseed oil mill can be broken down into electricity generation and process steam production.

The electricity required by the HUICOMA facility is generated by three DUVANT dual-fuel generation sets, each with a rated capacity of 640 kW, operating on a mixture of diesel oil (70%) and fuel oil (30%). Consumption of petroleum products for electricity generation to meet the the internal requirements of the oil mill is 5,000 l/day.

Process steam requirements are 3 t/hr at 15-bar pressure and 200°C. For the first two years of plant operation, steam requirements were met by a boiler consuming approximately 5,000 l/day of fuel oil.

The energy requirements of the oil mill were thus entirely met by petroleum products. A large number of Malian companies are in similar situations. More than one-half of the major agro-food industries in the country are 80 - 100% dependent on imported hydrocarbons.

According to World Bank forecasts, the average yearly increase in real prices of petroleum will stand at 1.6% between 1982 and 1995. In view of this forecast, the reduction of an ever-increasing burden of energy expenditure has become a priority objective for these industries.

The HUICOMA operation was a response to this situation.

3 - SOLUTIONS ADOPTED

The plant was designed from the outset to utilize cottonseed hulls, which provide a fuel with excellent heat value (3,900 kcal/kg) in order to reduce the fuel oil consumption of the plant.

The first proposition accepted by the Compagnie Française de Développement des Textiles (CFDT) involved the installation of gas generators operating on compacted hulls, which were to be developed in France by the company DUVANT and its subsidiary SERMIE.

Electricity generating sets and the boiler were then designed to operate on 65% lean gas produced from these hulls. However, the project was abandoned as a result of high costs for tests run in France and the difficulties encountered with this type of fuel, during both compacting and gasification.

Nevertheless, it was still possible to use 50 t/day of hulls to meet the plant's process heat requirements. provided that a suitable boiler could be developed.

4 - HULL-FIRED BOILER

At the beginning of 1984, a hull-fired boiler was installed to replace the older fuel oil-fired boiler. The new boiler was built by in France by F.MOCK (Strasbourg) and has an hourly capacity of 2.5 t of hulls for hourly production of 6 t of steam.

In response to problems of storage, a hull silo was specially designed by CFDT, which provides technical and financial support for the project. Hulls are transported by a screw system and fed into the boiler pneumatically (FAMA system).

Hulls are burned in suspension by injection of air from beneath the grate on which the hulls are spread out. A draught fan maintains slight negative pressure in the entire combustion chamber.

Thermal efficiency of the boiler is approximately 80% and technical amortizement will take ten years.

5 - ECONOMIC RESULTS

The specific consumption of the factory prior to installation of the hull-fired boiler was 35 liters of hydrocarbons per ton of product processed (10,000 l/day for 300 tons of product processed). The fuel oil savings made possible by the installation are thus 5,000 l/day, i.e., approximately FM 1,500,000/day (FF 15,000) at FM 300/l (FM = Malian franc).

For approximately 135 days of operation per year (pessimistic forecast), yearly savings reach approximately FM 200 million (FF 2 million). The total investment cost FM 300 million, including FM 130 million for the boiler itself.

From these figures, the payback time on the investment can be calculated as 18 months. The investment thus appears highly profitable.

6 - CONCLUSION

This project has been successful from two viewpoints:

- French technology:

  Although most groundnut oil mills have for a considerable time utilized available shells to produce steam or electricity, the use of cottonseed hulls for the same purposes involved major handling problems (transportation difficulties) and combustion difficulties (ash, unburned solids).

  The HUICOMA project demonstrates that the technique of combustion of oil mill by-products in suspension has now been mastered.

- Malian policies to promote efficient and rational management of local energy resources:

  The hull-fired boiler not only allows for considerable foreign currency savings, but uses only 33% of the total hull production available as cattle feed. This reduction in available resources of animal feed is relatively low, and does not jeopardize the success of the food self-sufficiency policy followed by the government of Mali.

OTHER INDUSTRIES IN THE AGRO-FOOD SECTOR

COMBUSTION OF RICE HUSKS

Summary report of speech delivered by Mr Moureau, Director, SICA FRANCE RIZ

1 - INTRODUCTION

The term "rice husks" is imprecise: it would be more appropriate to speak of "paddy husks", since the rice that arrives from the field is already known as "paddy". It is surrounded by a sleeve, or husk, that represents approximately 20% of the weight of the paddy and is removed together with another layer to produce white rice.

However, 40% of rice is consumed in other forms (steamed rice, parboiled rice, etc.). Large quantities of steam are required to process these products (approximately 1.5 tons of steam per ton of steamed rice, and 2.5 tons of steam per ton of parboiled rice).

Traditionally, the steam was produced from fuel oil, and the husks were stripped off and thrown away. Now it is possible to utilize the paddy husks to meet process steam requirements.

2 - PRINCIPLE OF OPERATION OF THE PROCESS

The first two boilers to operate on paddy husks were built in 1974 and 1978 respectively.

The principle of operation is very simple: the husks are fed into a combustion chamber where they are burned in suspension at approximately 800°C. The mixture of fumes, air and ash is then sent to a boiler with an hourly capacity of one ton of husks.

Boilcer feed is assured by a supply system, and storage capacity of 25 m3 for 25 t of husks is needed. The husks are sent directly into a buffer hopper that supplies the combustion chamber proportionately to boiler demand.

On leaving the boiler, the ash-laden fumes circulate through the boiler tubes and are then treated in cyclones to separate the ash and bring ash content of emissions into line with legislation.

The ash is recovered and bagged. Its utility in steel manufacture raises its market value.

3 - COST BREAKDOWN

To produce 25 tons of husks per day, 125 tons of paddy are needed (25.000 tons per year).

The approximate cost of such an installation is FF 3 million, which can be broken down as follows:

- boiler and combustion chamber: FF 1.4 million;

- husk storage, boiler supply: FF 400,000;

- dust removal and collection of ash: FF 400,000;

- electrical installations and civil engineering works: FF 800,000.

An identical fuel oil-fired boiler would cost FF 700,000. The husk-fired boiler thus involves additional costs of 2.3 million francs. Fuel savings made possible by this installation are FF 2,080,000 (updated to 1984).

Additional electricity consumption and operating costs account for expenditure of FF 320,000. A certain amount of revenue is generated through sales of ash. Savings on yearly operation can thus be calculated as FF 2,135,000, which gives a payback time of 13 months on this type of installation.

4 - CONCLUSION

In 1973, our costs in terms of steam energy per kg of product were FF 0.02 for parbioled rice and FF 0.006 for steamed rice.

In 1984, if the plant had still been running on fuel oil, unit product costs would have been FF 0.30 and FF 0.10. The husk boiler brings these costs down to FF 0.08 and FF 0.02/kg.

It is nonetheless true that a rice mill can only utilize available paddy husks in this way if the process it selects is based on steam production so that prices of products remain competitive.

ENERGY PRODUCTION FROM COFFEE HUSKS

Summary report of speech delivered by Mr Kerever, Engineer, Commissariat à l'Energie Atomique. Member of the Groupe d'Echanges Scientifiques et Technologiques (GEST)

1 - INTRODUCTION

The coffee we buy is produced by two types of process:

- wet method, producing parchment coffee;

- dry method, producing husks, after drying and dehusking.

Husks make up 50% of the total weight of the fruit. They are produced in large quantities in certain countries, expecially in Africa. Husks are put to few or no further uses and can cause environmental pollution.

They can be used to replace fuel imports and meet local energy requirements.

2 - RESOURCES AND REQUIREMENTS

Resources have been assessed on the basis of industrial dehusking facilities producing more than 10,000 tons of green coffee per year. This level of production generates approximately 300,000 tons of husks per year (100,000 TOE/year).

Energy requirements are highly varied:

- Dehusking plants require 400 kWh per ton of coffee produced, chiefly for electricity, drying and transportation.

- Other industries (cacao, rice, cassava, etc.), when harvests coincide.

Other local requirements also exist: partial replacement of woodfuel or charcoal by briquettes or charcoal formed from coffee husks.

It should be stressed that coffee husks cause three types of problem: storage (considerable space requirements close to dehusking facilities due to low weight per unit volume), odor (through fermentation), and combustion (when waste is disposed of by burning).

3 - PLANNED ACTION

The reasons outlined above were behind our decision to examine the problems encountered in the utilization of coffee husks under a program led by the association GEST, the Agence Française pour la Maîtrise de l'Energie (AFME) and the Ministry of the Environment, with the technical support of the CEA and the Institut de Recherche sur le Café et le Cacao (IRCC). Several manufacturers were also involved in the program.

Twenty tons of coffee husks were sent from Ivory Coast (a major coffee producer, with 16 dehusking facilities handling more than 10,000 tons each). The husks were distributed among the different equipment manufacturers for use in research into utilization of this by-product.

4 - CHARACTERISTICS OF COFFEE HUSKS

The physical and chemical properties of coffee husks are similar to those of other forms biomass of this type, with moisture content of 8 - 18% and ash content of 6.5% including appreciable levels of silicon.

Higher heat value is 18,000 kJ/kg, but weight per unit volume is low. Combustion involves risks of clinker formation because of the presence of silicon, and risks of particle entrainment because particle size is very small.

5 - ONGOING TESTS

Our objectives in examining the utilization potential of coffee husks are as follows:

- to outline different handling modes (raw, granulated, or pulverized husks);
- to run full-scale trials with industries to test existing equipment and discover whether the problems can be overcome;

solutions might include gas generators, burners, or charcoal kilns.

- to analyze and evaluate results in order to promote these techniques with the AFME in countries requiring such technology.

Test are currently being run on crushing processes to convert husks into pulverized biomass (for combustion in burners) or into granules for use in boilers or gas generators. Another handling process based on extrusion pressing is under examination. Carbonization processes under examination include the production of compacted husk charcoal, and densification of carbonized husks. We have no results from this research at this time.

PRODUCTION OF ENERGY FROM FORESTRY BY-PRODUCTS AND PRIMARY PROCESSING INDUSTRIES IN MIXED TROPICAL FORESTS

Summary report of speech delivered by Mr Vergnet, Centre Technique Forestier Tropical (CTFT) Coordinator of the Woodfuel Program (France)

Between wood in the forest and the product marketed after primary processing, volume is generally reduced by 65 - 75%, and a certain amount is completely wasted through burning. This situation is serious. We are going to examine possible remedies by anayzing respectively: the industrial sector, by-products, and a case study that provides a meaningful indication of the future situation.

1 - THE INDUSTRIAL SECTOR

Low levels of efficiency in processing have brought industries closer to their areas of supply. One positive consequence of this tendency is that all by-products are concentrated at the same location, and it is thus easier to look into ways of utilizing these by-products.

Industrial timber complexes that are currently being set up or planned are large-scale facilities within which different technologies will have opportunities to develop, provided they optimize production. The size and diversity of these complexes lead to considerable and varied energy requirements. All alternatives to petroleum products, which are used traditionally and at great cost, are thus liable to be of interest, particularly if these alternatives involve the use of the by-products that are already available on site, and that are technically and psycholgically very difficult to deal with.

2 - BY-PRODUCTS

Unlike by-products from other industries in the agro-food sector, those in the timber industry are highly mixed in terms of physical, mechanical and chemical properties, and require very varied handling procedures. Utilization of these by-products is only possible if processing techniques are well suited to each different type.

2.1 - Forestry

Roads and storage clearings account for 2 - 3% of total forest area, and represent approximately 200 m3 of industrial timber per hectare.

Forestry operations themselves leave at the base of the tree 6 - 10% of stock volume in the form of tips. 19 - 23% of the remainder is left at the side of roads or in log preparation clearings. It is uneconomical to collect the products left at the foot of the tree or in clearings in the forest.

The 200 m3 of industrial timber per hectare can be collected economically, but varieties are very mixed (several hundred different species; specific gravity from 0.3 to 1.3; diameter from 0.2 to more than 2 m). Processing techniques for this timber are not developed on the scale of the companies under consideration. Only the fruit bearing shoots left in roadside clearings (average diameter: 0.6 - 1 m) can be mobilized, but this operation involves high costs for recutting and sorting.

2.2 - Processing

The type of by-product depends on the primary processing technique adopted: sawing, peeling (rotary cutting) or slicing.

Yield varies from 30 to 50%, depending on the quality of the raw material, the finished product, the machinery used and the knowhow of operators.

By-products thus represent 50 - 70% of the volume of processed timber, and, in sawmill processing for example, are made up of 6 - 8% sawdust, 4 - 6% bark, and 37 - 43% heavier waste: edge-saw cuttings, offal timber and flitches sometimes weighing 100 kg or more.

Although these by-products are highly mixed, they can for the most part be handled economically and thus utilized.

3 - CASE STUDY

The case under examination is a timber complex in the Congo basin with forestry operations of 100,00 m3/year, including sawing of 50,000 m3 of logs per year, and slicing of 8,500 m3/year.

The energy requirements of the complex include electricity (installed power: 2,300 kW; weekly consumption: 98,000 kWh) and heat energy (106.000 th/week in the form of 10-bar steam). Available by-products represent 1.240,000 th/week, i.e., close to 4 times requirements (calculated as 320.000 th/week). Energy production relies on two boilers (27 t/hr, 25 bars, 325°C) two AC generators and a stand-by diesel unit (400 kW). This equipment is reliable and well suited to the needs of the complex.

Additional investments involved in the production of energy from by-products are around FF 10 million, with a payback time of around 3 years.

Thus, the satisfaction of the energy requirements (electricity and steam) of primary processing complexes through the utilization of by-products now seems a reliable and highly economical solution.

Forestry facilities of the future will have suitable characteristics, and, under the pressure of governments that are showing an increasing tendency to cooperate in this respect, should help make the utilization of by-products for the production of energy a generally accepted practice.

PART THREE

PROJECTS PRESENTED BY PARTICIPANTS FROM DEVELOPING COUNTRIES

Summary reports of speeches

ARGENTINA

Summary report of speech delivered by Mr Rosman, Vice-President, Bank of Santa Fé

The production of alcohol from sugarcane and other agricultural products has recently taken on considerable importance as a profitable way of countering the energy deficit.

1 - INTRODUCTION

How can petroleum products be partially replaced, providing ecological and qualititave advantages for the country, and at the same time having a positive effect on the national product, the balance of trade, and the foreign currency balance, and reinforcing the sovereignty of the nation?

How can new employment be found, making it possible, in view of the type of jobs involved, to reverse the negative tendencies of falling populations in rural areas, and increase the country's production of goods and services?

It is possible to meet these objectives in the short term, provided that technological innovations are introduced and applied to the production of alcohol as a replacement for petroleum products.

2 - OBJECTIVES

Six provinces of Argentina have been working together on a project that is a good example of regional integration, and that will make it possible to contribute very considerably to the supply of energy, to solve certain problems in deprived areas where jobs can be created, and to improve the social and economic situation, not only of the region, but of the country as a whole.

A program of this kind has very significant consequences on the society and economy of the country, and its effect cannot be gauged in terms of energy alone.

The market demand for alcohol will be sufficiently wide and stable to make it possible not only to solve the problems faced by those regions that will be able to produce sugar with agricultural surplus and sufficient industrial capacity, but will also open new horizons to the economic development of the agro-food industries that are involved in this production.

Moreover, there will be a considerable effect on other activities supplying goods and services: industrial equipment, machinery, fertilizers, pesticides, etc.

3 - REGIONAL ASPECTS

In view of its size, Argentina has a very complex and varied regional infrastructure. Thus, the Northern provinces, located farthest from the ports through which petroleum is imported, are the areas where conditions are most favorable to the implementation of alcohol-fuel projects.

The six regions affected by the project consititute a geographic unit. They have much in common and encounter the same problems.

The development of alcohol production in these regions will strengthen the bonds between the different parts of this geographic unit.

Unlike other provinces, where fuel market conditions do not justify the implementation of an alcohol production project, the Province of Santa Fé offers a potential market for alcohol production that has no equivalent in other fuels.

Santa Fé has thus been selected to lead the first phase in the project, which involves a pre-feasibility study (which is essential, in view of the level of investment required ($13 - 14 million, including $3 - 4 million for waste treatment).

4 - CONCLUSION

The private sector will be participating extensively in this project, providing capital and carrying out studies: a State company does not appear necessary in this instance.

Nevertheless, the technical cooperation of international organizations for research support and facilitation of the transfer of technology, and that of France and other developed countries in a position to enhance the reliability of investment projects, would be most welcome, particularly with a view to making it possible to set and develop productive and export-oriented activities that will help us reduce our foreign debt.

BOLIVIA

Summary report of speech delivered by Mr Trepp, Project Director, CONNAL National Consultants

Our project involves the manufacture of organic fertilizers through anaerobic fermentation of available waste in Bolivia.

1 - THE CHALLENGE

There is a serious problem of soil erosion in Bolivia's crop-growing areas, and this phenomenon has repercussions on agricultural yield and on socio-economic aspects of the agricultural sector. It is thus essential to take immediate action at all levels in an effort to slow the process of cropland deterioration that is the result of excessive cultivation and inappropriate agricultural practices.

Striking illustrations of the situation are provided by the cereals sector, where our average yield is 0.7 t/ha compared with optimum yield of 4 - 5 t/ha.

In industrial crop production, we achieve sugarcane production of 42 t/ha, where the ideal level is 100 t/ha.

In the Santa Cruz region, some 1.5 million hectares are affected by this process of deterioration.

2 - AVAILABLE WASTE

We have conducted a market survey for the principal agro-food industries in the East of the country, i.e., around Santa Cruz. Sugarcane production is the primary source of agro-food waste in this region, and oil mill waste is also available.

Grape production is fairly well developed in the South of the country, and provides various waste products.

In the tropical North-West of the country, sizeable amounts of coffee husks and parchment coffee are available.

3 - THE PROJECT

The project has two phases:

- The installation of a pilot complex, with capacity for technical adaptation, for examination of treatment of different raw materials.

  This pilot plant is designed with two 20 m3 digesters that can be operated simultaneously or individually for treatment processes involving high levels of dissolution.

- A prototype (capacity: 1,740 m3) will then treat the waste products from a sugar production facility (causing high levels of pollution) and from the region's dairy production facilities and abattoirs.

4 - ECONOMIC ASPECTS

The project considers the production of energy from biogas to be of secondary importance. Our principal objective is not the energy aspect, but the production of fertilizers.

The economic advantages presented by the conversion of a vegetable by-product, e.g., bagasse, into a fertilizer, is the subject of much more controversy than are the advantages of the same process in terms of energy.

It can be said, however, that production costs (that exist for fertilizer production facilities in the same way as for any other plant) will be offset by the very high price levels that can be calculated for a product with similar nitrogen content.

5 - CONCLUSION

The potential uses of these fertilizers are infinite, and Bolivia needs a large number of plants of this type if agricultural production is to return to a normal level.

The project was conceived in the private sector, but efforts should be made to involve the State, which could then attempt to obtain financing for an exhaustive study, which would ideally be carried out in association with national companies.

COLOMBIA

Summary report of speech delivered by Mr Beltran, Director General, National Educational Foundation for the Development of Agriculture and Livestock Production (FEDAN)

The principle objective of the Foundation is to provide assistance to Colombian peasants who have few economic resources. Several programs have been set up in Colombia to develop systems of treatment for abattoir waste.

1 - THE PROJECT

The project introduced here has been submitted jointly to UNIDO and the French government. It involves an integrated pig and cattle production cycle based on the use of agricultural waste.

The project is located in the Meta province and consists of:

- extension of an existing livestock breeding facility to increase production from 700 to 3,000 pigs;
- construction of a production unit for pasteurized foodstuffs for cattle (from market and abattoir waste) with a capacity of 1,500 l/hr;
- construction of a biogas production unit (550 m3 digester) operating on slurry;
- construction of a gasification unit operating on rice husks (200,000 t) for the generation of electricity for use at the farm (100 kW).

2 - CONCLUSION

This integrated pilot plant is the first of its kind in Latin America, and is liable to lead to similar projects both in Colombia and in neighboring countries.

The project could be implemented over a two-year period starting in 1985.

It aims to favor pig production and thereby generate foreign currency earnings for the country.

Colombia is witnessing a drop in its currency reserves. The project will help the country avoid imports of raw materials, such as soybean cake, fishmeal and cereals.

The model project has three different aspects:

1) the transfer of technology

2) the supply of necessary equipment

3) a training and integration program.

When the program has been completed and operation is underway, we plan to organize a seminar for all Latin American countries to assess the project from the viewpoint of communities in Colombia and elsewhere.

IVORY COAST

Summary report of speech delivered by Mr Konan David, Technical Director, SODEPALM-PALMINDUSTRIE

1 - INTRODUCTION

Since 1960, Ivory Coast has extensively developed oil palm production, and is now the world's third largest producer, after Malaysia and Indonesia.

In our oil mills that are energy self-sufficient, almost all solid waste is utilized:

- Bunch refuse is incinerated in pits dug in the ground, and the ash obtained is spread on the plantation as fertilizer;

- Fiber and shell debris are utilized as fuel in the boilers to produce the steam required to drive a turbine generator for electricity generation, and as a source of heat for the production process;

- Shells are only partly utilized, as a make-up fuel for the boilers.

However, liquid waste was dumped until 1978-1979, when tests were run on a pilot methanization plant.

2 - PILOT PLANT AT DABOU

This pilot plant is made up of a 20 m3 fementation unit into which sludge is pumped continuously. The sludge has undergone preliminary aerobic fermentation after being stored in a buffer tank.

Only sludge from the clarification process has been treated to date in this fermentation unit. This sludge contains 50 g of dry matter per liter (5%), 100,000 mg raw COD/liter and 35,000 mg BOD5/liter.

Digested sludge floats to the surface and flows into a settling tank for aerated lagooning, while concentrated sludge is recycled.

Biogas is injected constantly into the digester to ensure homogeneity, and the sludge circulates through a water heater operating on biogas to maintain digester temperature at 35°C.

Tests were run over a one-year period, and results were particularly good:

. residence time in digester: 14 days;

. biogas production in fermentation unit: 2.86 m3/m3 of digester capacity;

. overall biogas production: 40 m3/m3 of waste.

Biogas yield per unit of untreated waste is excellent compared with the results obtained in Malaysia, for example, where biogas yield was 28.8 m3/m3 of untreated waste.

3 - PROJECT FOR THE INSTALLATION OF AN INDUSTRIAL PROTOTYPE

Three objectives are sought:

- reduction in pollution levels by significantly reduced COD (more than 90%) through anaerobic treatment;
- utilization of products of the methanization process:
  . biogas for electricity generating sets for lighting in factory staff accomodation;

  . digested sludge for possible agricultural use;
- construction of a prototype that could serve as an example to the entire region.

3.1 - Action taken

Under the auspices of the Ministry of the Environment and the Conseil de l'Entente, a fact-finding mission was led in November 1983 by Mr de Gromard of the AFME (Agence Française pour la Maîtrise de l'Energie), who proposed a visit by technical specialists to assess the research program proposed by the Ministry and the company PALMINDUSTRIE, and to estimate the costs of pollution control.

This technical and economic visit was made in January 1984 by a specialist from the company BIOMAGAZ. His conclusions were as follows:

- The cost of upgrading the Dabou pilot unit is so high that it would be wiser to consider installing a new plant.
- The results obtained from this unit and the statistics collected in the field confirm that the methanization of palm oil mill effluent is an economically viable project.

3.2 - Further action

The project has not found financing to date. The Conseil de l'Entente is very interested in the project and has already contacted financing institutions with a view to implementing this project, but full financing has not yet been granted.

Additional studies must still be carried out into the biological aspects of the project (biogas yield and composition), as well as into technological and technico-economic factors.

Further, a more accurate assessment should be made of the possible uses of biogas and treated sludge in thye light of the organization and requirements of each of PALMINDUSTRIE's twelve industrial facilities.

Finally, provisions must be made for design engineering, technical assistance for the construction and operation of the plant, and, if necessary, staff training.

IVORY COAST

Summary report of speech delivered by Mr Traore, Société Ivoirienne de Technologie Tropicale (I2T)

1 - INTRODUCTION

This project involves the use of a low-capacity gas generator operating on parchment coffee, and aims to further our attempts to master the use of the suspension-type gas generator, in response to the good results obtained with gas generators operating on coconut fiber and hevea (rubber tree) wood.

2 - PROBLEMS ENCOUNTERED

In coffee plants in Ivory Coast, parchment is not utilized at present, and is completely wasted through burning. This parchment can be utilized to supply a gas generator producing lean gas to run a diesel-engined electricity generating set. The energy savings achieved would reduce cost price of the finished product.

In order to utilize this by-product, however, the capacity of the gas generator must not exceed 140 kW, since the dimensions of this type of equipment are such that narrow cross-sections are required, and circulation problems can arise, particularly with parchment coffee.

Further, gas generators manufactured in industrialized countries are generally not specifically designed for these uses, since they are either designed for higher power levels or else because they are not suited to the use of by-products such as parchment coffee. They are not usually intended for use in developing countries, since this would require robust design, simple operation and easy maintenance.

3 - THE PROCESS

The gas generator planned is fairly conventional, with a vertical combustion chamber mounted over an ash box. It does, however, have a number of more original features:

- There is no grating between the combustion chamber and the ash box.
- Air is injected in the center of the ash box in order to monitor particle size.
- The base of the ash box is fitted with a hydraulic seal and two injection nozzles for injecting cool air into the center of the hearth and thereby reduce the formation of fusible ash around the perimeter.
- Facilities are planned to allow for the suction of water vapor and gas from the top of the combustion area for drying the product.

4 - COST BREAKDOWN

Costs are presented below ('000 CFA francs):

EQUIPMENT	COST
Gas generator	20,000
Electricity generating set (150 kW) with dual-fuel engine	35,000
2 fans (600 m3/hr and 150 m3/hr)	8,500
Pipes and valves	1,000
Scrubbing system + pump	500
Gasometer (25 m3)	8,000
Connections (electrical + engine supply)	1,000
	======
TOTAL	74,000

The transportation of parchment coffee (3 million CFA francs), development studies (5 million CFA francs) and labor costs (30 million CFA francs) bring the total cost of the project to 112 million CFA francs.

IVORY COAST

Summary report of speech delivered by Mr Sery Gale, Director for Agro-food Industries, Ministry of the Interior

1 - INTRODUCTION

There are three principal sources of wood waste:

- Deforestation for agricutural purposes: it is difficult to gauge how much waste is generated by these activities, but some 500,000 hectares of forest are felled for this purpose every year.

- Forestry activities: Ivory Coast produces an estimated 4 million cubic meters of timber each year. For every m3 of marketable timber, 3 - 4 m3 are wasted, which represents approximately 12 - 16 million m3 of unused wood.

- Sawmills: of the 4 million m3 of timber, 1.8 is sent to sawmills. Our sawmills operate at 40 - 42% efficiency. Approximately 1 million m3 of sawmill waste is thus generated each year.

2 - DESCRIPTION OF PROJECT

We believe that these waste products could be utilized to produce gas, and we have prepared a preliminary project concerning the gasification of sawmill waste.

In view of the levels of efficiency attained by sawmills in Ivory Coast, these facilities are forced to destroy large quantities of waste. The use of this waste for the generation of electricity seems an economical method of minimizing the cost price of the finished product.

Possibilities include combustion and the production of lean gas through a gasification process.

The gas could be used directly in an engine designed to operate on lean gas driving an AC generator to produce electricity.

The method that is most appropriate for developing countries seems to be the gasification process. Gasification makes it possible to limit investment and enhance energy efficiency.

The process planned under this project involves:

- processing of waste into cubes of approximately 4 x 4 x 4 cm;
- partial drying of wood;
- gasification in a vessel that could be built *in situ*;
- partial dedusting of gas;
- three stages of filtration of gas.

The gas could be used to run a diesel engine, that could be transformed with a system of regulation.

3 - CONCLUSION

To ensure the success of this project, efforts must be concentrated on the handling of the sawmill waste, the drying of this waste, and the manufacture of gas by the gas generator.

All these phases could be carried out in Ivory Coast, and our intention in coming here today is to find a suitable technology, as well as financing for the implementation of this project *in situ*.

IVORY COAST

Summary report of speech delivered by Mrs Toka Djega,
Directorate for Agricultural Planning and Modernization and
Utilization of Agricultural Products and By-products, Ministry
of Rural Development

1 - INTRODUCTION

The project that I am going to speak to you about involves the recovery of forest clearance waste for subsequent production of gas in rural areas.

The project is in fact a pilot project and forms part of the rural planning strategy adopted by the Ministry of Rural Development in an aim to increase recognition of rural population groups and improve their standard of living.

2 - DESCRIPTION OF PROJECT

The Directorate for Agricultural Planning and Modernization and Utilization of Agricultural Products and By-products, which I am representing today, is proposing to utilize forest clearance by-products.

These by-products consist of twigs, dead leaves and tree trunks that are discarded during clearance activities. Clearance activities can be classified as follows:

- Clearance of large areas carried out by the forestry commission SODEFOR under the reforestation plan. These activities are controlled by the Ministry of Agriculture, Water Resources and Forests.

- Large areas are also being cleared for young farmers to become established. The number of operations is small, but the total area involved is considerable.

- Small-scale farmers are clearing forest areas in a large number of locations.

Each of these types of clearance activity generates substantial quantities of by-products.

Collection and utilization of these by-products in biogas production will make it possible to solve various problems (accumulation of waste in cleared plots, the absence of electricity supply in remote areas, supply of diesel oil to remote areas equipped with generating sets, migration of young people to cities due to a lack of basic comforts in rural areas).

In an effort to solve these problems, we propose the following program:

- quantitative assessment of by-products;
- examination of profitabiltiy of project;
- selection of a rural location for the project, aiming to meet the lighting requirements of a village;
- design and construction of a suitale gas generator operating on wood and dead leaves;
- collection and drying of by-products;
- start-up of gas generator;
- production of gas to supply a diesel-engined electricity generating set of 50 - 100 kW, aiming to supply the distribution grid of a village of 200 - 300 inhabitants.

3 - CONCLUSION

Our project is still in the early stages of development, and we have not made a full examination of all the aspects of the problem. We hope and believe that the presentation we have made today will attract the interest of all the financing institutions and companies we have come to meet.

The Directorate for Agricultural Planning and Modernization and Utilization of Agricultural Products and By-products will be happy to provide those organizations with further details of the project, so that work can be started as soon as possible.

Mrs Toka Djega then proceeded to give with a brief presentation of another project concerning the gasification of rice husks generated by Ivory Coast's six rice processing facilities.

Close to 45,000 tons of paddy were processed by these facilities towards the end of the rice season. Average yield is 77%, leaving 23% waste materials. Waste thus represents approximately one-quarter of the total weight of processed rice (11,000 tons).

This waste is due to increase in volume considerably by 1986 under the emergency rice program that has been launched in Ivory Coast.

Rice processing facilities are installed throughout the country, and initial problems thus include the selection of a site for the project and the collection of waste products.

CUBA

Summary report of speech delivered by Mr Tutor Sachez, Specialist in Project Analysis and Development, State Committee for Economic Collaboration

1 - BACKGROUND

The first biogas production plants (operating on pig slurry) were not built until 1982.

A nationwide survey was carried out to determine whether sufficient quantities of raw material existed in Cuba to justify the development of this technology.

In the cattle, pig and poultry breeding sector, for example, potential resources stand at one million TOE (tons of oil equivalent).

Aside from the energy aspect of this project, such a solution overcomes the hygiene problems posed by the accumulation of livestock and poultry excreta.

The basic goal of the project is to develop a system of highly efficient anaerobic digesters for pig breeding centers located throughout the country, in an aim to produce biogas and fertilizers that can be utilized by each of those centers.

2 - PLANT CAPACITY

Calculations were made in a pig breeding center with a capacity of 24,000 pigs producing 650 m3/day of slurry with 1% dry matter content (due to high levels of dilution: 27 liters of water/day/animal).

One digester can thus be loaded with 80 m3 of slurry with 8% dry matter content.

2.1 - The energy aspect

- Average electricity consumption of the centers is 50 kWh/day.

- Two electricity generating sets (unit capacity: 50 kW) are planned for each center, one of which would be a stand-by unit for use in peak periods.

2.2 - The economic aspect

The Cuban Ministry of Agriculture has approved this project, but financing is now required from an overseas body. Financing would cover equipment costs and the technical program, supervision of construction and installation of the plant, and training of the Cuban staff that will work within the company.

Financing requirements have been estimated at $720,000.

Cuba would handle civil engineering, heating, hydraulic and electrical plant with technical assistance from abroad, costing an estimated $1,200,000.

3 - CONCLUSION

- The production of biogas in pig breeding centers is a response to current problems such as environmental pollution, hygiene, and the production of organic fertilizers from waste materials.

- Raw materials are available, as was demonstrated by a survey carried out throughout Cuba, and it is possible to use the energy potential of these raw materials to replace conventional energy sources.

- Results of a pilot plant have made it possible to confirm that pig slurry is an interesting source of biogas, allowing for high yields and relatively short retention times.

- The use of biogas produced in anaerobic digesters has the following advantages:

  . relatively low investment costs;

  . simple, accessible and unsophisticated technology;

  . possibility of centralizing utilization and production of this energy so as to minimize transportation costs;

  . minimal risks of environmental pollution.

DOMINICAN REPUBLIC

Summary report of speech delivered by Mr Pou, Head, Technological Coordination Bureau, National Commission for Energy Planning (COENER)

1 - INTRODUCTION

I am going to introduce the agricultural program that we have implemented with a view to utilizing wood as a source of energy.

The Dominican Republic covers an area of 49,000 km², of which 60% is mountainous. The population of 6 million is growing at a rate of 2.6% per year. The energy crisis which the Dominican Republic, like so many other countries, has experienced over the last few years, is primarily due to the very high cost of petroleum and petroleum products. This crisis has led us to seek other sources of energy, and the use of traditional sources of energy has thereby been rationalized.

Traditional activities involving the use of wood for the production of woodfuel and charcoal have had an effect on the country's ecological balance, and large areas of forests and woodland have been cleared.

Over recent years we have developed the concept of energy plantations. That concept involves utilizing a number of areas of dry, semi-dry and wet woodland for the production of woodfuel from rapid-growth trees. We believe that this can help meet fuel requirements in rural and urban areas, which in turn should bring a sharp decrease in the rate of deforestation.

2 - CURRENT SITUATION

At this time approximately 75% of the population uses woodfuel for cooking purposes. Bakeries and rural brickworks also use woodfuel.

Twenty-five percent of the nation's energy requirements are met by wood, of which 82% is consumed by households. The main source of this woodfuel is dry woodland, which covers some 600,000 hectares, but semi-dry and wet woodlands also provide woodfuel, and cover 440,000 hectares in the mountainous regions of the country. It is estimated that woodfuel production would require clearance of 140,000 hectares of woodland, since average yearly consumption is 0.45 m3 of wood per inhabitant.

Requirements are thus 270,000 hectares per year. According to assessments that have been made, forestry reserves for woodfuel and charcoal could be exhausted by 1987 if an energy plantation program is not implemented very rapidly.

3 - THE COENER PROGRAM

A series of studies and research projects have been carried out under the woodfuel production program that we have been carrying out since 1982, including:

- strategic planning for woodfuel charcoal and charcoal;

- preliminary analysis of the energy plantation project;

- assessment of financial possibilities for forest plantations;

- outline of 12 different projects for energy plantations;

- preliminary project for the creation of commercial plantations;

- study of the processing ofdry wood from native species;

- tests on species occurring in all ecosystems in the country (eucalyptus, citriodora, etc.);

- installation of a gasification plant with several types of kiln, for the production of charcoal.

Several rural communities already have small areas of woodland that are utilized for the production of their own charcoal. Dry woodland is of great importance. The Agricultural Institute uses 1,000 hectares as a test area for energy plantations.

Certain areas of wet woodland are also available for experiments, but the work is being carried out by companies in the private sector. We these companies technical assistance to ensure that experiments continue.

4 - REQUEST OF 1HE COENER

The work that has already been successfully completed demonstrates that technical solutions are being found to most of the problems that we have encountered during the development of this program. We have already identified the species of native trees that are most suitable. The yield and performance of forestry systems and charcoal production techniques have been enhanced.

Under these conditions, the government of the Dominican Republic considers that the creation of energy plantations in the short term, particularly in areas close to the edge of existing dry woodland, should be a priority of the national energy policy.

A number of private banking institutions, including the Groupe Financier Populaire (one of the country's largest financing institutions) have demonstrated their interest in this program.

Nevertheless, in view of the importance of the program, we feel that a development fund should be set up to centralize potential or existing private initiative in the field of production of wood as a fuel source.

For the creation of this fund, the Dominican Republic is seeking the participation of overseas financing institutions and foreign investors that are interested in establishing energy plantations in order to develop the process of woodfuel and charcoal production, and that would be willing to make joint investment committments with the government or with private bodies.

3 - CONCLUSION

We believe that a feasibility study should be carried out to assess the economic advantages that such investments can bring to interested organizations.

We request financing for this study from the Consultative Committee. A summary report of work carried out to date would be required, as well as an analysis of the current market for wood as a fuel source and as a raw material for gasification and combustion (charcoal, woodfuel, etc.).

Studies must also be made of the financial viability of the project, and of the conditions in the country in 1985. We also believe that work must cover the various different ecosystems of the country. The study should be made over a period of five months. Investors must be involved either in woodfuel production projects, or in charcoal conversion projects. Financing can come from mixed sources (private and public) and a final report should be submitted towards the middle of 1985.

EGYPT

Summary report of speech delivered by Mr Khalek, Chairman and Chief Executive, United Group

We have recently completed a feasibility study of the construction of an organic waste treatment plant for household waste.

1 - CHOICE OF SYSTEM

The population of Egypt is growing, and at the same time deforestation is reducing the quantity of available wood. A shortage of forage is imminent.

Furthermore, soil quality is deteriorating due to excessive cultivation, and pollution cause by municipal and industrial waste are increasing.

Certain types of waste, such as paper, plastic and glass, can be re-used.

The above reasons have led us to adopt composting as a system of processing household waste.

2 - THE PROJECT

Egypt already has some experience in the field of composting: a private plant treating household waste has been set up without financial support from the municipality, and has been followed by five other projects located in different areas of the country.

We have recently completed a feasibility study on combustion and composting of the organic matter contained in household waste.

When applied to a city of 500,000 inhabitants, the plant will be able to treat 100 tons of household waste per day, to produce 60 tons of compost in an initial period.

Subsequently, it will be possible to collect all other compostable materials, and compost production could be doubled (depending on requirements) after two or three years.

The total cost of the project has been estimated at FF 25 million, but if capacity is doubled from the outset, costs would be 25% lower. Selling price of the compost produced by the plant will be FF 300/ton. The payback time on an investment of this type is at least ten years.

3 - THE PROCESS

The organic matter contained in the household waste undergoes a period of decomposition during which micro-organisms convert the waste into useful nutrients (natural fertilizers).

The principal parameters of fermentation are oxygen, temperatire, moisture content and particle size.

Micro-organisms involved in anaerobic fermentation can produce toxins: temperature levels must be high enough to initiate ionization. Experience has shown that 2 m3 of oxygen are required, particularly during the first two weeks of fermentation, and that oxygen demand then falls gradually.

The physical or chemical properties of certain substances can have a negative effect on the mixture. High organic matter content, however, is a favorable factor.

Sludge or water can also be involved for enriching the substrate and increasing the percentage of nitrogen in the mixture.

Temperature can be raised in an effort to maximize bacterial activity, but the spaces between particles then become full of water and anaerobic conditions are not optimized.

Nevertheless, the thermal process that raises the temperature to 65°C sterilizes the compost, eliminates undesirable bacteria, and favors multiplication of micro-organisms.

Particle size is another important factor. If a substrate is finely crushed, micro-organisms can act on a larger surface area. If the waste is more coarse, micro-organism activity is more difficult.

3 - CONCLUSION

Approximately 25,000 tons can be treated each year in a machine operating at maximum capacity. This level of input is equivalent to an area with a population of 100,000.

A preliminary study must be made for each plant to analyze the composition of the mixture. To ensure good results, the composition of the mixture must be specified in great detail, and close attention must be paid to local conditions.

Equipment must be technologically suited to local conditions, and maintenance must be easy.

GABON

Summary report of speech delivered by Mr Issembe, Deputy Director for Research, Ministry of Agriculture

1 - INTRODUCTION

This project involves the production of energy through methane fermentation of the droppings of laying hens, for the production of electricity and heating for incubators.

The project is planned in four phases:

1) Laboratory tests on a 100 l fermentation unit carried out at the INSA facility in Toulouse (France)

2) Installation of a 5 m3 pilot plant in France

3) Industrial pilot plant (80 m3) installed at the SMAG (Société Meunière et Avicole du Gabon)

4) Full-scale plant: 360 m3.

The project is currently in phase 3.

2 - THE CHALLENGE

Poultry droppings cannot usually be spread as manure due to health hazards (poultry disease). Use of this fertilizer is even more difficult in Gabon, where there are few areas of agricultural land in the proximity of the breeding facilities. Eighty percent of the country is covered with rain forests.

3 - THE RESPONSE: DESCRIPTION OF THE 80 M3 PILOT PLANT

The solution involves a concrete fermentation unit in continuous operation, which is loaded with 5 m3 of droppings per day with 10% dry matter content (after removal of feathers).

Despite its agricultural context, this unit is based on the very latest innovations in bacteriological fixing by screens (30 m2/m3).

After a retention time of 15 days at 33°C, the fermentation unit produces two volumes of biogas for each tank volume each day (35 TOE/year).

If the following modifications are made:

- retention time: 12 days

- volume of droppings: 6.7 m3/day

- fermentation unit temperature: 45°C

production can be increased to 3.3 volumes of biogas per tank volume per day, which thus generates 58 TOE that can be used in a dual-fuel (fuel oil/biogas) electricity generating set.

4 - PROSPECTS

The plant must now be enlarged (phase 4 of the project) in order to utilize up to 30 m3 of droppings per day. This level of production requires a fermentation unit of 360 m3, would allow for production of 200 TOE/year, and would make the breeding facility self-sufficient in terms of energy.

5 - COST BREAKDOWN

Investment costs would be FF 3 million, including the electricity generating set, and would allow for diesel oil savings of 207,000 l/year. Payback time on the investment is 3.5 years.

3 - CONCLUSION

- Gabon's objectives are food self-sufficiency, the increased participation of agriculture in the national economy, and the reduction of rural depopulation.

- In view of these objectives, the production of energy through such a project will help villages to modernize and would favor the repopulation of rural areas and the development of agriculture.

- Further, market openings exist, since Gabon produces 2,500 tons of chickens, for domestic consumption of 7,000 tons.

- In the light of falling petroleum production (the cornerstone of Gabon's economy), it is essential for the country to prepare itself for the "post-petroleum" period.

GUINEA

Summary report of speech delivered by Mr Camara, Engineer, General Directorate for Agro-food Industries, Ministry of Industry

1 - THE KOBA SUGAR COMPLEX

1.1 - Introduction

The sugar complex at Koba has been in operation for 11 years, and derives part of its energy from bagasse.

The plant has a yearly production capacity of 6,000 tons of sugar, and includes a distillation plant producing 720,000 liters of alcohol.

According to forecasts, the plant was expected to produce 7,800 tons of bagasse per year, which is equivalent to 14.4.10 9 kcal of energy. However, under actual operating conditions, an average of only 3,700 t of bagasse is produced each season, which is equivalent to 6.8.10 9 kcal.

The production of bagasse could increase if sufficient areas were cultivated (1,500 ha) and if yield was high (40 tons of cane per hectare) When these two conditions have been met, the energy consumed by the facility will be chiefly derived from bagasse, with fuel oil as a make-up source.

1.2 - Utilization of energy

Steam energy is used in various ways:

- in the refinery: evaporation, boiling and spinning (i.e., sugar processing);

- in the electricity power plant, for the supply of electricity to the plant and the industrial zone;

- in the distillery, for the production of alcohol.

After combustion, all bagasse ash is discarded.

1.3 - Alcohol production

Yearly molasses production should reach 2,700 tons, but the plant produces an average of 500 tons, which is equivalent to

135,000 liters of alcohol per year (375 kg of molasses produces approximately 100 liters of alcohol).

The alcohol produced by the plant is sold to a pharmaceuticals company for use by a variety of consumers, including hospitals.

The carbon dioxide given off during the distillation of molasses is completely wasted.

1.4 - Conclusion

Various requirements have come to light:

- increased bagasse production;

- improvement of the process utilized for crushing and pressing of cane;

- examination of the possibility of replacing fixed grates by mobile grates in the boiler;

- examination of the possibility of utilizing the alcohol produced as a fuel.

The following action is planned:

- We are seeking technical assistance for an exhaustive study of the problems linked to the maximization of energy production from various by-products, as well as financing for the cultivation of new sugarcane plantations.

- We are currently planning to transfer plantations to areas at lower altitudes. A feasibility study has been made, and we are seeking financing for the implementation of this project.

2 - OTHER PROJECTS

2.1 - SALGUIDA Company

SALGUIDA is a Libyan-Guinean parastatal involved in agricultural and agro-industrial development. The company has an integrated pineapple plantation and processing facility.

A project was launched in 1984 in an aim to guarantee the energy self-sufficiency of the company. It involves the production of energy from biomass and sunlight. The biomass is as follows:

- The biomass involved is pineapple crop residue. After crushing and drying, the product is densified into briquettes or shives with a heat value of 4,500 kcal/kg.

- The quantity of waste in terms of dry matter content is estimated at 700 t/year, and is to be used to supply gas generators producing lean gas to run engines to generate electricity (efficiency: 20%).

- This type of gas generator is suitable for running trucks, manuring vehicles and dumpers, and would thereby replace imported petroleum.

- The energy is utilized to supply electricity to the plant and offices, for pumping water and irrigation of plantations.

The cost of biomass energy has not been calculated separately: it is included in the total cost of biomass + solar power: FB 442.5 million.

The following action is planned:

- We are seeking technical assistance for a critical analysis of the project.

- If the project is feasible, we will proceed with a feasibility study and will seek financing for the implementation of the project.

- We are also considering utilizing draff as a fuel.

2.2 - Particle board facility

The installed capacity of this facility is 5,300 tons of particle board per year, but current production is only 3% of this level.

The facility utilizes waste (dead wood collected in neighboring forests) to produce a proportion of the energy consumed.

Aside from the particle board facility, there is a cinchona processing facility in the same area that is faced with the same energy problems.

We are seeking technical assistance for an examination of the conditions of setting up an energy project based on the use of the by-products from these two facilities to produce electricity.

2.3 - Groundnut and cottonseed oil mills

- the Dabola groundnut oil mill has a capacity of 10,000 tons of groundnuts (in shells), i.e., 7,500 tons of groundnut kernels.

  The facility utilizes the shells to meet a proportion of its energy requirements.

  However, the actual level of production stands at only 3% of these figures. These poor results are chiefly due to supply problems of raw materials (lack of transportation, unreliable production) and to energy problems (outdated boiler equipment, irregular operation of the hydroelectric plant).

- Under a cotton production project, we plan to build a cottonseed oil mill at Dabola, which will be associated with the groundnut oil mill.

  Planned capacity is 1,000 for 7,000 tons of seed.

  The cottonseed hulls will be processed to supply a proportion of the energy required by this mill.

INDIA

Summary report of speech delivered by Mr Singh, Director, Bio-energy Division, Non-traditional Energy Sources Department, Ministry of Energy

1 - INTRODUCTION

India has 700 million inhabitants, and a total cattle population of 345 million head.

These populations are increasing, and energy requirements are increasing with them. I should like to give you an idea of the residual materials that make up India's potential resources in this area. The residue should not be considered as waste, since it is re-utilized, and can be processed to form additional products.

2 - UTILIZATION OF BIO-ENERGY IN INDIA

We have a large number of bio-energy projects in many different sectors. The most important sectors, however, are rice and sugarcane.

- The use of rice husks is of great importance, as is the use of rice straw. These industries have tremendous potential if they can further optimize the use of rice crop residue.

- Another important area concerns the sugar industry, and the utilization of bagasse, which is burned in a quite inefficient manner by the industry at this time. We are in the process of setting up a unit inside a sugar production facility that crushes 2,000 tons of cane per day. To date, we have been using bagasse to generate electricity to meet the plant's requirements. We now intend to produce 16 MW, of which 10 MW will be used to supply the plant with electricity, while the remaining 6 MW will go to the distribution grid.

  We have more than 400 sugar production facilities. We are planning action in this sector, but I believe that there is room for cooperation in this highly specialized field, provided, of course, that we can find the financing required.

- We are taking action at local level in the utilization of waste products generated by distilleries. India has 125 distillieries throughout the country, but there is nonetheless room for overseas cooperation and the transfer of technology from abroad.

- Our livestock population is very large. Various types of program have been launched to improve the quality of the livestock, and to increase the weight of animals while retaining stability of the population. The quantity of waste materials will thus increase. This development offers tremendous potential for the production of energy and manufactured products.

3 - PROBLEMS

We are running a nationwide program for biogas production for domestic uses. In this respect, industry can play a major role, in that unit costs must fall as the number of gas generators produced increases. I do not understand why engineering principles cannot be applied to the reduction of the size of digesters. While we do not believe that digesters should be reduced to the size of pressure cookers, we feel that a combination of mass production techniques and the use of plastics for the construction of gas containers would make it possible to reduce the cost of these units while increasing the numbers produced.

At industrial level, we have large quantities of waste materials and animal excreta. There are livestock production facilities and dairies in and around most large cities, and these activities give rise to animal excreta that are both abundant and available. One project involves the generation of 3 MW of electricity from this waste.

We have outlined a large number of projects, and have selected sites. Now we are seeking cooperation in the areas that I have mentioned. We welcome the contributions that you have already made, and would greatly appreciate a cooperation agreement that would allow us to improve our knowledge of the areas in which you are working, and that would enhance your understanding of our specific needs.

3 - CONCLUSION

The bilateral cooperation program that could be set up as a result of this meeting could solve to our mutual advantage a number of the problems we are facing.

It is important to understand the efforts we are making in an aim not only to analyze objectives, but also to examine the potential resources of a country such as India, and thereby make a more meaningful assessment of what French industry and the European Community can do to help us solve the problems that face us.

INDONESIA

Summary report of speech delivered by Mr Soeriaatmadja, National Coordinator of Biomass Energy Technologies; Aide at the Ministry of State for Population and the Environment

1 - THE PROBLEM

One of the principal activities of the inhabitants of Lampung, Southern Sumatra, is tapioca production for the manufacture of cassava flour. Over the last five years, 11 large-scale industrial agro-food complexes for the processing of tapioca have been set up in that region.

Input for the industry and for flour manufacture is 200 - 400 tons per day on average, for a daily production of 100 tons of flour. The remaining 100 - 300 tons are generally dumped in rivers, leading to high levels of pollution in these watercourses. Water quality is deteriorating, and the situation is incompatible with the region's surface water resources, which are required by the tapioca industry.

The development of the tapioca industry has improved quality of the finished product, and markets are favorable both at home and abroad. Average income has also increased in the region. Certain by-products of this industry have considerable potential, but are not utilized at this time.

The negative aspects of this industry are beginning to make themselves felt more than the positive aspects, however, and small-scale tapioca processing is disappearing due to the greater competitiveness of large-scale facilities.

Another negative aspect concerns the ecology of the region. Surface water is highly polluted in terms of COD and BOD, and the quantity of water-borne toxic chemicals is increasing to such an extent that there is an imminent shortage of unpolluted surface water for use by population groups.

2 - ACTION PLANNED

A program has been outlined, covering technological and socio-economic aspects of the problem, as well as the question of management.

Tapioca industries must become involved in this program alongside local population groups, and the government must commit itself to the implementation of these meesures, in an attempt to increase awareness of the gravity of the problem and to find an effective solution.

Steps that have been taken to date involve technological aspects of the problem. Stabilization lagoons must be improved. Waste from the tapioca industry must be recycled, and this project faces additional problems.

The objective is to manufacture granulated animal feed and citric acid, and this causes additional problems of pollution.

By-products must be recycled:

- through composting

- through biogas production.

3 - CONCLUSION

Recycling of by-products is still at the experimental stage. We have made little progress in the examination of biogas, and we have come here today to find out which different approaches could be taken to solve the various problems that face us. All parties concerned by the pollution caused by tapioca waste must be involved in this project and must work together towards finding a solution.

We have already formed a provincial environment unit that is responsible for pollution control, the assessment of case studies, and staff training.

KENYA

Summary report of speech delivered by Mr Jones, Energy Conservation and Fuel Oil Replacement Adviser, Ministry of Energy and Regional Development

1 - INTRODUCTION

Kenya has no known reserves of coal or petroleum. The country's energy comes from a number of hydroelectric and geothermal electricity schemes, and from substantial quantities of imported petroleum.

A survey is to be carried out to assess the potential for replacing petroleum with residual biomass such as waste from rice, coffee, flour, soybean and other agro-food industries. The substitution value of these by-products (utilized at the factory location) is $6 million.

2 - OBJECTIVES

To a certain extent, this project is a demonstration operation aimed to identify the most efficient way of utilizing residual biomass in existing boilers and generators.

The operation will thus allow for more widespread use of this type of technology and increased use of this type of fuel.

3 - THE PROJECT

The specific proposals of the Kenya Cashewnut Company would involve an engineering and feasibility study, in an aim to identify the steps that the company should take in an effort to make the most suitable investments needed to adapt its equipment and make it possible to burn cashewnut waste.

The factory utilizes 3,000 tons of petroleum each year to roast and dry cashewnuts.

At the same time, it produces 7,500 tons of cashewnut shells, whose market value is very low, and which are disposed of by burning.

Utilization of these shells in the plant's boilers would allow for savings of $600,000 on fuel oil expenditure.

The project involves three uses of cashewnut shells:

- in the roasting process
- as a fuel
- to generate the electricity needed in the factory, surplus (if any) being sold to the distribution grid.

3 - CONCLUSION

This project would serve as a demonstration operation for the use of low-cost equipment for the local production of energy.

Between 50 and 100 plants in the country would be suitable for a project of this type, provided ovens and boilers are converted.

MADAGASCAR

Summary report of speech delivered by Mrs Razafindrakoto, Directorate for Programming and Financing, Ministry of Livestock and Animal Production, Water Resources and Forests

1 - INTRODUCTION

In line with the government's energy policy, the project presented here aims to further the integration of the country's extensive unused resources, particularly with a view to contributing to the satisfaction of very large energy requirements for domestic purposes.

The project thus involves the integration of biogas in Madagascar at community level, and its main objectives are as follows:

- to utilize available agricultural and animal waste that is suitable for the producitón of biogas;
- to utilize local resources to supply energy to population groups or isolated villages, farms or industries.

2 - THE PROJECT

The biogas production project is applied here in the form of a pilot plant for a Technical Training Center for Livestock Breeding, offering courses for breeders and livestock agents. The center has seventy head of cattle, and facilities (dormitory, kitchen, etc.) that consume energy for lighting, heating, cooking and preparation of cattle feed.

The center, which is currently connected to the national electricity distribution grid, has a diesel-engined electricity generating set for emergency use.

3 - ENERGY BREAKDOWN

The seventy head of cattle at the center produce approximately 250 tons of manure per year, which is theoretically equivalent to an average biogas production of between 12,500 m3 and 25,000 m3.

The easiest way of using this energy is in the form of electricity. At 1.5 kWh/m3 of biogas produced, and with transmission losses of 20%, potential production that can be used directly by the center is estimated at 15,000 - 30,000 kWh.

The center requires an estimated 30,000 kWh per year.

In the least favorable scenario, 50% of the center's consumption is thus covered by biogas production, while under optimuim conditions processed waste can meet energy requirements fully.

4 - EXECUTION SCHEDULE

4.1 - Installation phase

Five months will be needed to build and install a biogas production unit of the type proposed by the Groupe de Recherches et d'Echanges Technologiques (GRET), designed to operate on 0.5 - 2 tons of manure per day, and producing 25 - 80 m3 of gas per day. These levels of input and production correspond to the characteristics and requirements of the first site selected: the Technical Training Center for Livestock Breeding.

4.2 - Development phase

The plant will be run in over an eleven-month period, and a more detailed study will be made with a view to enlarging the scope of the projects to cover other sites.

4.3 - Economic and financial assessment phase

Another eleven months will be needed to assess the total investment requirement for the preparation of new sites, civil engineering work, machinery and other capital goods, etc., and to identify sources and conditions of financing for the project.

5 - CONCLUSION

This presentation is merely a preliminary step towards the development of the use of new and renewable energy sources in Madagascar. It thus involves a general appreciation of the resource opportunities for the integration of the use of biogas at community level in Madagascar.

Much remains to the done before a genuine feasibility study can be carried out during the development phase, but it will be possible to consider the first pilot plant as a reference, and thereby ease the subsequent financial and economic appreciation.

MAURITIUS

Summary report of speech delivered by Mr Rivet, Principal Assistant Secretary, Ministry of Energy and Internal Communications

1 - INTRODUCTION

The island of Mauritius has few resources, and depends to a large extent on imported petroleum products (18% of total imports) for the satisfaction of its energy requriements.

The country produces 30% of its energy through the combustion of petroleum. It was thus decided to replace this imported energy source with a cheaper fuel.

To reach its objectives in the energy sector, various options are open to the government:

- increased hydroelectric production

- increased electricity generation from bagasse

- increased energy production from imported coal.

2 - THE PROJECT

In view of the climatic changes that have been observed in Mauritius, the island's objectives for hydroelectric production, which we thought could be developed over the next decade, will probably not be reached.

The generation of electricity from bagasse will thus be a major factor in Mauritius' aims to produce electricity without importing petroleum in 1986, and will make it possible to meet one-half of our energy requirements using national resources.

The project is in an advanced stage of development, since it is approaching the investment phase.

Preliminary estimates have been made in a number of factories, and have made it possible to assess the size of the investments that will be required by our program.

For example, a pilot project has indicated that for a plant processing 100,000 tons of sugarcane, a bagasse treatment facility with a capacity of 25 t/hr would require an investment of $14 million.

Other sugar complexes could also become involved. This would make it possible to produce 250 kWh from bagasse and would increase investments to $72 million.

Further, if all units were fitted with pelletizing lines, electricity production costs would fall by one-third.

Bagasse storage should also be taken into account, so as to ensure a constant supply of fuel. However, storage has a negative effect on the heat value of the fuel.

It should be possible to extend the project to all of the island's 21 sugar complexes, but in the first instance, pelletizing lines are planned for the four major facilities whose potential is the greatest.

MALAYSIA

Summary report of speech delivered by Mr Baharunden, Director, Raw Materials Processing Department, Federal Land Development Authority (FELDA)

1 - INTRODUCTION

The organization I represent is a public body involved in the utilization of brushlands within the wider context of the government's agricultural program, but more particularly with a view to developing oil palm plantations.

Malaysia has 208 palm oil mills (State-owned and private sector combined), and 25 additional State-owned mills are to be built under our next program.

2 - BIOGAS POTENTIAL IN MALAYSIA

Given the number of palm oil mills in the country, the removal of the large quantities of wastewater disharged by this industry is a very real problem. A new technique now makes it possible to adopt a different approach to the problem, since oil mill waste can be used to produce methane and other related gases.

This biogas can then be a significant source of energy for the production of electricity under the Malaysian government's program to bring electricity supply to rural areas. It is estimated that daily biogas production could reach 6,000 m3, which is equivalent to 630 kWh.

3 - UTILIZATION OF BIOGAS

A number of studies have been led into the utilization of biogas for domestic purposes, but propositions have not been of particular interest due to the high costs involved.

The most usual method of utilizing biogas to generate electricity involves direct combustion of the biogas in a gas-fired engine, after removal of other related gases. However, it is difficult to completely remove sulfur from biogas, and very high maintenance costs are incurred. Further, this type of system has not been recommended for use in oil mills, since it does not improve steam distribution, particularly in palm fruit sterilization.

An unccupled co-generation system for steam production has been adopted for most of the palm oil mills in Malaysia that have an hourly processing capacity of 20 - 60 tons of fruit. Biogas is produced through methanization of the waste in a digester and is burned without any sulfur removal in the boiler, and thereby utilized in the production of high-pressure steam. Electricity is generated through steam turbines and is then distributed by the central grid to private users in rural areas.

The government has opted for this system, and it is encouraging its use for the production of electricity in rural areas. The system has the following advantages:

- increased electricity generation capacity
- no sulfur removal for combustion in boiler
- minimized operation and maintenance costs
- possibility of integration with oil production process to improve efficiency.

For the project to be viable, 630 kWh of electricity must be generated. Other conditions include:

- maximum cost of $1 million
- yearly operating costs less than $21,000
- annual electricity production greater than 2,900,000 kWh
- average unit cost of electricity: less than 4¢/kWh.
- average lifetime of installation: 25 years.

4 - CONCLUSION

We have highlighted a number of statistics concerning palm oil mills, and have examined the utility of electricity production. However, to implement this type of project, low-cost, efficient boilers and steam turbines must be purchased.

At this time, a more detailed examiniation must be made, perhaps by French specialists, to make it possible to install factories or equipment in a more economical and more appropriate way.

I invite all French companies to contact me in Malaysia, where resource and investment potential are both highly promising.

MOROCCO

Summary report of speech delivered by Mr Zabi, Secretary General, Comité de Développement des Energies Renouvelables (CDER)

The two projects that I am going to talk about are part of a renewable energy source development program, and are based on the use of animal waste for the production of electricity. They have been studied in collaboration with the Agence Française pour la Maîtrise de l'Energie (AFME) and the Comité de Développement des Energies Renouvelables (CDER).

1 - PROJECT 1: MARRAKECH MUNICIPAL ABATTOIR

1.1. - Introduction

This multi-purpose abattoir produces an average of 5,000 tons of carcasses each year, and has a theoretical maximum capacity of 10,000 t/year. It is integrated in an industrial complex including a refrigerated warehouse, an industrial dairy and an animal market.

1.2 - The problem

Liquid waste that is dumped untreated into the drains poses a serious hygiene problem. Solid waste is treated with tolyl, which is a highly expensive substance.

1.3 - The solution

The solution adopted to remedy these problems involves total waste processing using an industrial biogas-composting system, which is to be integrated in a project to modernize the abattoir.

The process is based on the principle of anaerobic fermentation in a favorable mesophilic environment (35°C).

Estimated average volumes are as follows:

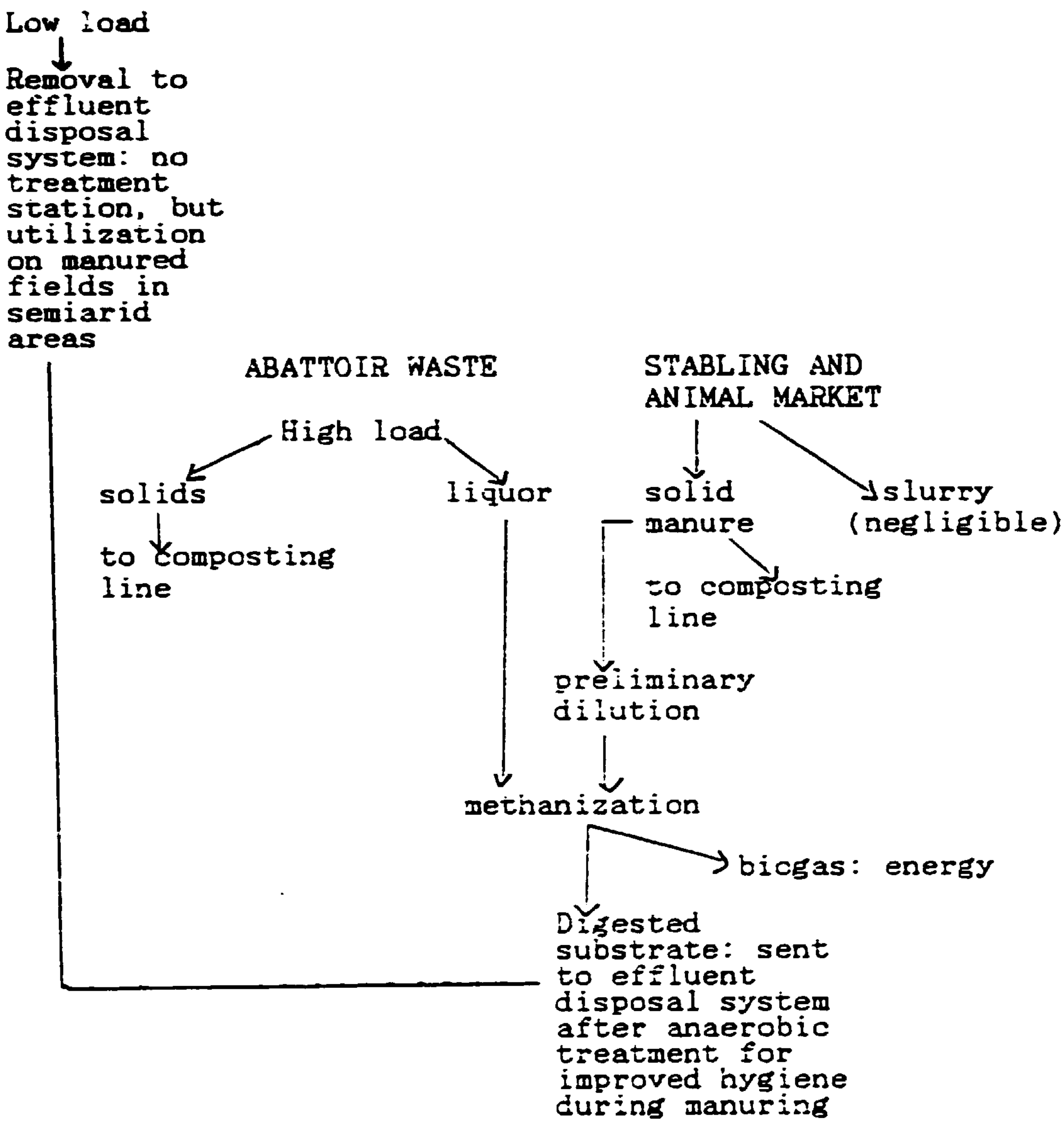
- slaughtering capacity: 17 t/day

- waste: 250 m3/day.

Total pollutant level is 1160 kg COD/day, which can be broken down as follows:

Type of waste	average daily volume (m3/day)	average daily pollution level (kg COD/day)
Centrifuged fecal matter (1,000 t/year at 12% dry solids content)	1	60
Waste from offal and concentrated waste*: 10 m3/ton of carcass	65	600
Liquid manure, slurry and rediluted manure with low straw content	10	500

* after water economy program


Low load
Removal to effluent disposal system: no treatment station, but utilization on manured fields in semiarid areas
ABATTOIR WASTE
STABLING AND ANIMAL MARKET
High load
solids
liquor
solid manure
slurry (negligible)
to composting line
to composting line
preliminary dilution
methanization
biogas: energy
Digested substrate: sent to effluent disposal system after anaerobic treatment for improved hygiene during manuring

1.4 - Estimated energy breakdown

With a recycling system and very short retention times, 0.35 m3 of biogas are produced for each kg COD removed (efficiency: 70%). Total daily biogas production is thus 285 m3 (100,000 m3/year).

- At 6 kWh/m3 of biogas, 600,000 kWh of electricity could be generated (thermal) or 150,000 kWh of electricity + heat energy.

- The hot water will be utilized to heat the fermentation unit.

- Specific consumption of the abattoir: 55,000 kWh/year.

- Electricity consumption for refrigeration: 250,000 kWh/year.

1.5 - Estimated cost breakdown

Energy costs of the abattoir are DH 46,000/year (DH 1 = FF 1), and refrigeration costs are DH 154,000/year, giving a total of DH 200,000/year.

Expenditure incurred through modernization and purchase of additional electrical appliances (approximately DH 50,000) must be added to this figure, bringing the total to DH 250,000/year.

Investment costs for a fermentation unit, a gas storage facility, electricity generating set and utilities would stand at approximately DH 750,000, with a payback time of 3 years.

Sales of 200 t/year of compost would bring revenue of DH 10,000.

2 - PROJECT 2: THE SODEA FARM

2.1 - Introduction

The SODEA (Sociéte de Développement Agricole) is a State-run company that manages production facilities covering 56,000 ha throughout Morocco, including a 5,000 ha facility in the Marrakech region.

This facility that has been selected as a site for this project cultivates an area of more than 500 ha of olive groves, citrus and other fruits, and has a mixed livestock production capacity (milk + meat).

2.2 - The problem

This agricultural complex is not connected to the rural electricity distribuition grid (Office National de l'Electricité). All its electricity requirements (lighting, production lines, official housing, farmworkers' douar, milk reservoir, offices, etc.) are satisfied by two diesel-engined electricity generating sets. Costs for connection to the grid have been estimated at DH 45,000.

2.3 - The solution

Given the availability of 55 EHC (equivalent head of cattle) producing 3 m3 of slurry per day, and a retention time of 20 days, tank capacity requirements are 60 m3.

Average biogas production from this type of slurry is 2 m3/m3 of tank capacity, i.e., a total of 120 m3/day.

At the rate of 5.5 kWh/m3 of biogas produced, a total of 660 kWh of electricity (thermal) can be generated. A biogas-fired engine will thus make it possible to generate 60,000 kWh and 120 kWh (thermal) per year, which will be used to heat the fermentation unit, run milking machines, and meet cleaning and domestic requirements.

2.4 - Energy breakdown

To produce the electricity required for lighting and for the milk reservoir, the production facility has two diesel-engined electricity generating sets that operate for 9 - 10 hours a day.

In 1983, total diesel oil consumption reached 10,000 liters.

Overall diesel oil consumption (for 5 tractors, 9 water pumping sets and 2 generating sets) was 193,250 liters in 1983.

2.5 - Estimated cost breakdown

Overall energy expenditure of this farm is DH 600,000, including DH 116,500 for the diesel oil needed to operate two generating sets and a motor for raising water from a well.

Investment costs for the system proposed under this project (including tanks and biogas-engined generating set without related equipment) are DH 500,000.

Gross payback time on the investment will thus be 4.2 years.

The project is of considerable social importance, since it will make it possible to supply biogas for cooking and lighting of a douar of 30 families.

MOZAMBIQUE

Summary report of speech delivered by Mr Forte, Chief Executive, BOROR

1 - INTRODUCTION

BOROR is a State-run company operating four coconut production facilities of 4,000 - 6,000 ha each along the Mozambique coast. Overall yearly copra production is 14,000 - 18,000 tons, and objectives are to produce 20,000 tons by 1988 and 40,000 tons by the year 2015.

This company is faced with considerable problems of fuel supply and transportation, and yet most of its by-products (fiber and shells) are unused.

The present introduction is based on the feasibility study that was carried out by the engineering company SATEC DEVELOPPEMENT in late 1983, and outlines a project for the utilization of these by-products to produce energy with a view to arousing the interest of potential sources of financing.

2 - DESCRIPTION OF PROJECT

Each of the 4 units making up the company is divided into 39 blocks of 200 - 600 ha of plantation each. Each block has one or two copra drying kilns.

In order to automate each bloc and improve working conditions of the laborforce (7,000 - 8,000 in total), an electricity generating set would be required for each block. If this solution is adopted, the choice of gas generators would be fully justified.

Potential and requirements must thus be assessed.

2.1 - Fuel availability and requirements

Depending on requirements, we have estimated that one or two electricity generating sets operating on lean gas (unit capacity: 40 kW) would be required for a medium-sized block. To produce 40 kW of electricity, 6,000 coconut shells must be burned each day in the gas generator. A standard kiln processes 12,000 coconuts per day, and consumes approximately 40% of the husks (4,800 husks). Availability for conversion into energy is 7,200 husks and 12,000 shells.

Although this first approach has only been adopted for certain blocks, it has transpired that a standard kiln handling 12,000 coconuts per day is fully capable of producing 40 kWh, without affecting current methods of copra preparation.

2.2 - Proposed solutions

- A 40 kW gas generator costs FF 418,000 at this time. The difference in investment costs between this type of unit and a conventional electricity generating set is FF 332,000, which corresponds to fifteen months' supply of diesel oil to operate the conventional unit. Equipment is totally amortized in 19 months.

- A configuration with 3 gas generators of 40 kW unit capacity coupled in parallel would make it possible to generate 120 kWh at peak periods, off-peak requirements being met by one or two generators on stand-by.

- A smaller gas generator (15 or 20 kW) could be installed on a trailer for use on mobile units. This type of generator costs FF 90,000.

  A 400 kW gas generator unit consumes 10 tons/day of shells and produces 2 tons of charcoal. Power levels cannot fall below 270 kW, and investment costs are FF 4.5 million. A better solution would be to couple two 200 kW units, that would allow for an operating range of 140 - 400 kW, and would cost FF 6 million.

- Kits to convert farm tractors to dual-fuel (diesel oil/lean gas) or to lean gas only operation are reliable and offer good operational flexibility.

2.3 - Acquisition proposal

Foreign currency savings are a major concern of the authorities of Mozambique. In view of the vast areas covered by BOROR's activities, its difficulties in obtaining diesel oil, and the example that could be set by the gas generator project, the following proposals for purchase of equipment can be made:

- 3 electricity generating sets with gas generators (2 at Macuse, 1 at Pebane);

- 5 tractors fitted with gas generators.

These purchases would provide BOROR with economic references in this field, and the company could then opt to install this equipment throughout its plantations as and when investment is necessary.

CONCLUSION

A further examination of the modules available on the market must be carried out, although the 40 kW module is at present well suited to the needs of each block.

We should like industries to propose one module or several connected modules, including the following equipment: crusher, compacter, gas generator, and, possibly, a copra drying system operating on lean gas.

It is estimated that total savings of 1,000 TOE could be made in this way.

PAKISTAN

Summary report of speech delivered by Mr Shah, Technical Officer, Appropriate Technology Development Organization, Ministry of Science and Technology

1 - LIVESTOCK BREEDING: CONSIDERABLE POTENTIAL

1.1 - Methane fermentation from manure

Pakistan has 21 million head of cattle in rural areas, producing 10 kg of manure per animal per day. Only half of this manure is collected, and total yearly availability is thus 38 million tons. It would thus be possible to produce 1,418 million m3 of biogas and make fuel oil savings of 879 million liters (costing 3,076 million rupees).

1.2 Fertilizer production from manure

Moreover, the methanization of 1 kg of manure produces 0.72 kg of compost containing 2% fixable nitrogen. Only 20% of this nutrient is available in solid form, which gives a total nitrogen production capacity of 110 million kg/year.

A conventional composting process, producing compost at the rate of 0.56 kg with 1.5% nitrogen content per kg of manure (of which 20% is in solid form) would make it possible to obtain 64 million kg of nitrogen per year.

Methanization can thus lead to the production of an additional 46 million kg of nitrogen, with a value of 230 million rupees (5 rupees/kg).

1.3 - Poultry breeding

Fourteen million birds (laying hens, breeders or meat chickens) could supply a digester with 1,267 tons of droppings per day, and thereby make it possible to produce 23 million m3 of biogas per year (0.05 m3 of biogas/kg of droppings). This project would bring savings of 14 million liters of petroleum (costing 57 million rupees), plus revenue from fertilizers (2.8 million rupees).

Overall, Pakistan would thus save 3,400 million rupees in this sector each year.

2 - LEVEL OF DEVELOPMENT OF THE SYSTEM

Four types of digester are currently being developed in Pakistan:

- a fixed dome digester (capacity: 65 m3) supplied with cattle manure;

- a digester of 25 m3 supplied with poultry droppings;

- a digester of 5 m3 with flexible gasometer;

- a portable digester of 3.5 m3 that can be installed in a matter of hours.

The energy produced is usually utilized for cooking and lighting, but it can also be used to run an electricity generating set or pumping unit.

3 - CONCLUSION

1) Pakistan has considerable potential for methanization, and its clearly defined and determined policy should favor the utilization of this source of energy.

2) Projects should be developed with a view to obtaining optimum results under the country's different climatic conditions.

3) An information program should be launched in the press and on radio and television, and mobile units should be used to inform the population about this technology and the advantages it offers.

4) Volunteers should be trained in each district in order to ensure that the technology is quickly adopted throughout the country. Special incentives should be offered to these volunteers on the basis of the number of installations built under their leadership.

5) To overcome the difficulties encountered in installing conventional domestic units (foundations, steel constructions, etc.) turnkey plants are recommended, so as to enable installation by villagers themselves. Certain companies have run trial operations in this area, and results are encouraging.

SENEGAL

Summary report of speech delivered by Mr Cisse, Director for Energy, Minstry for the Development of Industry and Craftmaking

The government of Senegal has drawn up a program allowing for a 50% reduction in domestic consumption of petroleum products over about ten years. The projects presented here are part of this program.

1 - HOUSEHOLD WASTE IN DAKAR

This project involves the incineration of household waste produced in the city of Dakar, with a view to producing electricity.

The 1,200,000 inhabitants of the city of Dakar currently produce 1,000 - 1,200 tons of waste per day. This waste is of very varied composition and particle size.

Nevertheless, the following results were obtained from the analysis of a sample of this waste:

- moisture content: 30%

- LHV (dry): 2,150 kcal/kg

- LHV (untreated): 1,330 kcal/kg

- carbon content: 16.5%.

Estimations show that the incineration of Dakar's municipal waste would make it possible to generate 100,000 TOE of electricity, which would reduce the country's overall petroleum bill by close to 18%.

This preliminary study has been carried out by the EDF subsidiary DITT, and was associated with an examination of the commercial outlets for the electricity generated as a by-product. At this time, the national electricity company is prepared to handle all the electricity produced through incineration, provided that selling price per kWh remains lower than the prices currently practised.

A feasibility study will make it possible to optimize the choice of a site for the industrial incineration plant (estimated costs: FF 17 million), and to plan an adequate collection infrastructure. It would then be possible to consider household waste as a national resource, and an integral part of the nation's energy accounts.

2 - DAKAR ABATTOIR WASTE

This project involves the production of methane and compost from abattoir waste.

The Dakar abattoir currently handles daily:

- 200 head of cattle
- 600 sheep/goats
- 30 pigs.

Abattoir activities produce an estimated 10 tons/day of fecal matter, all of which could be treated in an industrial methane fermentation unit.

This unit will make it possible to produce:

- electricity (generated by biogas-fired generating sets) and hot water (essential for washing the abattoir), thereby meeting 40 - 50% of the abattoir's total energy requirements;
- compost (with a natural outlet in the market gardening areas of the Dakar peninsular).

The project will also make it possible to reduce pollution caused by the current practice of dumping this waste in the ocean.

Investment costs have not yet been precisely calculated, but will not exceed approximately FF 2 million.

Overseas assistance is sought for the feasibility study into the utilization of this waste, with a view to specifying the following:

- composition of waste;
- financing for investment;
- possibility of installing the industrial unit before the end of 1985 or during the first half of 1986;
- local training requirements for operation of facility.

SRI LANKA

Summary report of speech delivered by Mr de Alwis, Head, Agricultural Development Department, National Research and Development Center

1 - INTRODUCTION

Coconut fiber, a by-product of the copra industry, is available in large quantities in certain parts of Sri Lanka.

Natural decomposition of coconut husks is a very slow process, and these substances are at present very little utilized. Attempts have been made to re-use the husks as fertilizer in the coconut plantations, but organic matter content is insufficient.

A small-scale unit has been installed in one copra production facility to produce briquettes from the fiber. The production of these briquettes appears uncompetitive compared with charcoal production, since the briquette manufacturing process consumes large quantities of energy.

2 - AVAILABILITY OF THE BY-PRODUCT

The low density and high moisture content of coconut fiber (70 - 80%) make utilization difficult. Any process aiming to utilize this material must thus be preceded by a drying line and a briquetting line, both of which consume large amounts of energy. The treated product, however, has a heat value of 12,000 kJ/kg.

Coconut fiber production (10% moisture content) can be estimated at 150,000 tons/year. It is produced throughout the country, but particularly in the "Coconut Triangle" near Colombo.

The low density of coconut fiber makes it preferable to locate briquetting units in that region to avoid excessive transportation costs.

3 - EXISTING MARKETS

Fifty-five percent of the energy consumed in the country is derived from wood. Woodfuel consumption stands at 840,000 tons, of which half is utilized in the domestic sector.

There would be considerable demand for briquettes in urban and suburban areas if prices were competitive with prices of woodfuel. In rural areas, on the other hand, where wood is collected individually, demand is likely to be substantially lower.

Large quantities of liquid gas are consumed for cooking food in urban areas, and it would thus be fair to assume that the market for coconut fiber briquettes is open in this sector. However, since users are unwilling to return to the use of traditional open-hearth stoves, it is indispensable to install combustion equipment that is suited to this type of fuel. Our organization has developed an ideal cooker for this purpose, with a level of efficiency of 25%, compared with 5 - 10% achieved with traditional stoves.

There is also a market in the industrial sector: many industrial processes (small-scale foundries, blacksmiths, etc.) utilize fuel oil, woodfuel or charcoal, and constitute further market potential for coconut fiber briquettes.

4 - THE PROCESS

4.1 - Drying

Preliminary drying of the raw waste is very important, since it is a determining factor in the economic viability of the briquetting process.

Moisture content can be reduced to 40 - 50% simply by using hydraulic presses or rolling mills.

Solar-powered drying units are then used in the second phase of the drying process to reach 20% moisture content. A solar panel of 3.5 m^2 can dry 30 kg of fiber per day.

4.2 - Briquetting

Dry fiber is compressed into briquettes at a temperature of 130°C.

Compression is carried out by hydraulic machinery fitted with heated cylinders. These cylinders require a supply of hot gas or superheated steam.

A gas generator supplied with a small quantity of briquettes produces lean gas for a burner unit. This burner can be utilized with a boiler to produce superheated steam, or with a gas mixer to obtain hot gases at the temperatures required for the process.

Residual gases at the outlet of the briquetting machine can be utilized to supplement the solar-powered drying line.

5 - COST BREAKDOWN

The cost of an installation including presses, solar drying line, briquetting unit, gas generator and related equipment is estimated at 1.6 million rupees.

Operating costs (maintenance, electricity, etc.) are estimated at 23,000 rupees per month.

With daily production of 10 tons of briquettes, the plant will have produced 15,000 tons in 5 years. Five percent of this production will be utilized to supply the gas generator.

Briquette production costs are thus 0.38 rupees/kg.

Transportation costs between the factory and the point of consumption (50 km), and the density of the product (750 kg/m3) raise costs to 0.45 rupees/kg.

6 - ENERGY BREAKDOWN

Coconut fiber briquettes have a heat value of 12,000 kJ/kg. The price of the heat produced by these briquettes can thus be calculated at 37.3 rupees/GJ.

This price is only 60% of the least expensive alternative (wood).

TANZANIA

Summary report of speech delivered by Mr Nindie, Research Engineer, Energy Conservation Department, Organization for Industrial Research and Development (Tanzania)

The economic background of Tanzania (increasing problems of balance of payments and inflation rates, and decreasing rates of growth) is a result of the sharp price rises for petroleum products, and has led the government to direct research towards alternative sources of energy.

1 - ETHANOL PRODUCTION FROM MOLASSES

1.1 - Advantages and objectives

Tanzania sees alcohol fermentation for ethanol production as a feasible alternative, and favors small-scale units (5 m3/day). Such units would have the following advantages:

- low level of investment

- direct access to supplies of animal feed

- rapid implementation

- participation of local farmers (impact on employment)

- improved geographical distribution of alcohol-fuel supply

- effective instrument of rural development.

The Organization for Industrial Research and Development has carried out an investigation with a view to setting up a small-scale ethanol production facility.

The objectives of this project are as follows:

- to reduce foreign currency expenditure and redress the balance of payments;
- to increase per capita income in rural areas, while increasing the nation's agro-industrial activities associated with alcohol production;
- to reduce environmental pollution caused by disposal of molasses in Tanzania's rivers.

1.2 - The project

A pilot plant is planned, with a capacity of 5 m3 of ethanol per day.

This installation and those that follow will make it possible in the long term to supply more fuel to domestic markets, and thereby replace diesel oil and gasoline utilized by cars. Further, it will be possible to increase production of alcohol-derived chemicals to replace petrochemical input.

In 1983, 120,000 tons of gasoline were consumed in the road transportation sector. To replace with alcohol 20 - 30% of the petroleum utilized, production of approximately 30,000 m3 of ethanol will be required each year. Large-scale sugar production facilities produce 75,000 tons of molasses/year, of which only 6% is currently utilized for alcohol manufacture and cattle feed.

The pilot plant will have a capacity of 1,000 m3/year, i.e., 5,000 l/day for 200 days of operation per year. Total investment required for this plant is $750,000. Production costs for ethanol are $200,000/year, and the ethanol will be sold at $0.7/l. If the plant operates at 60% of its installed capacity, it will return profits of $300,000/year.

The payback time on the investment is thus 2.5 years.

1.3 - Conclusion

The plant is designed for a yearly ethanol production capacity of 1,000 m3.

Specific gravity of gasoline is 735 kg/m3. If 1,000 m3 of ethanol are utilized instead of gasoline, the national economy will make savings of 735 tons of gasoline.

Gasoline prices on world markets stand at $275/ton. Thus, savings of approximately $200,000 would be possible.

2 - DESCRIPTION OF PROJECT AIMED TO REDUCE DEFORESTATION

2.1 - Introduction

At this time, a large proportion (90%) of the energy consumed in our country is derived from woodfuel. We consume 40 million m3 of wood each year, and are woodlands and forests are disappearing as a result.

Considerable peat reserves have been discovered in North-East Tanzania. We should like to try to use this peat in an aim to reduce the rate of deforestation.

We will also require the transfer of new techniques in order to manufacture charcoal under optimum conditions (increased efficiency).

2.2 - Project for the manufacture of peat briquettes

Several diesel oil-fired electricity generating sets are installed in the area around these reserves, and we incur considerable expenditure by importing the fuel they require. We have examined the possibility of using briquetted peat to generate electricity for heating in the households sector. Transportation causes various problems in these areas.

We do not have direct access to the technology required to survey these peat reserves, and it is for this reason that we are approaching specialists in an aim to assess in greater detail whether our project is feasible.

2.3 - Improvement of equipment for the production and utilization of charcoal

In theory, 4 million m3 of wood are carbonized to produce 290,000 tons of charcoal. The wood has a specific gravity of 0.8, and efficiency of the charcoal production process is 10%.

As one speaker has already pointed out, charcoal kilns now exist with levels of efficiency reaching 20 - 30%. This equipment must be utilized in our country in order to limit deforestation.

We wish to gain access to the technology needed to produce high-efficiency kilns, and thereby increase our charcoal production.

Annual charcoal demand in Tanzania stands at 300,000 tons, and is growing at a rate of 5% per year.

Forty-three percent of our country is covered with woodland, but our reforestation program is not succeeding in maintaining the rhythm of deforestation.

The charcoal that is produced is utilized chiefly in urban areas, in charcoal ovens with 10% efficiency. These ovens are widely used, since gas or electric cookers are not available in sufficient numbers and costs are too high. Traditional charcoal cookers are thus in wide use, and levels of efficiency are very low.

We are aware that ovens of improved quality are now available, and we intend to carry out an investigation to assess the real needs of charcoal users, and to increase efficiency.

2.4 - Conclusion

It is estimated that 500,000 households in this country utilize charcoal ovens. At this time, those households are using traditional charcoal cookers built by local craftsmen, and levels of efficiency are very low.

We would like to set up a small-scale facility producing 20 cookers per day, or improving the quality of these ovens so that we can gradually ensure that this new technology spreads throughout the country and that the different manufacturers apply the technology to their production processes.

We intend to carry out an investigation aimed at both manufacturers and users.

A traditional oven consumes approximately 600 kg of charcoal per year, while an oven of improved quality consumes only 240 kg. Yearly savings of 1,728 tons of charcoal can be made using a kiln with 10% efficiency and wood with specific gravity of 0.8. These savings represent an economy of 21,000 m3 of wood.

THAILAND

Summary report of speech delivered by Mrs Suvachittanont, Researcher, Energy Research Division, Thai Institute of Scientific and Technological Research (TISTR)

1 - INTRODUCTON

In 1983, our rice production was 17 million tons, containing 20% paddy husks (i.e., approximately 4 million tons). Most of these husks are unused, and rice producers are obliged to dispose of the by-product by incineration.

The Thai Institute of Scientific and Technological Research has thus decided to organize pilot programs to promote pyrolytic technologies for the utilization of rice husks.

2 - OBJECTIVES

The program of action led by the Institute seeks to achieve several objectives:

- to convert rice husks into charcoal, oil and gas in an aim to replace conventional sources of energy and to remove these waste products;

- to apply the technology to other agro-food industries as a method of disposal of waste;

- to supply agro-food industries with recycled energy;

- to create employment;

- to export the technology to other developing countries.

3 - PYROLYTIC TECHNOLOGY

Pyrolysis is the thermochemical conversion of organic matter into combustible gas in the limited presence of air. No external source of heat is required for the reaction.

The husk storage system is fitted with a device to feed fuel into the reactor. The product is collected in a charcoal drum in the base of the reactor. This conversion system is fitted with a test unit to check that the reaction has been completed and that the finished product is a pyrolytic gas.

Further, we have designed and developed a briquetting machine for the production of balls made by mixing carbonized rice husks with cassava starch (tapioca). These balls of charcoal can then be utilized for domestic purposes.

The gas produced during the process is dedusted in a cyclone before being stored in a gasometer connected to a 5 kW electricity generating set.

4 - ENERGY AND COST BREAKDOWN

We have several demonstration plants, two of which have been set up in provincial areas, with unit capacity of 1.5 tons of rice/day. Mixing tanks have been installed to allow for the supply of gas to a 280 hp diesel engine. Thirty percent of the fuel requirements of these diesel engines has thereby been economized.

Most rice production facilities produce 40 tons/day of rice husks. Processing requires 130 liters of fuel per day. The installation of a system of pyrolysis will make it possible to economize approximately 50 liters per day.

Payback time on the investment (around FF 60,000) is approximately 2 years.

5 - CONCLUSION

Our Institute would like to act as administrative coordinator between local organizations, overseas investors and rice producers, and seeks financing at low interest rates.

We could also supply the basic design parameters, as well as information as to cost and optimum conditions of operation. In conjunction with the National Energy Agency, we could offer financial assistance to investors in the form of special incentives for the reduction of taxes or the extension of fiscal payment schedules.

TUNISIA

Summary report of speech delivered by Mr Maherzi, Directorate of Design and Development, Entreprise Tunisienne d'Activités Pétrolières (ETAP)

The Tabarka livestock breeding facility SOCELTA has launched a project for the production of biogas from animal excreta, and in particular from poultry droppings.

1 - INTRODUCTION TO THE LIVESTOCK BREEDING FACILITY

This farm breeds laying hens, meat chickens and breeding hens.

- The laying hens are accomodated in about twenty buildings. An average total population of 160,000 produces 32 tons of droppings each day throughout the year (11,500 tons/year).

- Meat chickens number an average of 70,000 (although the buildings can house up to 520,000 birds) and produce 500 tons/year of droppings with 30 - 50% moisture conten

- 100,000 breeder hens produce 3,500 tons of droppings per year.

The farm thus produces a total of 15,500 tons of droppings per year.

The buildings housing the laying hens each require an air cooling and humidification unit, three 1.5 hp motors for scraping droppings, and lighting equipment.

Buildings for meat chickens and breeder hens require lighting and heating equipment to maintain temperature at 25°C.

SOCELTA also has a cattle feed plant producing 100 tons per day. A granulation project is underway, and requires a new 350 kW transformer.

2 - THE PROJECT

2.1 - Preparation

A study must first be carried out into the suitability of setting up demonstration digesters for modules of different sizes:

- installation of digesters for single buildings each housing 10,000 hens and producing 260 - 540 tons of droppings per year;

- installation of digesters for a group of 4 buildings housing a total of 40,000 hens and producing 1,000 - 2,500 tons of droppings per year;

- installation of a central digester for all the company's buildings with an average total yearly capacity of 15,000 tons of droppings.

The different possibilities for utilizing the gas produced must then be examined, as well as the feasibility of replacing conventional fuels (electricity, LPG, etc.) with biogas, so as to maximize energy self-sufficiency for such facilities.

2.2 - Implementation

Three phases are needed to implement this project:

- installation of one or more biogas production unit(s), depending on the solution adopted;

- installation of equipment needed for total consumption of the gas produced, in replacement of existing equipment, in response to the findings of preparatory investigations;

- installation of a compost processing unit.

Mr Maherzi then described a pilot biogas production plant set up on a private farm with 15 head of cattle and using a bell-type digester to produce 5 m3 of biogas per day. This plant is used for lighting and heating purposes.

Mr Maherzi also explained that 47% of the population of Tunisia is located in rural areas. 85% of these households are not supplied with electricity, and more than half are located in remote settings. An investigation is underway to assess the energy consumption of these small-scale farms (3 or 4 head of cattle), where barrel-type digesters can be installed. Biogas will be used for pumping water as well as for cooking and lighting.

PART FOUR

ROUNDTABLES

Summary reports of proceedings

OTHER USES OF BY-PRODUCTS FROM AGRO-FOOD INDUSTRIES

Mr Affholder, Director, ANRED, and Chairman of this session, gave the floor to Mr Cheverry and Mr Richard.

Mr Cheverry, Agence Nationale pour la Récupération et l'Elimination des Déchets (ANRED)

First I should like to say a few words about the spreading of organic soil improvers, a method of utilizing waste from agro-food industries that is likely to develop further in the future.

Spreading, or manuring, is advantageous as this effluent contains organic matter and minerals and can thus be of help as:

- water supply to the soil

- mineral supplement through fertilizers

- organic matter supplement (for structural stability and biological activity in soil).

A further, quite widespread use involves composting. This technique makes it possible to utilize solid or semi-solid waste, which cannot be spread on the fields.

The utilization of animal waste can be of interest in that once the energy potential has been removed, the protein concentration of the by-products is higher and they can thus be used in animal feed in place of other products.

The process nevertheless involves problems of preservation and storage, and composition can vary over a period of time.

Existing techniques must be adapted on a case-by-case basis to take account of each of these obstacles.

Another method of utilizing waste consists in enrichment of these products themselves in terms of nitrogen or protein content. The technology required for this biological process is considerably more sophisticated.

Each time, therefore, that a real chance appears to utilize waste from agro-food industries, it is essential to study each of these options before deciding how best to adapt to the local context and to the local conditions of the producer.

Mr Richard, Head of Food and Nutrition Department, Institut de Recherche sur l'Elevage et de Médecine Vétérinaire des pays Tropicaux (IEMVT)

We are particularly concerned in our research with two types of application for utilizing by-products for cattle feed:

- as a supplement in extensive livestock breeding (particularly in the Sahel);

- intensive feeding (chiefly of ruminants).

We are attempting to make up a number of different types of ration depending on the composition of the by-products available:

- molasses with high energy potential;

- cattle cake with high nitrogen content;

- brewery by-products with high energy and high nitrogen content;

- bagasse, groundnut shells or cottonseed hulls with low energy potential (through digestion) and low nitrogen content.

For example, sheep feed rations were made up with mollasses, cottonseed hulls, cottonseed cake, cottonseed and urea.

The problem of energy potential comes into play when we want to use a by-product of limited possibilities either in terms of energy or in terms of nitrogen (bagasse, cottonseed hulls).

In response to a question concerning the IEMVT's experience with rice husks, Mr Richard continued:

We have only limited experience of rice husks. A number of tests were run with a State company in Cameroon.

These by-products have high silicon content, and are not ideal for feeding animals, since they cause pathological disorders when more than 10% of the ration consists of rice husks.

The type of production sought is an important factor:

- in extensive livestock breeding, rice husks can be used as make-up feed in higher proportions;

- in intensive activities, to produce milk or meat at a rate of 500 g gain per day per animal, rice husks can hardly be used.

Mr Singh (India) pointed out that rice husks, which are widely available in India, are not currently utilized to produce energy in India, but incinerated in kilns or burned in the fields, which causes serious pollution. He suggested that the use of small-scale power plants be developed in rice-growing areas.

Mr Maung, Honorary President of the Consultative Committee and Head of Industrial Development (Chemicals Industry) Service of UNIDO (Vienna), pointed out that an FAO report is available on the use of rice husks in boilers, as are the results of a pyrolysis unit in the Philippines.

Mr Camara (Guinea) questioned Mr Cheverry on the subject of utilization of pineapple draff.

Mr Cheverry, ANRED

In pineapple canning activities in Martinique, bract waste is pressed and the juice that remains is filtered to recover the suspended solids. The pressed residue and the suspended solids are then stored in silos as animal feed.

Investigations are underway into the use of the juice to produce energy, but to my knowledge no such study has been made of the solid waste.

In response to a question by Mr Bouity (Congo), concerning financing aid for the development of research and implementation of projects in the renewable energy sector, Mr Lambert replied:

Mr Lambert, Agence Française pour la Maîtrise de l'Energie (AFME)

Covering both research and demonstration projects, the "Maîtrise de l'Energie" program (formerly "Sahel, Energies Nouvelles") set up by the Cooperation and Development Department at the Ministry of Foreign Affairs (Mrs Geissmann) and the AFME, has subsidized a number of pilot or demonstration plants in the renewable energy sector.

It is clear that energy management projects must in all cases form part of wider action involving rural development, housing projects, agro-food industries, transportation, etc.

There is thus no credit available for renewable energy projects since there are no renewable energy projects that exist as such. There are pumping schemes that meet irrigation requirements, biomass projects that help to stabilize the energy balance and cost balance in a project for an agro-food industry, and so on.

For countries concerned by the Fonds d'Aide et de Coopération (FAC), i.e., chiefly French-speaking African countries, there are financing possibilities, either for a feasibility study, or in the form of partial subsidies (in conjunction with the Caisse Centrale de Coopération Economique.

For other countries, organizations such as the CFCE (Centre Français du Commerce Extérieur) can provide COFACE credits (export credits guarantees) in certain cases, but all these details will be given later.

POLLUTION CONTROL

Mr Lucas, Assistant Director of Technology and Innovation, Directorate for Agricultural and Food Industries, Ministry of Agriculture, and Chairman of this session, pointed out that French policy in 1964 has made it possible to deal with the problem linked to water treatment through action taken by the Water Authorities in relation with the competent public bodies.

Mr Noël, Head of Industry Department, Artois-Picardie Water Authority

Agro-food industries cause more than half the pollution in our country (excluding toxic substances). The first technology to be developed was aerobic purification. This treatment process is highly efficient, but involves two major drawbacks:

- production of residual sludge (that cannot be utilized);

- considerable electricity consumption.

Later, research carried out in France led to the development of new techniques involving anaerobic treatment.

It should be pointed out that most installations in France are large-scale stations, since they treat large quantities of pollution, created by urban conglomerations of several hundreds of thousands of inhabitants.

Even if anaerobic treatment can be used to produce methane for use in boilers, this gas cannot be sold as a source of energy.

The treatment process is nevertheless less costly in terms of energy that aerobic treatment, since no energy input is required for operation. There are, however, disadvantages:

- lack of long-term experience (the earliest plants have been operating for 3 years);

- the need for high levels of pollution in water treated (preliminary preparation of water required);

- production of other pollutants (e.g., ammonia).

The technologies utilized by French companies vary quite considerably, and costs vary accordingly. Each technique should thus be analyzed closely before deciding which one to use for a given case.

Mr Duriez, Engineer, Environment Department, Regional Directorate for Industry and Research (Nord-Pas-de-Calais)

In France, waste containing organic matter is responsible for a level of pollution equivalent to 100,000 tons of COD per year. If all this waste was treated anaerobically, yearly savings of approximately 100,000 TOE could be made.

Anaerobic digestion is only possible if there is a need for energy in the vicinity to stabilize the heat balance of the installation. Waste must thus be at the temperature required by the process. Two cases are possible:

- The waste can already be hot and have sufficient organic matter content (as in canning industries), and can thus be used directly in methane production;

- The waste can be cold, and low-cost energy is required to raise temperature (as in sugar production). To avoid using the biogas, energy recovery must be incorporated in the design of the whole treatment line.

The combustion of biogas can produce energy for the company. Biogas burners are available, and operate on pure biogas or biogas/natural gas mixtures. Biogas can also be stored to ensure a regular supply to the burners. There are, however, safety problems linked to the use of biogas:

- Biogas is produced at low pressure, and there is thus a risk of air leakage into the equipment.

- Biogas contains significant quantities of other gases, such as carbon dioxide (20 - 40%) and hydrogen sulfide, and equipment operation can be affected.

Over recent years, the processes involved in methanization have undergone intensive and highly effective development. For example, the fixed-culture method of methanization makes it possible, through the relatively high volumetric load capabilities compared with conventional methods (non-intensive or uniformly mixed), to improve the efficiency of installations as well as the biogas yield, while reducing the volume of the digesters (and thus costs), but above all to reduce the retention time of the effluent.

On average, it would be fair to assume that in agro-food industries, 1 kg of COD can produce approximately 0.4 - 0.65 m3 of biogas containing around 60% methane.

This recovered energy is generally equivalent to 10 - 20% of the primary energy consumed by the installation.

Mr Cheverry, Engineer, ANRED

Before speaking about pollution control, attempts must be made to reduce levels of pollution at source by adopting manufacturing processes that produce less pollution, as distilleries have already done.

The same company can have types of waste with different pollution levels, and it is of interest to separate these different types of waste at source in order to apply specific treatment processes.

Each treatment process (methanization, aerobic treatment, lagooning, etc.) has a critical level, and, depending on local conditions, can be selected on the grounds of its relative cost or efficiency.

Further, each treatment process itself generates by-products, and sludge in particular. These by-products can be discarded, or utilized as organic soil improvers. But problems can arise since the sludge contains pathogenic germs (that are a danger to the environment) and heavy metals (that affect soil quality).

Mr Albagnac, Director of the INRA Food Technology Center (Lille)

When choosing between mesophilic and thermophilic methanization, it should be pointed out that from a biological viewpoint, the activity of methanogenic bacteria populations is similar in both cases. It is thus practically never of interest to opt for mesophilic fermentation, which is more sensitive to sudden changes in temperature (especially in temperate climates).

In terms of the general philosophy with regard to energy applications for crop residues or for effluent generated by agro-food industries, methanization is the latest technique available. Separation lines or separate collection systems can be set up so as to be able to treat pollution by conventional methanization techniques, and to recover substances that can be utilized in animal feed and pharmaceuticals selectively and without causing water pollution.

Aside from new, high-performance processes such as fixed-culture methanization, there is a wide variety of processes that have been known for some time, yet are not obsolete. The choice of process must be made on a case-by-case basis, and must take into acount the variability of the properties of the waste, the amount of space available, etc.

The average cost of an installation treating 1 ton of COD per day can be estimated at FF 400,000.

It should nevertheless be pointed out that problems remain for the utilization and degradation of solid residue where levels of efficiency and treatment speeds are relatively low. A number of "phase separation" processes are being developed, but are still at the experimental stage.

In response to a question from the Tunisian representative concerning the procedures already adopted to overcome the risk of explosions, Mr Duriez made several points:

- If air enters the installation during anaerobic treatement, methane production stops. This fact is thus a primary safety factor.

- If the process is maintained at slight pressure because of storage requirements, the problem is not encountered.

- At very low pressure, however, an oxygen analyzer is required for checking oxygen content of the gas and thus avoid all risks of explosion.

A representative from Ivory Coast asked whether the figures 0.4 - 0.65 m3 of biogas with 60% methane per kg of COD treated applied to all types of waste.

Mr Noël stressed that these were average figures, but that at the Thumeries sugar production facility near Lille, 0.4 m3 of biogas with 85% methane was produced from each kg of COD treated.

Mr Albagnac added that it is preferable to speak in terms of production of methane per kg of COD broken down, and that there is a theoretical limit of 350 l of pure methane per kg of COD broken down, and that 80 - 90% of this potential is recovered in practice.

Mr Lucas closed the session by drawing the attention of participants to the capital importance of process diagrams in developing an approach to problems of pollution control: the point of departure should not be the quantity of waste available, but the very beginning of the process. Other possible uses should be examined, the residue left behind after treatment must be taken into account, and so on.

He added that social organization is required to facilitate optimization of certain pollution control techniques.

PART FIVE:

REPLIES FROM FRENCH INDUSTRIES

Summary report of proceedings

UTILIZATION OF BY-PRODUCTS: THE IMPACT ON AGRO-FOOD INDUSTRIES

Summary report of speech delivered by Mr Lucas, Assistant Director for Technology and Innovation in Agricultural and Food Industries, Ministry of Agriculture

1 - BY-PRODUCTS = ADDED VALUE

By-products of the agricultural and food industries are very extensive and very varied resources, which should be utilized whenever possible.

In France, for example, by-products from the sugar industry represent more than 20 million tons, and those from dairy industries in the form of milk serum contain more than 300,000 tons of dry matter. They can constitute added value for product lines, which is essential, and which determines profitability in certain cases. There is sometimes a very fine distinction between pollutant waste and useful by-products that can become highly profitable products (although this is all too rarely the case).

2 - RECOMMENDATIONS

In many instances, it is important to insist on the need to re-assess the type and even the quantities of by-produucts available. Except in certain specific cases (shells, bones, etc.) the by-product should not be considered as a homogenous mass leaving the factory.

On the contrary, the entire process must be examined with a view to achieving three objectives:

- limited losses

- optimum utilization for entire plant

- optimum timing of product/by-product separation phase.

Many examples can be found in milk, cereals, sugar and oleaginous crops.

3 - APPLICABILITY OF BY-PRODUCTS

There is a wide variety of types of by-product found in agricultural and food industries in the countries represented here today: brewery malt returns, dolo and cassava draff, cake from groundnuts, copra, cottonseed, oil palm, palm fruit, etc., cacao pods, and so on. Many of these are still wasted or under-utilized. However, they are suitable for various applications, notably in the production of energy and food.

3.1 - Utilization in livestock breeding

The energy value of each by-product is expressed in terms of nitrogen, minerals and dry matter. The composition of these by-products is known, and some are more interesting than others. Certain by-products are complementary. Thought must be given to the following:

- the possibility of developing a local livestock breeding facility utilizing these by-products;

- an assessment of the potential of the cattle feed manufacturing industry, in the light of local and regional conditions: type of needs, frequency and duration of needs, costs for breeders, etc.;

- the possibility of exporting a product with higher added value.

3.2 - Energy production from by-products

The rise in energy prices which has affected certain countries, and particularly France, has brought an urgent need to intensify the efforts we are making to replace fossil fuels with renewable energy sources. In many countries where biomass production is at a moderate or low level, or where biomass is difficult to mobilize, the use of waste from agro-food industries is of capital importance in this replacement procedure, whatever the disadvantages of the product (space requirements, low specific gravity, moisture content, etc.) might be.

The experience gained in Europe over the last ten years in the field of waste-derived energy has demonstrated that the thermochemical process involving combustion, gasification, carbonization or pyrolysis has very interesting prospects, as does the biochemical processes including methane fermentation and ethanol production.

4 - CONCLUSION

This approach can bring greater productivity to agricultural and food industries, provided the following facts are taken into account:

- There are no general solutions: each case must be examined separately, and as critical an approach as possible should be adopted. Otherwise, there is a risk of breaking ground that has never been known to be profitable.

- It is important to continue research and development work on many subjects in an aim to further improve on the results obtained and to exchange our respective experiences, as we are doing this week.

EXAMPLES OF APPLICATIONS FROM ENGINEERING COMPANIES

Summary report of speech delivered by representatives of the companies CLE TECHNIP, SPEICHIM and LERMINET

1 - BAGASSE TREATMENT IN MAURITIUS (Mr Suzor, CLE TECHNIP)

Most Third World countries depend to a considerable extent on foreign exchange earned by the sugar industry. Regrettably, much of this foreign exchange is spent on the purchase of petroleum products.

The sugar industry nevertheless has a sound infrastructure that makes it possible, with a few modifications, to optimize the utilization of bagasse.

1.1 - Drying

Until now, bagasse with 50% moisture content has been burned directly in boilers, with efficiency of 45 - 50%.

Half of the energy contained in the bagasse is thus lost at the gas outlet. Logically, the first step that was taken was to recover this waste heat.

The characteristics of the gases to be recovered must be identified before they can be sent to appropriate equipment and utilized for drying bagasse.

When the bagasse is dry, the facility possesses a fuel source. The dry bagasse can either be converted entirely into electricity or stored for later use.

Sugar industries seek to stagger their activities over a six- to eight-month period, and in this case storage is necessary.

1.2 - Densification

Before storing dried bagasse, it needed to be densified. Several methods were tested, and the final choice was pelletization. This choice was based on the economic viability of the factories in Mauritius, but the situation changes regularly and it is thus conveivable that the solution will be reconsidered in the coming years.

1.3 - Mauritius

A program has recently been launched concerning the 21 sugarcane processing plants in Mauritius.

These 21 sugar facilities could supply 80% of the island's electricity requirements. through drying systems in all facilities and densification lines in 12 facilities.

We have recently finished installing the first dryers and densification lines for the launch of this program.

1.4 - First installation

Bagasse is transported to the drying unit on conveyor belts.

At the outlet of the unit, a proportion of the dried bagasse is sent to the factory where it is used as fuel, while the rest is sent to the densification unit.

The increased efficiency of the system is largely due to the combustion of dried bagasse in the boiler units.

Before densification, dried bagasse goes through various procedures:

- sorting, needed for selecting particles of suitable size for pelletization;
- steam treatment, needed to achieve malleability required for pelletization.

The drying unit is supplied with gases taken off the stack. A certain quantity of gas is systematically released so that air does not enter the stack.

This entire system is closely monitored and required only two days of training for the operators in Mauritius. This first plant will produce 18,000 tons of densified fuel per year, which will be used by another factory and converted into electricity.

$80 million will be required to complete this program. Savings over 10 years are estimated at $110 million.

2 - TREATMENT OF WASTE FROM PALM OIL MILLS (Mr Blayo, SPEICHIM)

The combustion of by-products from palm oil mills provides an ideal example of a successful project, since this application has now spread to all the industrial oil mills that have been set up over the last 20 - 30 years.

It appears in practice that palm oil mills have a good supply of energy resources, but that their principal problem lies in the reliability of equipment and installations.

2.1 - Principal types of waste

The finished product, oil, represents only 25% of the raw material by weight.

The waste consists of bunch refuse (25%), shells (7%) fiber (8%) and liquid waste.

The combination of two factors (quantities of waste and rapidly increasing production) explains the importance attached to research into means of utilizing this waste in order to cut running costs.

2.2 - The process adopted

The solution generally adopted for producing energy needed by the factory is the combustion of oil palm fiber and shells.

In practice, from one ton of bunches per hour, it is possible to produce 500 - 600 kg of steam at 20 - 25 bars.

The steam pressure is reduced to 3 bars in a turbine, and the low-pressure steam is then used in the factory for sterilization of bunches and heating of different products.

The pressure-reducing turbine drives an AC generator that supplies electricity to the various motors and to the accessory equipment in the factory (lighting, laboratory, etc.).

This simple process did however require certain modifications to the oil mill machinery:

- medium-pressure boilers were required, and water-treatment requirements were thus greater;
- a mechanic and an electrician were required for the turbo-generator and stand-by electricity generating set.

2.3 - Limitations of the conventional process

Efforts are generally not made to reduce electricity consumption, since energy savings would incur additional operating costs to remove unspent fuel.

This reasoning has been repeated many times over the last 10 - 20 years, but such an approach is limited:

- Palm oil mills do not operate continuously. They are sized to handle peak periods of production that last only a few weeks of each year. During these periods, all the installations remain hot from one day to the next, and there is a surplus of fuel. On the other hand, in certain off-peak periods, insufficient fuel is available and a make-up fuel source is indispensable (e.g., for a diesel-engined generating set).

- In small-scale units capable of handling 6 - 8 tons of bunches per hour, energy self-sufficiency is not reached, and diesel-engined generating sets are required. Operating costs of the factory are thus significantly higher.

To replace fuel oil, one interesting solution is to install gas generators operating on shells to produce lean gas.

3 - UTILIZATION OF ABATTOIR WASTE AND BREWERY MALT RETURNS AS ANIMAL FEED (Mr Devoisin, LERMINET)

3.1 - Brewery malt returns

World beer consumption is growing sharply, particularly in developing countries, although it is relatively stable in Europe.

3.1.1 - The by-product

Beer is produced through fermentation of barley grains, during which the starch is converted into sugar. Dried, mashed malt is added and the mixture is boiled. Returns are filtered out, and the liquid ferments to produce beer.

The returns (barley without starch) is rich in proteins and is a first class nutrient for animals. However, they contain only 20% dry matter and must thus be dried to avoid rapid decomposition. Since energy prices rose, the cost of drying returns has become prohibitive.

3.1.2 - Dehydration by lipid bed evaporation

Our company thus sought an efficient means of reducing the moisture content of the returns that avoided the restrictions of traditional methods of drying.

The dehydration process involves treating the returns as soon as they are filtered out of the wort. At this stage the product is at 75°C and can be evaporated on a lipid bed by feeding oil into a multiple-effect exchanger until the solids suspended in the oil are water-free. At the end of the process, dehydrated returns are separated from the oil bath in a centrifuge, and the oil can then be re-utilized.

Centruifuging will not be perfect, however, and a certain quantity of fats will remain in the final product, thereby increasing its energy potential.

3.1.3 - Comparison with traditional drying method

Traditional methods of drying consume approximately 5 kg of steam for each kg of water evaporated, while lipid-bed evaporation requires 0.12 - 0.25 kg of steam for each kg of water evaporated (depending on the number of effects of the evaporator in the low-temperature thermocompression system). If a system of mechanical recompression of steam is applied to the product when hot, steam consumption can fall to a maximum of 0.05 kg/kg of water evaporated.

3.2 - Abattoir waste

A poultry slaughtering facility has recently been set up that uses no fossil fuels, and with electricity requirements of 0.15 kW and water requirements of 4 l for each bird slaughtered.

The problem remained of how to dispose of the products that are not aimed for human consumption:

1) head, feet, necks (1,550 kg/day)

2) entrails (1,700 kg/day)

3) feathers (1,800 kg/day)

4) blood (600 kg/day).

The mixture of 1) and 2) has moisture content of 65%, and contains 66% - 70% feathers and 83% blood.

Feathers can be pressed. Pressing requires only 15 to 20 kcal/kg of water removed, while dehydration requires 500 - 1,000 kcal/kg of water removed.

However, the other forms of waste must be processed untreated and are thus dehydrated immediately in an air- and water-tight mixing unit (a heated, rotating tank kept under pressure, and fitted with an internal screw device to avoid aggregation).

The volume of this tank depends on the size of the abattoir, but is generally 5 m3.

Gas is needed to heat the mixing unit. For a product with 65% moisture content, cost price of the kg of water evaporated is approximately FF 0.33, excluding related costs and amortizement of capital equipment.

LIST OF INDUSTRIAL COMPANIES REPRESENTED

ABC BIO INDUSTRIE	Mr Morgan, Chief Executive Biological preservation of animal and vegetable by-products suitable for recycling as animal feed.
AIC - SIT	Mr Romin, Chief Executive Assessment and management of factories, technical assistance and training in various industries in the agro-food sector.
AINF	Association Interprofessionnelle de France Mr Wallyn, Director, Commercial Relations Official non-profit organization established for nearly 90 years and with a staff of 500 persons. The AINF has in-depth knowledge and unequalled experience in technical inspection, consultancy and training.
BERTIN	Mr Delcros, Director, International Relations Research and Development company with a staff of 500, including 250 engineers and managers, involved in the development of processes considered a priority for future industrial application in the following fields: thermal equipment, energy, fluid mechanics, optics, electronics and industrial systems.

BIOMAGAZ	Mr Aubart, Director Mr Seve, Chairman Design and manufacture of treatment stations using methane fermentation. The company is part of the EMC Group (Entreprise Minière et Chimique) and is particularly involved in agricultural supplies (fertilizers and animal feed).
CdF INGENIERIE	Mr Coulombel, Head of Industrial Equipment Department Regional company formed by Houillères du Bassin du Nord et du Pas de Calais, a subsidiary of Charbonnages de France (CdF). Engineering company supplying turnkey industrial plants in all fields.
CEREX	Mr Dutreux, Commercial Director Mr Ledru, Project engineer Recovery and utilization of bagasse.
CGEC	Compagnie Générale d'Entreprise de Chauffage Mr Fourncls, Exports manager Paris-based subsidiary of Société Française des Pétroles BP, CGEC has a staff of 1,000 and a yearly turnover of FF 850 million. Installation, operation, routine and specific maintenance of heating plant, air-conditioning equipment, cold storage facilities, electrical installations, electricity generating sets and water treatment plants.

CIDEN	Mr Royer, Technical/Commercial Director Lyons-based company specialized in equipment for treatment of slurry, manure and organic waste from all livestock breeding facilities from small-scale farms with a capacity of 50 pigs to large-scale facilities of 1,000 - 10,000 pigs.
CLE-TECHNIP	Mr Suzor
DECOBECQ	Mr Carion, Commercial Director Large, independent design office with a staff of 550, including 100 engineers working in 13 offices. This design office is involved in design, engineering work and technical assistance in building industries, handling and lifting equipment, and mechanical, electrical and electronics industries. The company has wide experience of liquid waste treatment.
DUVANT CREPELLE	Mr Martin, Commercial Department Mr Delval, New Energy Sources Department 250 persons working at Lille, Sedin, Valenciennes (production facilities) and Soultans (test facility). 60% of turnover from export markets (French-speaking Africa and Southeast Asia). Activities: utilization of lean gas (generator gas) and biogas in diesel engines. References: 450 kW gas generator operating on coconut shells; conversion of standard

diesel engine into gas-fired engine (natural gas, lean gas or biogas).

EDF

Mr Boillot, New Energy Techniques division

Electricité de France: more than 100,000 persons

Investigations and Research Directorate: 3,000 persons

Resource-based activities: bagasse, sugarcane molasses slop, water hyacinths, eucalyptus brushwood; process-based activities (with in-house experimental equipment): combustion, gasification, methane fermentation.

Examination of technical and economic feasibility and identification of potential investors and industrial partners.

ENERSYSTEM

Mrs Mouinat Eboko

ENERSYSTEM is a subsidiary of TOTAL and of SPIE BATIGNOLLES.

The principal role of the company is to find solutions to problems of energy supply to sites located at considerable distances from the central distribution grid (agricultural settlements, industries or facilities).

Activities: pre-feasibility and feasibility studies, investigation and set-up of sources of financing, selection, operation and maintenance of equipment, and staff training for all multi-energy projects from 0 - 5,000 kW.

ERPAC

Mr Morawek, International division

Independent water-treatment company with a staff of 130 persons (50% managers).

Marketing of water-treatment equipment and products; regular technical assistance provided to French-speaking African countries; examination of all problems of water treatment in a production facility from inlet to outlet (sources, drinking water, process water, heating plant feed water, methanization: contact type , fixed-bed, anaerobic filter, sludge blanket, etc.)

HDG INDUSTRIE SOLAIRE — Mr Consigny

Regional company (based in the Lille area) manufacturing a range of solar arrays, particularly based on tiles and slates; also involved in photovoltaic technology.

France's second largest manufacturer in this sector.

Production of industrial hot water (30 - 70°C) for all applications in the agro-food sector.

LERMINET INGENIERIE — Mr Lerminet, Chief Executive

The company has a staff of 60 persons (80% engineers) and an annual turnover (works) of FF 500 - 600.

The company was established ten years ago, and is involved in general and process engineering in agro-food industries, manufacture of ethanol-fuel with utilization of by-products for production of protein for human and animal nutrition.

MECANIQUE MODERNE	Mr Dantonnet, Chief Executive This medium-sized company (PME) has a staff of 400 persons and is chiefly involved in oil mills (crusher, press, industrial installation), with activities in other agro-food industries and abattoirs.
NEU	Mr Maurice, Commercial Director Manufacturer and outfitter working in pneumatic transportation, air conditioning, dust extraction and dehydration.
PEC INGENIERIE	Mr Bouquie, Director (PEC Toulouse) Entirely owned by the EMC Group (Entreprise Minière Chimique), PEC Ingénierie has a staff of 200 persons and is developing its activities in the following sectors: chemicals, processing of nuclear waste, industrial and agro-industrial waste treatment (including animal excreta). The company has many references in agro-food industries in Latin America and Africa.
PILLARD	Mr Mestrius, Thermal Destruction of Pollutants Department Marseilles-based company owned by the Fives Cail Babcock Group, with a staff of 350 persons and three subsidiaries (in West Germany, USA and Brazil). General industrial heating company manufacturing conventional and special-purpose burners (e.g., for lean gas), gas generators, incinerators, combustion chambers and special-purpose kilns for vegetable waste.

QUILLERY	Mr Simon, Chief Executive Regional company (Nord-Pas-de-Calais) with a staff of 1,000 persons. General engineering company working in all types of technical equipment, particularly for solar power, waste treatment and desalination of seawater. Permanent facilities in the Caribbean basin, in French-speaking Africa and in English-speaking countries.
SATEC DEVELOPPEMENT	Mr de la Mettrie
SCET-AGRI BDPA	Mr Houel, Head of Agro-food Industries Department These two design companies are owned by the technical subsidiaries group of the Caisse des Dépôts et Consignations and are specialized in the implementation of rural development and agro-food projects. The SCET-AGRI BDPA (Bureau pour le Développement de la Production Agricole) Group has a staff of 350 persons, including 300 engineers and managers. The company adopts an integrated approach to the problems of development, from the rational use of natural resources to the processing and marketing of agricultural products and the utilization of by-products.

SEPAREPUR

Mr Decool, Technical Director

Regional design office and manufacturer employing 80 engineers and technicians. Particularly involved in pollution control of fresh water and process water, and in wastewater treatment.

SERMIE

Mr Loisel, Director

(Société d'Etudes et de Réalisations de Matériel Industriel et Energétique)

The company has designed several composting units for ligno-cellulose waste (400 kg - 2.5 t/hr), a low-capacity gas generator, high-powered electricity generating sets, and special-purpose boiler equipment in the manufacture of pressure vessels.

SGN

Mr Fremin du Sartel, Bio-industries

SGN (Société Générale pour les Techniques Nouvelles) is a subsidiary of the CEA (Commissariat pour l'Energie Atomique) and TECHNIP.

The company is specialized in nuclear technology, but has activities in automation, the installation of flexible workshops and in industrial biotechnology.

SGN has developed with the INRA a fixed-film methanization process, installed at the BEGHIN-SAY sugar production facility at Thumeries (Nord-Pas-de-Calais) and at a distillery slop treatment facility in the Cognac region. A project for the methanization of sugarcane molasses slop is also underway in India.

SGN is also developing a process for continuous alcohol fermentation on fixed cells.

SNPE-CE

Mr Lesur, Commercial Director

CE (Chimie Expansion) is a subsidiary of SNPE (Société Nationale de Poudres à Explosif).

Aside from the firm's principal activity, which involves the construction of factories and workshops for its French-based parent company, SNPE-CE has diversified into engineering for the agro-food industry: process, projects, implementation, commissioning and safety engineering.

SODETEG

Mr Costa, Sales Engineer

General engineering company.

SOMDIAA

Mr Hanon, Director

Design, engineering, agronomic management, administrative techniques.

SPEICHIM

Mr Blayo, Chief Engineer

SPEICHIM (Société pour l'Equipement des Industries Chimiques) is an engineering company owned by the SPIE Batignolles Group.

Its principal activities involve design, installation and technical assistance for chemicals and agro-food industries.

In the agro-food sector, the company works chiefly with its own processes in the following areas: distilleries for production of alcohol-fuel or pure alcohol, fermentation and yeast production units, seed and palm oil mills.

VALORGA — Mr Bouchardeau, Engineer

PART SIX

ECONOMIC AND FINANCIAL ASPECTS

Summary reports of speeches

1 - FRANCE'S PUBLIC-SECTOR INVESTMENT FINANCING INSTRUMENTS

Mrs Larsilière, Representative, Caisse Centrale de Coopération Economique

In France, development aid and financing to be allocated for industrial development are handled by two ministries, namely the Ministry of Foreign Affairs and the Ministry of Finance.

The allocation of public-sector funds for project financing is handled by the Ministry of Finance, which makes loans available to countries covered by protocols concluded at government level. Those loans can be used in conjunction with private export credits known as Treasury loans.

These loans are granted to a large number of countries. Others, to which that possibility does not apply, and with which France has signed cooperation agreements, may receive funding from the Caisse Centrale de Coopération Economique as well as the Fonds d'Aide et de Coopération (FAC) of the Ministry of Foreign Affairs.

The Caisse Centrale de Coopération Economique is a government body operating under the auspices of the Ministry of Finance. It grants assistance to a finite number of countries, covering the developing countries, including virtually all of Africa, a sizeable portion of the Caribbean, Haiti, the Lesser Antilles, the Seychelles, and the Comoros. Those countries may apply for long-term loans to finance productive investments. I would like to emphasize the productive aspect of those investments: as financing involves loan capital, projects must generate sufficient income to ensure loan repayment.

Nevertheless, the Caisse Centrale de Coopération Economique does take an interest in pilot projects or studies, provided they show considerable promise of developing into productive projects.

In order to facilitate industrial promotion, the Caisse Centrale de Coopération Economique founded a subsidiary, PROPARCO, a company for economic promotion, that offers financing through the acquisition of shareholding interests. Its primary aim is to bring French companies into contact with medium-sized companies in the developing countries in order to help them increase production or develop technology. PROPARCO's activities are limited to providing technical assistance and participating in joint investments. Projects which have been identified by PROPARCO can become eligible for financing by the Caisse Centrale de Coopération Economique.

PROPARCO manages the Fonds des Etudes Industrielles Renouvelables, which is replenished from FAC subsidies, and which allows for the granting of loans to French industries willing to execute a general study of a technological or commercial installation in a developing country. Reimbursement for these studies is required only if the corresponding project reaches the execution stage and generates income.

Aside from granting loans, certain French government agencies have developed instruments designed to offer assistance for innovation, in the form of financing for preliminary studies. I will mention just a few of those agencies:

- ACTIM, which helped organize this consultative committee meeting;

- ANVAR, and more particularly the ANVAR Développement division, which is especially active in the developing countries;

- a number of funds managed under the auspices of technical ministries, particularly the Ministry of Agriculture and the Ministry of Research, which are also in a position to offer subsidies or financing for innovation.

Aside from the possibilites offered by the French government, commercial banks can also provide financing. Banque Nationale de Paris (BNP), which has agreed to act as leader of the commercial banks represented here by Société Générale, Crédit Agricole and Banque Indosuez, will discuss the various possibilities in this field and the means by which they participate.

2 - POSSIBILITIES OPEN TO FRENCH BANKING ESTABLISHMENTS FOR PROJECT FINANCING

Mr Charpentier, Banque Nationale de Paris (BNP)

The way in which the BNP is organized to handle foreign trade, which is similar to that of all the major nationalized banks, enables us to operate in a manner that is both centralized and decentralized.

BNP has a General Directorate for Foreign Trade, located in Paris, which is staffed by foreign trade "technicians". These technicians work in one of two areas: operations within France and operations in specific zones outside France. Here with me today are two other representatives of the General Directorate: Mr Bergeron, whose geographical zone is Africa, and Mr Bocquet, whose geographical zone is Asia. My responsibility is in the agro-food, agro-industrial, non-specialized engineering, cement, and rubber sectors for all countries. (Unfortunately, the person in charge of the zone covering the Americas could not be with us due to unforeseen engagements elsewhere.) The professional sectors covered by the General Directorate are agro-food, transportation, energy, building and public works, and aeronautics.

The staff of every BNP branch in France includes a person we call Director for International Trade, whose job is to make contact with suppliers located in the zone covered by his branch, study that supplier's export projects, and direct him to one of two places: either to the foreign trade assistant for the subdivision which includes his branch, or else to the General Directorate in the event that medium- or long-term financing is required for exporting.

BNP maintains centralized and decentralized sectors in France as well as an international network covering the 74 countries in which BNP is represented. Representation takes the form of representative offices, which are specially designed to assist suppliers and establish contacts with potential buyers; branches, which are more directly involved in actual banking; and subsidiaries, which acquire shareholding interests alongside those of BNP.

BNP, like all the major nationalized banks, can grant export financing at stabilized rates for projects that have been approved by the export credits guarantee commission made up of the Directorate for External Relations (DRE) and COFACE.

I would now like to give the floor first to Mr Bergeron, who will explain the role of the geographic agent within the General Directorate at BNP, and then to Mr Bocquet, who will discuss the various framework agreements and protocols that can exist within a given zone.

Mr Bergeron, BNP

Geographic agents play an executive role. Each is responsible for one geographical zone. There are currently five geographic agents, one for the Maghreb, one for Asia/Oceania (Mr Bocquet), one for the Americas, one for Europe, and myself for Africa (excluding the Maghreb).

The geographic agents are on the staff of the General Directorate for Foreign Trade, which comprises two financing bodies (one in France and one abroad). The French body is represented by French exporters and is supervised by executives from the professional sector, including Mr Charpentier. The other body is represented by buyers and foreign importers and is supervised by BNP geographic agents.

The first job of the geographic agent is to make preliminary contacts with the DRE, the Caisse Centrale de Coopération Economique, embassies, and other organizations. He must also become familiar with his zone, a task which requires him to establish contacts with ministries, private sector companies, representatives of the Caisse Centrale de Coopération Economique in each of the different countries, and the BNP network through its representative offices, correspondent banks, subsidiaries, and branches.

Once contacts have been established, he must familiarize himself with projects, which can be renovation projects, private or public sector projects, or new projects. In some instances, he may be called upon to propose framework agreements to satisfy needs for financing.

After that, his job is to write reports that will be widely circulated throughout the network. He must also try to match the desire of French companies to export with the financing needs of foreign importers.

Mr Bocquet, BNP

For my zone, which is Asia/Oceania and the Middle East, I would like to discuss the types of financing available for your various projects.

As indicated by Mrs Larsilière, there exist government protocols between France and a number of other countries. These protocols involve long-term credits (10 years) at low interest rates, which are granted by the French Treasury, and which are linked to purchase credits granted by French banks at interest rates approved by OECD consensus as applicable at the time of signature of the sales contract.

The countries of the Asia zone with which France has concluded protocols are India, Indonesia, Malaysia, Pakistan, Sri Lanka, Thailand, Nepal, and Bangladesh. Virtually all of those protocols were negotiated in French francs.

In order to take advantage of a protocol, your project must have been presented to French government officials at a very early date, as well as to the local government, with your customer acting as intermediary. A certain number of protocols are pre-allocated at the time they are signed, and a list of clearly specified projects is attached in appendix to the text of the protocol.

However, in some countries, these protocols included two distinct tranches:

- one, which is known as the project tranche, is pre-allocated for specific projects (the minimum amount per project is 5 to 10 million francs);

- the other, which is known as the non-project tranch, is usually set aside for financing small capital goods, or even consumer goods; the minimum allocation is 80,000 FF per project.

These protocols entitle you to recei[illegible] 100% financing for your sales contract.

Naturally, when this type of protocol is signed between the French government and the government [illegible] another country, it is followed by a bank commitment agreement, which is signed by most of the French commercial banks. Due to the fact that those banks cannot grant purchase credits for periods exceeding 7 years, the State-run Banque Française du Commerce Extérieur

(BFCE) takes over for the last three years, as credits are granted for ten-year periods.

As a general rule, financing is provided in French francs. However, negotiations are currently underway to allow for financing in other currencies also.

In addition to government protocols, commercial banks occasionally sign private framework agreements with local banks, but only involving conventional purchase credits. That procedure is advantageous because the text of the credit agreement is negotiated once and for all. Thus, credits can be arranged more quickly, using credit reports.

Lastly, all French commercial banks are in a position to offer specific purchase credits for individual transactions.

3 - UNIDO'S TECHNICAL COOPERATION ACTIVITIES

Mr Maung, Director of Industrial Development Service (Chemicals Industry), UNIDO

Our basic technical cooperation program is centered around the project pre-investment phase, which extends only as far as the pilot plant stage.

In order for an initial contact to be made, the government of a developing country must file a request with United Nations Development Program (UNDP) representative stationed in his country. This procedure concerns requests for technical assistance:

- requests for aid in the form of experts or short-term consultancy;

- requests for the provision of services by consultancy firms, whereby they would carry out feasibility studies;

- the organization of training sessions.

UNDP supplies most of the available funds (70%) as part of this technical assistance program. There is an allocation for each developing country, which the respective governments must distribute among their country's various projects.

There is a Fund for Special Industrial Services ($85 million per year) the purpose of which is to finance short-term activities (including consultancy and the solving of delicate problems).

There are also financial assistance programs in the least developed countries.

The United Nations Industrial Development Fund (UNIDF) receives 15 million dollars annually from two types of contribution:

- contributions from the governments of the industrialized nations which are transferred to a common fund on which UNIDO draws to finance various projects according to carefully defined procedures

- contributions from donor countries that can be used to finance specific projects upon agreement from the donor country.

It should also be pointed out that some countries seek their own financing. Syria, for example, called upon the Islamic Development Bank, the Arab Fund, and the OPEC Fund to finance a project for composting municipal waste. The three institutions involved in the project requested that UNIDO experts carry out consultancy missions, and their request was approved (the basic study having received prior financing from UNIDO). At the present stage of the project, bids are being assessed.

4 - SOURCES OF INFORMATION FOR PROJECT FINANCING

Mr Peyrard, Chief Executive Officer, International Research Center for Investment Funding in the Developing Countries (IRCIF)

Not being a banker, I am not a specialist in financial syndication, but rather in project financing in the developing countries, essentially involving bilateral and multilateral governmental organizations, some of which are referred to as aid organizations.

Two years ago, we authored a reference work which is now in its second printing. Translation for the English-language version is nearing completion, and it should be released in the United States by next spring. The French title is "Banques et Fonds Internationaux".

We have been carrying out our information work by publishing articles almost monthly, usually in "Industries et Travaux d'Outre-Mer", "MOCI" (the fortnightly review of the Centre

Français du Commerce Extérieur), and the well-known review "Banques", with which we have collaborated on other occasions.

We hold training sessions, in Paris and selected African cities, particularly in conjunction with the Centre International de Formation de la Profession Bancaire. We offer corporate counselling, and we are creating a computerized database in conjunction with the appropriate subsidiary of the Caisse des Dépôts.

As we have the most comprehensive documentation on the subject, we are also preparing a guide to engineering firms that have been involved in projects partly financed by bilateral and multilateral organizations.

Since 1982, it has become very rare for commercial banks alone to provide total financing for projects; while not impossible, it is simply difficult to arrange. Commercial banks request participation by one or more financing organizations (such as the World Bank, to take a well-known example). These bodies can participate in one of several ways.

Taking the example which was processed by the Cai‹ ₃ Centrale de Coopération Economique and its subsidiaries, t ɜre exist ordinary and special loans.

- Ordinary loans are loans whose interest rates are roughly the same as those prevalent on the market. Ordinary loans are used to finance profitable projects. As they are repaid, the same funds are reloaned after a certain number of years. There is no shortage of these loans, despite the fact that needs are indeed very great.

- Special loans are more closely related to grants. The amount of the grant can reach 80 to 90% of the loan, and occasionally even 100%. Special loans are granted for infrastructure or projects that promise long-term profitability, and funds become scarce when only a small portion is repaid.

In addition, these bodies can acquire shareholding interests in companies, local banks, or national development banks, they can finance technical assistance, and they can offer guarantees to certain borrowing countries.

The purpose of some of these bodies is to promote economic cooperation among the Member States, as practised in Africa and Latin America.

Most of these bodies also grant loans to national development banks and national development financing institutions, which in turn are responsible for lending the money to small and medium-sized companies within the country. Some of those lenders establish loan programs.

Most often, this involves joint financing, that is, the acquisition of shareholding interests by several financial backers. There are two types of joint financing:

- common pool financing;

- parallel financing (funding related to actual characteristics).

There are many beneficiaries of this type of financing, including governmental organizations, public-sector companies, or in certain cases, private-sector companies.

The criteria used to grant financing are extremely varied, depending on the origin of the funds. The World Bank has certain criteria, for example, France's Caisse Centrale has others, and the Islamic Development Bank has yet others. They can be geographic, historical, or otherwise related to actual projects.

In addition, there are very strict procedures governing these types of joint financing, often involving international invitations to tender.

Mr Peyrard ended his presentation with an illustration of joint financing: the Entreprise des Industries Chimiques du Sénégal (ICS), which was inaugurated a few months ago.

Total financing amounted to over 75 billion CFA francs, divided into 40% equity capital and 60% loans from different financing bodies: the OPEC Fund, the Arab Bank for Economic Development in Africa, the European Investment Bank, and the European Development Fund.

Mr Dutreux, Foreign Trade Counsellor in France

Manufacturers and sellers are just as motivated as foreign representatives when it comes to executing the projects that have been presented to us. However, it is regrettable that information does not circulate better at that level. Sellers can rely on the CFCE (Centre Français du Commerce Extérieur) for a general idea of the aid that is available (for example, from COFACE or their own region).

It should also be pointed out that by the time a protocol is signed, it has practically run out. Therefore, protocols must be drafted with French manufacturers or sellers as partners, on the one hand, as they are your best advocates in dealing with French financial organizations, and with the commercial attaché of your embassy acting as intermediary, on the other hand.

In order for a project to be included in a protocol, it must be profitable and have undergone in-depth study. This is often a very long process (1 year), as investments are granted on the basis of a fourth, fifth, or sixth proposal, a situation which causes problems for manufacturers. However, manufacturers may receive support from COFACE (in the form of prospecting insurance or project insurance). After that, they must surmount the obstacles posed by the export credits guarantee commissions (DRE, COFACE, or BFCE).

The greater the detail used in presenting a project, the greater are its chances of being implemented, even in the case of non-budget or non-protocol projects. CFCE is available to help you achieve that goal.

5 - QUESTIONS FROM PARTICIPANTS

Representative from Colombia

Mr Peyrard neglected to mention that the operation in Senegal took place nearly ten years ago, because the idea was mooted in 1974, and that all of this was launched only a month ago.

Obviously, these are large-scale, long-term projects. However, in the situation in which the developing countries currently find themselves, for projects that last ten years, the people here will only hear about the implementation of projects presented today in the year 2000. We feel that greater efforts should be made, especially by the banks.

In an operation of this type, the amount involved is less astonishing than the number of countries and bodies that have taken part (World Bank, OPEC), despite which, it has taken 10 years to reach the implementation stage.

When projects are smaller in scale, we are simply told that the type of project is not worth the trouble.

Mr Millimono, Representative of the Republic of Guinea, UNIDO Office, France

I would like to point out a few small problems we have encountered. We are often asked to submit good projects, that is, productive projects, profitable projects, projects that promote exports and generate hard currency income, in order to achieve return of investment within a reasonable period of time.

However, in order to define a good project, proper financing is required from the very outset.

We have contacted a number of French industrial companies in order to work out a preliminary project which we could present to financing organizations. It goes without saying that on the basis of a preliminary project, it is difficult for a financing institution to come to a decision on whether or not to provide financing. In fact, financing is usually refused.

Next, we are asked to suggest reasonable projects, that is, medium-sized projects. When these projects are defined, we are informed that their profitability is uncertain, that the project is small, and we run up against financing problems.

When we suggest large-scale projects, we are told that the local market is not very great, and that the sub-regional market is not big enough to absorb production. Here again, we come up against problems in obtaining financing.

Our question, therefore, is "What are we supposed to do?"

Moreover, I would like to know the practical steps to take if our country, Guinea, has signed credit agreements.

Mrs Larsilière answered the first question put by Mr Millimono, indicating that apart from the different instruments mentioned previously, which can be used to pre-finance studies, the Caisse Centrale has developed a range of procedures that are in wide use and that are all linked to productive projects as determined by studies. For the least developed countries, the Caisse Centrale may even agree to carry out its own study, providing full financing, and passing it on to the country or company in question if the project is to be carried out.

Mr Bocquet suggested that Mr Millimono find a French bank that would be willing to sign a private framework agreement with a Guinean bank, either through one of its local branches or through its head office.

6 - COMPREHENSIVE TABLE OF BANKS, MULTILATERAL INTERNATIONAL FUNDS, AND BILATERAL INTERNATIONAL FUNDS

6.1 - International Organizations

- World Bank Group

International Bank for Reconstruction and Development - IBRD
International Development Association - IDA
International Finance Corporation - IFC

- United Nations

United Nations Development Program - UNDP
United Nations Industrial Development Organization - UNIDO
International Fund for Agricultural Development - IFAD
World Food Program - WFP
United Nations Industrial Development Fund - UNIDF
Self-replenishing Fund of the United Nations
United Nations Conference on Trade and Development Fund - UNCTAD Fund
International Fund for Science and Education
United Nations Capital Development Fund - UNCFD

6.2 - Regional Organizations

Inter-American Development Bank - IDB
African Development Bank - ADB
African Development Fund - ADF
International Finance Corporation for the Development of Africa - SIFIDA
Asian Development Bank - ADB
Asian Development Fund - ADF
Private Investment Corporation for Asia - PICA
European Investment Bank - EIB
European Development Fund - EDF
OPEC Fund for International Development
Arab Bank for Economic Development in Africa - ABEDA
Arab Fund for Economic and Social Development - AFESD
Islamic Development Bank - IsDB
Arab Monetary Fund - AMF
Arab Authority for Agricultural investment and Development - AAAID
Interarab Corporation for Investment Guarantees

6.3 - Sub-Regional Organizations

- Africa

West African Development Bank - WADB
Development Bank of Central African States - BDEAC
East African Development Bank - EADB
Fund for Cooperation, Compensation, and Development - FCCD (ECOWAS)
Community Development Fund - CDF (WAEC)
Solidarity and Intervention Fund for Community Development - FOSIDEC (WAEC)
Mutual Aid and Guarantee Fund of the Conseil de l'Entente
Guarantee Fund of the Common African And Malagasy Organization - OCAM
African Solidarity Fund - ASF (Franco-African Conference)
Interstate Committee for Drought Control in the Sahel - CILSS
Club du Sahel (OECD)
Great Lakes States Development Bank - BDEGL

- Latin America

Central American Bank for Economic Integration - CABEI
Andean Development Corporation - ADC
Caribbean Development Bank - CDB

6.4 - Bilateral Organizations

- Europe

France: Caisse Centrale de Coopération Economique - CCCE
Fonds d'Aide et de Coopération - FAC
Belgium: Société Belge d'Investissement International - SBI
Britain: Commonwealth Development Corporation - CDC
West Germany: Deutsche Entwicklungsgesellschaft - DEG
Deutsche Gesellschaft für Technische Zusammenarbeit Gmbh - GTZ
Netherlands: Nederlandshe Financierings Maatschapij Voor Outwik Kelingslanden NV - FMO
Sweden: Swedish International Development Authority - SIDA
Norway: Norwegian Agency for International Development - NORAD
Denmark: Danish International Development Agency - DANIDA
Industrialization Fund for Underdeveloped countries - IFU
Finland: Finnish International Development Agency - FINNIDA
Finnish Fund for Development Aid - FINNFUN
Switzerland: Direction de la Coopération au Développement - DCD/DDA
Italy: Department for Cooperation and Development

- **North America**

United States: United States Agency for International Development - USAID
Overseas Private Investment Corporation - OPIC
Canada: Canadian International Development Agency - CIDA

- **Pacific**

Australia: Australian Development Assistance Bureau - ADAB
Japan: Japanese International Cooperation Agency - JICA
Japanese Overseas Development Corporation - JODC
Overseas Economic Cooperation Fund - OECF
Export-Import Bank of Japan
New Zealand: New Zealand Development Assistance Office

- **Middle East**

Kuwait: Kuwaiti Fund for Arab Economic Development -
Abu Dhabi: Abu Dhabi Fund for Arab Economic Development -
Saudi Arabia: Saudi Development Fund - SFD

CONCLUSION

ENERGY MANAGEMENT IN AGRO-FOOD INDUSTRIES

Summary report of speech delivered by Mr Martelly, Agence Française pour la Maîtrise de l'Energie (AFME)

1 - ENERGY: A CHALLENGE TO AGRO-FOOD INDUSTRIES

In France, energy consumption related to agro-food industries is approximately 5 million tons of oil equivalent (TOE), which represents around 0.1 TOE per inhabitant, excluding energy expenditure in agriculture itself.

Energy expenditure varies enormously from industry to industry within the agro-food sector, but can represent up to 40% of production costs.

Wide coverage has been given over the course of this week to examples of food industries where available by-products can be utilized to produce energy and thereby meet the energy requirements of those industries.

The conclusion might be drawn that the need to save energy disappears as soon as low-cost, renewable, alternative energy sources become available. This is far from the truth. Energy savings and alternative energy sources are not mutually exclusive. They are complementary.

2 - DIFFERENT LEVELS OF ENERGY SAVINGS

Very considerable energy savings are technically possible in almost all fields.

Dehydration, for example, which is known to be a very costly operation, can be carried out with negligible energy consumption by condensing water vapor in the final stages of the process and utilizing a multiple-effect evaporator. In theory, there is no maximum possible number of effects, but clearly investment costs very quickly become a limiting factor.

Managers of a given company must thus decide upon a level of investment in the light of profitability criteria that are specific to that company, after having taken all possible action (involving no investment or investments that are paid back quickly) to bring about reductions in energy consumption (reduced wastage, installation of automatic regulation systems, lagging, etc.).

Investments involving modifications of the manufacturing process or of the energy flow of the factory can be made at various different levels of energy management.

3 - RECOVERY OF WASTE HEAT

All industrial activities produce hot effluent in gaseous or liquid form, from which large quantities of heat can be recovered, either directly or using heat exchangers.

Recovery of hot air

Energy can be recovered from an industrial drying unit, for example, in several different ways:

- by limiting excess air up to stoechiometric proportions;
- by recycling hot air from the outlet;
- by heating the product to be dried;
- by condensing the water vapor released by the product.

Recovery of hot water

In dairy production, for example, hot water requirements are very numerous, and recoverable hot water is abundant. However, needs and resource availability do not always occur simultaneously. Correct management of this hot water, with intermediate storage at different temperature levels, can make it possible to fully satisfy the energy requirements of a cheese production facility.

4 - ENERGY RECOVERY USING A HEAT PUMP

The temperature of a waste product can be raised to the required level by using a heat pump. In canning plants, sterilizers supply water at 60°C, while liquor tanks require water at 90°C. The water at 60°C is fed via a system of heat exchangers to a boiler, and releases heat to the evaporator of a heat pump, which is then used to heat the liquor to 90°C, with energy savings of 50%.

5 - MECHANICAL RECOMPRESSION OF STEAM

Mechanical recompression of steam is a similar system to that of a heat pump operating on an open cycle: instead of utilizing a coolant that is alternately condensed and evaporated in a closed system, the process steam itself serves as the convector fluid once its temperature has been increased by compression. This steam releases heat when it condenses, and the condensate is removed.

Mechanical recompression of steam is a highly efficient means of transferring heat to a liquid, or of concentrating or distilling that liquid. Energy consumption is reduced by a factor of 10.

6 - MECHANICAL PRESSING AND INVERSE OSMOSIS

Another method of removing water from a product is through a direct mechanical process: pressing, when applied to a solid, or inverse osmosis when applied to a liquid.

7 - CONCLUSION

Energy saving processes basically involve:

- the systematic re-utilization of heat produced (the notion of energy cascading);

- the efficient use of electricity as an alternative to heat energy derived from fossil fuels.

These processes have already aroused the interest of French industries in the agro-food sector, as is demonstrated by an average reduction in energy consumption of 20% (for equivalent levels of production) since the beginning of the energy crisis.

CLOSING SESSION OF THE CONSULTATIVE COMMITTEE

Summary report of speeches

Mr Maung, UNIDO (Vienne), Chairman of Session

It is clear that the objective that we should be trying to attain is to move from the identification of needs to the design of projects. the preparation of investment propositions, and finally to the implementation of these projects.

The objective is clear. How can it be reached?

Mr Soeriaatmadja (Indonesia)

I suggest that the proceedings of this meeting of the Consultative Committee be recorded in a detailed summary report. This task could be accomplished by UNIDO.

As interested parties, we should develop our own individual follow-up in conjunction with our colleagues from French industry and with the institutions involved in research into tapioca.

With a view to sharing the experience that we will gain during the follow-up to this meeting, I sincerely wish a second meeting of the Consultative Committee to be held quickly.

Mr Rivet (Mauritius)

The preparation of a summary report of all the speeches and addresses made during this meeting is of vital importance in the transmission of information.

Before leaving this meeting, we should know what follow-up action UNIDO and the organizers are to take, so that we are in a position to relay this information to our governments, since each and every one of us will be called upon to make a report as to the appropriateness of our speeches.

Mr Maherzi (Tunisia)

If a second meeting of the same type is to be organized in the near future, it would be of interest to attach greater importance to existing techniques, research initiative and current operations involving the production of biogas.

Mrs Suvachittanont (Thailand)

In my opinion a future meeting should allocate more time to the presentation of our projects (30 minutes or even one hour) so that more attention can be paid to technical aspects.

Mr Trepp (Bolivia)

It seems that this Consultative Committee has directed its consultation towards the technologies offered by France, and not towards the interests of the different countries represented here.

Clearly, a project that is at the stage of a feasibility study cannot be presented in fifteen minutes.

Mr Zabi (Morocco)

I should like to thank the organizers of this seminar for the opportunity they have provided for us to present each of our projects, our problems, and the means of solving them.

It must be said that ideas are legion, but that we are faced with difficulties in putting these ideas into practice, through lack of financing. I would thus stress the importance for financing institutions and international organizations to help us to develop our standard of living.

For a future meeting of the same kind, I would suggest Water as a suitable theme, since agriculture depends on it, and several countries are currently suffering from drought.

Mr Shah (Pakistan)

I suggest that an exhaustive document be drawn up listing the names and addresses of the different participants.

Representative from Cameroon

I should like to draw the attention of UNIDO and of industrialists to the obstacles to development and the optimum utilization of new technologies with which we are faced. This is true in all sectors of the economy.

In the North of Cameroon, for example, cattle breeding activities make it possible to feed the country's 10 million inhabitants. Drought is advancing throughout this region, and the cattle population is short of food. Meanwhile in the South of the country, waste from sugar production and from cotton and coffee plantations is going to waste, when it should be utilized to manufacture cattle feed.

It is important to know what we want before we can hope to put into practice the means that exist to obtain it. The most important help we can receive is in organizing ourselves.

Mr Camara (Guinea)

I am particularly satisfied with this meeting, which has allowed us, above all, to compare ourselves with other countries on the same path towards economic and social development.

We would request the organizers of this meeting to act as swiftly as possible so that our projects might succeed.

Representative from DUVANT CREPELLE

Unlike certain persons who have criticized this meeting for having too commercial a flavor, I should like to point out that no contracts have been signed, but that we came here with a view to opening discussions on contracts that we hope to conclude favorably in a relatively distant future.

What was important from our point of view was to know whether the technologies that we have been developing provided suitable solutions to the different problems that exist. In this aspect, the meeting has been a complete success.

Mr Miraud (Minstry of Foreign Affairs)

I should first like to point out that our foremost objective, the setting up of contacts, seems to have been achieved.

In addition to the North-South cooperation that was the real aim and object of the meeting, two things have happened that I personally did not explicitly expect to see:

- South-South cooperation, in response to the realization by participating developing countries that complementarity exists between them, that they have shared fields of interest, and that exchanges of information -- and even of techniques -- can be made between them.

- North-North cooperation, with industries whose roles and activities are complementary meeting each other and coordinating themselves better to meet the needs that have been indicated by our friends from abroad.

The meeting was originally intended for about twenty participants from developing countries, but we eventually reached about thirty-five. We are very pleased that so many participants have been here, but it was of course necessary to restrict the length of speeches to give everybody the chance to speak at the same time.

Nonetheless. I think the time allotted for the presentation of technical possibilities by industries was even more restriced. In this respect, there are no grounds for speaking of imbalance.

While it is true that swift action is essential, it is also important to realize that the key to any preferential action leading to development is not in the hands of the organizers, but in the hands of the participants from developing countries in conjuction with their technical and financial partners.

Furthermore, we are very favorably disposed to attempting another event of this type, but it is impossible today to say where, when, or with what financing.

Mr Maung (UNIDO, Vienne)

Contact has been made, and we are very happy to see overall the satisfaction of the many parties involved.

It will be to the advantage of each and every one of the French industries that have developed new technologies for the production of energy from biomass to use UNIDO's vast network to transmit information from the developed countries to the developing world.

We should like many French companies and specialists to be enrolled at UNIDO for the supply of services and equipment, to make it possible for specialists to supply services in as short a time as possible.

Mr Meyour (ACTIM)

The ACTIM can continue the cooperation that has begun here in two ways:

- It can take action prior to negotiations, by organizing and participating financially in consultation, whether it be in identification at the request of companies or preparation and feasibility at the different stages of assessment of projects.

- It can take action after negotiations, by organizing courses in French companies for nationals of developing countries.

Mention must also be made of the assistance that our Agency can provide by maintaining relationships after the operation by forwarding all kinds of technical documentation.

Mr Jeanroy (UNIDO, Paris)

While certain participants have found the agenda of these last few days too dense, it has nonetheless been possible, given the quality of the speeches delivered both by the many representatives of developing countries and by companies, to paint as complete a picture as possible of the problems encountered and of potential solutions to those problems.

Emphasis should also be laid on the importance of the follow-up to this meeting, which cannot be carried out without the active participation of the representatives of developing countries and of industries present here, in completing the questionnaire that will be forwarded to them.

We would very much like other meetings of this type to be organized in other sectors of activity, such as fisheries and mining engineering, which are of particular relevance to this region of France.

Mr Josephe (Nord-Pas-de-Calais Regional Council)

The subject that has been discussed this week is of capital importance for life throughout the world and for the survival of our planet. I would personally like to urge those around me to take steps to ensure that action is taken. This is a vital question for developing countries, but it is also vital for industrialized countries, and it is most probably essential to peace among the men and women of our world.

APPENDIXES

LIST OF PARTICIPANTS

UNITED NATIONS

Mr Maung	Director for Industrial Development, Chemicals Industry, UNIDO
Mr Baum	UNIDO Consultant
Mr Jeanroy	Director, UNIDO Office (France)
Mr Gonbert	Deputy Director, UNIDO Office (France)
Mr Faidley	Senior Officer, FAO
Mr Hadj Sadok	International Affairs, United Nations

NORD-PAS-DE-CALAIS REGIONAL COUNCIL

Mr Josephe	Chairman
Mr Peyre	Director, Regional Cabinet
Mr Tetelin	Chief Executive, Regional Cabinet
Mr Capron	Head of Regional Energy Management Department
Mr Lamblin	Chargé de Mission, Regional Energy Management Department
Mr Six	Project Director, Regional Development Agency .
Mr Bel	Consultant

FRENCH GOVERNMENT OFFICES

Mr Pierret	Director, United Nations and International Organizations (NUOI), Ministry of Foreign Affairs (MRE)
Mr Biraud	Head of Economic Division (NUOI - MRE)
Mrs Khazal	NUOI - MRE
Mrs Martinet	Head of Renewable Energy Sources Department, Ministry of Industry
Mr Laparade	Ministry of the Environment

Mrs Petillot	Ministry of the Environment
Mrs Beltrame	General Directorate for Energy and Raw Materials, Ministry of Industry
Mrs Geissman	CODEV, Ministry of Foreign Affairs
Mr Fondeur	Ministry of Agruculture
Mr Lucas	Directorate for Agricultural and Food Industries, Ministry of Agriculture

OTHER FRENCH INSTITUTIONS

ACTIM:	
Mr Lejeune	Deputy Director General
Mr Mayour	
Mr Assemat	Engineer, Agro-Development
Mrs Kremer	Public Relations
AFME:	
Mr Chartier	Scientific Director
Mr Devin	Head of International Action Division (SAI)
Mr Radanne	Nord-Pas-de-Calais (NPC) Regional Delegate
Mr Villain	Nord-Pas-de-Calais (NPC) Regional Delegate
Mr Lambert	SAI
Mr Martelly	Industry Division
Mr Cousin	Biomass Division
Mr de Gromard	SAI
Mr Cornut	SAI
Mr Thomas	SAI
Mr Jacques	SAI
Mrs Delibrias-Mas	SAI
WATER AUTHORITY:	
Mr Noël	Head of Industry Division (Artois-Picardie)
ANRED:	
Mr Affholer	Director General
Mr Vellaud	Head of Organic Waste Department

Mr Cheverry	Agriculture Department
Mr Antoine	NPC Regional Delegate
Mr Broix	Local Communities Division
Banque Indo-Suez	Mr Rigaux
BFCE (Lille)	Mr Masson
BNP	Mr Charpentier
	Mr Bergeron
	Mr Bocquet
CEA	Mr Lemaitre, Renewable Energy Group
	Mr Kerever, DPT - SEIP
CCCE	Mrs Larsillière, Chargée de Mission
CEEMAT	Mr Vaing
CEMAGREF	Mr Molle, Head of Energy Division
CFCE	Mr Mosse, Directorate for Industries and Services
CIRFI	Mr Peyrard
Crédit Lyonnais	Mr Durance, (Lille)
	Mr Pic (Lille)
CTFT	Mr Vergnet, Coordinator, Woodfuel Program
DRIR	Mr Duriez, Environment Division, NPC
EDF	Mr Boillot, New Energy Techniques Division
Experts	Mrs Doucet
	Mr Petitpierre, EEC Consultant
	Mr Moureau, Director, SICA France Riz
IEMVT	Mr Richard, Head of Food Division
INRA	Mr Bories (INRA Narbonne)
	Mr Albagnac, Director (INRA Lille)
	Mr Dubourguier, Deputy Director (INRA Lille)
Sema-Metra	Mr Cagnot, Sema Energie

PARTICIPANTS FROM DEVELOPING COUNTRIES

See list page 37

OBSERVERS FROM DEVELOPING COUNTRIES

Argentina	Mr Kuhaz, Industrialist
Cameroon	Mr Basomo, Head of Investigations, Ministry of National Plan and Planning
Colombia	Mr Cheer, Director, RETECO
Egypt	Mr Khalek, Director
Ivory Coast	Mr Moussa Bado, Assistant Director, Industrial Environment
Malaysia	Mrs Cheah, Director, Porim
Tunisia	Mr Nouri Amah, Director, Energy

OVERSEAS DELEGATES TO UNIDO OFFICE (FRANCE)

Colombia	Mr Gomez, Foreign Trade Division, Ministry of Economic Development
Congo	Mr Bouity, Technical Advisor, Ministry of Industry
China	Mr Huanzhang, Ministry of Foreign Economic and Commercial Affairs
	Mr Baosheng, CITIC
Guinea	Mr Millimono, Deputy Director General, Investigations, Ministry of Industry
Angola	Mr de Morais, Director, International Affairs, Ministry of Industry

FRENCH COMPANIES

See list page 200

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United Nations
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UNIDO Service in France
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UNITED NATIONS

CONSULTATIVE COMMITTEE

UNIDO

REPUBLIQUE FRANÇAISE

15795-E

(2 of 3)

ENERGY UTILIZATION OF AGRO-FOOD INDUSTRY BY-PRODUCTS

NOVEMBER 1984 - LILLE (FRANCE)

Part 2

VALUATION OF THE POTENTIAL

UNITED NATIONS

CONSULTATIVE COMMITTEE

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REPUBLIQUE FRANÇAISE

ENERGY UTILIZATION OF AGRO-FOOD INDUSTRY BY-PRODUCTS

NOVEMBER 1984 - LILLE (FRANCE)

Part 2

VALUATION OF THE POTENTIAL

1/2

AN EVALUATION OF THE POTENTIAL AND THE LEVEL OF DEVELOPMENT OF TECHNOLOGY IN DEVELOPING COUNTRIES

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CONTENTS

INTRODUCTION

The Agence Française pour la Maîtrise de l'Energie (AFME) has commissioned SEMA-ENERGIE to draw up an inventory of agricultural product processing waste with energy potential in the developing countries, and to analyze possible energy production methods.

This document covers all the main tropical cash crop processing industries that produce waste of this kind, as well as livestock breeding and household waste from major cities; in each case it sets out:

- types of waste produced, and the energy production processes according to current levels of development;

- a flow chart of the process showing waste output at each stage;

- the breakdown of potential world reserves in terms of the quantity of waste produced and its usable energy content;

- other uses for the product which can compete with energy production.

The processes considered here involve the main industrially processed tropical crops, since industrial-scale processing ensures that waste is to some extent localized in one place. These are:

- coffee	- cotton
- cacao	- cashew and shea nut
- coconut	- sugarcane
- oil palm	- rice
- groundnut	- grain maize

For each crop an attempt has been made to identify the waste and by-products that are produced before the industrial processing stage, i.e., crop residues in the field or in the producing villages.

The other two activities considered here also produce large quantities of biomass with energy potential. These are:

- traditional or industrial cattle, pig and poultry production;

- household refuse production in large towns, with or without centralized collection.

1 - WASTE WITH ENERGY POTENTIAL AND ENERGY PRODUCTION METHODS

For each type of waste that can be converted into energy, applicable technologies are listed and their current level of development is indicated.

Waste and by-products with energy potential can be classified in four different ways:

- **quantities produced**, allowing for the fact that below a worldwide yearly production level of 500,000 tons there is little incentive for technological investment;

- **quantities available**, allowing for the quantities already utilized at the present stage of development;

- **type of availability** (whether or not the waste is pre-collected): prior collection will often be a deciding factor in the profitability of industrial-scale energy production from a given type of waste;

- **opportunity cost**, (or the utilization value of the by-product): if this is high, (for example with exported molasses from cane mills), it can have a detrimental effect on certain projects, while if it is low or negative (for example with noxious waste such as palm oil processing sludge) it can be a very favorable factor.

It is especially useful to classify energy conversion processes according to:

- **level of development**, which can be broadly assessed as follows:

  . boiler burning: industrial stage, reliable, but specific problems of choice of feed method, depending on particle size and substrate handling;

  . methanization: industrial stage, reliable for liquid substrates; development stage for solid substrates;

  . gasification: industrial stage for wood and cottonseed hulls, development stage for other substrates, particularly due to maintenance problems in developing countries.

- **profitability of conversion**, the current level of which can often be correlated with level of development:

. industrialized technology already in wide use: profitable process;

. pilot industrial project stage: technological process has been mastered but economic profitability and maintenance procedures have not yet proven themselves on a commercial site;

. technology at laboratory stage: cost parameters have not been adequately defined and there are no guaranteed development prospects.

2 - PROCESS FLOW CHARTS

The series of operations by which the harvested crop is converted into the finished product, generally a food or drink product, varies widely across the world.

We have restricted ourselves here to crops processed **in the producer country**, since the waste that interests us is that of the developing countries. Successive operations are shown in a simplified flow chart which takes into account:

- the waste produced throughout the post-harvest system, including that produced **prior to processing**: for example, crop residues such as straw, haulm and palm trunks are shown (even though such waste is generally scattered around fields, plantations and villages), since the energy potential in such waste can be enormous and utilized to very varying degrees.

- the dichotomy that exists, with many crops, between **first-stage non-industrial processing**, and **more or less integrated industrial processing**. While some crops, like groundnuts and coffee, are processed entirely at industrial level, others which partly serve as a food crop may be handled by the producers or by village craftworkers, either for **the preparation stage** (e.g., copra production, cacao bean drying), or for **the entire processing operation** (palm oil, shea butter, rice, maize).

Certain factors, such as the varieties grown, the composition of the harvested plant product and the processing operations, can vary significantly from one country or region to another. As far as possible, however, to provide points of refence, two calculations have been made for each intermediate and final product and for the waste from each processing operation. These calculations are:

- **yield in weight** per 100 kg of the processing sequence product normally cited in production statistics;

- **moisture content** expressed as relative humidity of the primary product (RH) or as the proportion of dry matter in the primary product (DM).

These ratios are given as guidelines; for the most part they come from West Africa, and more particularly from the Conseil de l'Entente countries.

Lastly, the flow charts for waste output from livestock production and large cities have been conceived rather differently:

. the different types of waste generated by cattle, pig and poultry production are described qualitatively;

. urban household refuse is described in terms of per capita output and composition, according to the level of development of the country concerned.

3 - POTENTIAL WORLD RESERVES

An attempt has been made to estimate, for the main developing producer countries, the potential energy reserves incorporated in waste from cash crop processing industries, livestock production and household refuse:

. The production statistics used are the FAO statistics for 1982-1983 and, where there are considerable fluctuations, a round average for the last 5 known years is adopted.

. For crops like cacao, which is partly exported raw and partly processed in situ, the quantity **consumed by the exporting country's factories** is indicated and used as a basis for estimating the industry's waste output.

. National production statistics generally only take into account the **quantities sold commercially**. In other words, this estimate, except for livestock, takes no account of waste from **farm consumption of food crops**, which are also the most scattered and least easily usable types of waste (recycled as fertilizers).

. In the particular case of household refuse, the estimate is restricted to output from Third World cities with a population of over 1 million.

. The waste produced, in tons, has then been calculated in terms of the ratio of waste to commercial product. This approximate ratio has been calculated in the same way for all countries, except in the case of household refuse.

. Estimates of potential energy reserves are based on the **quantities of waste produced** and not the quantities actually available. In fact it is not yet possible to quantify the proportion of waste already utilized (a qualitative assessment is given in Table 1 for each product). On the other hand, such a quantitative assessment would in any case not take account of the conditions and cost of waste utilization, a factor which affects economic feasability.

. The estimate of potential energy reserves is linked to the technology under consideration. For each country, only those reserves linked to **conversion techniques feasible on an industrial scale** have been quantified. The estimate is based on:

  . the net heat value of the waste (This is not generally known with any accuracy, since it is based on too small a corpus of analytical data, and the data itself is too variable);

  . the energy conversion efficiency actually observed during normal operation.

  Output estimates have been based on an average figure for combustion (60-65%), and a conservative figure for gasification (0.20 kWh/th of heat value) and methanization.

Estimated energy reserves must be understood:

. **as usable energy**, i.e., final energy output allowing for whether it is used for heat or electricity, and taking conversion efficiency into account,

. **as potential energy from all the waste produced**, not merely the waste available actually through given current uses and utilization conditions,

. as having **a high level of uncertainty** (estimated at 30 - 40%), due to the quality of the statistics and the lack of precision in the ratios used.

4 - COMPETING USES

Energy production from biomass in general, and from agricultural processing waste in particular, has to be considered in comparison with other types of potential uses for these materials:

- **animal feed**, wherever waste with high protein content can find a market near the place of production (e.g., molasses from sugarcane mills);

- **soil improvement and manuring**, wherever there are significant amounts of N, P or K, either by direct application or after burning or composting;

- **miscellaneous uses**: paper and board, traditional building materials, industrial raw material, etc.

  These competing uses must be examined in terms of:

  - **cost breakdown**: processing and packaging costs involved in each utilization system, cost price of the product replaced, gains in terms of local added value and foreign currency earnings;

  - **accessible markets**: volume of existing demand close enough to the point of waste production for the processed waste to be of economic interest to users or the community.

An analysis of projects has been made in order to shed light on the comparative value of these different uses. This analysis has shown that:

- **in economic terms**, projects are highly sensitive to transportation costs, and therefore tend to favor short-range collection, whatever use is to be made of the waste:

- **in market terms**, the slow development of industrial livestock production in developing countries and the under-use of organic fertililizers at this time favor the use of waste for the production of energy.

UNITS OF MEASUREMENT AND ABBREVIATIONS

hl	hectoliter (1 hl = 0.1 m^3)
kcal	kilocalorie (1 kcal = 10^{-3} th = 10^{-7} TOE = 4185 J = 3.97 BTU)
kWh	kilowatt hour (1 kWh = 0.86 10^3 kcal = 0.86 th = 3.6 10^6 J (physical equivalence)
RH	relative humidity (as percentage of raw material by weight)
DM	dry matter (as percentage of raw material by weight)
t	ton (metric)
th	thermie (heat energy needed to raise 1 metric ton of water from 14.5°C to 15.5°C at a constant pressure of 1 standard atmosphere)
TOE	ton oil equivalent (1 TOE = 1 TEP = 7.33 BOE = 10^7 kcal = 10^4 th = 4.18 10^{10} J) = 4 10^7 BTU

POTENTIAL ENERGY RESERVES IN 11 CROP PROCESSING INDUSTRIES

A - COFFEE

COFFEE

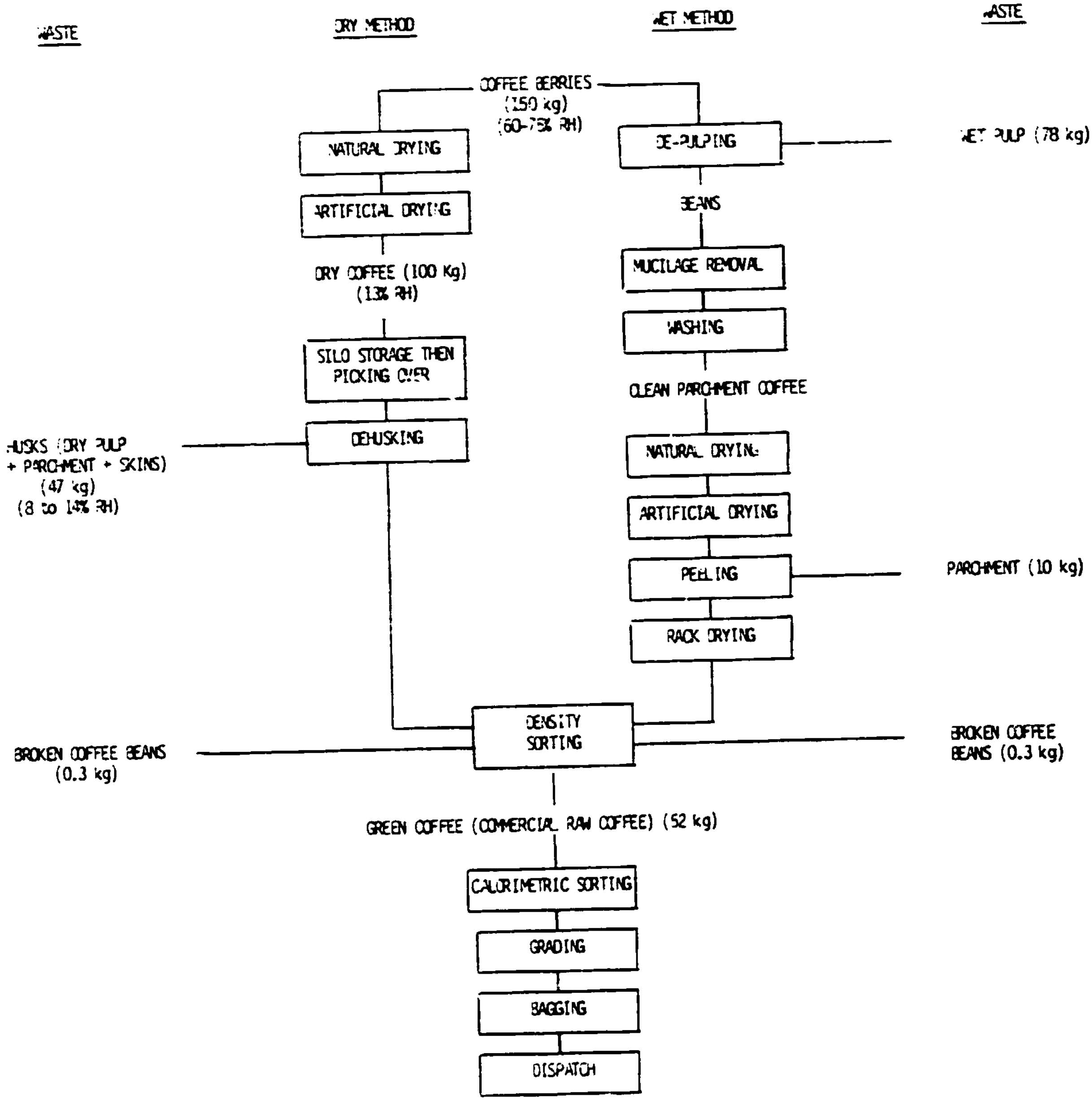
1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
WET METHOD PROCESSING	wet pulp	1500 10^3 t	none (noxious waste)	methanization	pilot plant	I.R.C.C. - VALORGA
	dried parchment	200 10^3 t	burnt in simple boilers	boiler combustion	industrial	
DRY METHOD PROCESSING	husks (parchment + dry pulp + skin)	3500 10^3 t	none (mildly noxious)	boiler combustion	pilot plant	I.R.C.C. - PILLARD
				combustion after grinding	pilot plant	AIRAIN
				combustion in briquette form	pilot plant	SERMIE
				gasification	laboratory	I.R.C.C. - PILLARD
INSTANT COFFEE MANUFACTURE	coffee grounds (25% D.M.)		40 to 50% burnt	boiler combustion	industrial (1)	Boiler manufacturers
				gasification	laboratory	
			compost	methanization	laboratory	

A.F.M.E. model operation sheet

(1) a steam boiler fuelled with coal and coffee grounds

COFFEE | 2. PROCESS FLOW CHART



COFFEE

3. POTENTIAL WORLD RESERVES

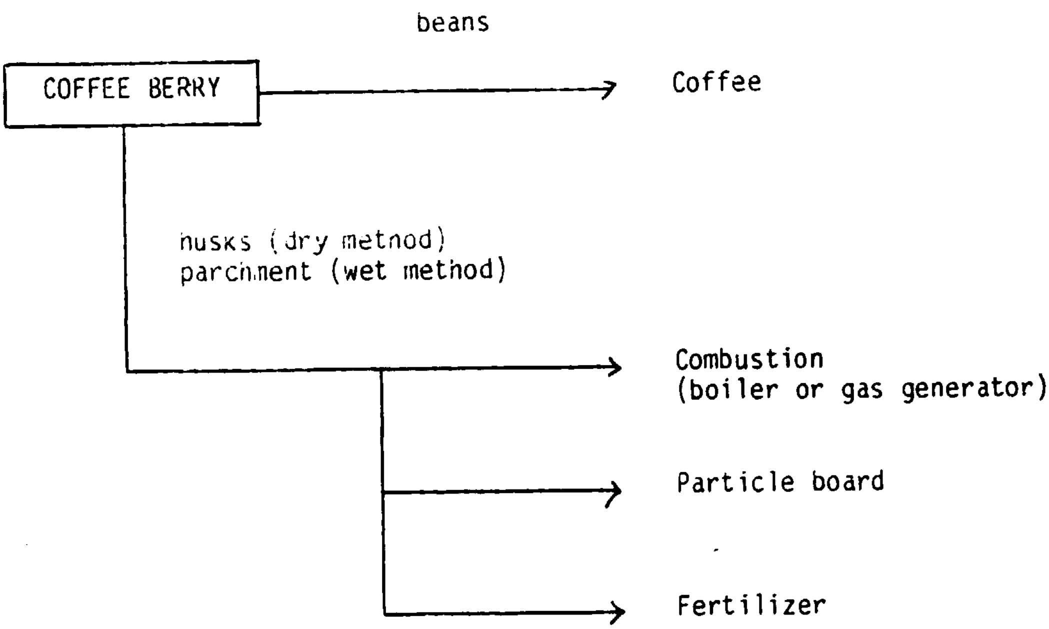
MAIN WORLD PRODUCERS	COMMERCIAL RAW COFFEE		HUSKS (dry method)			WET PULP (wet method)	
	1982-1983	estimated average	average production	reserves for combustion	reserves for gasification	average production	reserves for methanization
Brazil (A)	1065	1300	878	196	614	485	21.4
Colombia (A)	810	800	540	121	378	300	13.2
Indonesia (R)	318	300	270	60	189	-	-
Mexico (A)	252	250	169	38	118	94	4.1
Ivory Coast (R)	234	250	225	50	158	-	-
Ethiopia (A)	201	200	135	30	95	75	3.3
Uganda (R)	180	180	162	36	113	-	-
Guatemala (A)	148	150	101	23	71	56	2.5
El Salvador (A)	144	150	101	23	71	56	2.5
Costa Rica (A)	138	110	74	17	52	41	1.8
Cameroon (R)	117	110	99	22	69	-	-
India (A)	120	130	88	20	61	49	2.1
All above countries		3930	2840	635	1988	1160	51
WORLD (1982-83)	4870		3505	785	2455	1460	65
UNITS	10^3 t/year	10^3 t/year	10^3 t/year	GWh/year	10^3 t/year	10^3 t/year	10^3 TOE/year

	HUSKS: average production	HUSKS: reserves for combustion	HUSKS: reserves for gasification	WET PULP: average production	WET PULP: reserves for methanization
ENERGY CONVERSION EFFICIENCY		0.65	0.7kWh/kg		440 kcal/kg
HEAT VALUE OF WASTE	3440 kcal/kg				
WASTE:COMMERCIAL RAW COFFEE RATIO	0.9			1.5	

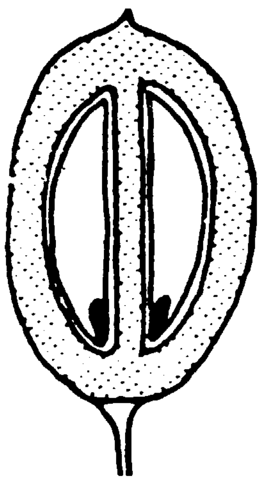
NB: A = arabica, R = robusta. It is assumed that in each country, 75% of arabica and 100% of robusta are processed using dry method, and 25% of arabica using wet method.

COFFEE

4. COMPETING USES



5. CROSS SECTION OF COFFEE BERRY



Botanists' nomenclature		Technical nomenclature
Exocarp	Red skin	Pulp
Mesocarp	Part clinging to red skin	Pulp
Mesocarp	Part clinging to silver skin	Mucilage
Endocarp ..	....	.. Parchment
Spermoderm .	....	.. Silver skin

Clean or commercial coffee { - Endosperm . Embryo }

Berry

From: Mémento de l'ajoint technique des travaux ruraux

French Ministry of Co-operation

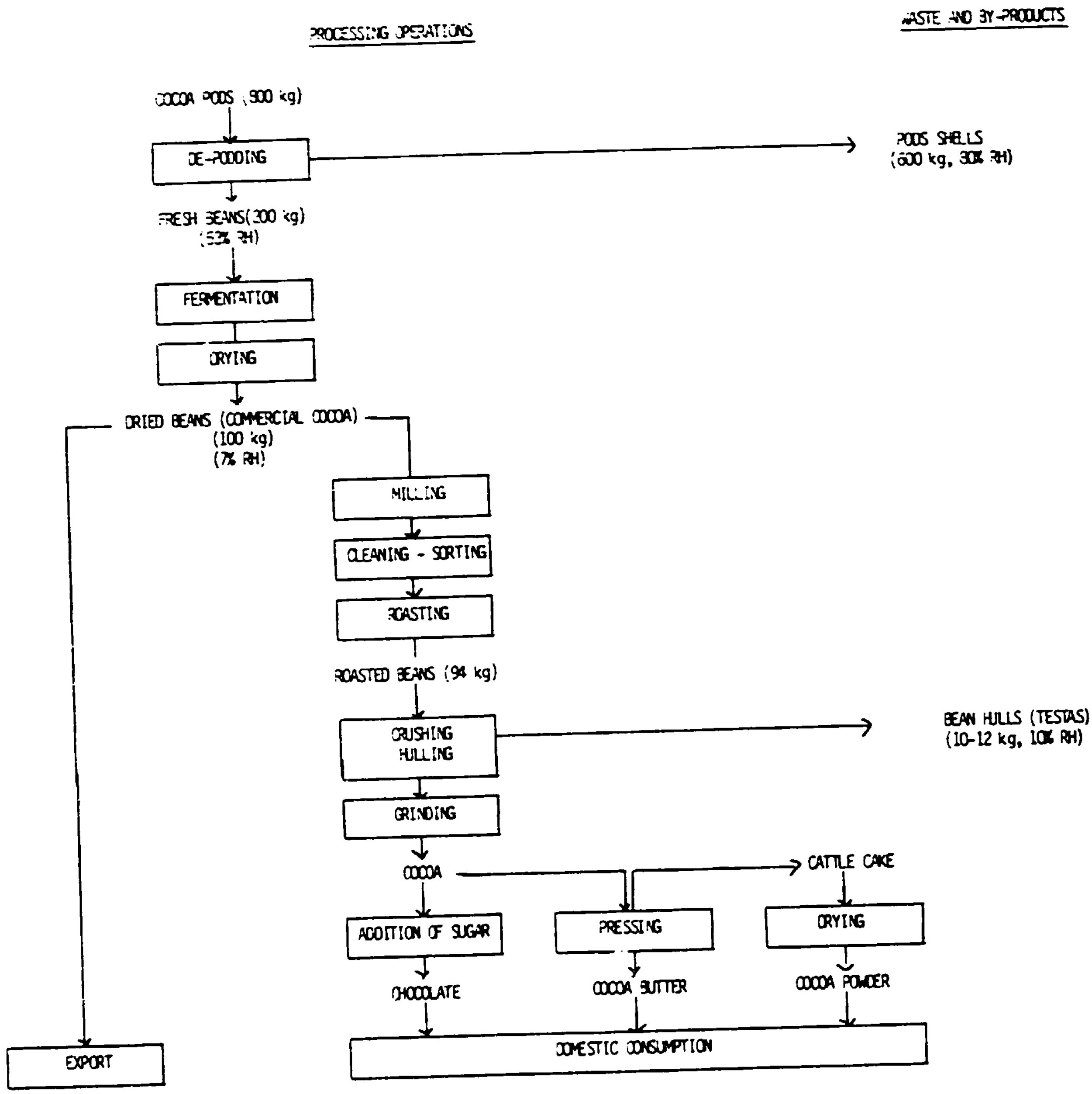
B - CACAO

CACAO

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
COCOA BEAN PROCESSING	pod shells	9400 10^3 t	. 80% shells not used (discarded in the field) . potash fertilizer	combustion after drying	laboratory	
				gasification after drying	laboratory	
				methanization	laboratory	I.R.C.C.
COCAO MANUFACTURE	bean hulls	150 10^3 t (including 66 10^3 t in LDCs)	mainly burnt in factory	boiler combustion	industrial	Boiler manufacturers

CACAO | 2. PROCESS FLOW CHART



CACAO

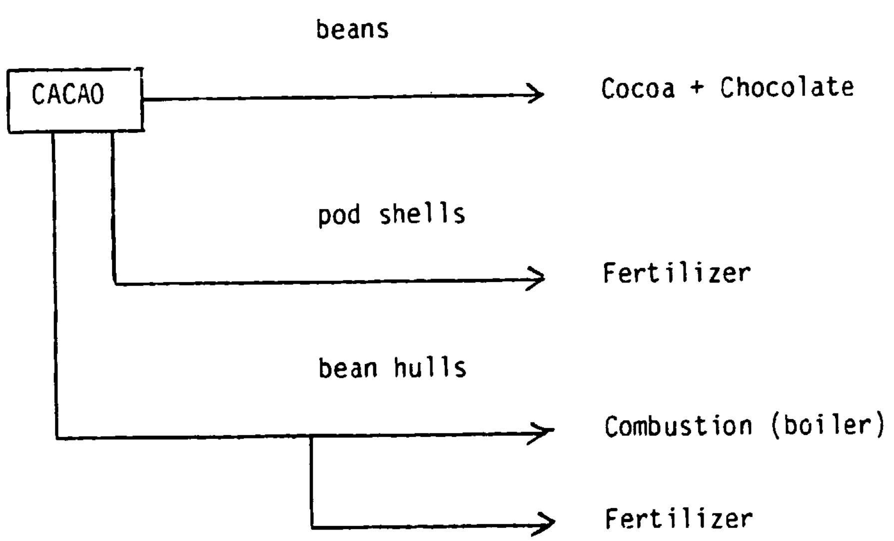
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	BEANS (COMMERCIAL COCOA) PRODUCTION			BEAN HULLS		WET PULP (wet method)		
	total production	exports	domestic consumption	national production	combustion reserves	production (20% DM) DM = dry matter	drying + combustion reserves	drying + gasification reserves
Ivory Coast	390	200	190	19.0	4.6	2340	91	281
Brazil	300	130	170	17.0	4.1	1800	70	216
Ghana	220	200	20	2.0	0.5	1320	52	158
Nigeria	170	140	30	3.0	0.7	1020	40	122
Cameroon	120	70	50	5.0	1.2	720	28	86
Ecuador	85	20	65	6.5	1.6	510	20	61
Mexico	40	-	40	4.0	1.0	240	9	29
Colombia	40	5	35	3.5	0.8	240	9	29
Dominican Republic	35	30	5	0.5	0.1	210	8	25
All above countries	1400	795	605	60.5	14.6	8400	328	1008
WORLD (1982-83)	1560	900	660	66	16	9360	365	1123
UNITS	10^3 t/year	10^3 t/year	10^3 t/year	10^3 t/year	10^3 TOE/year	10^3 t/year	10^3 TOE/year	GWh/year

	Bean hulls: national production	Bean hulls: combustion reserves	Wet pulp: production	Wet pulp: drying + combustion reserves	Wet pulp: drying + gasification reserves
ENERGY CONVERSION EFFICIENCY		0.65		0.65	0.60kWh/kg DM
HEAT VALUE OF WASTE	3700 kcal/kg		3000 kcal/kg DM		
WASTE:BEANS RATIO	0.10				

CACAO

4. COMPETING USES



C - COCONUT

COCONUT

1. WASTE WITH ENERGY POTENTIAL

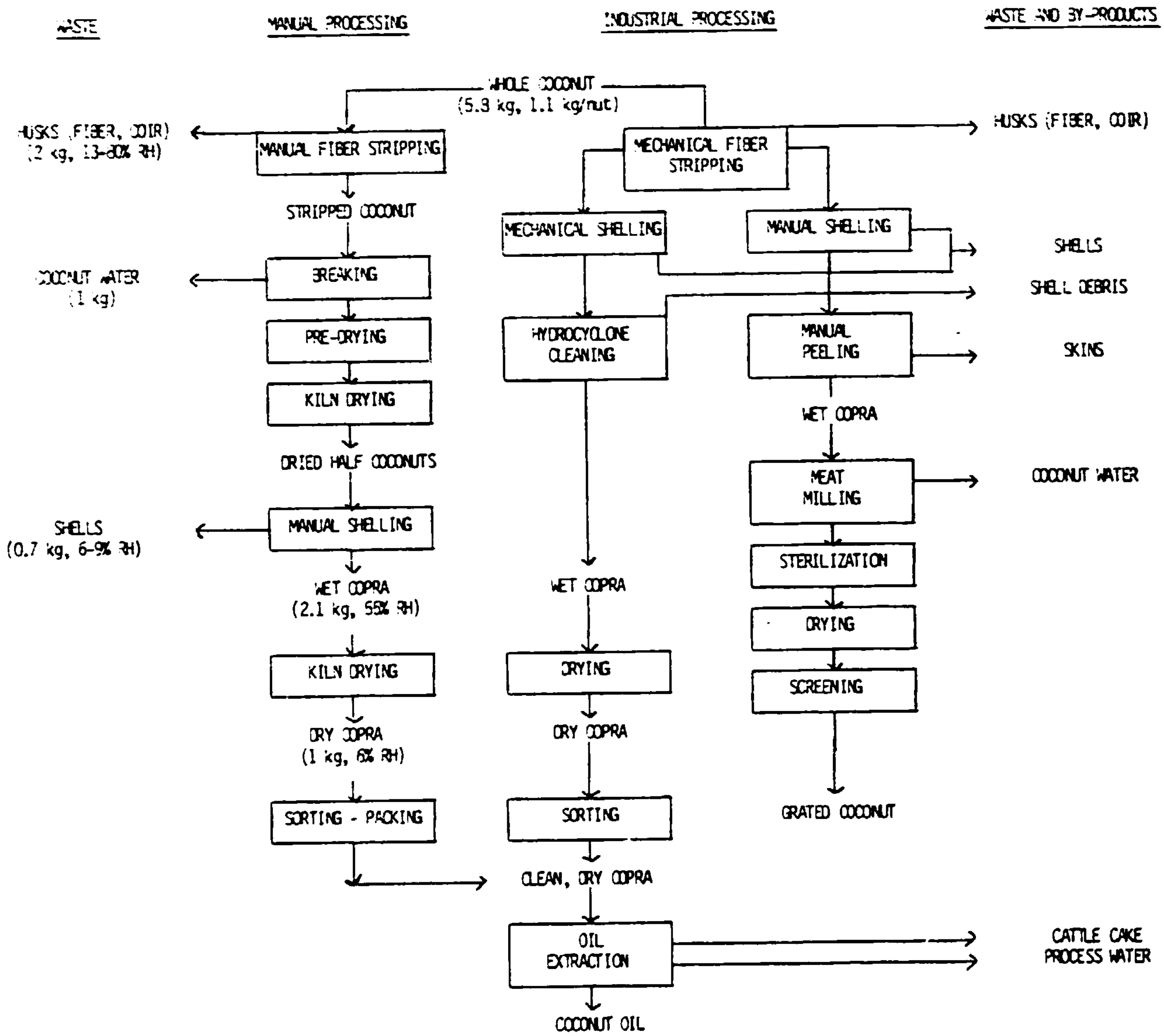
OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
COCONUT PLANTATION	palm trunks		considerable (rural situation)	shredding and combustion	village and laboratory	CEEMAT - C.D.F. - C.T.F.T. - I.R.H.O.
MANUFACTURE OF COPRA AND GRATED COCONUT	husks (fiber, coir)	10000 10^3	. in Asia, fiber industry: 50% . burning for fish-drying or on domestic fires . potash fertilizer	combustion in briquette form	industrial	
				gasification	industrial prototype (1)	ENTROPIE - CEA -
	shells	3700 10^3	considerable (domestic fires + activated charcoal)	boiler combustion	industrial	Boiler manufacturers
				gasification	industrial prototype	CEEMAT-CHEVET - I.R.H.O.
				carbonization	industrial	PILLARD - PICA
COCONUT OIL MILL	process water		none (noxious waste)	methanization	laboratory	
COCONUT FIBER INDUSTRY	coir dust		none	combustion in briquette form	industrial prototype	

A.F.M.E. model operation sheet

(1) gasification of coconut husks: Bora-Bora, French Polynesia

COCONUT

2. PROCESS FLOW CHART



COCONUT

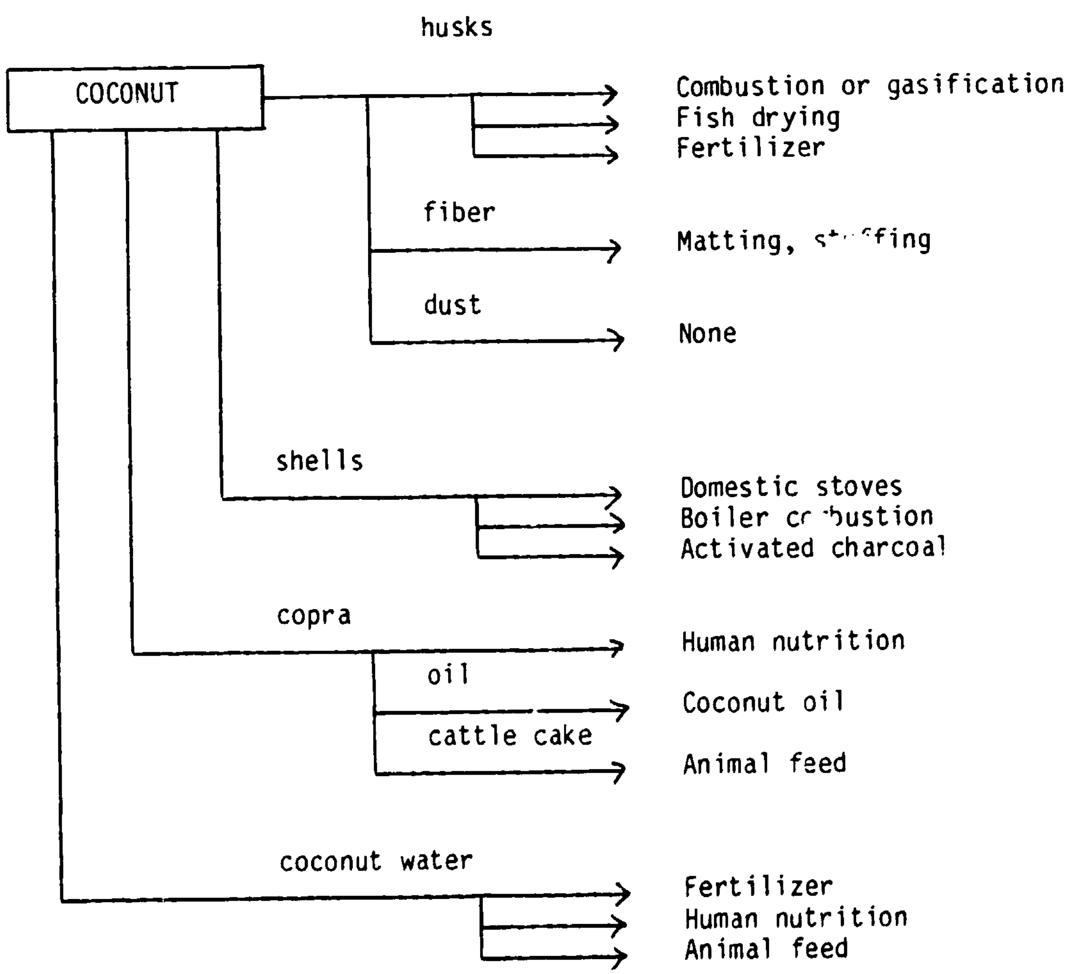
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	COPRA PRODUCTION		SHELLS			FIBER AND COIR		
	1982	estimated average	average production	combustion reserves	gasification reserves	average production	combustion reserves	gasification rerserves
Philippines	2558	2200	1650	408	1254	4400	660	1760
Indonesia	1389	1350	1013	250	770	2700	405	1080
India	340	330	248	61	188	660	99	264
Malaysia	200	200	150	37	114	400	60	160
Papua New Guinea	150	140	105	26	80	280	42	112
Sri Lanka	140	130	98	24	74	260	39	104
Mexico	120	120	90	22	68	240	36	96
All above countries		4470	3353	830	2550	8940	1160	3580
WORLD (1982)	4950		3710	920	2820	9900	1480	3960
UNITS	10^3 t/year	10^3 t/year	10^3 t/year	10^3 t/year	GWh/year	10^3 t/year	10^3 TOE/year	GWh/year

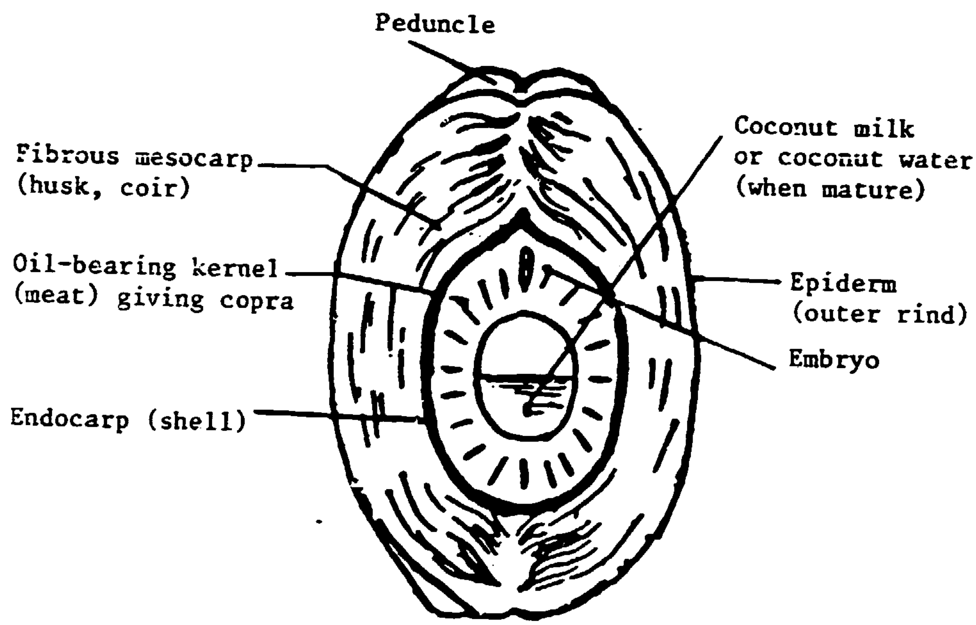
ENERGY CONVERSION EFFICIENCY		0.65	0.76 kWh/kg		0.65	0.40 kWh/kg
HEAT VALUE OF WASTE	3800 kcal/kg			2000 kcal/kg		
WASTE:COMMERCIAL RATIO COFFEE	0.75			2.00		

COCONUT

4. COMPETING USES



5. CROSS SECTION OF COCONUT



From: Mémento de l'agronome, French Ministry of Co-operation

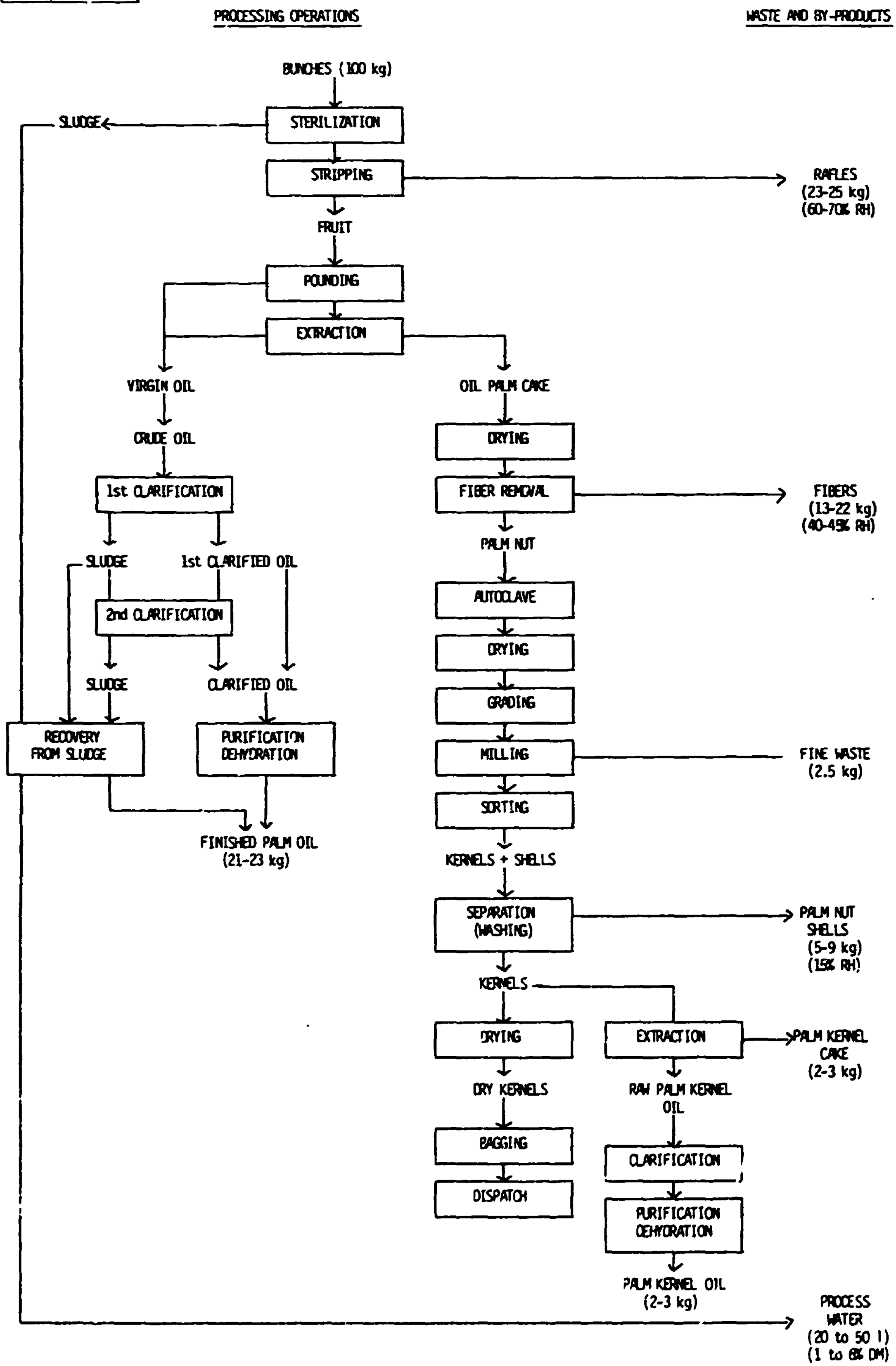
D - OIL PALM

OIL PALM

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
PALM PLANTATIONS	palm trunks		little used, rural situation (parasite problem)	carbonization	pilot plant	CEEMAT-I.R.H.O.
				shredding combustion	pilot plant	
PROCESSING OF PALM FRUIT BUNCH	bunch refuse (stalks) (humidity 60%	$7\ 10^6$ t	incineration for ash recovery	combustion after drying	laboratory	I.R.H.O.
	pericarp fibers (humidity 40%)	$6\ 10^6$ t	village or industrial scale burning 90%	combustion	industrial	Boiler manufacturers
				combustion in briquette form	laboratory (good results)	SERMIE
	nut shells	$2.5\ 10^6$ t	factory burning 10 to 30%	combustion	industrial	Boiler manufacturers
				gasification	laboratory	I.R.H.O. - CEEMAT
PALM OIL MILL	process water	$25\ 10^6\ m^3$	none (highly pollutant)	methanization	industrial	BIOMAGAZ

OIL PALM | 2. PROCESS FLOW CHART



OIL PALM

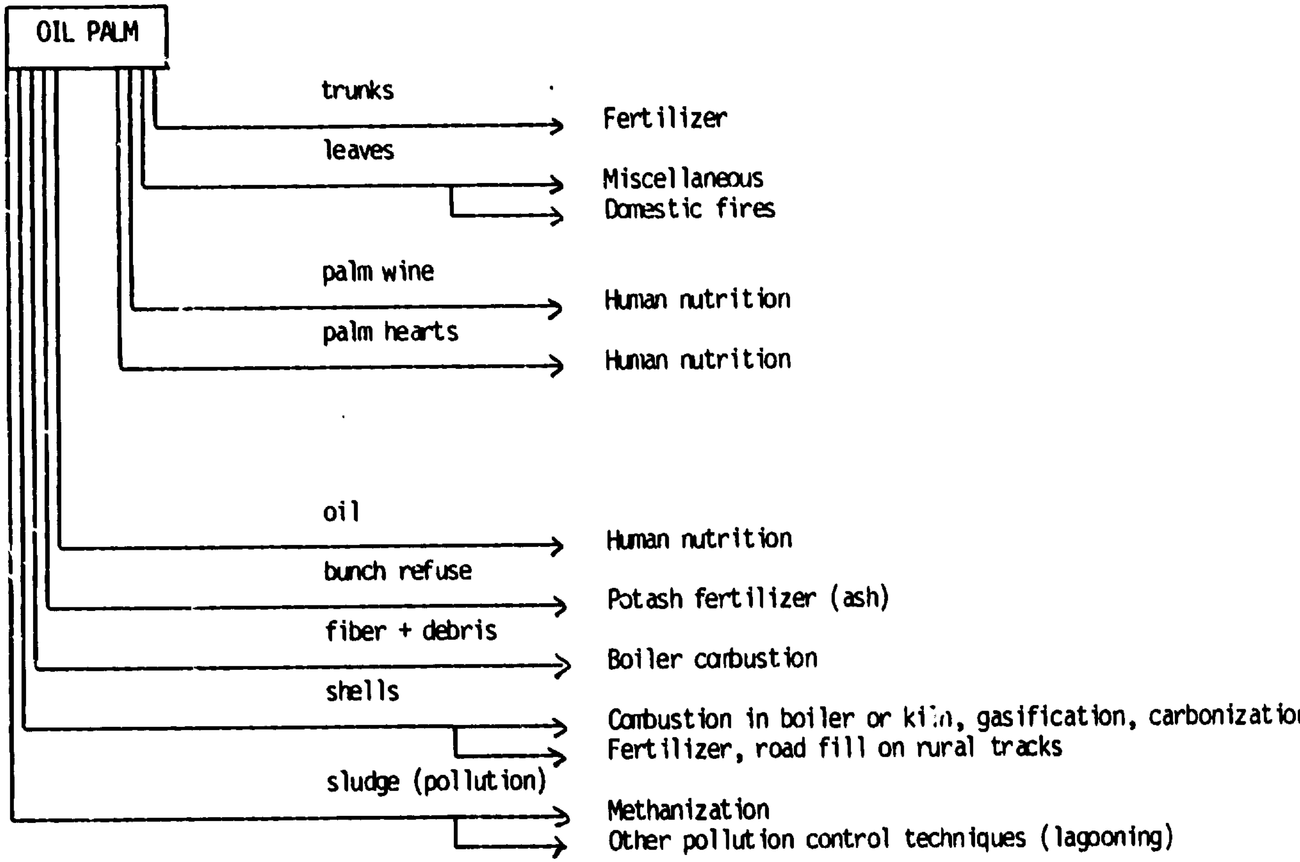
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	OIL PRODUCTION		BUNCH PRODUCTION	OIL PALM FIBER		PALM KERNEL SHELLS		PROCESS SLUDGE	
	1982	estimated average	estimated average	average production	combustion reserves	average production	combustion reserves	average production	methanization reserves
Malaysia	3500	3500	17500	3500	568.8	1400	364.0	8750	134.8
Indonesia	850	800	4000	800	130.0	320	83.2	2000	30.8
Nigeria	540	500	2500	500	81.3	200	52.2	1250	19.3
Ivory Coast	200	200	1000	200	32.5	80	20.8	500	7.7
Zaire	165	150	750	150	24.4	60	15.6	375	5.8
China	115	100	500	100	16.3	40	10.4	250	3.9
Colombia	95	90	450	90	14.6	36	9.4	225	3.5
All above countries		5340	25700	5340	868	2140	555	13350	206
WORLD (1982)	6075		30375	6075	987	2430	632	15188	243
UNITS	10^3 t/year	10^3t/year	10^3 t/year	10^3 t/year	10^3TOE/year	10^3t/year	10^3TOE/year	10^3m^3/year	10^3 TOE/year

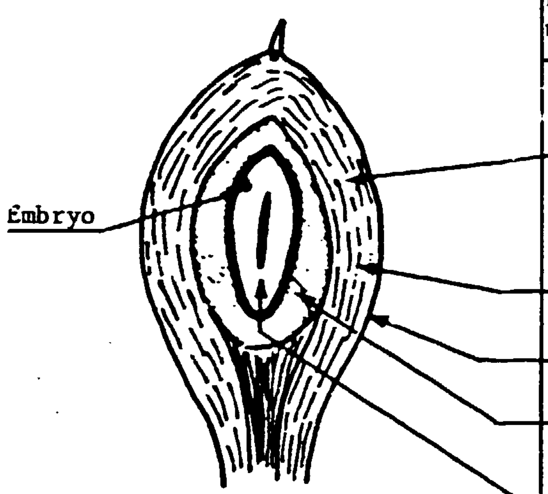
ENERGY CONVERSION EFFICIENCY		0.65		0.65		154000kcal/m^3 sludge
HEAT VALUE OF WASTE	2500 kcal/kg		4000 kcal/kg			
WASTE:OIL RATIO	1		0.4		2.5m^3/ t.oil	

OIL PALM

4. COMPETING USES



5. CROSS SECTION OF PALM NUT



Botanists' nomenclature	Technical nomenclature		
Mesocarp	Pulp	Oil Water Sludge	
Fibrous vascular bundle	Fibres	Insoluble dry matter	Oil cake
Epicarp	Rind		
Endocarp	Shell	Nut	
Albumen	Kernel		

From: Mémento de l'ajoint technique des travaux ruraux
French Ministry of Co-operation

E - GROUNDNUT

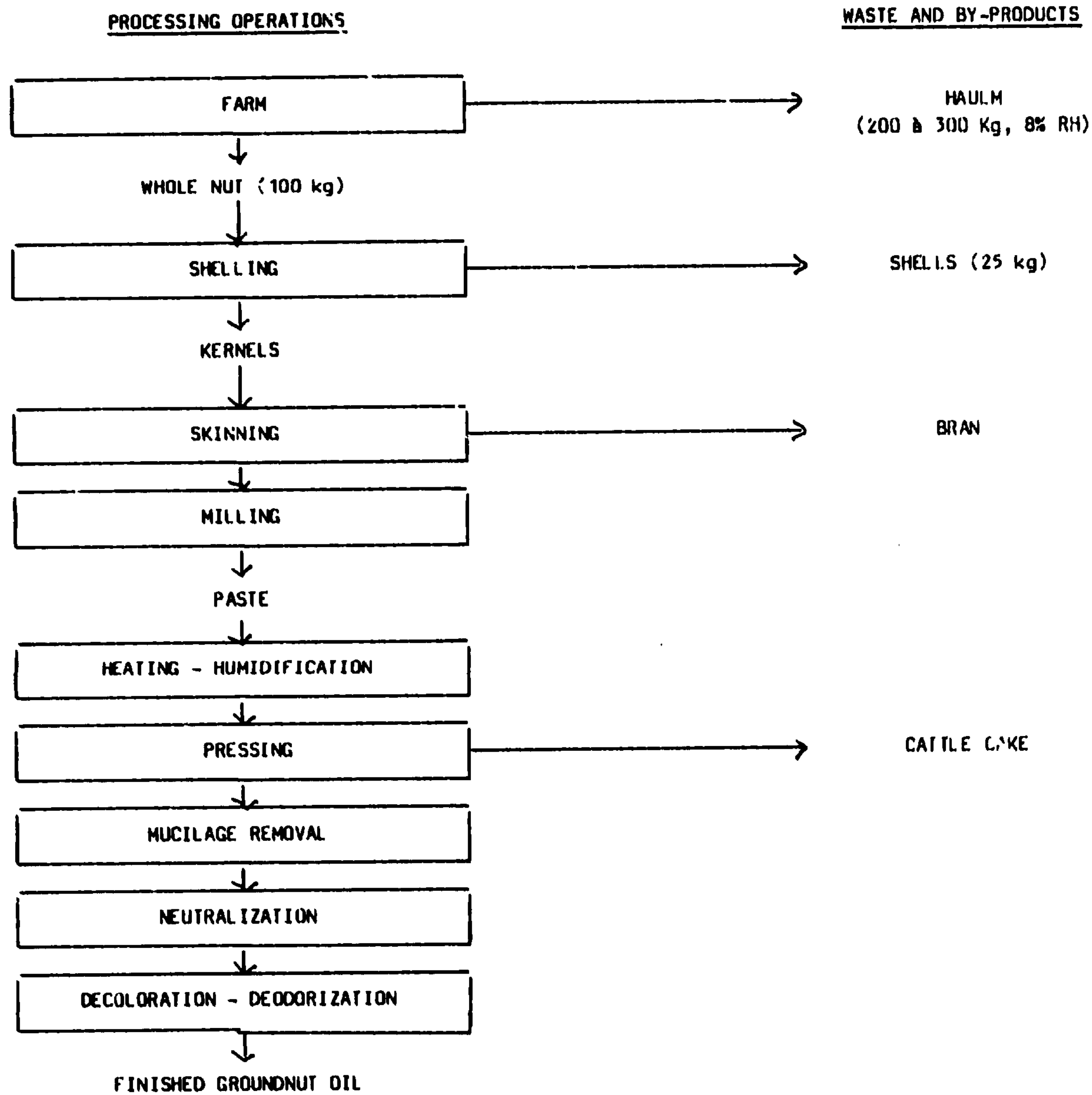
GROUNDNUT

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
GROUNDNUT FARMING	haulm	50 10^6 t	entirely used in cattle feed			
SHELLING PLANTS AND OIL MILLS	shells	5 10^6 t	little used in shelling plants, much used in combined shelling + milling plants (combustion)	combustion	industrial	Boiler manufacturers
				combustion in briquette form	industrial	SERMIE
				gasification	laboratory	

GROUNDNUT

2. PROCESS FLOW CHART



GROUNDNUT

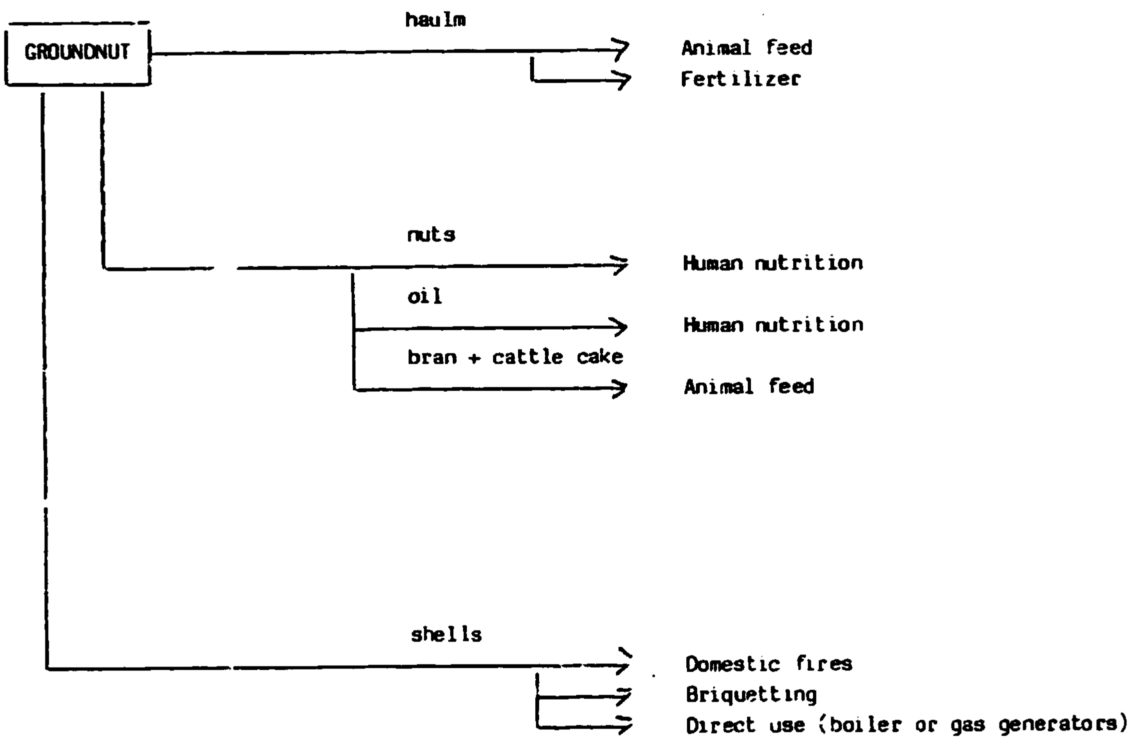
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	PRODUCTION OF WHOLE NUTS		SHELLS	
	1981-1982	estimated average	average production	combustion reserves
India	7239	6000	1500	390
China	3286	3800	950	247
Burma	3600	3000	750	195
USA	1806	1600	400	104
Indonesia	857	800	200	52
Sudan	850	830	208	54
Senegal	790	700	175	46
Nigeria	400	350	88	23
Zaire	295	300	75	20
Brazil	290	300	75	20
Argentina	240	300	75	20
All above countries		18000	4500	1170
WORLD	19591	20000	5000	1300
UNITS	10^3 t/year	10^3 t/year	10^3 t/year	10^3 TOE/year

ENERGY CONVERSION EFFICIENCY		0.65
HEAT VALUE OF WASTE	4000 kcal/kg	
WASTE:WHOLE NUTS RATIO	0.25	

GROUNDNUT

4. COMPETING USES



F - COTTON

COTTON

1. WASTE WITH ENERGY POTENTIAL

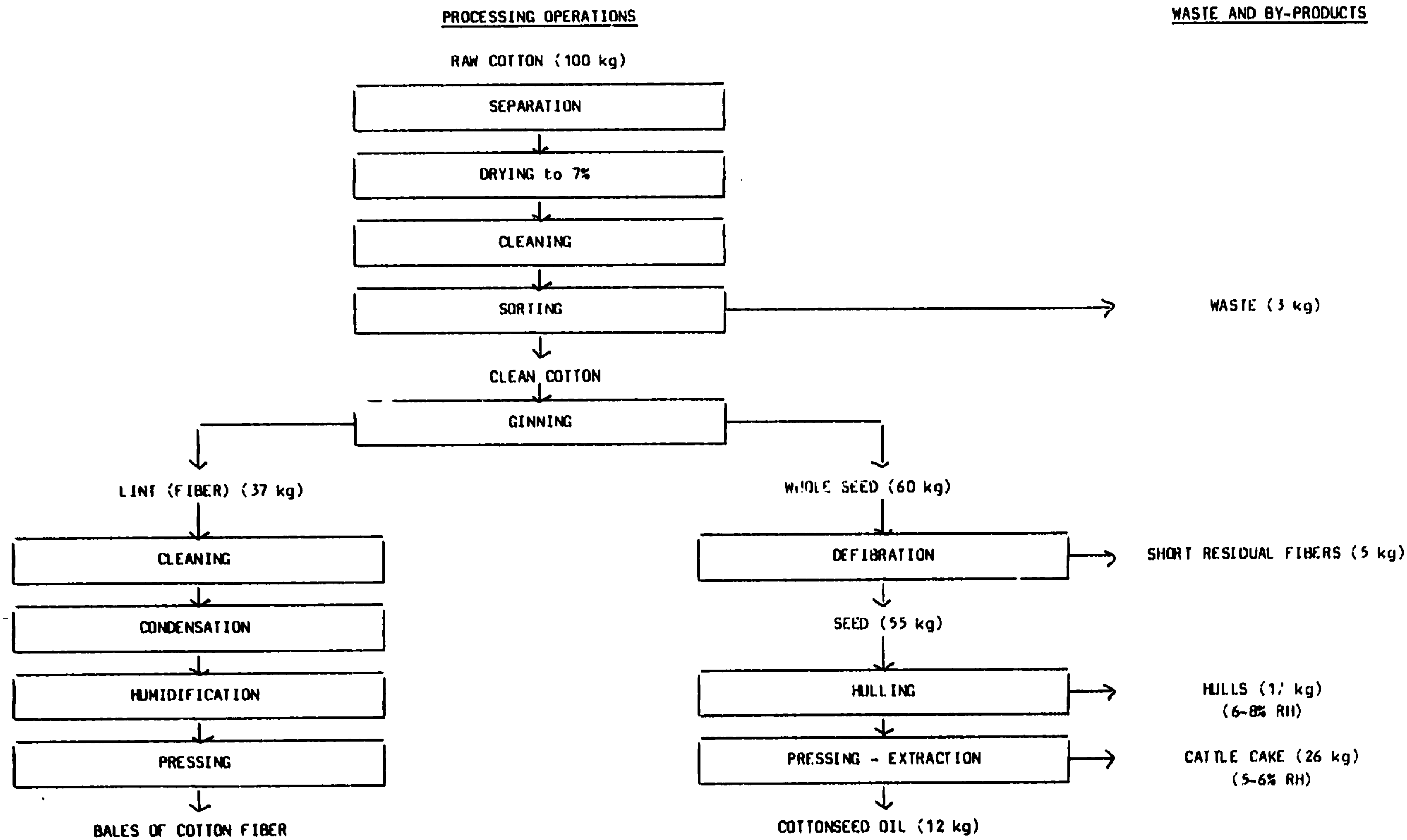
OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
GINNING	fiber dust and fine refuse	1 10^6 t	40% recovered for local craft-making; 60% burned or not used	combustion	industrial	Boiler manufacturers
PULVERIZING (oil mill)	seed hulls	7.7 10^6 t	widely used for combustion	combustion	industrial (1)	Boiler manufacturers
				gasification	industrial	DUVANT, CREUSOT-LOIRE

A.F.M.E. model operation sheet

(1) Combustion of cottonseed hulls in an oil mill in Mali

COTTON

2. PROCESS FLOW CHART



COTTON

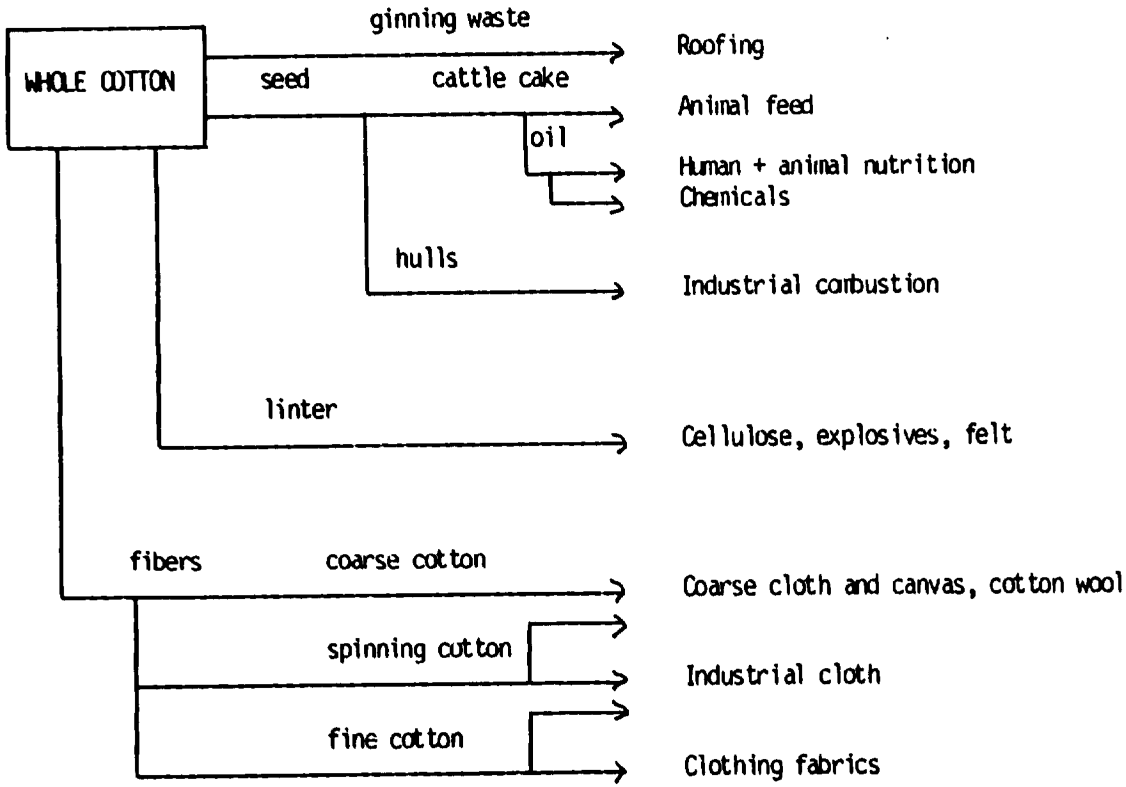
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	COTTONSEED PRODUCTION		HULLS		
	1980-1981	estimated average	average production	combustion reserves	gasification reserves
China	5414	5500	1650	418	1287
USSR	5082	5000	1500	380	1170
USA	4056	4500	1350	342	1053
India	2700	2700	810	205	632
Pakistan	1422	1500	450	114	351
Brazil	1057	1100	330	84	257
Egypt	896	800	240	61	187
Turkey	758	800	240	61	187
Mexico	570	550	165	42	129
Argentina	315	300	90	23	70
Sudan	264	250	75	19	59
All above countries		23000	6900	1750	5380
WORLD (1980-81)	25642		7700	1950	6000
UNITS	10^3t/year	10^3 t/year	10^3 t/year	10^3TOE/year	GWh/year

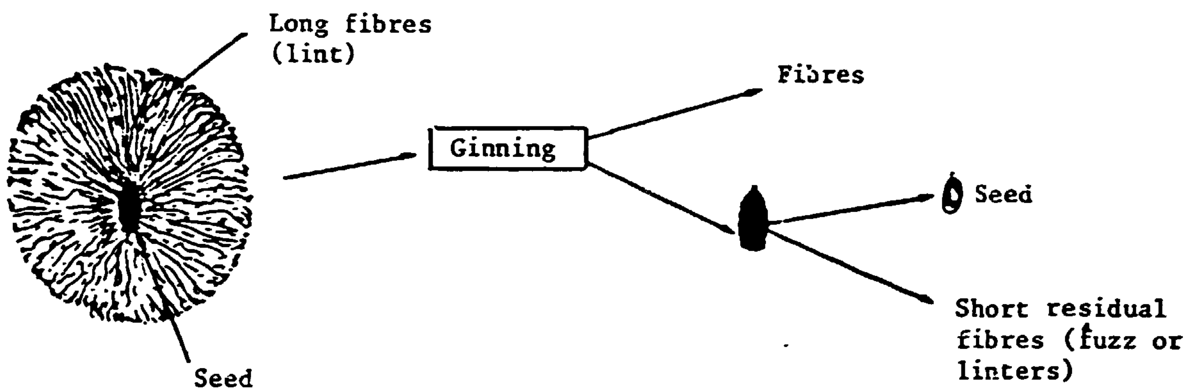
ENERGY CONVERSION EFFICIENCY		0.65	0.78kWh/kg
HEAT VALUE OF WASTE	3900 kcal/kg		
WASTE:COTTONSEED RATIO	0.3		

COTTON

4. COMPETING USES



5. THE THREE MAIN CONSTITUENTS OF COTTONSEED



From: <u>Mémento de l'ajoint des travaux ruraux</u>
French Ministry of Co-operation

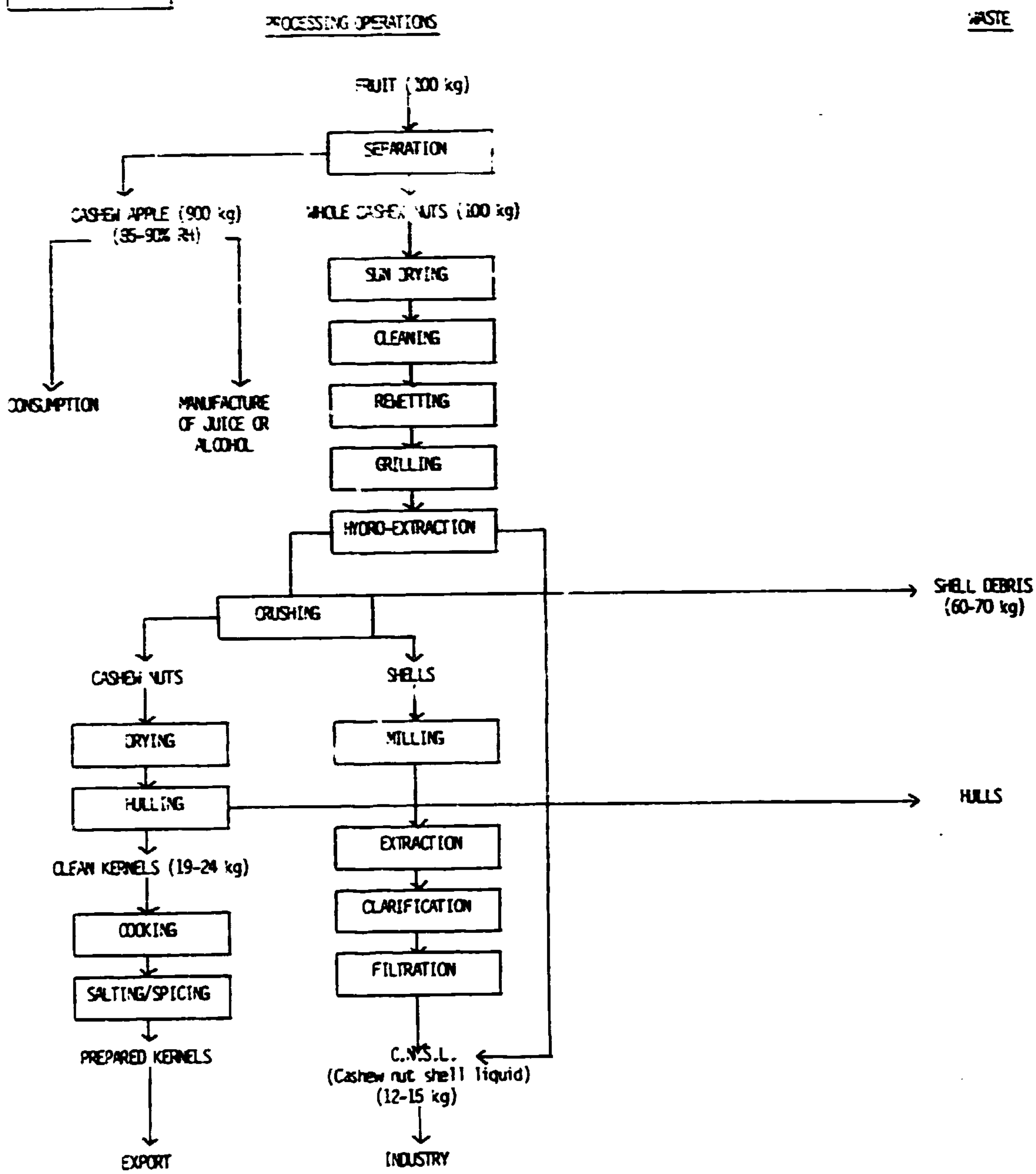
G - CASHEW AND SHEA NUTS

CASHEW & SHEA NUT

1. WASTE WITH ENERGY POTENTIAL

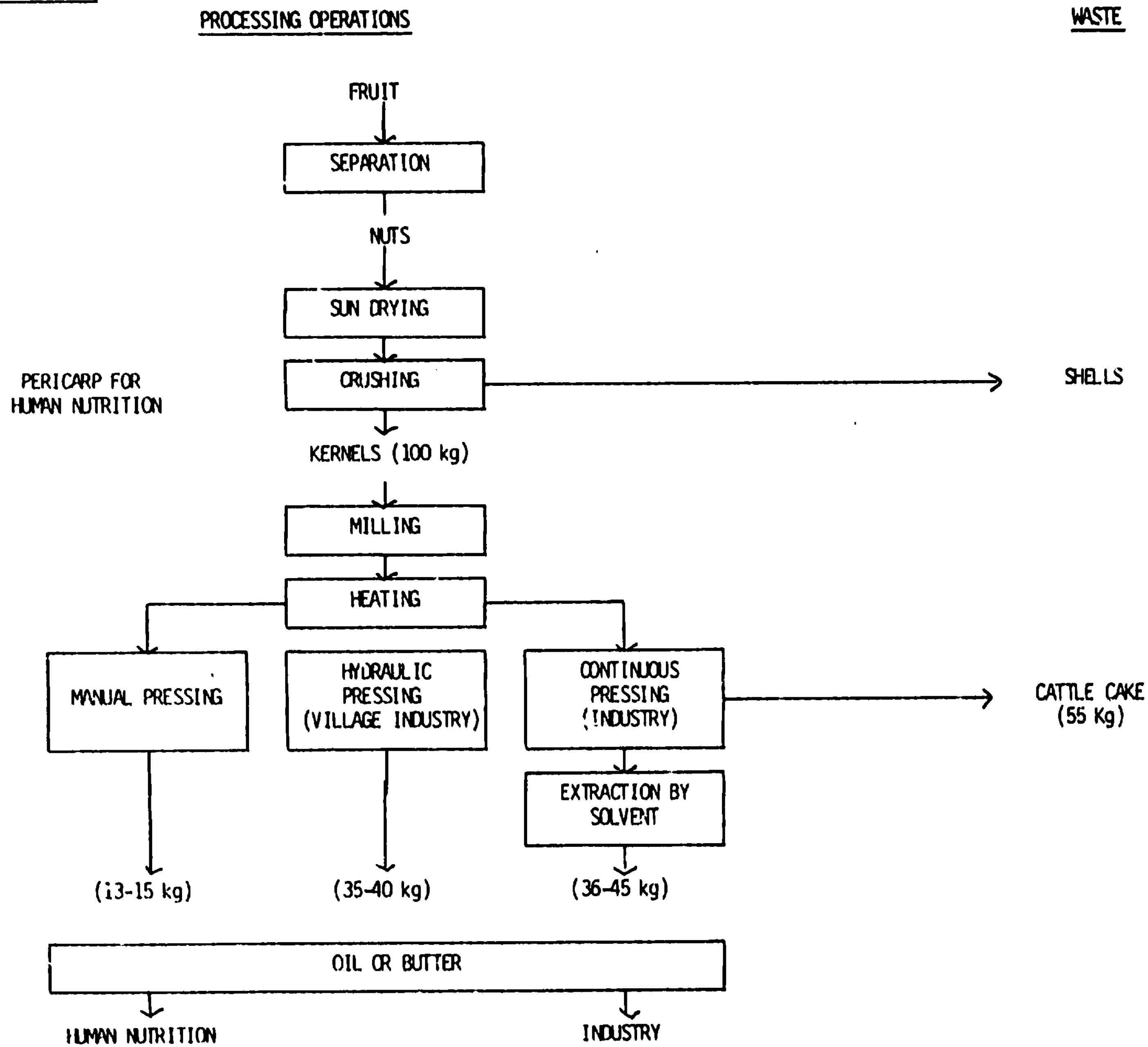
OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
CASHEW NUT AND C.N.S.L. PRODUCTION	shells	350 10^3 t (1977)	little used	combustion	pilot plant	I.R.F.A.
				gasification	laboratory	I.R.F.A.
SHEA BUTTER PRODUCTION	cattle cake	50 10^3 t	considerable in oil mills	combustion	industrial	

CASHEW | 2. PROCESS FLOW CHART



SHEA NUT

2. PROCESS FLOW CHART



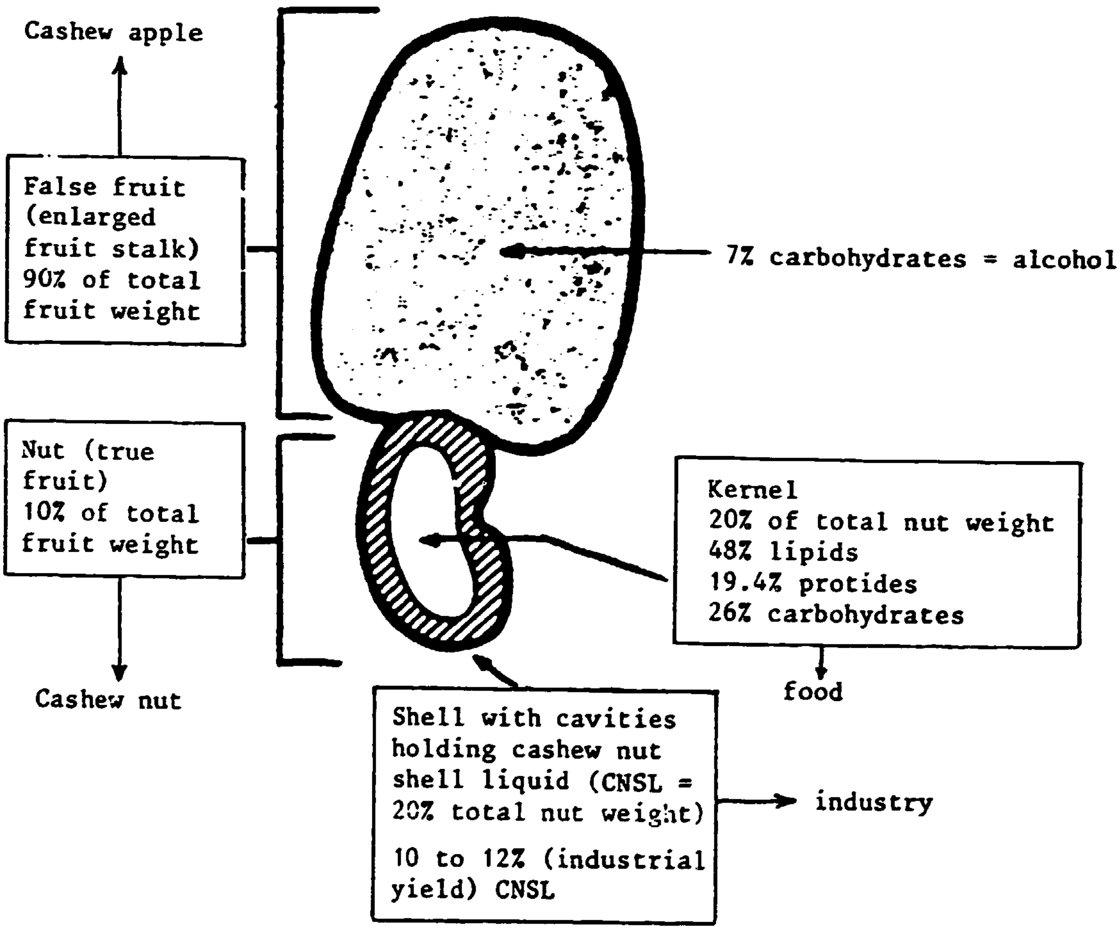
CASHEW

3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	CASHEW NUT PRODUCTION	SHELLS	
	1983	production 1983	combustion reserves
India	200	130	25350
Brazil	90	58.5	11400
Mozambique	70	45.5	8870
Nigeria	36	23.4	4560
Tanzania	35	22.8	4440
Kenya	12	7.8	1520
Guinea-Bissau	4.5	2.9	570
Pakistan	4	2.6	510
Thailand	4	2.6	510
All above countries	455.5	296.1	57730
WORLD	467	304	59000
UNITS	1000 t/year	1000 t/year	TOE/year

ENERGY CONVERSION EFFICIENCY		0.65
HEAT VALUE OF WASTE		3000 kcal/kg
WASTE:NUT RATIO	0.65	

4. CROSS SECTION AND USES OF THE CASHEW



From: Mémento de l'agronome , French Ministry of Co-operation

H - SUGARCANE

SUGARCANE

1. WASTE WITH ENERGY POTENTIAL

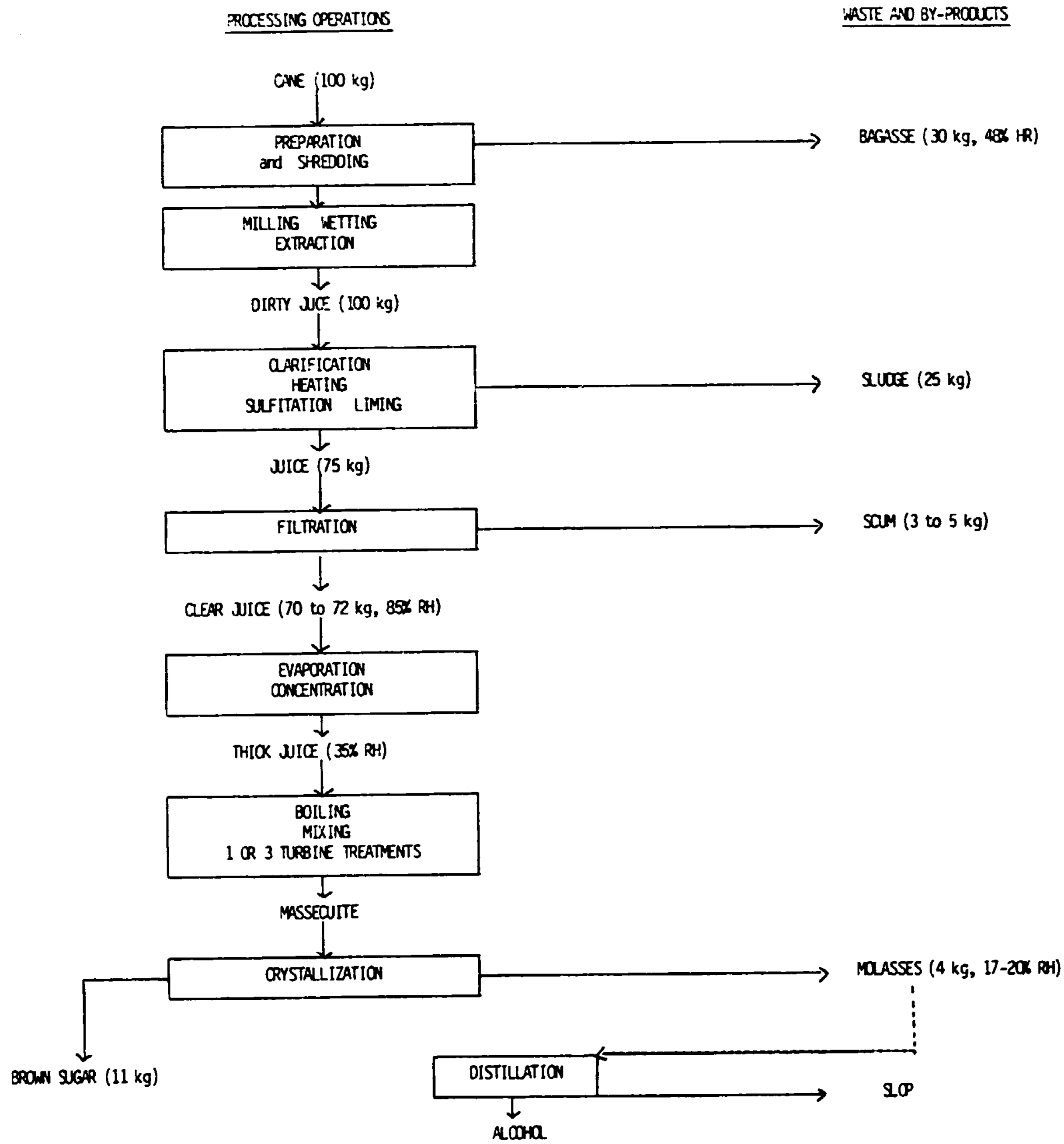
OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
SUGARCANE CROP	tops		chiefly animal nutrition	methanization	laboratory	
SUGAR MANUFACTURE (CANE)	bagasse	240 10^6 t	widely burned (surplus: 0 -30%)	combustion and briquetting combustion	industrial (1)	CREUSOT LOIRE FIVES-LILLE
				gasification	pilot plant	
				methanization	pilot plant	
	molasses	32 10^6 t	chiefly animal nutrition	fabrication of ethanol	industrial (2)	SPEICHIM SODECIA

A.F.M.E. model operation sheet

(1) Combustion of bagasse in a power plant associated with a sugar production facility (Reunion Island)

(2) Autonomous sugarcane distillery producing hydrous alcohol-fuel (Brazil)

SUGARCANE 2. PROCESS FLOW CHART



SUGARCANE

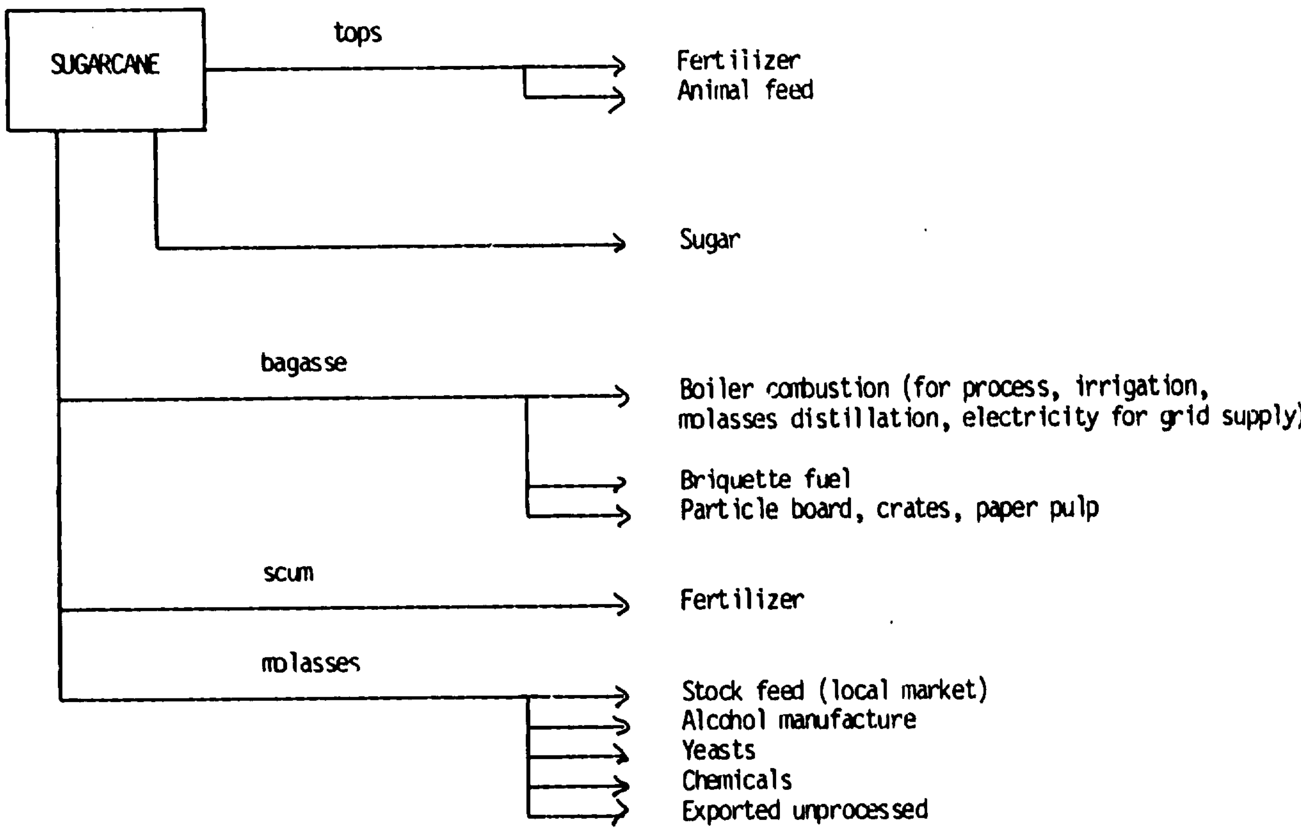
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	PRODUCTION		BAGASSE		MOLASSES		
	CANE	SUGAR					
	estimated average	estimated average	average production	combustion reserves	average production	ethanol reserves	ethanol reserves
Brazil	140	8.0	42.0	5190	5600	15570	1557
India	130	5.5	39.0	4820	5200	14460	1446
Cuba	65	6.5	19.5	2410	2600	7230	723
Mexico	32	2.5	9.6	1190	1280	3560	356
China	30	2.5	9.0	1110	1200	3340	334
Pakistan	28	0.8	8.4	1040	1120	3110	311
Colombia	25	1.2	7.5	930	1000	2780	278
Australia	24	3.1	7.2	890	960	2670	267
Philippines	21	2.3	6.3	780	840	2340	234
South Africa	20	2.0	6.0	740	800	2220	220
Argentina	17	1.0	5.1	630	680	1890	189
Indonesia	17	1.4	5.1	630	680	1890	189
Thailand	20	1.6	6.0	740	800	2220	222
All above countries	570	40	170	21000	23000	63000	6300
WORLD	800	90	240	30000	32000	89000	8900
UNITS	10^6 t/year	10^6 t/year	10^6 t/year	10^3 TOE/year	10^3t/year	10^3 hl/year	10^3 TOE/year

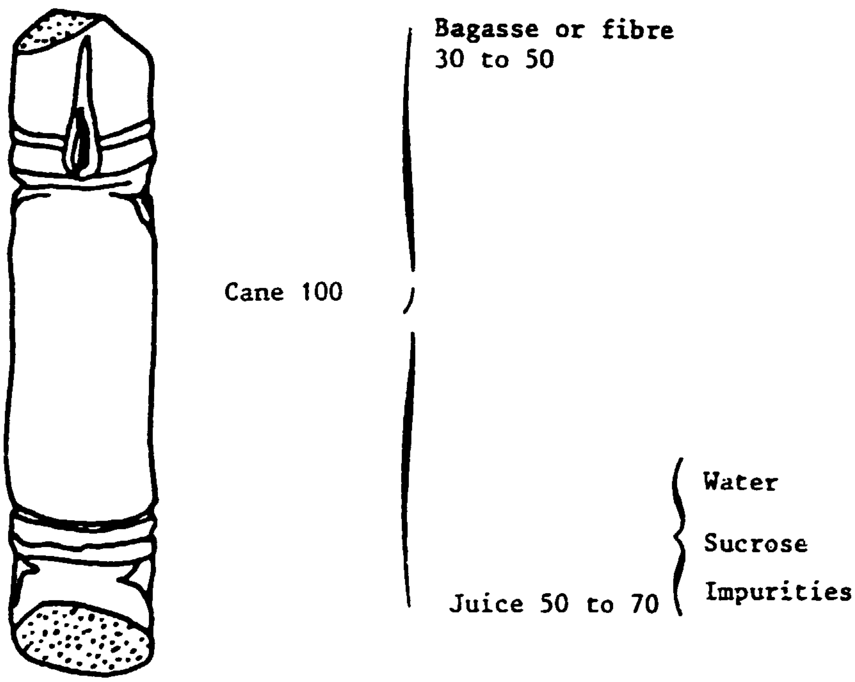
ENERGY CONVERSION EFFICIENCY		0.65		2.78hl/t molasses	0.1 TOE/hl
HEAT VALUE OF WASTE	1900 kcal/kg			3800 kcal/k(80%MS)	
WASTE:CANE RATIO	0.30			0.04	

SUGARCANE

4. COMPETING USES



5. THE CONSTITUENTS OF SUGARCANE



From: <u>Mémento de l'ajoint technique des travaux ruraux</u>
French Ministry of Co-operation

I - RICE

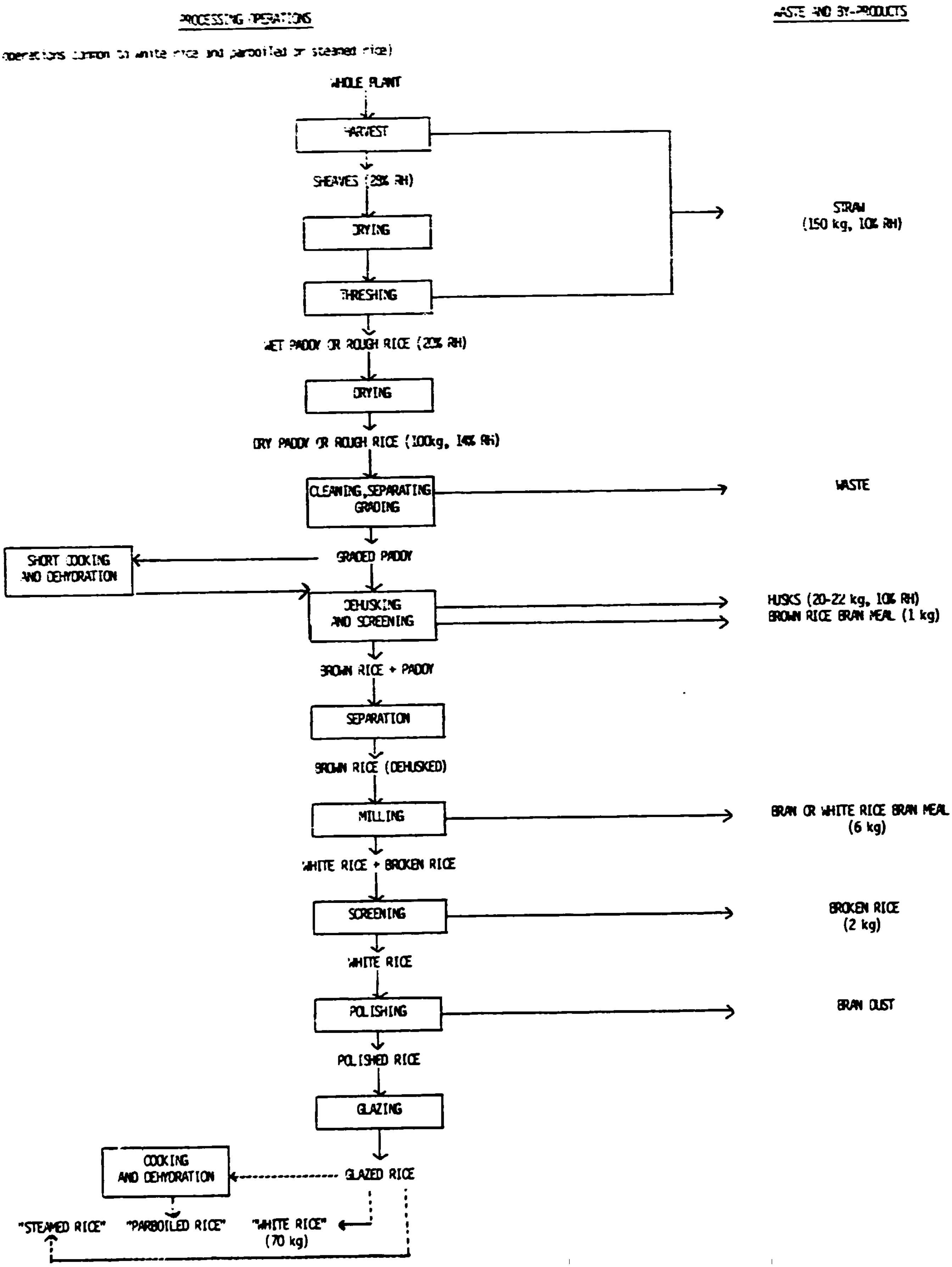
RICE

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
HARVESTING AND THRESHING	straw	620000 10^6 t	. animal feed . construction	combustion	industrial (1)	
				methanization	laboratory	
DEHUSKING (rice mill)	husks	80000 10^6 t	. none (burning) . boiler combustion in rice mills parboiling (Asia)	combustion	industrial (2)	
				combustion in briquette form	pilot plant	
				gasification	industrial (3)	PILLARD

A.F.M.E. model operation sheet
(1) Dehydration of fodder with straw-fired generator
(2) Steam production by combustion of rice husks
(3) Rice husk gas generator (Niger, Mali)

(operations common to white rice and parboiled or steamed rice)



RICE

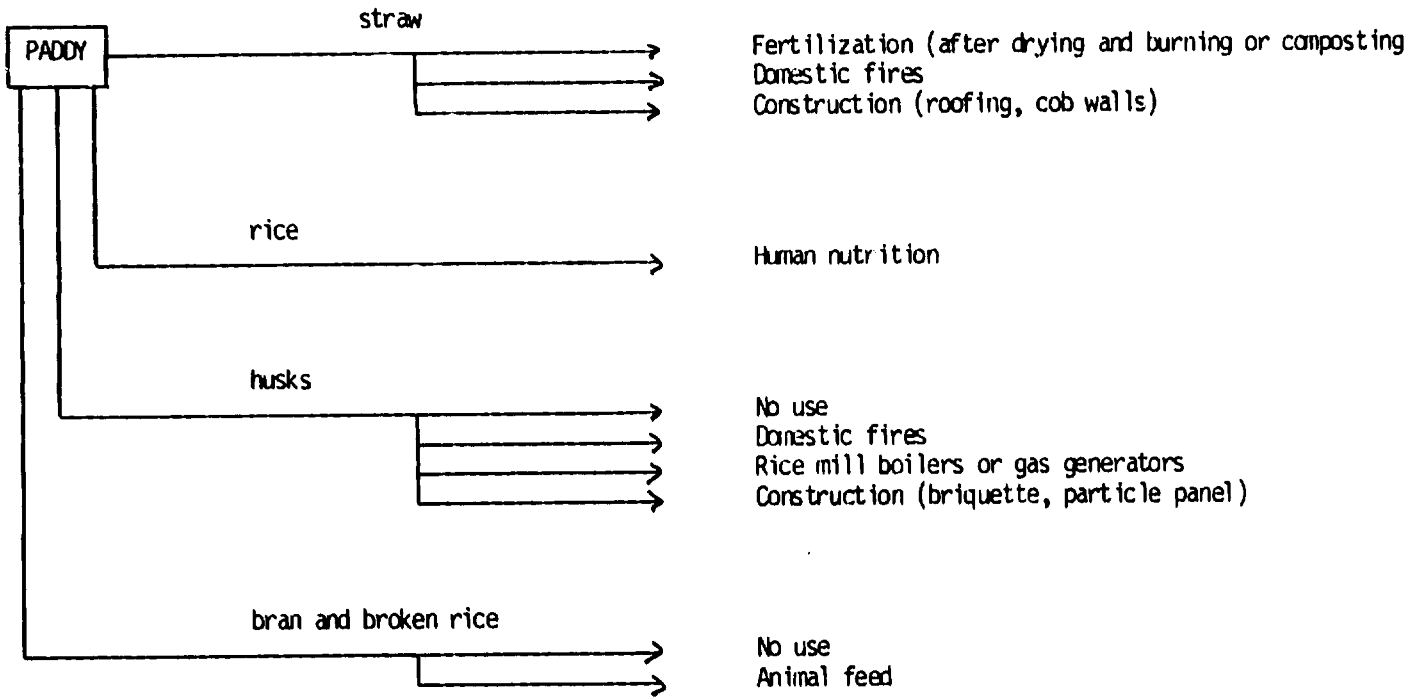
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	PADDY PRODUCTION		HUSKS		
	1981-1982	estimated average	average production	combustion reserves	gasification reserves
China	140.0	140	28.0	4906	16352
India	80.5	75	15.0	2628	8760
Indonesia	32.8	30	6.0	1051	3504
Bangladesh	20.5	20	4.0	701	2336
Thailand	18.8	18	3.6	631	2102
Burma	13.6	13	2.6	456	1518
Japan	12.8	12	2.4	420	1402
Vietnam	10.5	10	2.0	350	1168
Brazil	9.5	9	1.8	315	1051
USA	8.3	7	1.4	245	818
Philippines	7.3	7	1.4	245	818
Korea	7.0	7	1.4	245	818
All above countries		348	70	12200	40600
WORLD (1981-82)	412.5		83	14500	48200
UNITS	10^6t/year	10^6 t/year	10^6 t/year	10^3TOE/year	GWh/year

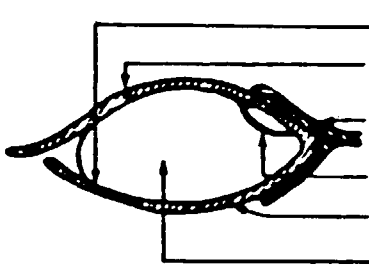
ENERGY CONVERSION EFFICIENCY		60%	0.58kWh/kg
HEAT VALUE OF WASTE	2920 kcal/kg		
WASTE:PADDY RATIO	0.20		

RICE

4. COMPETING USES



5. CROSS SECTION OF RICE GRAIN



Botanists' nomenclature	Technical nomenclature	
Palea	Husk	
Lemma		
Glume		
Embryo	Germ	Rice meal
Pericarp	Bran	
Caryopsis	Kernel	White rice

From: <u>Mémento de l'ajoint technique des travaux ruraux</u>

French Ministry of Co-operation

J - GRAIN MAIZE

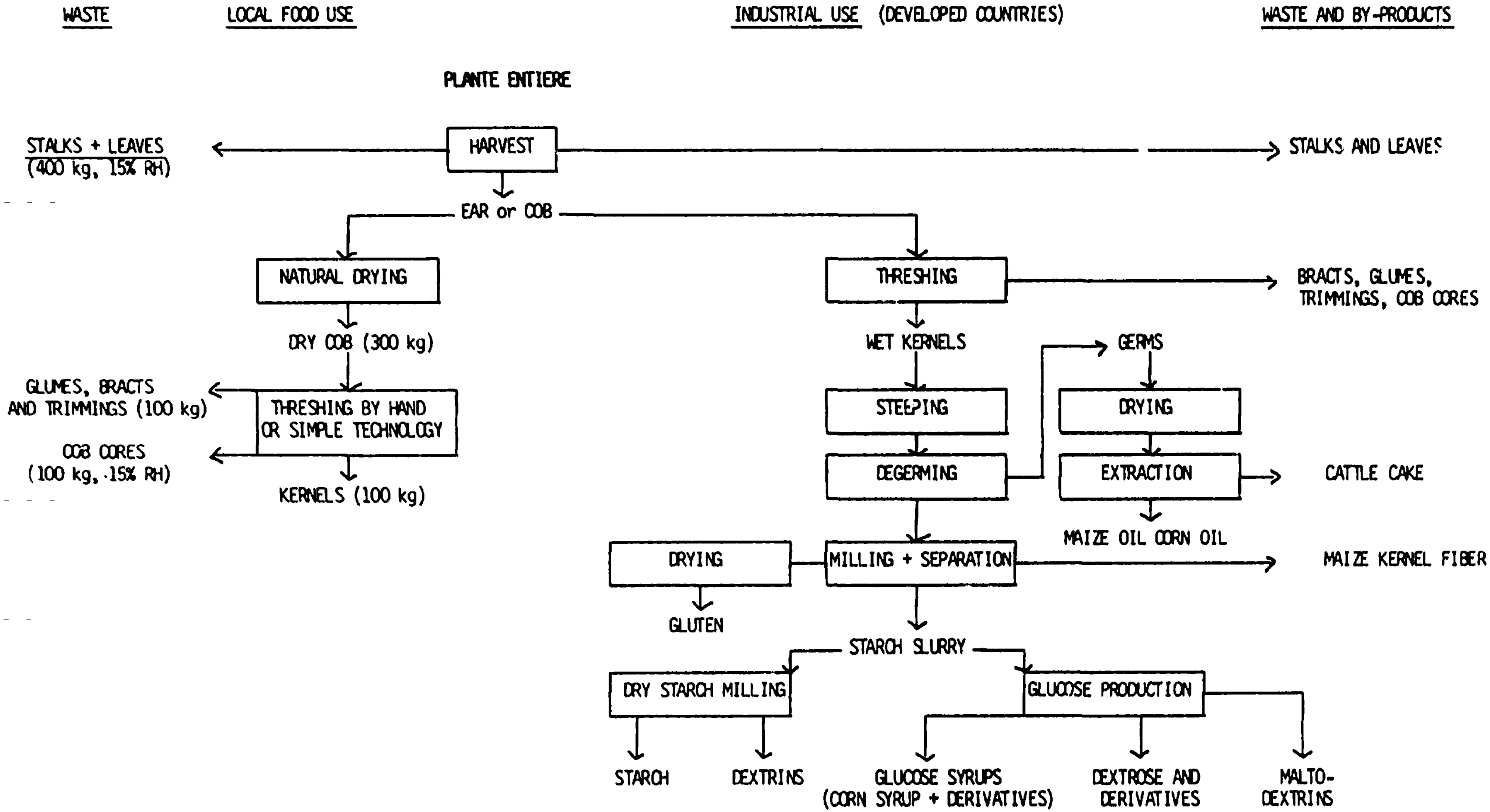
GRAIN MAIZE

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
HARVEST	stalks + leaves	$1750\ 10^6$ t	animal feed	gasification	laboratory	CEMAGREF
				methanization	laboratory	
THRESHING	cob core	$440\ 10^6$ t	animal feed and combustion	combustion	pilot plant	
				methanization	laboratory	

MAIZE GRAIN

2. PROCESS FLOW CHART



GRAIN MAIZE

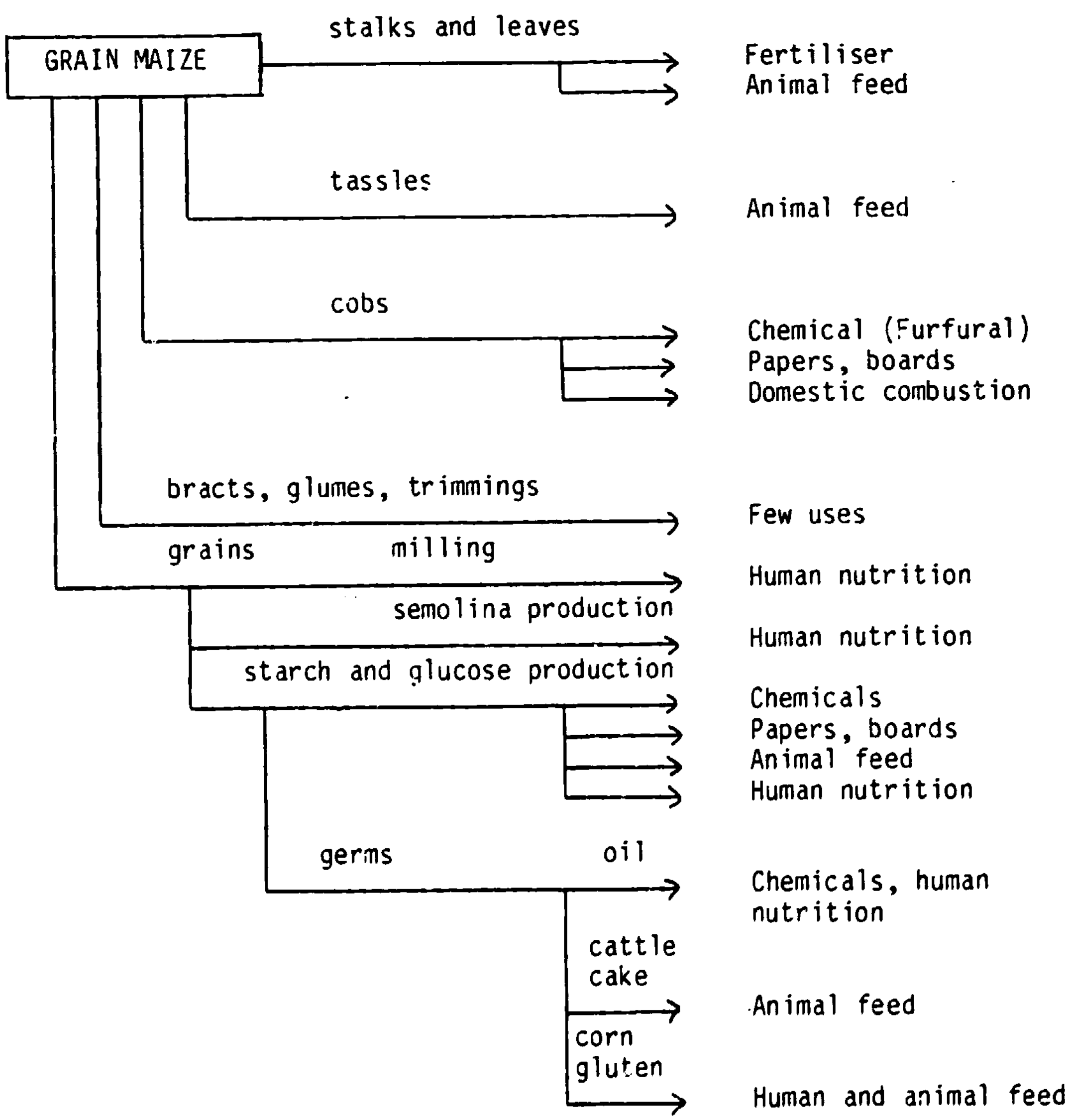
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	GRAIN MAIZE PRODUCTION		COB CORES	
	1981-1982	estimated average	average production	combustion reserves
USA	208	200	200	42000
China	59	60	60	12600
Brazil	23	22	22	4620
Mexico	12.5	10	10	2100
Romania	10.5	10	10	2100
Argentina	9.6	9	9	1890
Yugoslavia	9.8	9	9	1890
France	9.0	9	9	1890
South Africa	8.4	8	8	1680
Hungary	6.8	6	6	1260
India	6.0	6	6	1260
Indonesia	4.3	4	4	840
All above countries		353	353	74000
WORLD	437		437	92000
UNITS	10^6t/year	10^6 t/year	10^6 t/year	10^3TOE/year

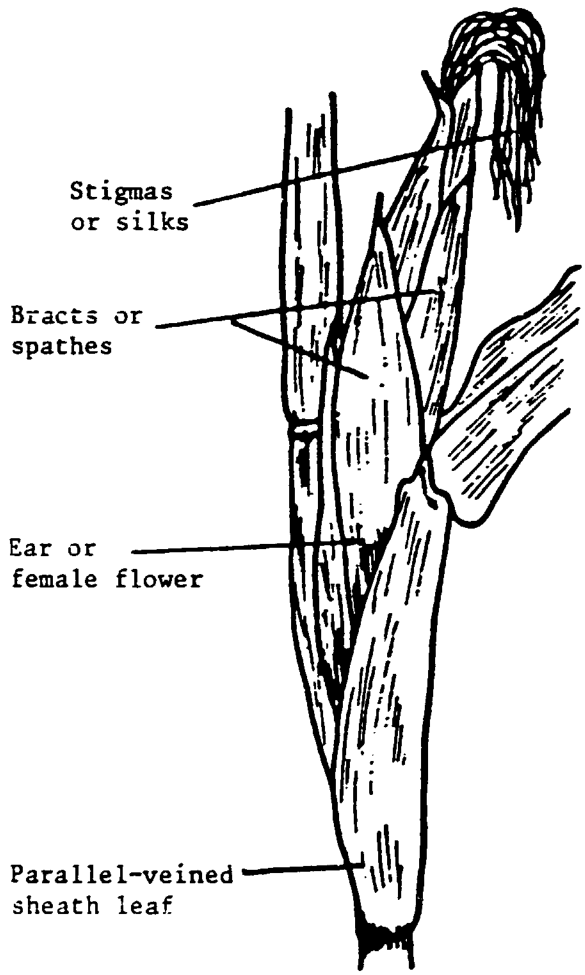
ENERGY CONVERSION EFFICIENCY		0.60
HEAT VALUE OF WASTE	3500 kcal/kg	
WASTE:GRAIN RATIO	1.00	

GRAIN MAIZE

4. COMPETING USES



5. MORPHOLOGY OF THE MAIZE EAR



From: Mémento de l'adjoint technique des travaux ruraux
French Ministry of Co-operation

K - LIVESTOCK PRODUCTION

CATTLE, PIG, POULTRY PRODUCTION

1. WASTE WITH ENERGY POTENTIAL

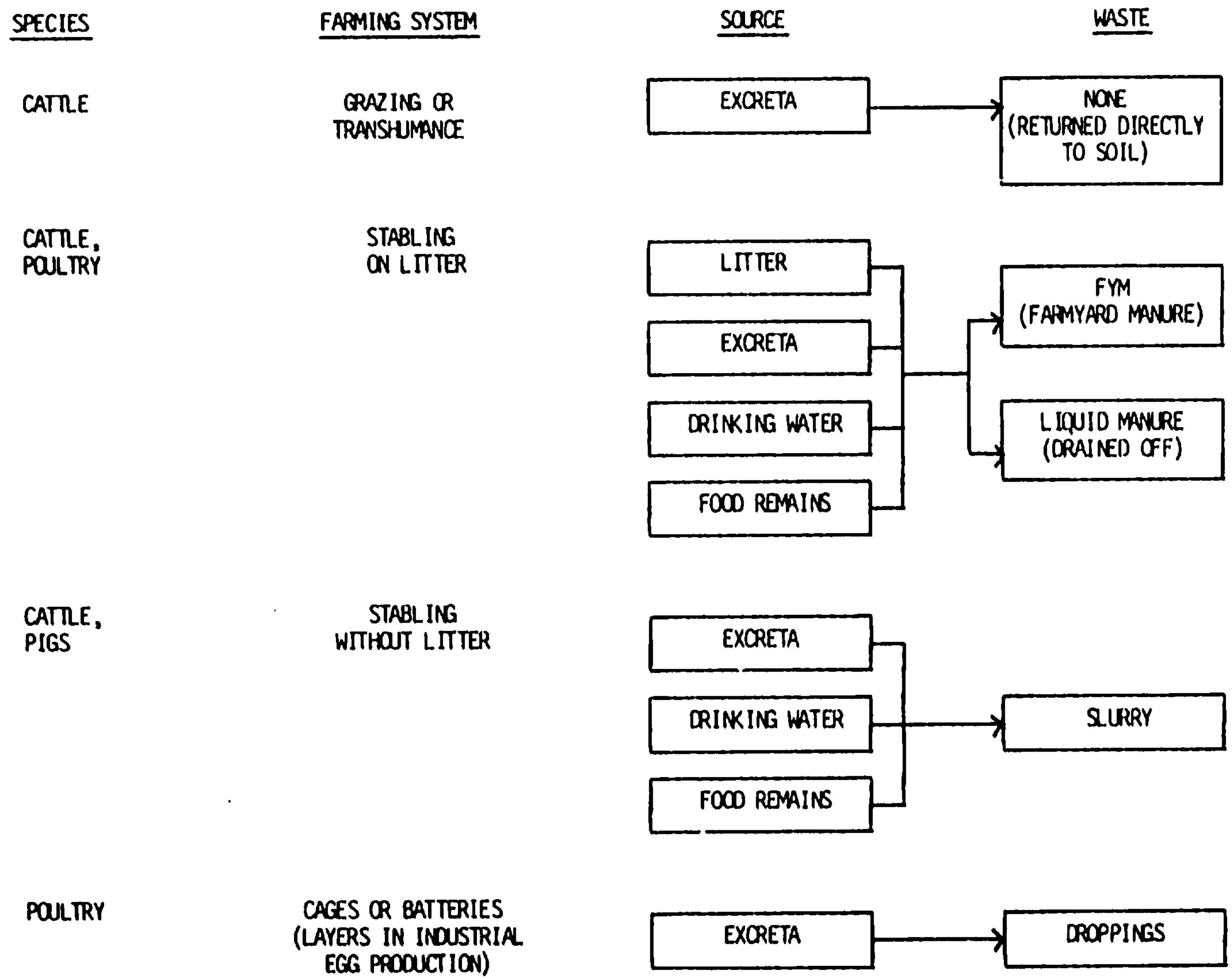
TYPE OF LIVESTOCK	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
CATTLE	excreta on land	1.2 10^9 t DM	. returned directly to soil . collection for domestic combustion (dried in Asia)			
	indoor excreta on litter (farmyard manure + dung liquor	(10.10^9 t at 12% DM)	. spread on fields, composted or not and worked in or not . drying then domestic combustion (dried in Asia)	continuous methanization	pilot plant	INDUFERMA - VALORGA
					pilot plant	SETAL/IRCHA METHNECO - ITCF
	dejecta without litter (slurry)			continuous methanization	industrial	BIOMAGAZ
PIGS	excreta mainly without litter (slurry)	95 10^6 t DM (1600 10^6 t at 6% DM)	. methanization before spreading (China) . spreading	continuous methanization	industrial (1)	BIOMAGAZ -L'AIR LIQUIDE - DEGREMONT BERTIN - SGN
POULTRY	yard droppings	35 10^6 t DM	. returned to soil	continuous methanization (mixture with other substrates favorable)	industrial (2)	VALORGA MIDA TRA
	large scale facilities: droppings + manure	(140.10^6 t 25% DM)	. marketed organic matter . none			

A.F.M.E. model operation sheet

(1) Pig slurry methanization in Singapore ; (2) poultry droppings methanization in Gabon

LIVESTOCK PRODUCTION

2. PROCESS FLOW CHART



CATTLE PRODUCTION

3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	HEAD OF STOCK ON THE HOOF	EXCRETA (not including litter)	
	1983	1983 production	methanization reserves
India	182000	182	24900
Brazil	93000	93	12700
China	57450	57.5	7900
Argentina	53670	53.7	7400
Bangladesh	36000	36	4900
Mexico	33670	33.9	4600
Ethiopia	26300	26.3	3600
Colombia	24270	24.3	3300
Sudan	19550	19.6	2700
Turkey	17100	17.1	2300
Pakistan	16160	16.2	2200
Tanzania	13450	13.5	1800
Nigeria	12300	12.3	1700
All above contries	585120	585.1	80100
WORLD	1225380	1225	167800
UNITS	1000 head	10^6 t DM/year	10^3 TOE/year

ENERGY CONVERSION EFFICIENCY		1370 kcal/kg DM
HEAT VALUE OF WASTE		
RATIO WASTE:STOCK	1 t dry matter/head/year	

PIG PRODUCTION

3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	HEAD OF STOCK ON THE HOOF	EXCRETA (not including litter)	
	1983	1983 production	methanization reserves
China	305580	628	5805
Brazil	33500	68.8	636
Mexico	18900	38.8	359
Vietnam	10780	22.2	205
India	8600	17.7	163
Philippines	7980	16.4	152
Thailand	3800	7.8	72
Argentina	3800	7.8	72
Ecuador	3600	7.4	68
Indonesia	3600	7.4	68
Venezuela	3200	6.6	61
Burma	2900	6	55
All above countries	406240	835	7718
WORLD	773600	1590	14697
UNITS	1000 head	10^6 t DM/year	10^3 TOE/year

ENERGY CONVERSION EFFICIENCY		92.5 kcal/kg
HEAT VALUE OF WASTE		
RATIO WASTE:STOCK	2 t/head/year(6% DM)	

POULTRY PRODUCTION

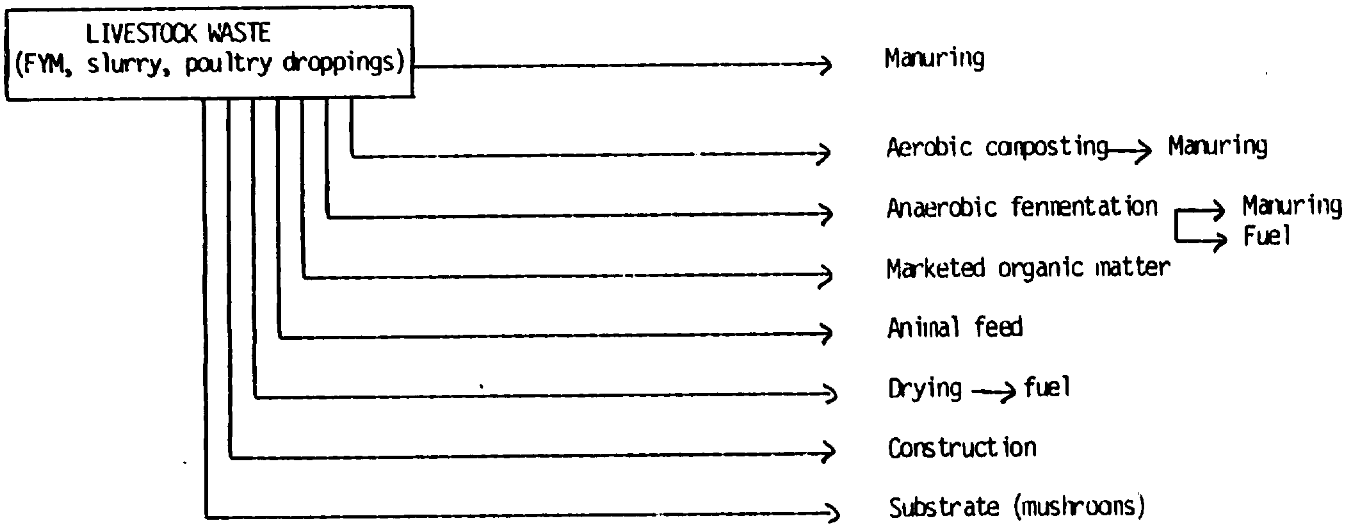
3. POTENTIAL WORLD RESERVES

MAIN WORLD PRODUCERS	CHEPTEL STOCK	EXCRETA (layers + meat chickens)	
	1983	1983 production	methanization reserves
China	1144	5606	912
Brazil	450	2205	359
Mexico	203	995	162
Indonesia	170	833	135
India	150	735	120
Nigeria	150	735	120
Malaysia	78	382	62
Bangladesh	75	368	60
Iran	74	363	59
Pakistan	72	353	57
Thailand	65	319	52
Philippines	62	304	49
Turkey	59	289	47
All above countries	2752	13485	2193
WORLD	7063	34610	5630
UNITS	10^6 head	10^3 t DM/year	10^3 TOE/year

ENERGY CONVERSION EFFICIENCY		1630 kcal/kgDM
HEAT VALUE OF WASTE		
RATIO WASTE:STOCK	4.9 kg DM/head/year	

CATTLE, PIG, POULTRY PRODUCTION

4. COMPETING USES



L - URBAN WASTE

URBAN WASTE

1. WASTE WITH ENERGY POTENTIAL

OPERATIONS	WASTE AND BY-PRODUCTS			ENERGY PRODUCTION FROM WASTE		
	Type	Annual world tonnage	Current use	Technology	Level of development	French firms or organizations involved
CENTRALIZED COLLECTION OF HOUSEHOLD WASTE	raw refuse		little used: . composting 5% . incineration . recycling (informal)	gas recovery on landfill	industrial	GAZ DE FRANCE
				incineration	industrial (1)	Manufacturer: CNIM-CEC Operator: TIRU
				methanization	pilot plant (4)	VALORGA
				incineration/ methanization (2)	pilot plant	VALORGA/TIRU
				RDF (3)/methanization	pilot plant	VALORGA/SOBEA
NON-CENTRALIZED COLLECTION OR NO COLLECTION OF WASTE	raw refuse		little used: . recycling (informal)			

(1) If average LHV of raw waste is sufficiently high: 1300 kcal/kg (minimum) (rare in LDCs)

(2) After simple sorting, fermentable fraction methanized, most combustible fraction incinerated

(3) RDF (refuse derived fuel) = storable fuel (in bales or granules) obtained from most combustible fractions of household waste

(4) Model operation sheet (AFME): continuous methane production from household waste in France

URBAN WASTE: SOLID WASTE PRODUCTION FROM HOUSEHOLDS

	100,000 INHABITANTS		
	LOW INCOME COUNTRIES	MIDDLE INCOME COUNTRIES	INDUSTRIALIZED COUNTRIES
Quantity of household waste	≈ 500 t/day	≈ 600 t/day	≈1,000 t/day
Apparent density of household waste	≈ 0.35 t/m3	≈ 0.25 t/m3	≈ 0.12 t/m3
Waste products liable to be collected with household waste	. Drain effluent . Animal waste	. Drain effluent	. Industrial and commercial packages
Composition (% of raw weight):			
Paper	0-5%	15-25%	20-40%
Glass	0-7%	1-5%	5-10%
Metals	0-4%	1-5%	3-12%
Plastics	1-4%	4-5%	3-10%
Textiles, leather, rubber	1-5%	3-7%	2-4%
Wood, bone, straw	1-5%	1-5%	0-2%
Fermentable substances	50-80%	40-60%	20-40%
Miscellaneous fines	5-30%	10-20%	5-20%
Moisture content	40-70%(1)	35-60%(1)	≈ 35%
Compostable or methanizable fraction (2)	≈ 80%	≈ 65%	≈ 40%
Highly combustible fraction (excluding food waste) (3)	≈ 10%	≈ 25%	≈ 40%
C/N ratio	≈ 20	≈ 22	≈ 35
LHV (kcal/kg)	≈ 900	≈ 1,100	≈ 1,700

---

(1) Highly variable with climate; this parameter is poorly defined but has a major bearing on the quantities of waste per inhabitant and on energy yields.
(2) Compostable or methanizable fraction: fermentable + part of the fines -- ratios not available calculated from expert data.
(3) Combustible fraction (LHV (dry): 3,000 kcal/kg): paper, plastics, textiles, leather, rubber, bone, straw -- ratios not available calculated from expert data.

URBAN WASTE

3. POTENTIAL WORLD RESERVES

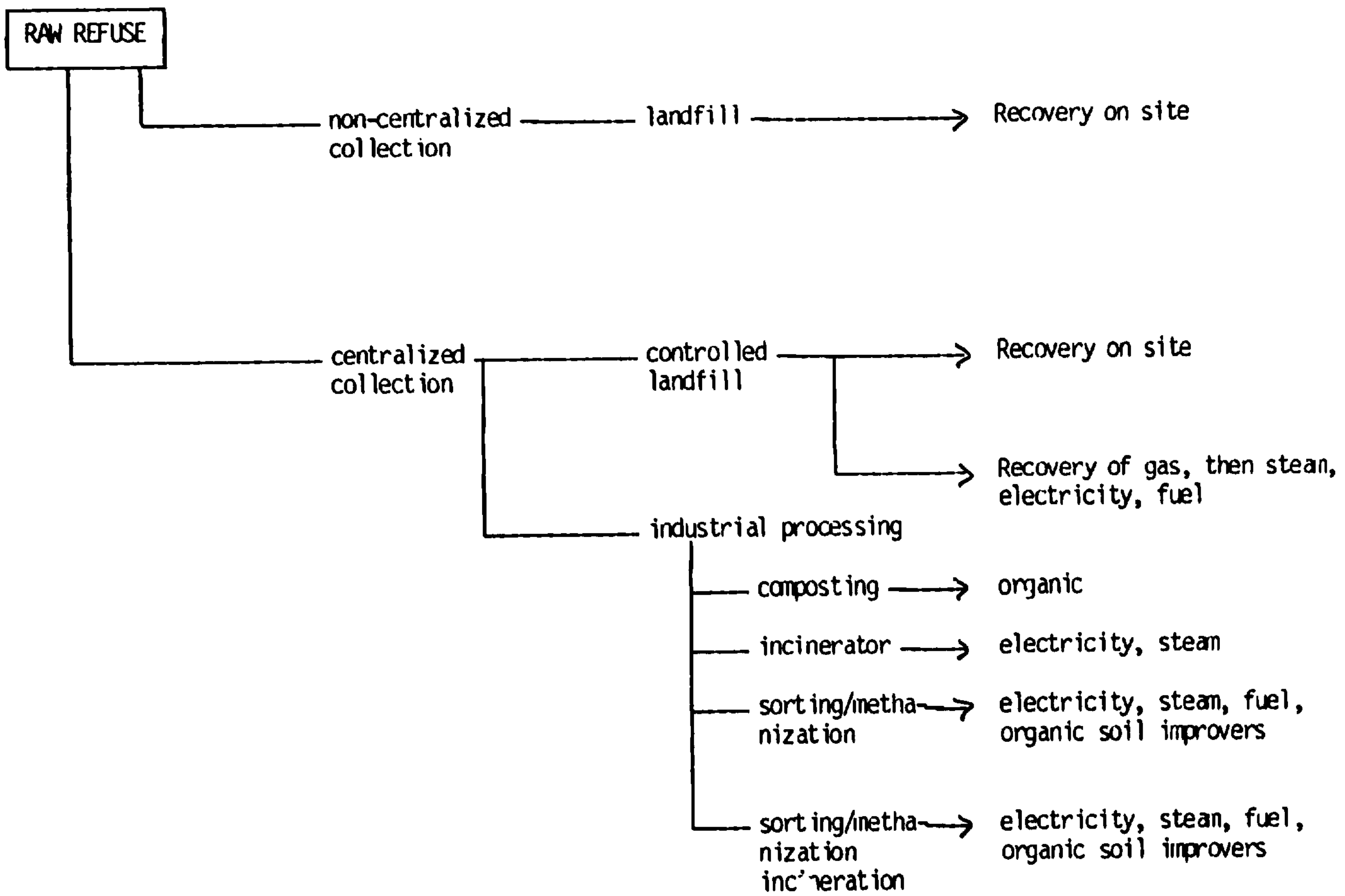
MAIN WORLD PRODUCERS	(1)	CITIES OF OVER 1,000,000 INHABITANTS		COMBUSTIBLE FRACTION		FERMENTABLE FRACTION		RAW REFUSE	
		number	population 1984	production 1984	combustion reserves	production 1984	methanization reserves (reactor)	production 1984	gas recovery from landfill reserves
China	L	25	84.4	1540	200	12322	616	15403	231
India	L	11	35.8	653	85	5226	261	6533	98
Brazil	M	7	18.7	1023	133	2667	133	4095	61
Mexico	M	4	16.9	925	120	2405	120	3701	56
South Korea	M	4	16.1	881	114	2291	114	3525	53
Indonesia	M	5	14.0	766	100	1992	100	3066	46
Egypt	M	3	12.3	673	87	1750	88	2693	40
Pakistan	L	2	9.4	171	22	1372	69	1715	26
Thailand	M	2	9.1	498	65	1295	65	1992	30
Ira[illegible]	M	3	8.3	454	59	1181	59	1817	27
[illegible]ia	M	3	8.2	448	58	1166	58	1795	27
[illegible]	M	1	6.4	350	45	910	45	1401	21
[illegible]key	M	2	5.5	301	39	782	39	1204	18
[illegible]rgentina	M	3	5.4	295	38	768	38	1182	18
Bangladesh	L	2	5.3	97	13	773	39	967	15
All above countries		77	255.8	9075	11798	36894	1845	51089	767
		108	300	11000	14000	43000	2200	60000	900
UNITS			10^3 persons	10^3 t/year	10^3 TOE/year	10^3 t/year	10^3 TOE/year	10^3 t/year	10^3 TOE/year
ENERGY CONVERSION EFFICIENCY (2) - LIC				X	0.65	X	500 kcal/kg	X	150 kcal/kg
MIC				X	0.65	X	500 kcal/kg	X	150 kcal/kg
HEAT VALUE OF WASTE (2) - LIC				2000 kcal/kg		850 kcal/kg		900 kcal/kg	
MIC				2000 kcal/kg		850 kcal/kg		1100 kcal/kg	
USEFUL WASTE:RAW WASTE RATIO (2) - LIC				0.10	X	0.80	X	1	X
MIC				0.25	X	0.65	X	1	X

LIC = low-income countries (1) level of income: L = low; M = middle

MIC = middle-income countries (2) ratios not available: figures calculated from specialist data

URBAN WASTE

4. COMPETING USES



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(3 of 3)

ENERGY UTILIZATION OF AGRO-FOOD INDUSTRY BY-PRODUCTS

NOVEMBER 1984 - LILLE (FRANCE)

Part 3

TECHNICAL DATA SHEETS

OF FRENCH AGENCY OF ENERGY MANAGEMENT

AFME FRENCH AGENCY FOR ENERGY MANAGEMENT

ENERGY PRODUCTION FROM BIOMASS

PHILIPPINES: WOOD-FIRED POWER STATION

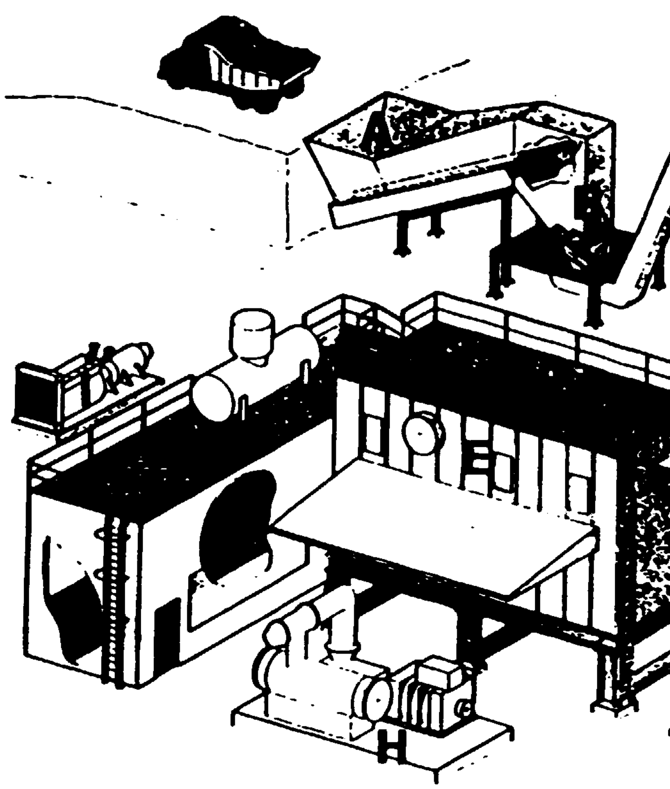
User: N.E.A. (National Electricity Authority of the Philippines)

Supplier: Alsthom-Atlantique Rateau
141, rue Rateau
93123 LA COURNEUVE
France

tel. (1) 838.92.89

In the wake of soaring oil prices, the Government of the Philippines laid down an electrification program designed to raise the country's total output to 498 MW, including 200 MW generated by wood-fired power stations. The Dendrothermal Program launched in 1979 by the National Electrification Authority (NEA), is designed to bring electricity to rural areas and involves the installation of 63 wood-fired power stations with a unit capacity of between 1 and 5 MW. These units are to be installed over the period from 1982 to 1990 and should enable the country to save 70 million dollars per year in petroleum product imports, for a total investment of 200 million dollars.

Problems of transportation intrinsic to the country's geography (7,000 islands scattered over a distance of 1,500 km) and the rich potential of the archipelago's forest reserves make the decision to install a large number of small-scale wood-fired power stations a legitimate and rational step. The first of the wood-fired units (capacity: 3.5 MW) was put into service at Bolinao (on Luzon island) in 1983 and is currently generating 15 million kWh annually.



A. Unloading area

B. Shredder

C. Storage silo

D. Drying unit

E. Boiler

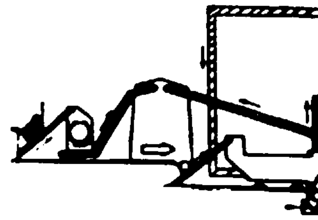
the challenge

The Bolinao power station is located near a 1,100 hectare ipilipil plantation which is exploited and renewed on four-course rotation. The plantation produces 41,000 tonnes of wood per year and meets the power station's fuel requirements.

Once felled, the trees are transported to the station by cable, at low cost. The moisture content of the wood (50%) must be reduced through drying before the wood can be used for fuel.

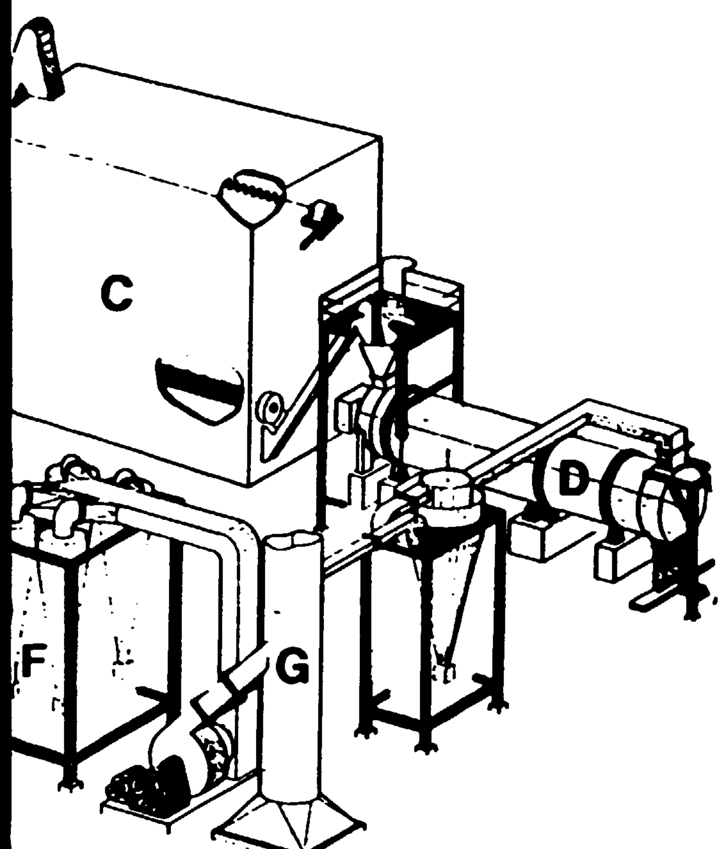
In order to optimize efficiency of production of steam, and then electricity, from wood with such high moisture content, a number of technical obstacles had to be overcome. These included monitoring moisture content, regulating combustion, automating storage and transportation operations, feeding the boiler, and removing ash.

MATERIALS



A B C D

OVERALL LAYOUT



F. Cyclone

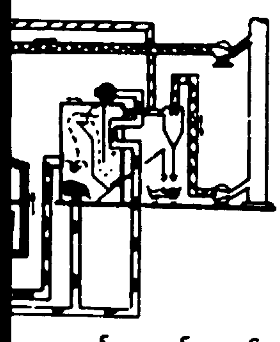
G. Stack

H. Turbogenerator and condensor

I. Engine

J. Monitoring station

GAS FLOW



Wood

Drying unit hot air system

Air discharge to stack

Boiler hot air system

the response

The thermal power station at Bolinao was built by Alsthom Atlantique and includes an automated wood processing and transportation system for feeding wood to the boiler. Hewn logs are transported by cable to the main shredder in one-tonne batches. They are broken up for better drying and then further reduced for pneumatic delivery to the boiler.

The wood chips are then injected into a drier that receives hot air from the boiler. The valve-regulated hot air supply is controlled by the gas temperature at the drier outlet. The main function of the drier is to regularize the moisture content of the fuelwood sent to the boiler, regardless of initial moisture content. Drying ensures flame stabilization and increases operating efficiency by 5%. Excess shredded dried wood is transferred to a storage silo with approximately 280 tonne capacity and is used to supply the power station during peak periods and weekends.

Fuel particles suspended in the drying air flow are recovered in a cyclone and sent to the boiler along with the dried wood chips by pneumatic conveyor. The pneumatic system operates on preheated air to evaporate the highly volatile matter contained in the fuel, thus improving combustion further down the line. The wood chips injected into the boiler from the cyclone are then burned in suspension.

Flame temperature is maintained at over 930°C (melting point of the fuel) by means of variable air intake. A vibrating grate with circulating water, located at the bottom of the boiler, allows for the recovery and combustion of the heaviest wood chips and helps avoid crust formation. The grate also removes ash.

The walls of the combustion chamber are lined with heat transfer tubes in which steam is produced. A second system of heat exchange tubes. in direct contact with the flame, provides for accelerated steam production. Steam at 380°C and 40 bar pressure drives a turbogenerator equipped with special lubrication, tightness, and regulation systems. It is then injected into a negative-pressure condenser where temperature is reduced by 10°C, allowing for water throughput 50 times greater than that of the condensed steam in the primary circuit.

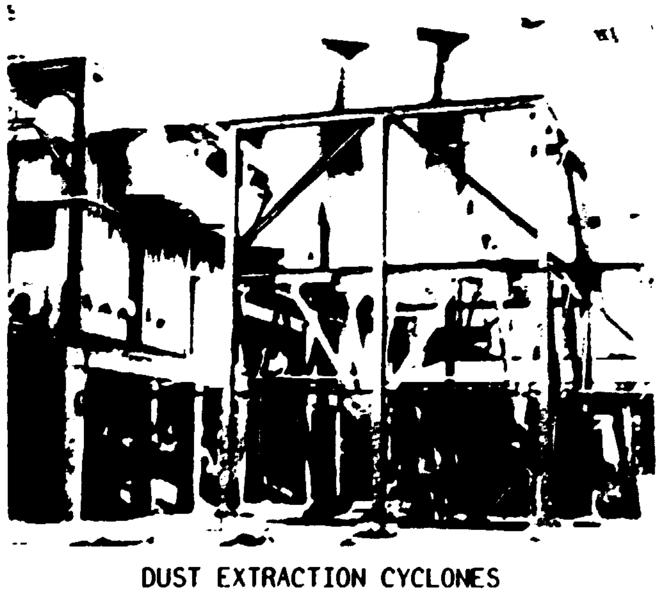
Accounting for yearly output of 15 million kWh with almost zero oil consumption (oil is used solely for start-up), the Bolinao wood-fired power station plays a successful part in the Philippines' drive to reduce its energy dependence.

energy breakdown

A 3.4 MW power station consumes 6 tonnes of wood per hour. Thus, one-quarter of the forest can provide enough fuel to operate the unit at full load for 6,600 hours. This utilizes 70% of available capacity.

Bolinao power station specifications:

Yearly wood consumption	41,000 tonnes
Rate of conversion of wood with 50% moisture content	2.6 kg/kWh transmitted
Thermal efficiency	16%
Gross output	20,400,000 kWh
Energy available for transmission	89%
Transformer efficiency	97%
Transmission efficiency	90%
Energy transmitted	15,850,000 kWh



DUST EXTRACTION CYCLONES

cost breakdown

Investment costs for the Luzon installation: (1 peso = US$ 0.071 = FF 0.60, as at 1/1/84)

Power station	25.0 million pesos
Plantation	4.5 million pesos
Transportation of wood	4.2 million pesos
Transmission	20.3 million pesos

Estimated costs for electrical energy (kWh) generated by a power station under the Dendrothermal Program are as follows:

	per kWh generated	per kWh transmitted
. Wood	0.136	0.175
. Staff	0.023	0.029
. Maintenance	0.024	0.030
. Operating costs	0.008	0.011
. Amortizement and financing costs	0.243	0.599

(Source: NEA - DTDO)

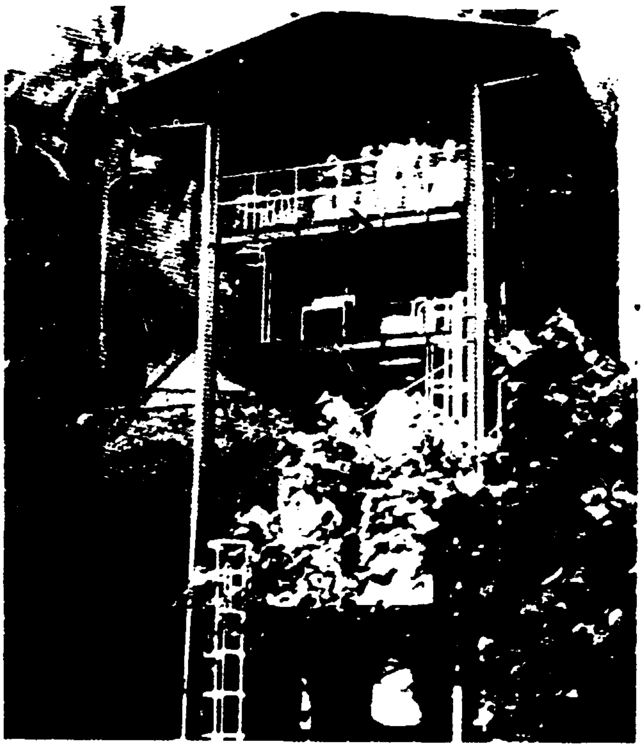
This assessment gives costs per kWh generated under the Dendrothermal Program which are similar to those per kWh generated using conventional equipment (0.42 pesos/kWh in 1982 on Luzon). Taking local conditions into account, the wood-fired power station is thus a viable economic alternative on the national level to electricity generation from oil or charcoal. Moreover, the installation of a large number of small-scale units will bring electricity to rural areas located at great distances from conventional energy production centers which have hitherto not been linked to the grid.

AFME: FRENCH AGENCY FOR ENERGY MANAGEMENT

EXEMPLARY OPERATION

ENERGY PRODUCTION FROM BIOMASS

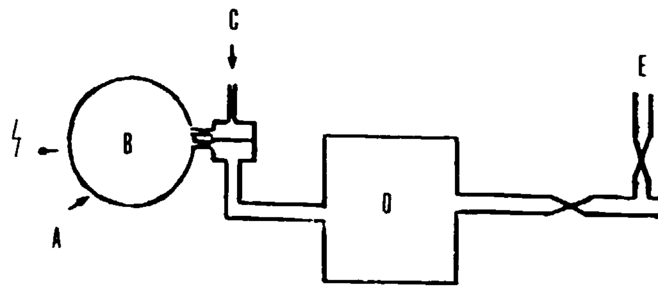
BORA BORA:
GASIFICATION OF COCONUT FIBER



User: Electricité de Tahiti

Supplier: Entropie S.A.
5, rue Thibault
78160 MARLY-LE-ROI
France

Polynesia has a high biomass potential. Much of the islands' untapped biomass reserves comes from waste products from the coconut industry, where every year the production of 14,000 tonnes of copra leaves behind 280,000 m³ of unused vegetable matter, in the form of fiber, which can be burned as fuel in gas generators. In energy terms, the volume of fiber readily available represents the equivalent of 6,000 tonnes of diesel oil, or 6% of Polynesia's total diesel oil imports. In 1976, Electricité de Tahiti decided to consolidate its utilization of this energy source, and in 1978 the company installed a gas generator on Bora Bora which is now coupled with a dual-fuel generator to supply 200 kW of electricity to the island's distribution grid.



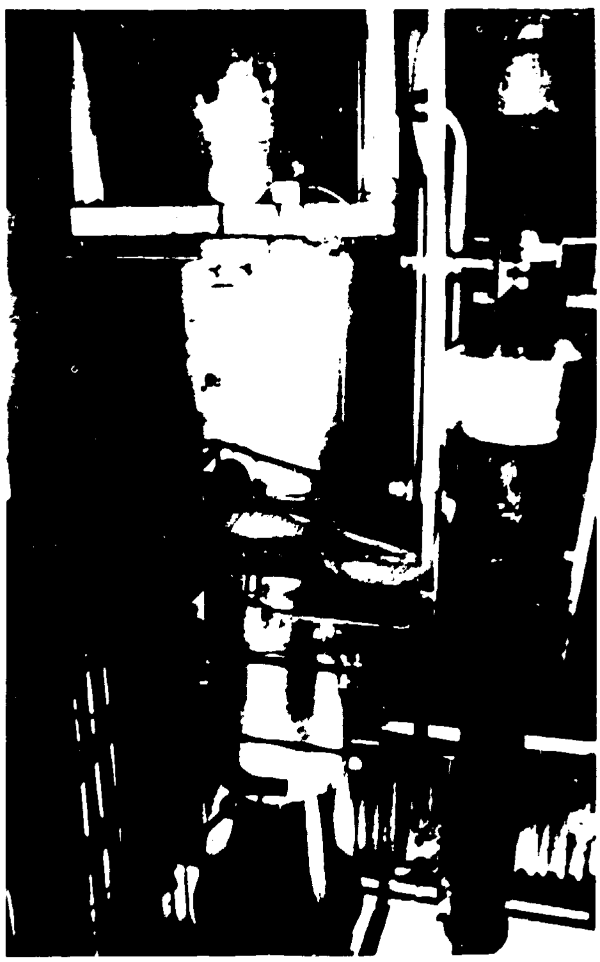
A. Fuel oil
B. Dual-fuel generating set
C. Air
D. Filter
E. Burner
F. Water cooler
G. Gas generator

the challenge

The gas generator operates on the principle of converting ligneous matter — containing large quantities of carbon, hydrogen, and oxygen — into combustible gas. The two stages of the process are: pyrolysis, whereby vegetable matter is reduced to charcoal, giving off tar and smoke, and gasification, where carbon is oxidized to produce carbon monozide and carbon dioxide.

The major difficulty encountered with gas generators is the fouling of pipes, burners, and engines caused by the significant quantities of tar and ash remaining in the gas. As the equipment quickly becomes clogged and requires frequent disassembly for cleaning, tar and ash must be eliminated.

Secondly, the gas generated is a mixture of combustible compounds (CO, H_2, CH_4) and inert compounds (CO_2 and N_2), making it a relatively lean gas compared to methane and city gas. Special engines must be used, as generator gas will not self-ignite when mixed with air.



the response

The Distibois/Delacotte gas generator, marketed by Entropie S.A., produces very clean, tar-free gas. The generator has a main chamber divided into pyrolysis and gasification sections and a combustion chamber.

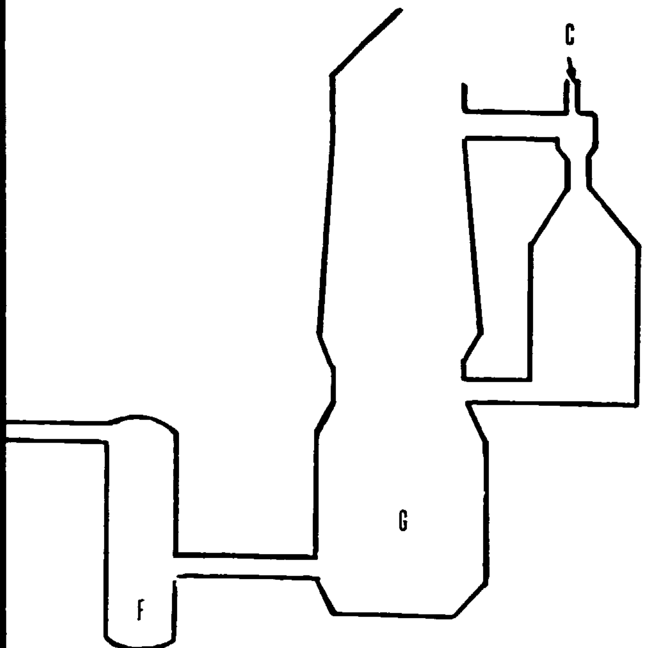
Coconut fiber is loaded into a feed hopper and then delivered to the pyrolysis section, where it is heated continuously to 950°C along a temperature gradient. The charcoal thus produced falls under its own weight, while the volatile matter — tar and water, in particular — escape with the smoke and are recycled to the combustion chamber where they are burned with air. At combustion temperatures of 1,000° to 1,100°C, tar decomposes completely into carbon dioxide and water. The hot gases given off are recirculated into the main compartment. Some 25% of the gases rise again to the top section and continue the pyrolysis of the solid matter as it descends. The remaining 75% of the gases traverse the gasification section in the same direction of flow as the charcoal stream.

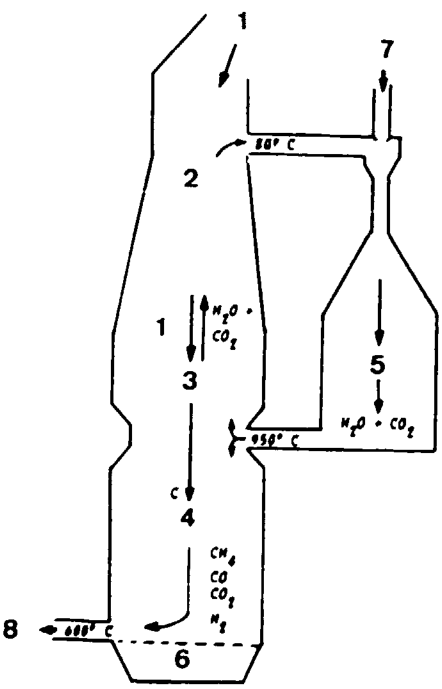
Charcoal is subjected to gasification under the influence of water vapor and carbon dioxide. Gasification reactions are highly endothermic and utilize the heat produced during combustion of pyrolysis products. Lastly, the gases are cooled to around 600°C (outlet temperature) and ash is removed from the bottom of the unit.

It should be noted that the generator will only operate satisfactorily if coconut fiber water content is below 30%; above this level, a drier must be used. Such a drier can be supplied with hot air from the cooling fan fitted to the gas outlet or to the generating set.

Although the Delacotte process is highly effective in removing tar, by-products from pyrolysis can still accumulate in the hot section of the burner feed pipe. This equipment must be disassembled for cleaning once every two to three weeks. One possible improvement would be to design a cleaning system that does not require equipment disassembly. Similarly, ash can collect in certain sections of the pipes.

After leaving the gas generator, the gas is cooled in a wet-process scrubber, filtered, and then fed to an engine where it is mixed with diesel oil and burned. The 200 kW generating set can run either on pure diesel oil or on a mixture of diesel oil and lean gas (generator gas). This feature of the generating set makes it possible to satisfy flucutating grid demand and ensures continuity of production during gas generator downtime.





GAS GENERATOR: PRINCIPLE OF OPERATION

1. Coconut fiber
2. Smoke and tar
3. Pyrolysis
4. Gasification
5. Combustion
6. Ash
7. Air
8. Gas

energy breakdown

Generating set consumption:

Diesel oil	50 g/kWh = 0.6 l
Dry fiber	1.3 kg/kWh

This compares favorably with the fuel consumption of a generating set of similar output running on pure diesel oil (approx. 280 g/kWh). When the power consumed by auxiliary equipment (associated with the gas generator and the diesel engine) is taken into account, the following conversion table can be drawn up:

1 kg of dry fiber	0.155 liters of diesel oil
1 coconut husk	0.110 liters of diesel oil

Therefore, for an hourly fiber consumption of 1.5 m^3 per hour (35 m^3/day), net output of the gas generator is equivalent to that of 25 liters of diesel oil per hour. The importance of this figure can be appreciated when it is considered that the average village consumer uses about 3 kWh per day. Accordingly, 5 to 6 coconut husks must be collected daily to meet the electricity requirements of each household.

cost breakdown

Assuming that the gas generator saves 50 liters of diesel oil per hour (1.2 m^3/day), and taking into account the price of diesel oil delivered to Bora Bora, the equivalent savings in terms of fuel costs can be estimated at around FF 2,500 per day. The 200 kg/hr of coconut husks required for operation of the generator are readily available on the island at a cost of only FF 700/day, for collection and transportation. Daily savings thus amount to FF 1,800 excluding operating costs. Investment costs can be broken down as follows:

Gas generator	FF 2,750 per kW
Dual-fuel generating set	FF 3,850 per kW
Installation costs	FF 1,000 per kW
Total	FF 7,600 per kW

Taking into account the high amortization costs, the retail price per kWh produced by the gas generator would be comparable to or slightly below that of kWh generated from diesel oil.

The use of gas generators for energy production should increase in the near future. Although the cost per gas generator kWh cannot be expected to decrease compared to the cost per diesel oil kWh, the primary advantage in developing gas generators would be in stimulating copra production. Many islands in Polynesia have ample coconut reserves to power gas generators, particularly in the low-output range.

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EXEMPLARY OPERATION

ENERGY PRODUCTION FROM BIOMASS

GASIFICATION OF DONAX REED A NEW ENERGY PLANT

<u>PARTNERS IN THE OPERATION</u>

User : Société Civile du Domaine du Grand Manusclat
Le Sambuc - 13200 ARLES - Tél. (90) 98 90 14

Builder : Société Pillard
13 rue Raymond Teissère - BP 56 -
13268 MARSEILLE CEDEX - Tél. (91) 79 90 21

Donax reed (Arundo Donax), which grows naturally in most warm and temperate regions of the world, is very abundant in France in the southern part of the country. Traditionally used as a windbreak and plot border, it has recently been the focus of genuine cultivation. Many research projects (INRA) have revealed that the production of donax reed offered an energy potential of 10 tOE/ha per year.

Domaine du Grand Manusclat, a 450 ha (1100 acres) farm near Arles, achieved energy self-sufficiency by using donax reed. In fact, it saves 1200 tOE per year with two biomass burning gas producers, which generate the energy required for two major activities :

- Dehydration of lucerne in summer,
- Heating of horticultural greenhouses in winter.

Donax reed thus appears to be the first plant cultivated for energy production in France. For this reason, its development is planned by the regional farmers to produce energy equivalent to approximately 200,000 tOE per year.

THE PROBLEM

The energy requirements of Grand Manusclat amount to about 2000 tOE per year, more than 80 % in the form of heat. In 1979, the undertaking was seriously affected by the sharp rise in oil prices. In 1980, fuel oil purchases accounted for one-third of operating costs, representing an insupportable burden. To discontinue its main activities (lucerne dehydration, hothouse cultivation) would have meant firing most of the personnel (25 employees) and the abandonment of an important product for the regional economy.

Throughout the Seventies, Grand Manusclat participated in research on the use of donax reed as a raw material for paper pulp. But the industry concerned dropped the project and it was decided to tear out the nurseries. However, the latest experiments demonstrated the energy value of this crop, with its mean annual productivity of 20 tons of DM (dry material) per hectare and a LHV (low heating value) of 4100 kcal/kg of DM.

Research was launched to determine the ideal equipement for the fuel available and for the needs of the farm. The technique adopted by the managers consists of the installation of a system producing its own heat by means of a donax reed chip gasification installation in two reverse draught gas producers.

THE ANSWER

The operation of the installation perfectly matches the needs of the farm :

- In summer, the simultaneous output of both gas producers supplies a producer gas burner fitted to a drying oven, allowing the production of 5000 tons of deshydrated lucerne per year,

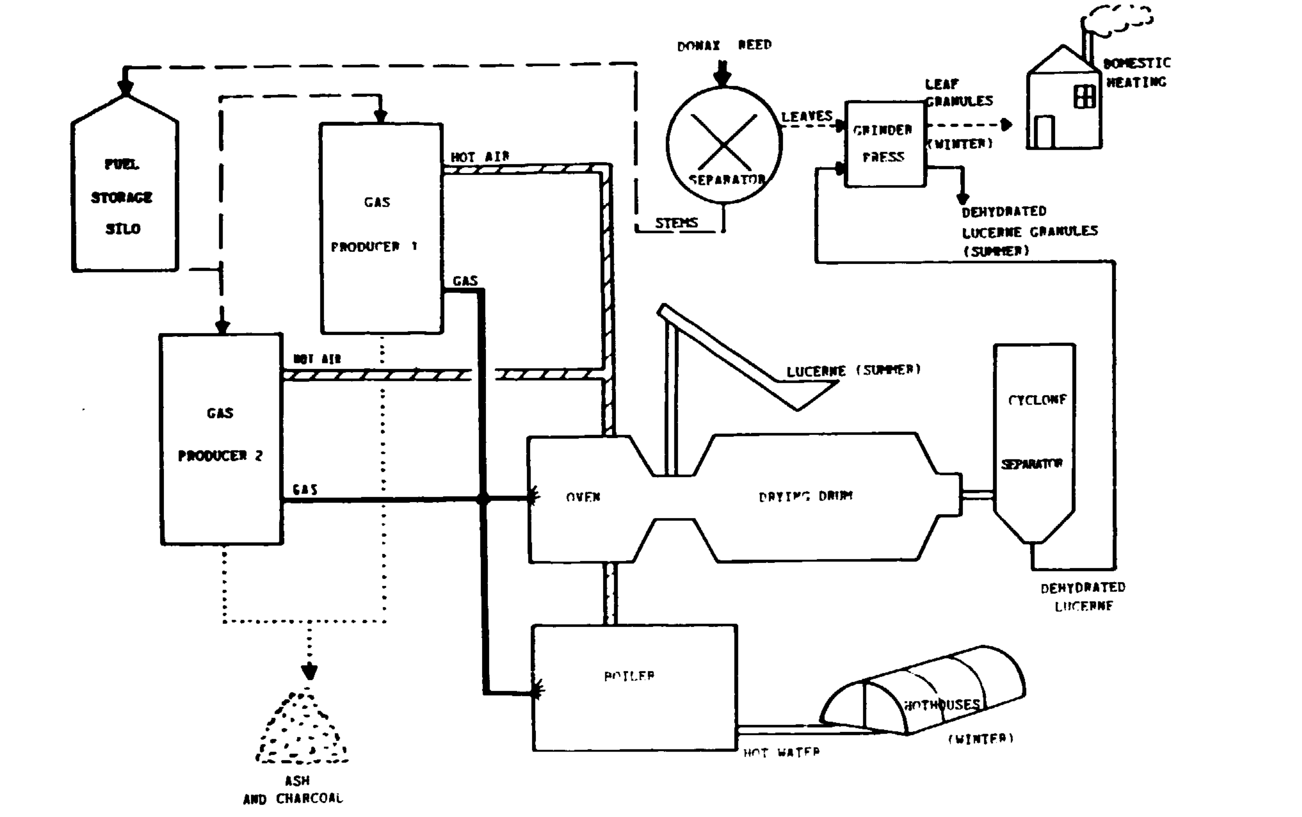
- In winter, only one gas producer is used fulltime, it serves to supply a burner installed on a hot water boiler to heat 10,000 m^2 of hothouse area.

Various agricultural by-products were tested and used as auxiliary fuels, including peach kernels, woodchips, etc. In the donax reed flow chart at Grand Manusclat, the leaves are first separated from the stem, so that a stripping installation was designed. The leaves are then used separately after grinding and pressing to produce granules that are either marketed or used in the farm for domestic heating.

Natural drying of the donax reed is necessary prior to this operation. This process involves a mechanical operation designed to cut and split the stems to facilitate drying in 2 to 3 weeks. This avoids artificial drying and achieves an equivalent reduction in moisture content (from 55 to 15 %).
In this way, the LHV of the dried reed reaches 4100 kcal/kg of DM.

The gas generators have a capacity of about 2000 Mcal/h. The gas produced (400° C) is sent after dust removal to the different points of use. The cooling air is also recovered and used to aid drying. The reed use efficiency is hence around 85 % in relation to the energy contained in the initial biomass. Moreover, a large part of the balance can be recovered in the ash in the form of charcoal.

INSTALLATION FLOWCHART



ENERGY BALANCE

Most of the heat energy consumption is provided by the gasification of donax reed and the auxiliary fuels fed to the gas producers. It is necessary to maintain a heavy fuel oil pilot burner in the drying drum (200 tOE).

The conservation achieved by the operation is summarised in the following table :

USE OF DONAX REED	tOE	ADDITIONAL CONSUMPTION	tOE
Lucern drying (gas producer)	890	Cultivation (plantation, irrigation, fertilisation, harvesting) 0.5 tOE/ha x 100 ha	50
Hothouse heating (gas producer)	230		
Domestic heating (leaf granules)	20	Electrical energy for gas producers	100
Fuel sales	70		
TOTAL	1 210	TOTAL	150

The total net conservation achieved by this farm is 1,210 - 150 = <u>1,060 tOE per year</u>.

COST BALANCE

The total capital investment (end 1983) amounted to 5,800,000 F and the cost per tOE saved is $\frac{5,800,000}{1,060} = 5,500F$

For a fuel oil cost of 1,650 F/tOE, the payback time of the investment concerning the equipment required is therefore 3 years and 4 months.

The potential areas that can be cultivated with donax reed will have to be taken from those allocated to cereal crops (durum wheat or rice) or sunflower. Using the gross margin obtained per hectare for sunflower (2900 F) as a reference, which is higher than that of durum wheat (2400 F), it turns out that the cultivation of donax reed as an energy plant is much more profitable.

The costs of the different items implicated in donax reed cultivation in plots are summarised in the following table (1983 figures):

COST	per ha and per year
Irrigation(Camargue)	300 F
Installation	1,300 F
Maintenance	900 F
Conditioning (drying)	400 F
Harvesting + transport	2,100 F
TOTAL	5,000 F

For production of 10 tOE/ha each year with a use efficiency of 85%, the valorisation per hectare of donax reed thus amounts to :

(10 tOE x 1,650 F x 85%) - 5,000 F = 9,000 F per hectare per year

The total cost per tOE of donax reed as a function of the installation depreciation period is determined from the cost of cultivation and the total capital investment.

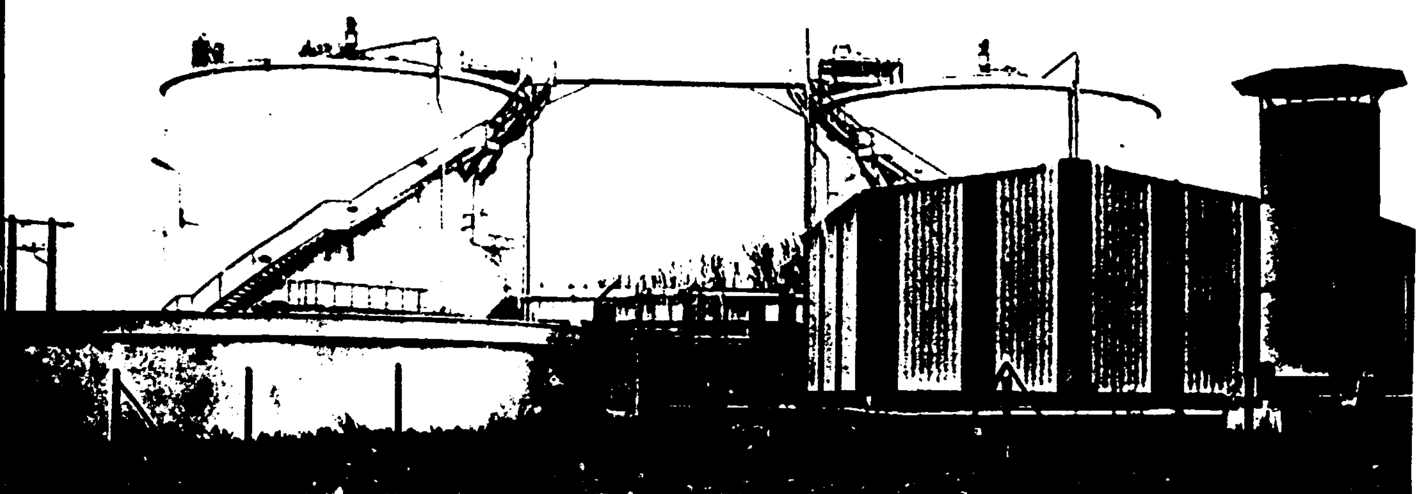
The cost per tOE produced in the field is $\frac{5,000 \text{ F/ha}}{10 \text{ tOE/ha}} = 500 \text{ F}$

DEPRECIATION	10 YEARS	5 YEARS
Total net conservation	10,600 tOE	5,300 tOE
Investment	5,800,000 F	5800,000 F
Cost per tOE conserved	550 F	1,100 F
Cost per tOE produced	500 F	500 F
Total cost per tOE	1,050 F	1,600 F

AFME : FRENCH AGENCY FOR ENERGY [illegible]

ENERGY PRODUCTION FROM BIOMASS

METHANE PRODUCTION FROM CANNERY WASTE



User: BONDUELLE
RENESCURE Factory
59173 RESESCURE
France

Builder: DEGREMONT
183, avenue du 18 Juin 1940
92508 RUEIL-MALMAISON
France

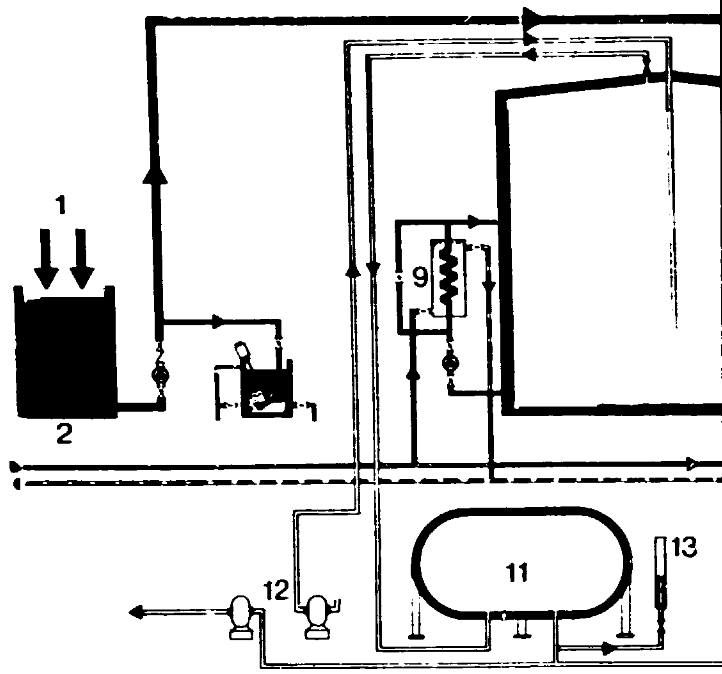
The fruit and vegetable canning industry is one of the highest energy consumers in the agro-industrial sector, using 280,000 TOE every year in France alone. By utilizing waste products from industries in this sector to produce methane, it is possible not only to reduce levels of organic pollution (with reduced energy consumption compared with aerobic digestion) but also to supply considerable quantities of energy to supplement the requirements of factories (up to 10 to 30% of total needs). Anaerobic fermentation is well suited to cannery waste, and net energy production from these factories can be particularly high, because:

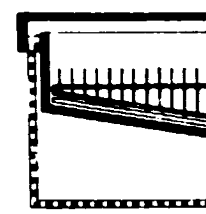
- cannery effluent is hot or tepid, and the heat from it can be used to maintain operating temperatures inside the digester, thereby reducing internal biogas consumption.
- the biogas produced can be used easily to satisfy the cannery's extensive water and steam needs.

the challenge

The Bonduelle factory at Renescure has a vegetable processing capacity of 110,000 tonnes of vegetables per year. Of this, nearly 60,000 tonnes is processed from 15 June to 30 September. Pollutants discharged from a unit of this capacity can be expressed as 25 tonnes of COD daily, which is equivalent to the waste from a city of 250,000 inhabitants.

For some years, the Renescure factory has treated its waste products by aerated lagooning, a system that proved efficient in the processing of effluent but was overloaded during the summer months. The cost of extending the existing treatment facility would have been prohibitive. Thus, the methane production project had to be implemented at moderate investment cost, leading to the decision to limit tank capacity and to treat effluent in the densest form possible over shorter retention times.

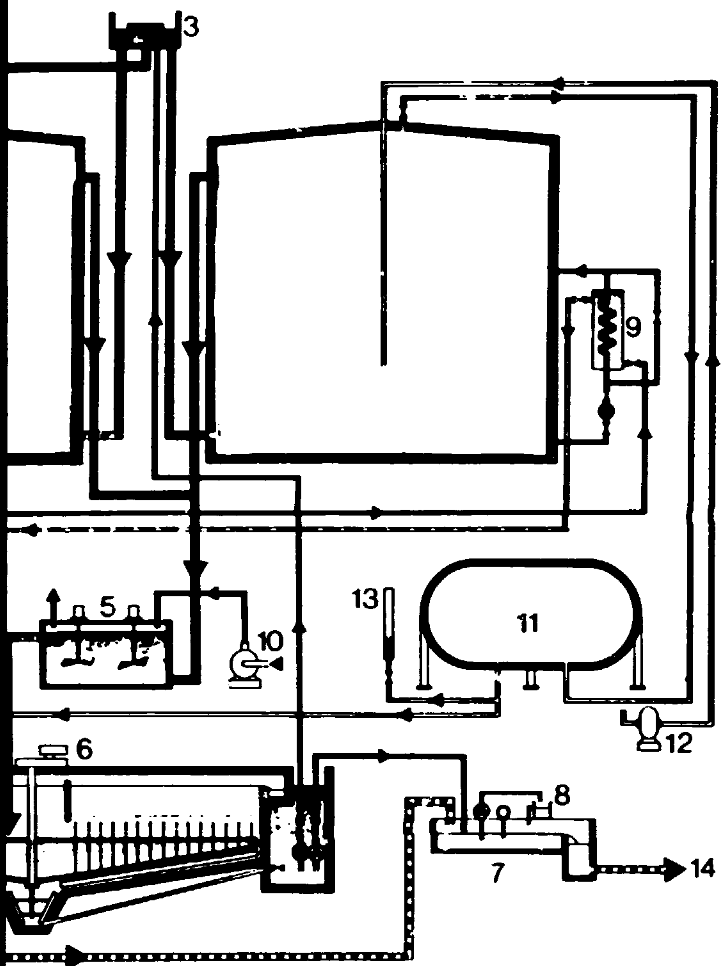




1. Untreated effluent*
2. Homogenization tank
3. Distribution tank
4. Digesters
5. Deaerator
6. Settling/thickening tank
7. Sampling and metering
8. Sampling
9. Heat exchanger
10. Deaerator fan
11. Gas holders
12. Gas compressors
13. Flares
14. Treated effluent

* blanching water: 320 m^3/day (COD: 8,400 kg/day)

peeling water: 400 m^3/day (COD: 11,800 kg/day)



the response

The goal of minimizing investment costs was achieved in two ways:

1) Installation of separate systems so that only the most concentrated effluent was delivered to the digester; only waste water from pea and bean blanching and carrot peeling processes was to be subjected to fermentation. The digester processes 10% of the factory's total waste discharge, which contains 50% of the pollutants leaving the factory. The low-concentration effluent is treated by aerated lagooning.

2) An advanced process for reduction of retention time. Anaerobic filters could not be used due to the high concentration of suspended solids; the sludge bed could not be used due to the heterogeneity of the suspended solids. The method selected involves single-phase anaerobic contact technology, which is well suited to high efficiency treatment of substrates with a COD in excess of 15 g/l and high concentrations of fermentable matter where acid formation is not a limiting factor.

These techniques allow for a retention time only one-third as long than that required using the conventional integral-mixture method. The unit is designed to treat all concentrated effluent at peak periods, i.e. 720 m^3 per day containing 20 tonnes of COD. Its major components are:

- an inlet and homogenization tank with a capacity of 80 m^3
- a distribution tank to deliver effluent to the two separate digesters
- two steel digesters - capacity: 2,500 m^3 (one insulated, one uninsulated). The digesters are maintained at 37°C and use gas stirring.
- two heat exchangers (with a unit capacity of 312 th/hr) for cooling in summer and, if necessary, heating in winter.
- a deaerator with stirrer and fan.
- a settling tank (1,000 m^3) in which sludge is recycled to the digesters at a rate of 100 m^3/hr.
- two variable-volume gas holders (max. unit capacity: 120 m^3).
- a centrifugal blower delivering gas to the factory.

Technical data on the treatment of blanching and peeling water (period: 4 peak months):

Average volume of effluent	720 m^3/day
Average temperature of the effluent to be treated	54°C
Max. specific flow rate	3.6 kg COD/m^3 x day
COD content	28 g/l

In winter, there is only half the quantity of COD to be treated compared with peak months. Heat losses are kept to a minimum by operating with the insulated digester alone.

energy breakdown

Results from Bonduelle's installation, after more than two years of operation, confirm that the anaerobic contact process is a successful method of treating effluent with high concentrations of biodegradable suspended solids. The table below provides operating statistics for the digesters during peak period (28 June to 30 September 1983):

Incoming COD	758 tonnes
COD removed	629 tonnes
Average treatment efficiency over:	
- total COD	83%
- suspended solids	47%
Volume of gas produced	400,000 m^3
Volume of methane produced	211,000 m^3
Efficiency of methane production	335 m^3 per tonne of COD removed

An average of 320 m^3/tonne of COD is removed annually.

A breakdown of the energy involved in the methane production process is given below. The figures are based on operation during the years 1981 and 1982 and show an energy gain of 520 TOE for 1,220 tonnes of COD removed.

Methane produced (400,000 m^3)	335 TOE
Energy consumed by the digester (270 MWh)	- 65 TOE
Energy savings compared to aerated lagooning (920 MWh)	250 TOE
Total energy savings	525 TOE

cost breakdown

Operating cost breakdown for 1981 and 1982:

Savings in electricity compared to lagooning: 980 MWh	
Electricity consumption: 270 MWh	
Electricity saved: + 710 MWh	+ FF 257,375
Methane production (substitution for heavy fuel oil n°2): 335 TOE	+ FF 452,250
Operating costs (excluding electricity)	- FF 205,000
Operating gains per year	+ FF 504,625

If theoretical investment costs for aerated lagooning are subtracted from the acutal cost of installing a methane production unit, overinvestment can be calculated as FF 8,200,000 - FF 4,000,000 = FF 4,200,000. **With a rate of discount of zero, overinvestment payback time is slightly over 8 years.**

(1 MWh = 0.25 TOE)

(1 TOE = 4.2×10^{10} J = 4×10^7 btu = 7.33 BOE)

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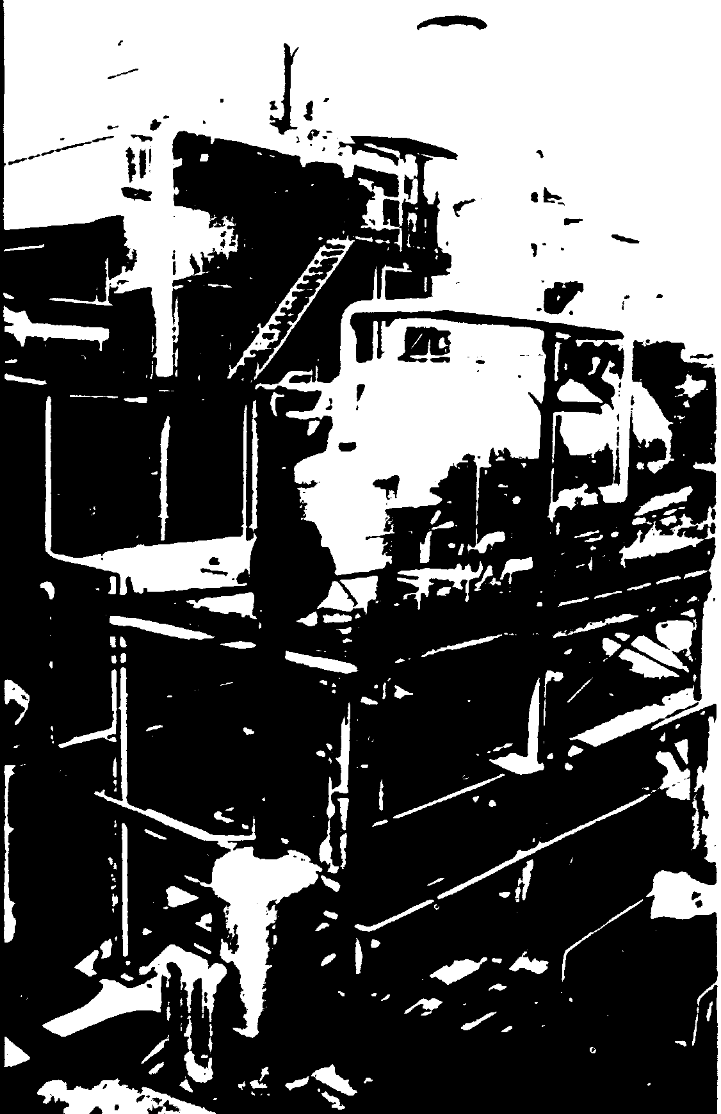
AFME FRENCH AGENCY FOR ENERGY MANAGEMENT

EXEMPLARY [illegible]

**ENERGY PRODUCTION
FROM BIOMASS**

REUNION ISLAND:

BAGASSE FUEL FOR A POWER STATION CONNECTED TO A SUGAR FACTORY



Users: Sucrière du Nord Est (S.N.E.)
Quartier Français
97441 SAINTE SUZANNE

E.D.F.

Engineering: Fives-Cail-Babcock

Creusot-Loire

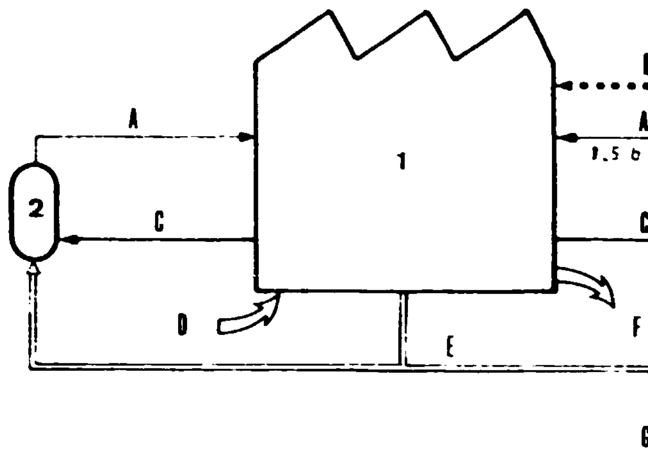
Jeumont

Builders: F.C.B. (boiler)

Creusot-Loire (power station)

The sugarcane industry has never regarded the supply of energy to its factories as its primary concern. Heat and electricity requirements of the factories are generally satisfied through the combustion of part of the bagasse (the fibrous material remaining after sugar extraction), while the rest goes unused.

In Réunion, surplus bagasse could be utilized to produce around 160 kWh of additional electricity per year, corresponding to one-third of the island's total consumption for 1983. For this reason, a bagasse-fired power station was built and connected to SNE's Beaufonds sugar factory as part of the program to restructure Réunion's sugar industry.



A. Steam

B. Electricity

C. Condensates

D. Sugarcane

E. Bagasse

F. Sugar

G. Cold water

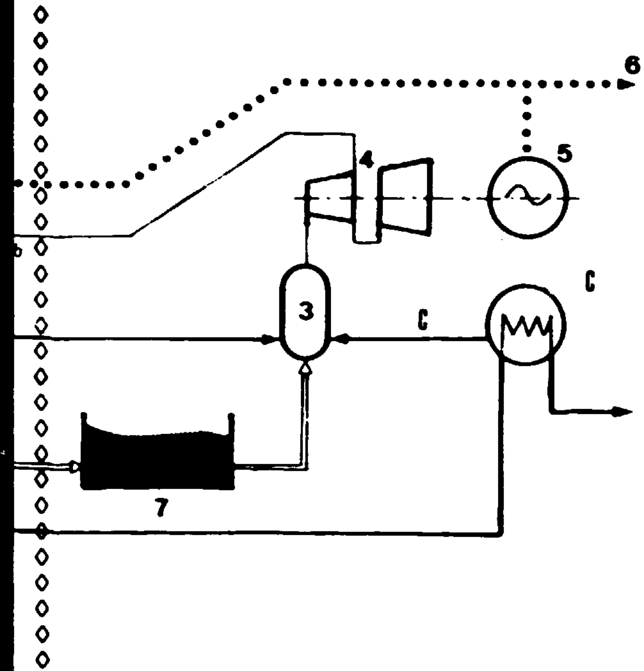
the challenge

The Beaufonds factory processes an average of 550,000 tonnes of sugarcane every year and produces some 30% of its waste (i.e. 150,000 tonnes per year) in the form of bagasse with 50% moisture content. At the outset, in 1983, the sugar factory achieved energy self-sufficiency by burning 70% of this bagasse. The remainder — expensive to store and remove — was considered a space-consuming, potentially harmful waste product. With no profitable solution for the rational use of surplus bagasse, the company pursued a wasteful energy policy and burned off as much of the surplus as possible in low-efficiency boilers. The drive to integrate the sugar factory and its biomass potential into a regional energy policy has encouraged efforts to make the manufacturing process more economical, thereby leaving greater quantities of bagasse for generating electricity.

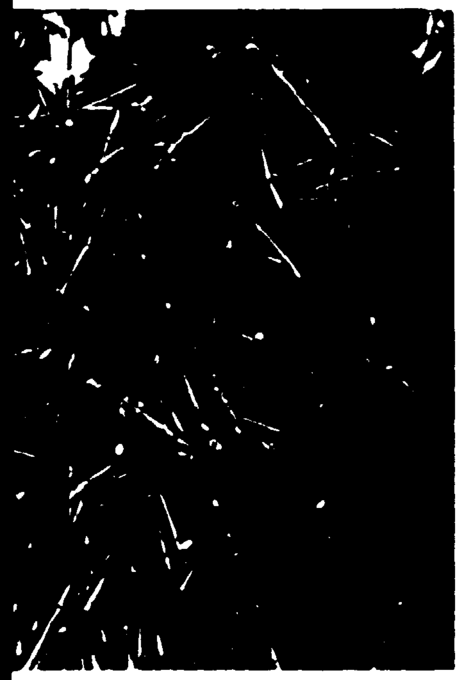
the response

Energy savings in the manufacturing process

Following extraction, purification, and concentration, sugarcane liquor is processed to cause the sugar to crystallize. The solution is boiled under partial vacuum in vacuum pans until the water evaporates beyond the supersaturation point, causing the sugar crystals to precipitate.



1. Sugar factory
2. 24-bar boiler
3. 45-bar boiler
4. Turbine
5. Generator
6. E.D.F. Grid
7. Bagasse storage



Until 1983, the Beaufonds factory performed this operation with batch-loaded crystallizers. Those units consumed 500 kg of steam per tonne of sugarcane processed. The massecuite produced was then centrifuged in three successive stages in order to separate out the crystals from the sugar syrup. By installing two continuous-load crystallizers running on low-pressure steam and employing continuous-process centrifuges, it became possible to reduce steam consumption to 430 kg per tonne of sugarcane. However, crystallization is still batch-process in part. The same holds for the centrifuging of the first two batches of massecuite. SNE aims to limit sugar factory steam consumption to 350 kg per tonne of sugarcane by using continuous process equipment. Under optimum running conditions, surplus bagasse could reach 40 to 45% of total bagasse production. In 1983, energy savings in the manufacturing process represented an increase in surplus bagasse of about 3%.

The power station

At present, bagasse is either burned in the old 24-bar boiler used to supply 21-bar steam to the factory, or else it is stored before being fed into the power station's new 45-bar boiler. The steam produced by the combustion of waste products in the power station boiler is delivered to a two-stage turbine coupled to a 24.6 MW generator. Two by-pass outlets from the first stage of the main turbine take part of the steam at 21-bar pressure to the sugarcane factories, while steam at 1.5-bar pressure is supplied to the crystallizers. Under normal running conditions, the generator operates with an output of 20.5 MW, of which 17 MW is supplied to the grid and 3.5 MW is used directly by the sugar factory.

The power station was designed to generate 45 GWh of electricity per year from 550,000 tonnes of sugarcane (i.e. 300 kWh per tonne of bagasse), of which 37 GWh were to be supplied to the grid. In 1983, however, the station supplied only 11 GWh to the grid because the unit was put into industrial production later than expected (August 1983), and because the incidence of breakdowns was higher at partial load than at nominal capacity. Moreover, only partial energy savings were achieved, and drought was responsible for a sugarcane shortfall. The goal for 1984 is to supply 36 GWh to the grid, 6 GWh of which is to be produced from 20,000 tonnes of bagasse from the nearby Bois Rouge sugar factory.

energy breakdown

One tonne of processed sugarcane produces about 300 kg of bagasse which is used as follows:

35%	consumed by the sugar factory
7%	stored for breakdowns and shut-downs
58%	available for the power station

For one tonne of sugarcane, the energy breakdown is as follows:

Bagasse	300 kg
Steam produced	700 kg
Internal electricity consumption	14 kWh
Electricity supplied to EDF	66 kWh

Under normal operating conditions, the power station generates 20.5 MW of electricity, of which 16.2 MW is available for supply to EDF. (At reduced load, these figures are 9.2 MW and 6.2 MW, respectively.)

Sugar production is on stream 19 calendar weeks per year. With an estimated downtime of 8 hours per week, factories have an actual operating time of 120 hours per week.

Potential yearly output of the power station (excluding legal holidays):

Under normal operating conditions:	
16,200 kW x 120 hrs x 18.33	35,633,520 kWh
At reduced load:	
6,200 kW x 12 hrs x 18.33	1,363,752 kWh
TOTAL	36,997,272 kWh

cost breakdown

Approximately one-half of the investment costs for restructuring the Beaufonds factory (FF 75 million) is related to energy saving equipment (heating and power station). EDF purchases electricity at FF 0.25/kWh. Corresponding revenue for 37 GWh is thus FF 9.25 million pe. year.

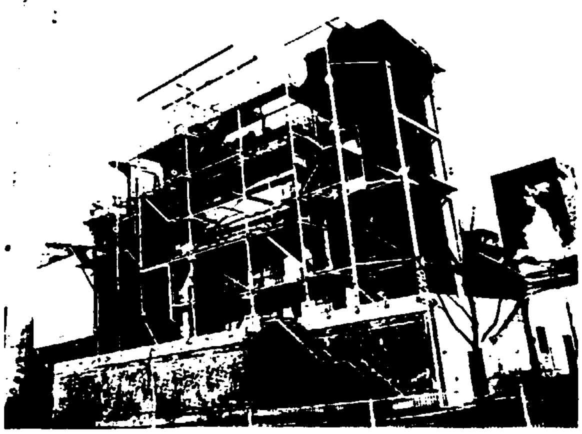
Payback time for investment	8 years

AGENCE FRANCAISE POUR LA MAITRISE DE L'ENERGIE

ENERGY PRODUCTION FROM BIOMASS

DUAL-FUEL STEAM BOILER:

COAL AND COFFEE GROUNDS



User: SOPAD-NESTLE
Dieppe Factory
Z.I. de Rouxmesnil-Bouteilles
B.P. 521
76370 NEUVILLE-LES-DIEPPE
tel. (35) 82.76.60

Builders: FIVES-CAIL-BABCOCK
80, rue Emile Zola
B.P. 95
93123 LA COURNEUVE
(boiler)

SPEICHIM
Tour Franklin
92081 PARIS LA DEFENSE
(presses)

TERNOIS EPURATION
14, rue Maréchal de Lattre
de Tassigny
28110 LUCE
(treatment plant)

Every year, the SOPAD factory at Dieppe, which produces instant coffee and powdered chicory, has to deal with several thousand tonnes of waste commonly referred to as coffee grounds. In an effort to limit the energy expenditure of this production unit, which originally included large quantities of fuel oil, the company has turned quite naturally to the use of its by-products as a valuable source of energy. Technical and economic studies show that optimum combustion of these substances is achieved by mixing them with a second fuel having a higher energy yield, such as coal.

The system installed, using the latest techniques, substitutes 6,000 TOE of coffee grounds and 7,000 TOE of coal for 13,000 TOE of fuel oil. Payback time on the FF 32 million investment is 3.5 years.

These steps are part of the company's global energy policy which is aimed at introducing new techniques and optimizing energy resource management. That policy can be outlined as follows:

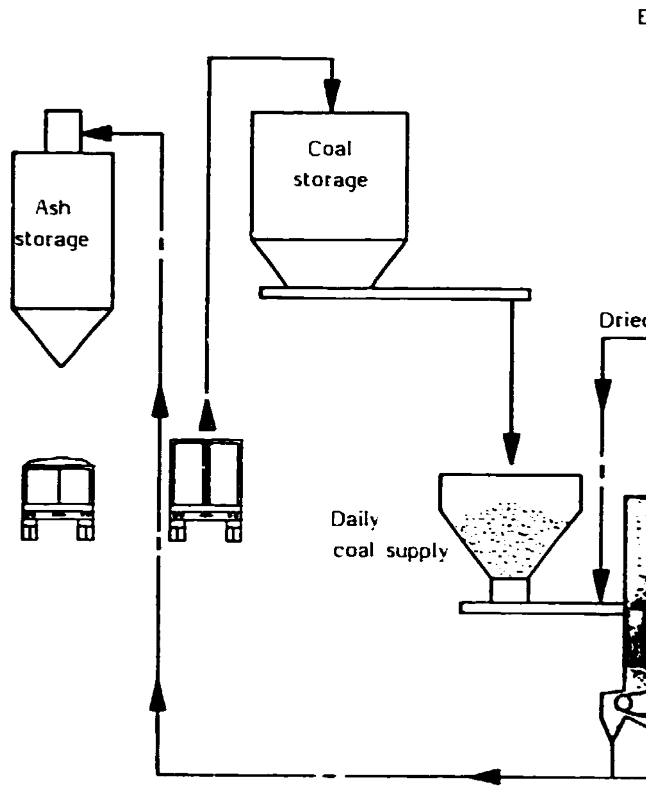
- using electricity for mechanical processing and preliminary treatment of colored effluent (reverse osmosis)
- using waste products from industrial processes as an energy source
- using coal as an ignition and make-up fuel
- using fluidized bed combustion for greater flexibility, higher efficiency, and a broader potential fuel range.

the challenge

Two problems were regularly encountered at the Dieppe plant:

- finding a reliable, long-term method for removing manufacturing waste products
- reducing energy expenditure (which was rising due to increasing oil prices), and to ensure continuity of production through diversification of energy supply.

Finding a reliable commercial outlet for the factory's waste products could have been the answer to the first of these problems, as they can be used as soil improvers and cattle feed. However, not only did this solution have little in common with the company's objectives, it also involved dependence on erratic and unpredictable agricultural markets. Investments aimed at reducing dependence on petroleum products either were very heavy or entailed long payback times (for coal, gas, or electricity). Moreover, the fuel oil-fired heating plant installed at the factory (producing 54 tonnes of steam per hour) was less than ten years old.

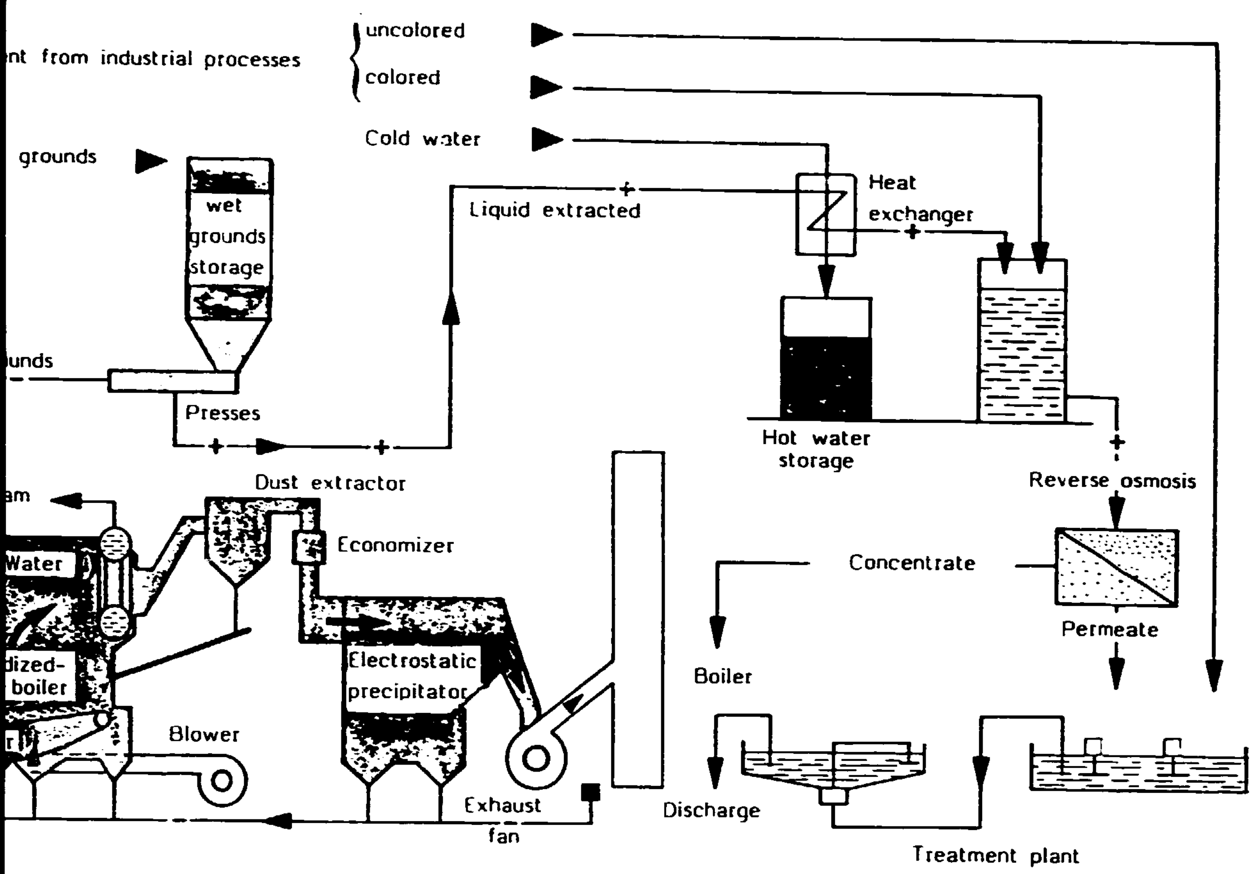


the response

Plainly, the solution to both problems lay in the rational use of by-products, thereby allowing the company to reduce its energy dependence while eliminating risks related to unsystematic marketing of waste products.

It is impossible to burn residual coffee grounds directly, since their moisture content is very high (around 75%). Once the moisture content of the grounds has been reduced to 50%, however, they have sufficient energy potential to be used as fuel (LHV: 2,100 kcal/kg), although it is still necessary to utilize mixed combustion techniques, adding a higher-yield fuel to the dried residue. Coal is particularly suitable for this technique. The above analysis led to the investment at the Dieppe plant which now includes both a fluidized bed boiler capable of burning the fuel mixture and a pressing unit designed to reduce the moisture content of the waste.

Coffee grounds leaving the manufacturing line with a moisture content of 75% are dried in three Speichim screw-type presses which have a unit capacity of 6 T/hour and are highly energy efficient. The presses replaced the existing rotary driers after a comparative study had proved the superiority of mechanical drying over conventional heat drying processes. Energy savings amounted to 1,550 TOE/year.



It should be noted that water leaving the presses is heavily laden and colored (COD: 50,000 mg/l) and cannot be treated using conventional methods. In particular, the strong coloration of the water necessitates a preliminary treatment phase involving one of two possible processes: the much-used system of evaporation, or the comparatively more modern and more energy-efficient system of reverse osmosis. With a throughput of 20 m^3/hr (5 m^3 hr from the presses plus 15 m^3/hr from the manufacturing process itself), membrane filtration allowed for yearly savings of around 200 TOE compared to a system involving a three-chamber evaporator used for mechanical steam compression.

The unit ultimately installed has six filtration stages for a total surface area of 750 m^2. Virtually total decoloration is achieved and levels of pollution (measured in COD) are reduced by over 90% (concentration ratio: 1/15).

The above effluent is then mixed with uncolored effluent from manufacturing lines before being treated in a biological treatment plant. This plant, with a nominal throughput of 70 m^3/hr, consists of a screening unit, an aerated buffer tank (capacity: 1,500 m^3), an aeration tank (capacity: 2,000 m^3), a settling tank, and a sludge thickener. The treatment plant was commissioned early in 1984.

Coffee grounds are pressed and then sent either to a storage facility or else directly to the combustion line. The moisture content of the residue is high, and a certain amount of dry fuel (coal, in this case) must be added before combustion can proceed. (Coffee grounds can only satisfy around 45% of the factory's total energy requirements.)

Fives Cail Babcock supplied the once-through, water-tube steam boiler. The fluidized bed combustion furnace consists essentially of a mechanical grate used for slag removal and distribution of fluidization air (primary air). Related equipment includes a mechanical dust extractor, an economizer, an electrostatic precipitator, and an exhaust fan discharging into a stack 42 meters in height.

The above unit produces 40 T/hr of 16-bar steam. This type of boiler was chosen over conventional grate boilers because it is better suited to the wide range of coal qualities available on the market and to significant variations in operating capacity (36 T/hr weekdays and 4 T/hr weekends). Moreover, tests run at the FCB test center at La Courneuve indicated that coffee grounds burn especially well when suspended in air.

energy breakdown

Average annual energy consumption for the Dieppe factory is around 12,750 TOE. Only heavy fuel oil was burned initially. At normal operating capacity (after start-up on coal alone) coffee grounds can supply 5,780 TOE per year. Taking into account the energy consumed for mechanical drying (70 TOE), the energy savings achieved amount to approximately 5,700 TOE.

Coal make-up requirements are approximately 6,875 TOE. This gives the factory an overall energy supply breakdown as follows:

- fuel oil to coal conversion: 54% of plant requirements
- energy recovered from manufacturing by-products: 46% of plant requirements.

the company

SOPAD-Nestlé holds a firm position in the agro-industrial market, manufacturing and marketing products with such widely known brand names as Nestlé, Nescafé, Mousline, and Maggi. Annual turnover exceeds 5 billion French francs, of which about 30% comes from exports.

The company has a staff of 6,200 including 600 engineers and managers. The range of 700 products includes instant drinks, chocolate, pre-packaged foodstuffs, and dietetic and dairy products. Seven plants in France manufacture most of these products. The Dieppe factory is one of France's major production units for instant coffee.

cost breakdown

(base year: 1981)

. Fuel oil consumption: 13,450 tonnes at FF 1,100 per tonne	FF	14,800,000
. Coal consumption: 11,445 tonnes at FF 515 per tonne	FF	5,895,000
. Additional energy consumption: 284,000 kWh at FF 0.29 per kWh	FF	83,000
. Savings	FF	8,822,000
. Energy investment (1981) ..... (excluding reverse osmosis decoloration and treatment plant)	FF	31,686,000

note: The coffee grounds utilized are assumed to be commercially valueless.

Gross payback time ..... 3.5 years

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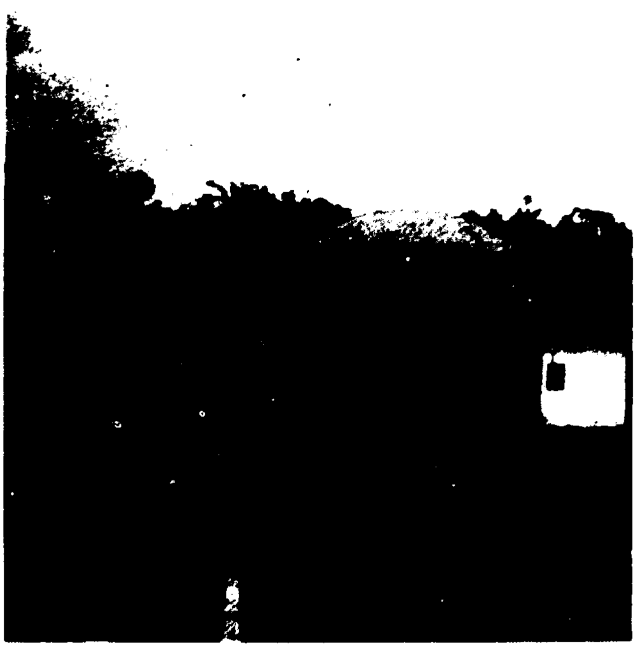
AFME: FRENCH AGENCY FOR ENERGY MANAGEMENT

ENERGY PRODUCTION FROM BIOMASS

GABON: METHANE PRODUCTION FROM POULTRY DROPPINGS



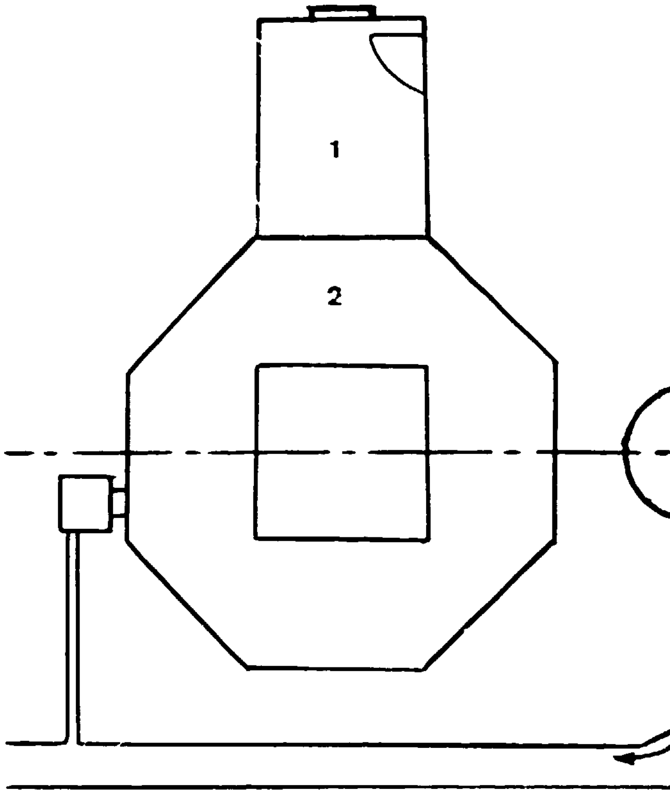
User: SMAG
B.P. 462
LIBREVILLE
Gabon

Engineering: SEPMA
4, rue du Colonel Briant
75020 PARIS cédex 01
France

Builder: MIDA-TRA
Castelnau-Barbarens
32450 SARAMON
France

SMAG — Société Meunière et Avicole du Gabon (Flour Milling and Poultry Company of Gabon) raises 156,000 laying hens, in cages 11 months a year, at its N'Koltang facility, which produces most of the eggs consumed in Gabon. Generally speaking, poultry droppings cannot be spread as fertilizer in Africa due to health hazards (poultry disease). These risks are compounded in Gabon because the waste would have to be transported to fields located some distance from the breeding facility.

In 1983, SMAG built a prototype industrial digester in N'Koltang as part of a research and experimentation program designed to determine the economic feasibility of methane production from poultry droppings. By applying these results to the treatment of all available waste, the company estimated that energy savings of 245 TOE could be achieved under normal operating conditions.

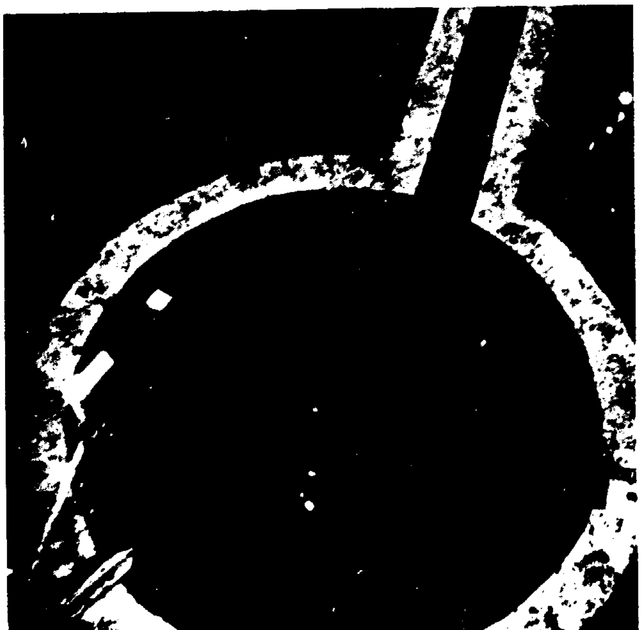


the challenge

The principle of methane production is to convert poultry droppings into methane-rich and thus combustible gas by means of anaerobic fermentation. The following major factors affect fermentation output:

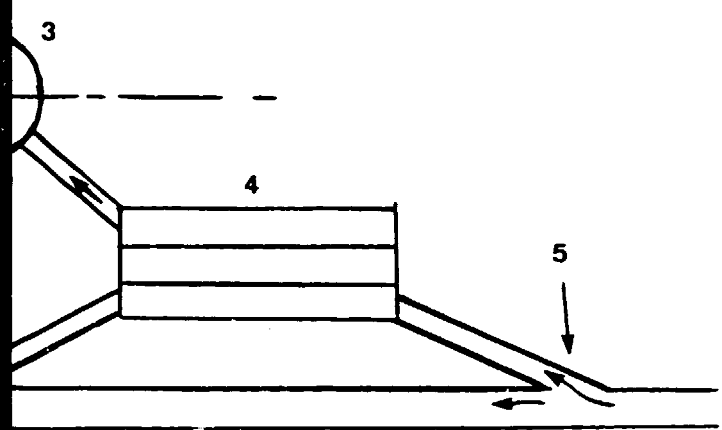
- optimum conditions for bacterial growth (temperature, pH, and ammonia concentration)
- the percentage of dry matter to be processed (optimum percentage for this facility was set at 10%)
- the efficiency of removal of non-fermentable waste found in the liquid manure (e.g. feathers and sand)
- the efficiency of crust removal operations.

Furthermore, as it leaves the digester, the gas contains 60% methane and 40% carbon dioxide, and cannot therefore self-ignite. Thus, it can only be used in specially adapted engines.



GRINDING AND HOMOGENIZATION PIT

1. Technical building
2. Pilot digester (80 m³)
3. Grinding pit
4. Settling tank
5. Slurry removal channel



the response

The industrial prototype of the anaerobic waste treatment unit for SMAG's poultry farming operation was put into continuous service on 10 August 1983 and has operated satisfactorily ever since. It was installed after SMAG and SOMDIAA had carried out tests in France on a microplant with a capacity of 2.3 m³.

The prototype digester, with a capacity of 80 m³, processes 6.7 m³ of waste (16% dry matter content) daily, at normal operating capacity. This represents 20% of the liquid manure to be processed. Solid waste collected in henhouses is delivered to the first of three compartments of a settling tank whose main function is to remove as many feathers and as much sand as possible in the shortest time.

When the liquid manure flows through the orifices in the bottom of the first chamber into the second chamber, the feathers are caught and sent to the feed canal. Sand and gravel are trapped as the liquid manure flows into the third chamber through the orifice located midway up the second chamber. As settling time in continuous process is 24 hours, the tank is filled the day before the liquid manure is to be used, but only once the digester has been filled with settled droppings and the unit has been completely cleaned.

The liquid manure then flows through a flap to the grinding pit which is fitted with a step in order to catch the last heavy pieces at the bottom. The waste is ground in the pit (at 16% dry matter content) and then diluted with water until a level of 10% dry matter is reached.

Every day, the homogenized mixture feeds a digester with four fixed-bed biological filters (downward flow). Four pumps ensure feed and recycling. Sand and crust removal operations are carried out once a week in order to prevent clogging. After a retention time of 20 days at a temperature of 30° to 32°C and a controlled pH of 8, the effluent is removed from the digester through an overflow pipe.

The biogas produced contains 60% methane and 40% carbon dioxide. It has a lower heat value of 5.5 thermies per m³. The gas is stored in a variable-volume tank with water seal (capacity: 80 m³) before being used to generate electricity in a dual-fuel generating set.

It should be noted that methane production takes place without heating the digester, which means that none of the biogas produced is used as process heat. Nevertheless, a fermentation temperature of 37°C would increase productivity by 10 to 25%. This could be done by recovering the calories from the hot water system in the generating set. It could also help in testing thermophilic fermentation at 55°C.

Installation of the digester has helped achieve the three goals laid down at the outset of the program:

- production of gas for energy uses
- reduction of the pollution levels of the effluent (COD cut in half)
- stabilization of the effluent, determined according to the C/N ratio, which decreases from 25 to 15.

energy breakdown

Experiments carried out by SMAG and SOMDIAA on the prototype in Gabon produced the following results over the observation period from August 1983 to May 1984:

(1 TOE = 4.2×10^{10} J = 4×10^{7} btu = 7.33 BOE)

Laying hens	35,000
Digester capacity	80 m³
Input (10% dry matter content)	6.7 m³/day
Electricity generation	54 TOE/year

Applying the above figures to the treatment of all waste produced provides the following data:

Laying hens	156,000
Digester capacity	360 m³
Input (10% dry matter content)	30 m³/day
Electricity generation	245 TOE/year

The 245 TOE produced are to be used for:

Electricity generated for breeding	150 TOE/year
Electricity generated for pumps (methane production)	27 TOE/year
Heat for incubators	26 TOE/year
Total	203 TOE/year

leaving a safety margin of 42 TOE, or about 20%.

cost breakdown

The total investment, including the generating set, amounts to 3 million francs, with amortization of 388,000 francs per year over a 10-year period and at a rate of discount of 5%.

A technical and economic analysis of the preliminary project leads to the following estimates:

Operating costs	F 80,000 per year
Amortization	F 388,000 per year
Total	F 468,000 per year

It costs 468,000 francs per year to produce the 176 TOE required for self-sufficient operation. This corresponds to a cost price of 2.26 francs per liter of gas-oil equivalent, which is lower than the current price of 2.70 francs per liter.

Internal rate of return (over 10 years)	17%
Payback time (on capital)	3.5 years

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AFME : FRENCH AGENCY FOR ENERGY MANAGEMENT

EXEMPLARY OPERATION

ENERGY PRODUCTION FROM BIOMASS

METHANIZATION OF RESIDUARY LIQUOR IN A COGNAC WINE DISTILLERY

PARTNERS IN THE OPERATION

User	:	Groupement d'Intérêt Economique REVICO BP 179 - 16106 COGNAC - Tél..(45)82.49.99
Engineering	:	S.G.N. (Sté Gale pour les Techniques Nouvelles) 1, rue des Hérons - Montigny-le Bretonneux 78184 ST QUENTIN EN YVELINES CEDEX - Tél. : (3) 058.60.00
Measurement Campaign	:	A.P.A.V.E. du Sud-Ouest (BORDEAUX) and I.N.R.A. (NARBONNE station)

This operation is the first fullscale project in France consisting of the methanization of residuary liquors of wine distilleries by the fixed bed process. The substrate was largely designed by the installer, SGN, with technical assistance from INRA, and financial backing from AFME, particularly at Condom, on Armagnac residuary liquors.
The process itself was developed on a different substrate (sugar refinery effluents) at Beghin-Say's Thumeries sugar refinery.

THE PROBLEM

Groupement d'Intérêt Economique (GIE) REVICO was formed by Cognac distillers to process their residuary liquors that could not be dumped into the natural environment. Two types of by-product are involved : a lees residuary liquor with 50 g gross COD (Chemical Oxygen Demand) per litre, and a wine residuary liquor containing 30 g gross COD per litre.

Until now, the residuary liquors were processed by the thermal method in a multistage concentrator, with a concentrated residuary liquor combustion unit designed to produce the steam required to operate the concentrator.
However, self-production of energy by this means only succeeded in covering 20 % of requirements. The balance was therefore supplied by fuel oil, whose price increase made the cost of processing the residuary liquors prohibitive to the members of the GIE.

The GIE therefore tried to solve the environmental problem by methanization. The new process offers the advantage of recovering the energy available for the needs of the establishment.

THE ANSWER

Methanization of all the effluents (settled residuary liquors and lees) helped to eliminate the need for fuel oil completely. The operating principle of the methanization unit is to treat the effluents separately for wine and lees residuary liquors. The methanization process employed is a fixed bed process for wine liquors and an intimate mix process for lees liquors.

The wine residuary liquor digester produced by the new generation of fermenters is packed with a stack of PVC rings (Flocor R packing) resting freely on gratings. Flocor offers a large area per unit volume (230 m^2/m^3). Thus the process serves to fix the maximum possible bacteria in the digester, enhancing the efficiency of fermentation and the production of biogas.

A mix digester for untreated lees residuary liquors with a high concentration of suspended matter is better for this type of substrate, which is much more concentrated. The average throughput of liquors to be processed is 80 m^3 per hour for 8 hours. Methanization of the 150,000 m^3 of corresponding liquors serves to produce around 1,400,000 m^3 of methane per year.

Five-twelths of the output are burnt in two motors to generate electrical energy and to produce hot water at 80° C.
This hot water is used to keep the fermenter at temperature and the surplus is sold to a user to head hothouses and schools belonging to the town of Cognac.

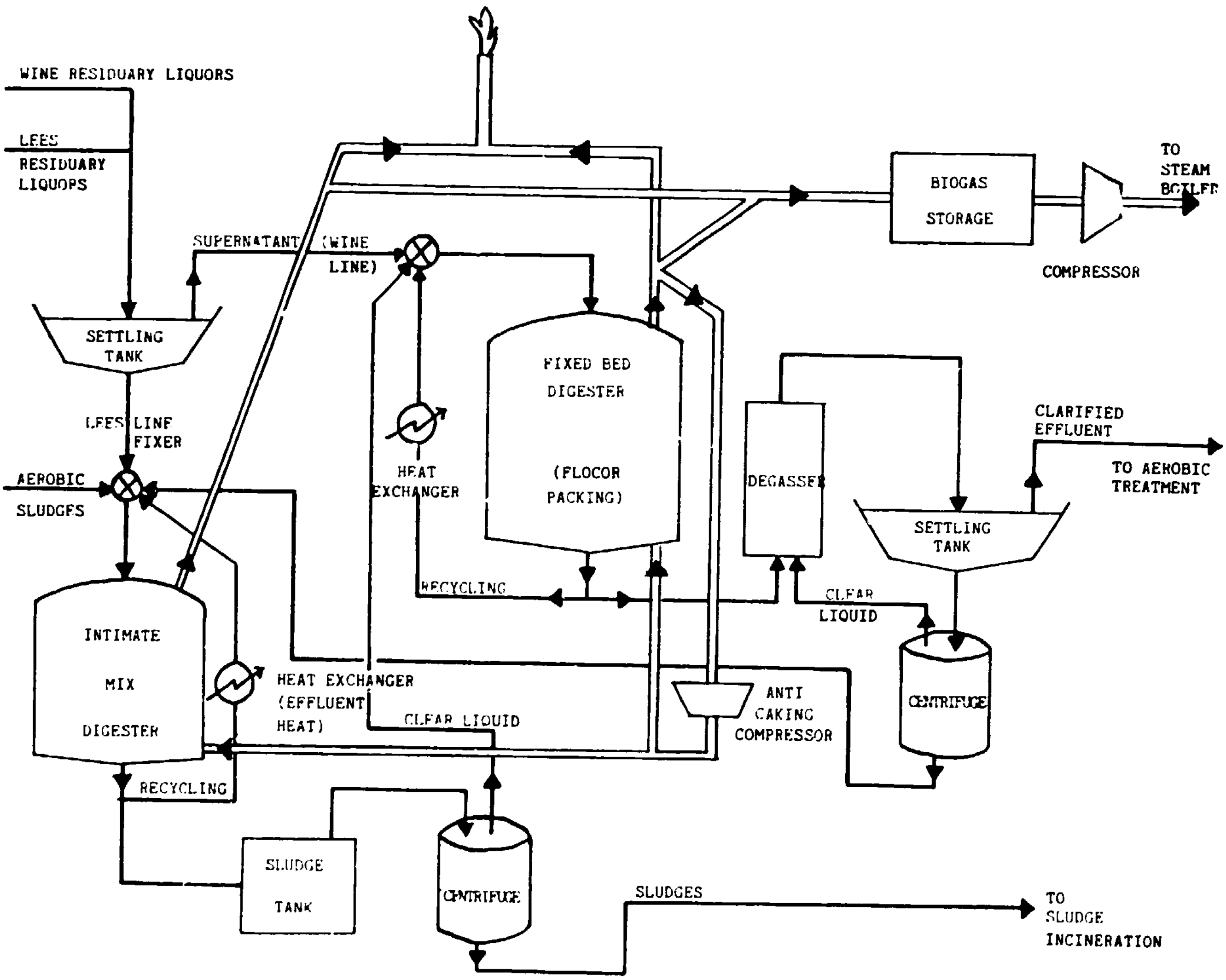
The remaining seven-twelths are burnt in a boiler to produce the steam required for the wine distillation column.

This helps to attain the two-fold objective set by the undertaking.

- To eliminate the pollution present in the effluents, this operation will be achieved with a 90 % cut in COD,

- To realise fossil fuel savings by producing energy from the biogas that is a fermentation by-product.

INSTALLATION FLOWCHART



FOREGAST ENERGY BALANCE

The products to be treated represent a total quantity per season of 150,000 m^3 with a purification efficiency of 90 %, and the average soluble COD of the residuary liquors is 30 g per litre.

$150,000 \times 10^3 \times 30 \times 10^{-6} \times 0.9 = 4,050$ tons of COD destroyed.

1 kg of COD destroyed produces 0.35 m^3 of methane with an LHV (Low Heating Value) of 8,500 kcal per m^3.

$4,050 \times 10^3 \times 0.35 \times 8.50 = 1,200$ tOE

From this, it is necessary to substract the energy consumption required to heat the residuary liquors, to maintain 37 ° C in the fermenter, and to operate the pumps and compressors, estimated at 250 tOE.

This methanization process substitutes for treatment by evaporation. Hence by shutting down the concentrators of the former installation, the operation must be credited for energy conservation of 3400 tOE. Thus the total energy balance of the operation is as follows :

```
  1,200 tOE from gas
-   250 tOE consumed by the process
+ 3,400 tOE conservation
-------
  4,350 Conservation per season
```

FORECAST COST BALANCE

The total budget of the overall installation is around 20,000,000 F excluding tax, broken down as follows :

- 14,500,000 F for the methanization part (digester, engineering, assembly, electricity and control, civil works),
- 5,500,000 F for the thermal part (generators, piping, compressors, burners).

The ratio of cost per tOE is thus :

20,000,000 : 4,350 = 4,600 F per tOE conserved.

This is equivalent to a payback time of 3 years.

…ATION

ENERGY PRODUCTION
FROM BIOMASS

STEAM PRODUCTION FROM RICE HUSKS

User: SICA France Riz
Clos du Jourdan
Gimeaux
13200 ARLES
France

tel. (90) 93.60.51

Builder: ETABLISSEMENTS PARENT S.A.
47600 NERAC
France
tel. (58) 65.19.00

SICA France Riz is a consortium of rice producing cooperatives. These cooperatives supply France Riz with long grain rice in the husk or with round grain rice, husked and milled.

Round grain rice is soaked, precooked (steamed), and dried, to produce 'minute' rice, while the long grain variety is parboiled, dried, husked, and milled to produce non-glutinous rice. The husking process leaves behind a by-product: the rice husk or hull.

Until very recently, this by-product — approximately 20% by weight of processed paddy rice — was burned in special incinerators and then dumped. Since 1978, however, two boilers have been running on rice husks to meet the factory's 1,600 TOE steam requirements. Additional investment costs for these units was paid back in two years, partly through savings made on heavy fuel oil to run the oil-fired boiler which would have been needed.

THE SICA (FRANCE RIZ) RICE PR

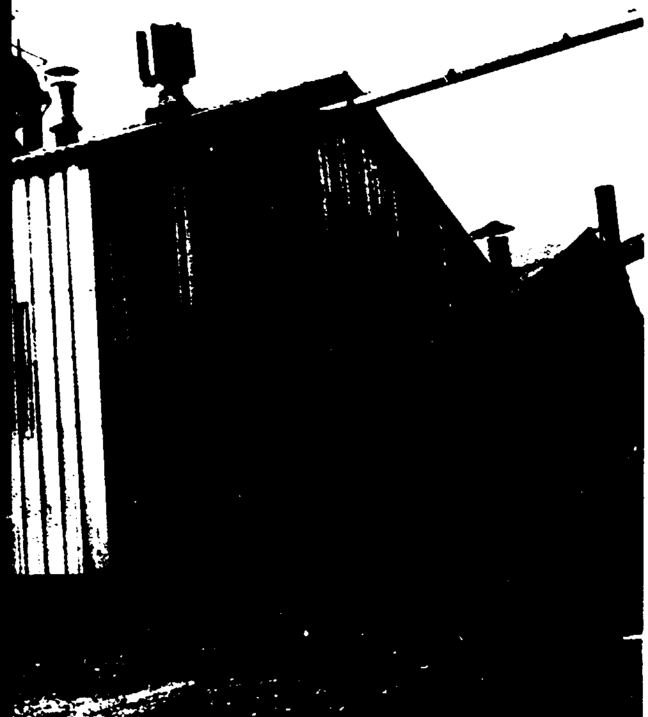
PRODUCING STEAM FRO

the challenge

SICA installed its first husk-fired boiler in 1974 while maintaining one oil-fired boiler on line. The biomass unit consumed all the rice husks available in the plant (3,000 tonnes per year) but failed to provide complete energy self-sufficiency; the factory continued to consume 800 tonnes of fuel oil every year.

With plans to increase factory output, SICA found it viable to install a second boiler running on vegetable waste provided by other SICA member-cooperatives.

Not only did the project overcome the problems of disposal of the by-product (which had formerly been burned in the open air and thus constituted an environmental hazard), it also made it possible for the plant to operate with zero fuel oil consumption at the same time as increasing its output by 50%.



SSING PLANT AT ARLES (France):

ICE HUSKS SINCE 1974

All available husks are burned. First, they are stored in a silo, before being fed into the furnace as and when steam is required in the plant. Smoke and ash pass through the boiler's smoke tubes and leave the unit at a temperature of 200°C. The ash is then separated from the fumes in a multi-cyclone, and collected in a storage silo. The ash is suitable for use in the steel industry. Ash disposal problems encountered with conventional husk incinerators are thereby eliminated.

The boiler operates with 70% efficiency and produces 4 tonnes per hour of 10-bar steam. Thus, it replaces not only the 2 T/hr oil-fired boiler formerly running in parallel with the first biomass boiler, but also a second oil-fired boiler that would have been needed to meet steam requirements for increased plant output.

The two units obviate the need for fuel oil (except in the old boiler, which is maintained on stand-by). Further plans exist for the replacement of the first biomass boiler (operating at full load since 1974) with an improved model similar to the one installed in 1978, and which would operate at two-thirds capacity.

the response

The second boiler (installed in 1978) has higher output and incorporates improvements based upon experience gained from the first boiler, to provide better performance. Five thousand tonnes of rice husks can be burned in the new boiler every year. As planned, factory capacity has increased by 50%.

energy breakdown

With production capacity increased by 50%, the plant's overall consumption reaches approximately 22,000 kWh per year. The 1974 model consumes 3,000 T/yr of rice husks, while the 1978 model consumes 5,000 T/yr. Together, these boilers can supply around 20,800 kWh per year, the remainder of the energy requirements being met (if necessary) by the stand-by oil-fired unit.

Installation of the second husk-fired boiler allows for energy savings of 1,300 TOE, calculated as follows:

$$5{,}000\ \text{T/yr at } 3.2\ \text{kWh/T} \times \frac{0.70}{0.85} = 13{,}000\ \text{kWh/yr}$$

or 1,300 TOE

Additional electricity consumption (200,000 kWh = 50 TOE) must be deducted from this figure. Overall energy savings are thus 1,250 TOE.

cost breakdown

Investment costs for the second biomass boiler are FF 1.6 million. A 2 T/hr oil-fired steam boiler would have cost FF 350,000. The table below shows savings made on plant operation during 1979 and 1980.

YEAR	1979	1980
Heavy fuel oil (1,250 T)	+ 594,400	+ 935,000
Additional electricity (200,000 kWh)	- 36,300	- 40,600
By-products gained (ash)	+ 58,000	+ 63,800
Waste handling costs	+ 20,000	+ 22,000
Additional running costs	- 95,000	- 104,500
TOTAL	541,100	875,700

(amounts quoted in French francs)

Overinvestment costs of FF 1.25 million are thus paid back in under two years.

ENERGY PRODUCTION FROM BIOMASS

LUCERNE AND PULP PREDRYING BY CONDENSATION ENERGY RECOVERY

PARTNERS IN THE OPERATION

User	:	Société Coopérative Agricole de Déshydration MARNE VESLE Voie Chantereine 51000 - RECY - Tel (26) 65.18.23
Manager	:	M. Benaut, Director
Builders	:	CEREX 18 rue Royale - 75008 Paris - tel (1) 260.37.53
Heat Exchanger	:	SERA - HUSSON 36 rue des Grands Champs 75020 PARIS - Tel (1) 373.72.34

The Marne Vesle dehydration cooperative at Recy is located a few kilometers north of Châlons-sur-Marne.

In 1982, the cooperative installed a low temperature predryer, using the latent heat of fumes produced by two temperature dryer drums operating alternately. These fumes contain steam which, when condensed, restores part of the energy consumed in the dryer.

This 10 MF investment helped to reduce specific consumption to 140 kg fuel oil equivalent per ton of granules. Primary energy consumption is thus 2300 tOE per year. Gross payback time of the operation is 3.6 years.

THE COMPANY

Formed in 1965, Coopérative Agricole Marne Vesle carries out the dehydration of lucerne, beet pulps or any other fodder material from the farms of its members. It collects the different materials, and processes, packages, stores and markets them.

The nominal capacity of the dryers is 45,000 liters of evaporation per hour, which currently serves to deal with 1800 to 2000 ha of lucerne, or 91,000 tons of fresh lucerne.

Production of dehydrated pulps is 12,000 tons of granules from 50,000 tons of compressed pulp. The lucerne and pulp activities account for 65 % and 35 % of turnover respectively, with a total of about 30 million francs in 1981.

The cooperative benefits from the technical assistance, research and development resources administered at Châlons-sur-Marne by the France Lucerne group.

THE PROBLEM

The Marne Vesle dehydration cooperative has two drying drums of 28,000 l/h and 17,000 l/h evaporation. The specific consumption of these dryers is around 200 g fuel oil equivalent per kilogram of dehydrated product (or 680 kcal/kg moisture), (the cooperative uses natural gas), which is a good starting point.

The fumes produced and discharged at a temperature of about 100° C are loaded with water vapor, around 500 to 600 g per m^3 air.

Aware that advances are still possible in the area of energy recovery, the cooperative initiated research in 1981 to recover the latent of the water vapor and to use it to predry the material to be dehydrated.

THE ANSWER

The answer was provided by CEREX (subsidiary of the CERIC Group) which designed a recovery system for the energy contained in the vapors.

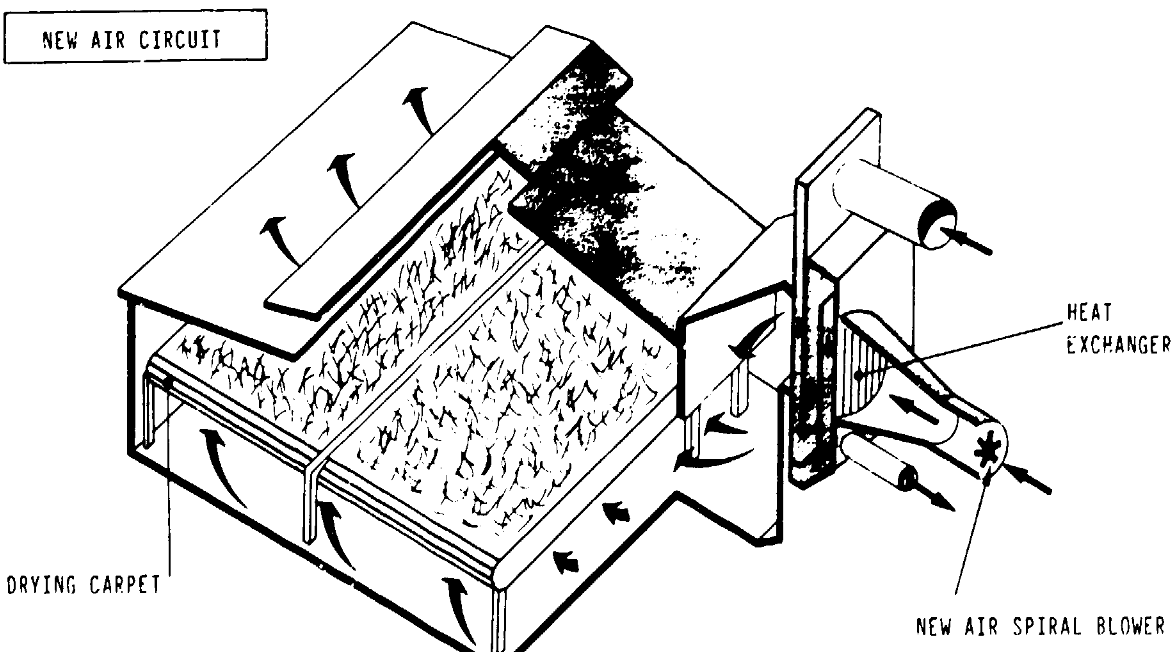
The spent gases are first sent to a scrubber-saturator where they meet a countercurrent flow of atomized water, which eliminates a large share of the fines and saturates the gases with water vapor. The gases then pass through a glass tube heat exchanger built by Sera Husson, where 75 to 80 % of the water vapor contained in these fumes is condensed. The condensates are stored in a tank and then spread on the land surrounding the plant.

The ambient air is pulsed by helical fans in contact with the glass tubes, where it is heated to a temperature of about 75° C. This warm dry air is used to predry the lucerne or pulp entering the plant.

These material are spread in a thin layer (20cm) on a perforated stainless steel apron 175 m^2 in area, using a conveyor belt actuated with back-and-forth motion, and the thickness of the lucerne or pulp layer is made uniform by rotary arms. The lucerne leaving the first apron is picked up by conveyor belts and redispersed on a second identical apron. These two aprons are traversed by warm air produced by the glass tube heat exchangers, with upward air flow, so as to "expand" the bed, a novel feature of the operation, thus avoiding excessive pressure drops. After crossing these two aprons, the spent air is discharged, completely saturated with water vapor, at a temperature of about 30° C.

Thanks to predrying, 30 to 35 % of the moisture to be eliminated is evaporated free :

	Predryer inlet	Predryer outlet	Finished product
Lucerne or pulp	100 kg	78 kg	28 kg granules
Moisture	75 %	68 %	10 %



ENERGY BALANCE

In 1982, during the lucerne and pulp seasons, the plant produced 37,000 tons of granules. Heat energy consumption was 5,120 tons oil equivalent. If the low temperature predryer had not been installed, this would have been 7,530 tOE. Specific heat consumption was 480 kcal/kg evaporated water.

Extra electricity consumption was around 400 MWh or 100 tOE in 1982, and 40 tOE in the following years.

Hence primary energy conservation amounts to :

7,530 - 5,120 - 100 = 2,310 tOE in 1982.

FINANCIAL BALANCE

Investment outlay was 10 MF, including 7.5 MF for the main energy conservation equipment.

NATURAL GAS CONSERVATION :		
	2,410 tOE x 1,300 F/tOE	= 3,133,000 F
EXTRA ELECTRICITY CONSUMPTION :		
	400,000 kWh x 24.2 c/kWh	= 97,000 F
ADDITIONAL COSTS :		
	Washing products and lime	= 50,000 F
	Manpower	= 90,000 F
	Maintenance	= 150,000 F
	ANNUAL GAIN	= 2,746,000 F

Gross payback time : 3 years 7 months

The survival of our activity will eventually require more than 50 % energy vation, says M. Benaut, Director of the Cooperative.

. Why did you make these investments ?

- The price of energy has become so high that it is indispensal to cut energy consumption. All conventional techniques, such as recycling and pretossing, are already employed in the firm, and enabled us to cut our specific consumption by 30 % in comparison with 1978. To go further, we had to use new techniques applicable to both beet pulp and lucerne.

. Do you plan to improve the efficiendy of your predryer ?

- Yes, it is possible to improve the operation of our new equipment and to approach 35 % energy conservation, by keeping below 460 kcal/kg water. This was effectively achieved in 1983.

. Right now, your plant runs on natural gas. Are you planning to use another energy source ?

- Like fuel oil, gas has become an expensive energy, and overall conservation of 50 % will perhaps be inadequate to guarantee the survival of our activity in the future. This is why we plan substitutions by switching to coal, or possibly other energy sources.

. What problems did you encounter at the financial level ?

- Achieving this scale conservation requires costly investments. It is therefore necessary to have considerable working capital. The aid from Agence Française pour la Maîtrise de l'Energie was obviously very useful, but the interest rates, and the professional tax that penalizes these investments, are hampering the spread of these operations within the profession.

TECHNICAL DATA : System Management

The steam contained in the fumes leaving the high temperature dryer contains substantial energy, available after condensation. For the main installation, this represents 83,000 to 98,000 MJ/h depending on the throughput of the H.T. dryer (22,000 to 28,000 kg water evaporated per hour).

After the partial use of fumes (30 to 40 %) in the recycling technique, 59,000 to 75,000 MJ/h of heat remains available depending on the operating rate. This is partly recovered by condensation (about 80 %) or 50,000 to 63,000 MJ/h in the form of hot air at 75° C (74 to 76).

The total heat balance depends on the specific efficiencies of the high and low temperature dryers, and the throughput of the H.T. dryer in accordance with the heat exchanger dimensions.

Given the exchanger characteristics, calculated for an economic optimum as a function of an H.T. capacity allowing a given production rate, maximum economy corresponds to 22,000 kg evaporation in the T.H. and 13,000 in the L.T. This makes :

13,000/ (22,000 + 13,000) = 37 %

If at 28,000 kg on the H.T., L.T. evaporation is 14,000 kg, the economy becomes :

14,000/ (28,000 + 14,000) = 33 %

If at 26,000 kg on the H.T., L.T. evaporation is 12,000 kg, the evaporation becomes :

12,000/ (26,000 + 12,000) = 31 %

The technical management of such a system requires precise knowledge of the operating conditions :

- respective evaporation of H.T. and L.T. dryers
- respective specific consumption of the dryers
- total specific heat consumption
- characteristics of a number of parameters :
  . moisture content of fumes
  . recycling rate
  . fresh air and spent air temperature
  . dew point
  . air flow rates

These data can be analyzed by the equipment controllers, or processed by microcomputer, capable of "giving" the results in synthetic form, tables, graphs, etc, and also capable of running the installation automatically.

The alternative selected was to procure aid for control, in the form of data transmitted in plain language by a microcomputer, enabling the operator to optimize the operation of the installations in accordance with the objectives of productivity, energy conservation, etc.

By parameter simulation, the system shows the effects of any corrections.

OTHER EXAMPLES OF PREDRYING

In recent years, several other dehydration plants in the Champagne-Ardenne region have acquired a predrying system. These installations were built by Promill.

The principle is practically the same as the CEREX process. Differences derive essentially from the construction of the predrying carpets : in the Promill system, the carpets are of fabric (nylon), they are superimposed, and the hot air traverses the layer of plants to be dehydrated in the downward direction.

The first dehydration unit to adopt this technique, in 1978, was Société Sucière de Saint-Germainmont in the Ardennes. This predryer, with a carpet area of 124 m^2, has an evaporation capacity of 5500 l/h, and recovers the fumes from a conventional 12,000 l/h dryer. It cost 3 million francs. Energy conservation is around 30 %, or 1300 tOE/year, and the overall specific consumption is 500 kcal/kg water.

The second installation of this type was built at the Coopérative Agricole de Déshydratation de l'Arne et Retourne at Pauvres in the Ardennes. This predryer has an evaporation capacity of 12,500 l/h, and the carpet area is 300 m^2. The energy conservation achieved by this installation amounts to 2600 tOE per year since the 1980 season. The installation cost 8 million francs at the time.

ENERGY PRODUCTION FROM BIOMASS

COMBUSTION OF COTTON SEED HULLS IN AN OIL MILL IN MALI

PARTNERS IN THE OPERATION

User : Huilerie Cotonnière du Mali (HUICOMA)
KOUTIALA - MALI -

Prime Contractor : C.F.D.T. (Compagnie Française de Développement des Textiles)
13 rue de Monceau
75008 PARIS - Tél. (1) 359 53 95

Builder : Ateliers F. MOCK
BP No 159
67042 STRASBOURG CEDEX - Tél (88) 33-16-22

For many years, most groundnut crushing mills had been using the hulls available for the production of steam or electricity.
But the use of cotton seed hulls raised serious problems of handling (very difficult substrate to transport) and combustion (ash, unburnts).

The primary energy requirements of a cotton seed oil mill are split more or less evenly between the production of electricity and steam for the process. It therefore seemed a good idea to try to gasify the hulls to supply producer gas both to the generating set and to a burner. Since this technology was not fully mature, it was decided to carry out combustion in suspension, which totally satisfied the process steam requirements.
The use of hulls thus cuts the plant's specific fuel oil consumption by half.

1 - <u>THE HUICOMA OIL MILL (Huilerie Cotonnière du Mali)</u>

. Of the latest design - the plant went on stream two and a half years ago - this installation processes cotton seeds from ginning plants located in the cotton growing regions of Mali, and especially from the neighbouring region of Koutiala.

Cotton production is supervised by CMDT (Compagnie Malienne de Développement des Textiles), a semi-public company, part of whose capital is held by CFDT (Compagnie Française de Développement des Textiles), which provides technical and financial support for the HUICOMA operation.

This new oil mill produces oil and animal feed from cotton seed, as well as a large quantity of wastes in the form of cotton hulls.

. The processing capacity is 300 t/day, yielding an average of :

150 t/day hulls,
60 t/day unrefined oil,
90 t/day oil cake.

. The last crushing season (1983/84) processed 45,000 tons of seeds to produce:

7,500 tons of neutralised oil,
15,000 tons of oil cake,
22,000 tons of hulls.

. The oil is first extracted mechanically (30 t/day) to a residual oil content of 15 %, and the rest of the oil is extracted by solvent (30 t/day) using hexane. The oil is then treated to eliminate acidity (addition of caustic soda) and then rinsed by hydrocyclone. The unrefined oil is consumed locally, or sold for refining in Europe or to SEPOM (Société d'Exploitation des Produits Oléagineux du Mali), because the plant does not perform any refining.

. The protein-rich extraction residue is exported (mainly to the EEC) in the form of cotton seed oil cake, or reduced to meal and mixed with cotton hulls to yield animal feed that is very popular with Malian breeders : 50 tons/day of hulls are used for this purpose. The distribution between these two product lines represents a compromise depending on governmental decisions. For the 1983/84 season, 11,500 tons of oil cake were exported and 30,000 tons of mixed feed sold locally.

. The export of oil cake is more profitable, although world prices are subject to wide swings. But the scale of the livestock population of Mali and the difficulties faced by the breeders to feed their livestock have led the Government to emphasise self- sufficiency : the capacity of the "animal feed" line will therefore be doubled. This means that ultimately, <u>100 t/day of hulls will serve to produced 240 t/day of animal feed</u> (mixture of hulls and cotton seed meal), currently sold on the domestic market at 1,250 MF (Mali francs) per bag of 50 kg.

2 - ENERGY SUPPLY

a- The Alternatives Selected

When the plant was in the design stage, it was already decided to use cotton seed hulls, a fuel with an out standing heating value of 3,900 kcal/kg, to cut the plant's fuel oil consumption. The 3 generating sets and the boiler installed are designed for dual fuel oil operation, and are all able to run to 85 % capacity on producer gas from the hulls.
The first offer picked by CFDT was to install gas generators burning compacted hulls, which were to be developed in France by the Duvant Company and its subsidiary Sermie.

Due to the cost of tests in France and the difficulties raised by this type of fuel, both in terms of compacting and gasification, the project was abandoned. Nevertheless, the possibility remained of using 50 T/day of hulls, corresponding to the process heat requirements of the plant, provided a suitable boiler could be developed.

b- Requirements

The maximum electricity demand set up in full season is :

- 800 kW for for crushing operations,
- 250 kW to produce oil cake and animal feed, delivered in the form of pellets,
- 120 kW for auxiliaries and accommodations.

Electricity will continue to be supplied by the three Duvant dual sets (3 x 640 kW) burning a mixture of diesel (70 %) and fuel oil (30 %). They are currently running at 60 % of capacity, and half of the electricity generated is sold to the neighbouring cotton ginning plant. Consumption of petroleum fuels to generate electricity is 10,000 l/day, including 5,000 l/day for the specific needs of the oil mill.

Process steam requirements amount to 3 T/h of steam at 15 bars and 200° C. During the first two years these requirements were supplied by the dual fuel oil boiler (burning fuel oil only) which consumed about 5,000 litres of fuel oil per day.
Thus the present hull fired boiler supplants the previous boiler. Its capacity is 2.5 T/h of hulls yielding up to 6 T/h of steam.

The plant's specific consumption before the installation of the boiler was 35 l of hydrocarbons/ton process (or about 10,000 litres daily for about 300 tons processed). This will cut by half by the commissioning of the boiler.

3 - THE HULL FIRED BOILER

The most difficult problems faced concerned hull storage, transport and feed:

- A hull silo was specially designed by CFDT
- The hulls are conveyed by screw conveyor
- Boiler feed is air-actuated (FAMA system).

The hulls are blown into the hearth on a board that can be guided for optimum distribution on the grate.

Combustion takes place in suspension by the injection of primary air below the grate. The entire hearth is kept in slight negative pressure by the draught fan. The boiler was built by Ateliers F Mock. The boiler heat efficiency is around 80%.

4 - ANTICIPATED COST BALANCE

The fuel oil economy realised is thus 5,000 l/day at the price of 300 MF/l, or about 1,500,000 MF/day. The number of days of annual operation varies widely according to year:

120 in 1982/83 for 36,000 tons processed (startup year),

150 in 1983/84 for 45,000 tons processed ("normal" year).

On the relatively pessimistic basis of 135 days/year, annual conservation would amount to about 200,000,000 MF. Total capital investment is about 300,000,000 MF, including 130,000,000 MF for the boiler itself. The gross payback time of capital expenditure is 1.5 years, making the project highly profitable.

AGENCE FRANCAISE POUR LA MAITRISE DE L'ENERGIE
27 RUE LOUIS VICAT 75015 PARIS - FRANCE
TEL. 33 1 765 20 00
TELEX 203 712 F

ENERGY PRODUCTION FROM BIOMASS

WOOD SCRAP FIRED BOILER FOR GREENHOUSE HEATING

PARTNERS IN THE OPERATION

User	: Etablissement Horticole Braun "La Brande" Route de Velles 36330 - Le Poinconnet - Tel (54) 34.55.87
Installer	: Entreprise Pastier 36 rue de Nexon 87000 Limoges - Tel (55) 30.56.74

Since 1981, the 10,000 m² of greenhouses of Etablissement Braun, near Châteauroux, have been heated using a new automatic boiler burning wood scrap. It helps replace 570 tons of fuel oil previously used by 8,000 m³ of wood scrap that the firm collects from the wood processing plants in the region. Investment outlay was 1,100,000 F (1981). Investment payback time is around 2 years.

THE COMPANY

Etablissement Braun was formed in 1968 and had 1,000 m² of glass hothouses. It was gradually expanded, and the program was completed in 1979 with a total area of about 10,000 m².

Its main products are the following :

- Nephrolepis (ferns) : 80,000 plants per year
- Ficus : 25,000 plants per year
- Aphelandra : 40,000 plants per year
- Others : 53,000 plants per year

THE PROBLEM

The production of potted plants is one of the most energy intensive of call cultivation under glass. The harmonious growth of the plants requires a perfectly controlled atmosphere that ensures that the light, moisture and heat requirements are satisfied.

Until 1981, heat was produced at Etablissement Braun by a boiler burning heavy fuel oil. Energy consumption was around 2500 MJ/m^2 (600 tOE ha).

The steadily growing prices of this form of energy made the operation less and less profitable. In early 1980 energy accounted for over 30 % of production cost.

To remain in activity, it was necessary to find a cheaper alternative.

THE ANSWER

A large forest area exists south of Châteauroux including the state forest of Châteauroux. Many sawmills and joiners' shops are established in this area, producing large quantities of combustible scrap (bark, sawdust, miscellaneous wood wastes) that are difficult and sometimes costly to dispose of (subject to authorized dumping).

Faced with the availability of these wood wastes, Etablissement Horticole Braun decided to install a sawdust and wood scrap fired boiler. It features a scrap grinding system and automatic feed. It is equipped with partial fume recycling, that helps to predry the wastes before feeding them to the boiler.

This new installation required the construction of a scrap storage building to guarantee self-contained operation of about 11 weeks at full capacity.

The establishment now has four 30 m^3 skips which it makes available to the wood scrap suppliers. The loaded skips are picked up and conveyed to the greenhouse. Since the scrap supplies are located within a radius of 25 km, transport costs are relatively low.

ENERGY BALANCE

The old heavy fuel oil fired boilerhouse was dismantled and apart from a few liters of home heating oil required to start up the sawdust boiler in case of prolonged shutdown, all requirements are met by wood scrap.

This means that 570 tons of heavy fuel oil have been replaced by about 8,000 m^3 of wood scrap (sawdust, chips, etc.) costing about 12 F per m^3 (price of scrap + transport).

PRIMARY ENERGY REPLACED : 560 tOE/year

The fuel consumption of the truck performing the shuttle between Etablissement Braun and the wood scrap suppliers is not taken into account, because it is much lower than the consumtion of the large tankers that transported heavy fuel oil from the refinery to the undertaking.

FINANCIAL BALANCE

The total cost of the operation amounted to 1,100,000 francs exclusive of tax (1980/81).

This is broken down as follows :

Boilerhouse 10,500 MJ/h	: 638,000 F ex tax
Scrap storage	: 102,000 F ex tax
Scrap transport (skips)	: 116,500 F ex tax
Civil works	: 243,500 F ex tax

The new fuel costs 12 F/m^3

	1981	1982 (Forecasts)
Energy conservation 570 t of FO2	650,000 F	710,000 F
Cost of fuel availability (wood scrap) 8.000 m^3/year	- 96,000 F	- 96,000 F
ANNUAL OPERATING GAIN	554,000 F	614,000 F
Cumulative		1,168,000 F

The gross payback period of the investment is two years.

SEIZING THE OPPORTUNITY (Interview of M. Braun, Manager)

. Why use wood ?

- In a radius of 25 km, many sawmills produce wood scrap. The total potential is estimated at 15,000 m^3 of sawdust and chips and 25,000 m^3 of bark, which the sawmills have tremendous problems getting rid of. We had to seize this opportunity to dispose of heavy fuel oil and its steadily growing price. I did this in 1980 by deciding to install the new boilerhouse.

. What kind of development problems did you encounter ?

- At the beginning, we planned to use a fuel consisting of a mixture of 50 % bark and 50 % sawdust and chips. Bark had to be abandonned although it was completely free. This is because it introduces soil into the firebox, raising serious combustion problems. Moreover, the bark had to be ground, entailling additional operating costs. Although the 1980-81 season was an uncertain year due to the problems we faced, 1981-82 was perfectly successful, and we expect this to continue.

. Other projects ?

- Insofar as the new boiler supplies all the needs of my operation, my concern is now to amortize the installation more rapidly. It was calculated to meet all requirements even in the coldest weather, so that it practically never operates at full capacity. We are currently examining a plan to supply energy to the neighbouring operation in the off-season period.

AN OTHER EXAMPLE :
STRAW FIRED BOILER FOR GREENHOUSE HEATING

M. Daniel Durand, an horticulturalist at Baconnes in the Marne, replaced his home heating oil fired boiler in 1980 by a straw burning boiler to heat his 916 m^2 of greenhouse area.

This boiler, with a capacity of 1700 MJ/hour, is equipped with an automatic feed system (vibrating belt, Archimedes screw). The boiler is fed with round bales at a rate varying with climatic conditions : 2 per day in normal periods to 7 per day in very cold weather.

M. Durand, who is also a farmer, has no lack of straw, and only has to pay for the gathering and storage of this straw.

In this way, 63 m^3 of home heating oil were replaced by 150 tons of straw.

<u>FINANCIAL BALANCE</u> :

Investment outlay : 164,500 F (1981)

	1982
Fuel conservation 65,000 liters of DFO	140,000 F
Cost of straw (200 F/ton)	- 30,000 F
Operating gain in 1982	110.000 F
Gross payback time : 1 and one-half years	

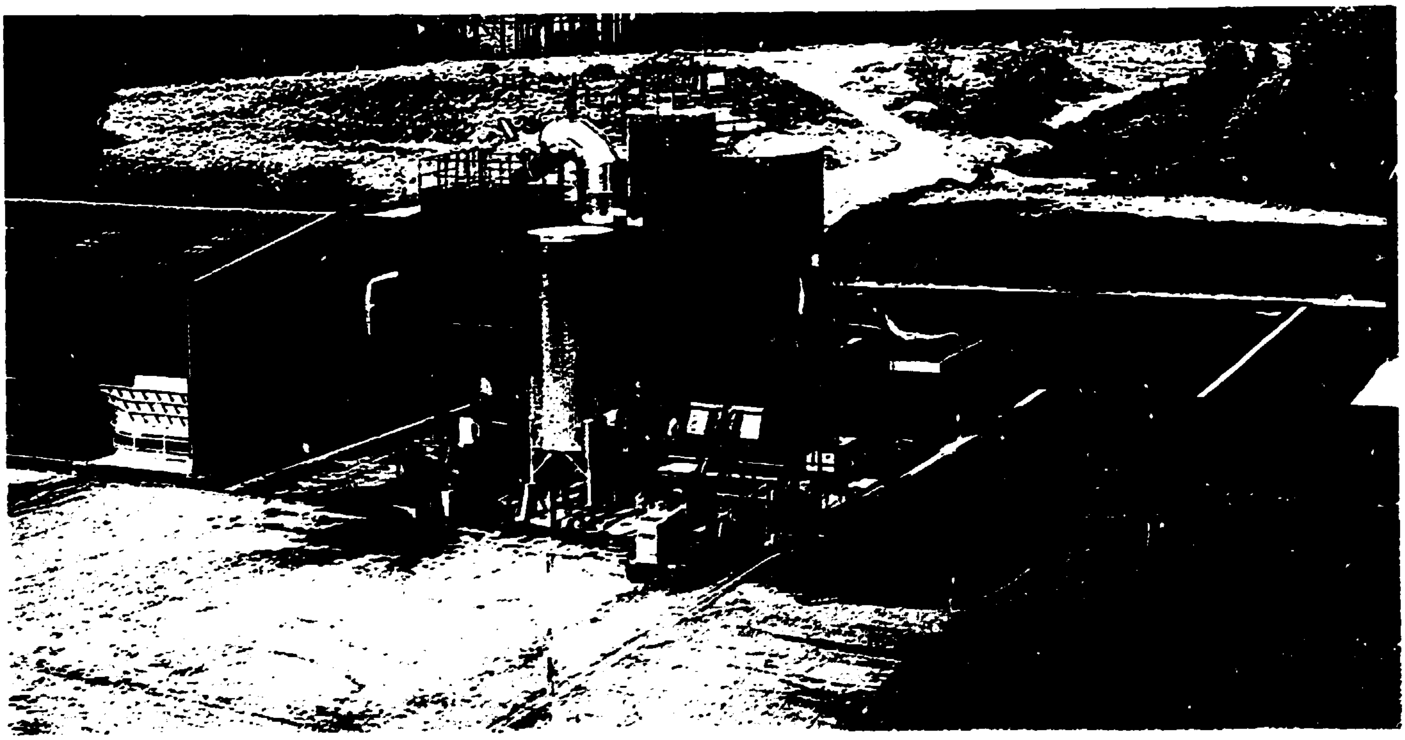
AFME: FRENCH AGENCY FOR ENERGY MANAGEMENT

[illegible] OPERATION

ENERGY PRODUCTION FROM BIOMASS

FRANCE:

CONTINUOUS METHANE PRODUCTION FROM HOUSEHOLD WASTE



User:

Syndicat Mixte d'Aménagement du Voironnais
Treatment and Recovery Center (Household Waste)
La Buisse
38950 LA BUISSE
France

Design:

SCOP CARENE
26, rue H. Duhamel
38100 GRENOBLE
France

Construction:

S.A. VALORGA
Z.I. de la Lauze
34430 ST JEAN DE VEDAS
France

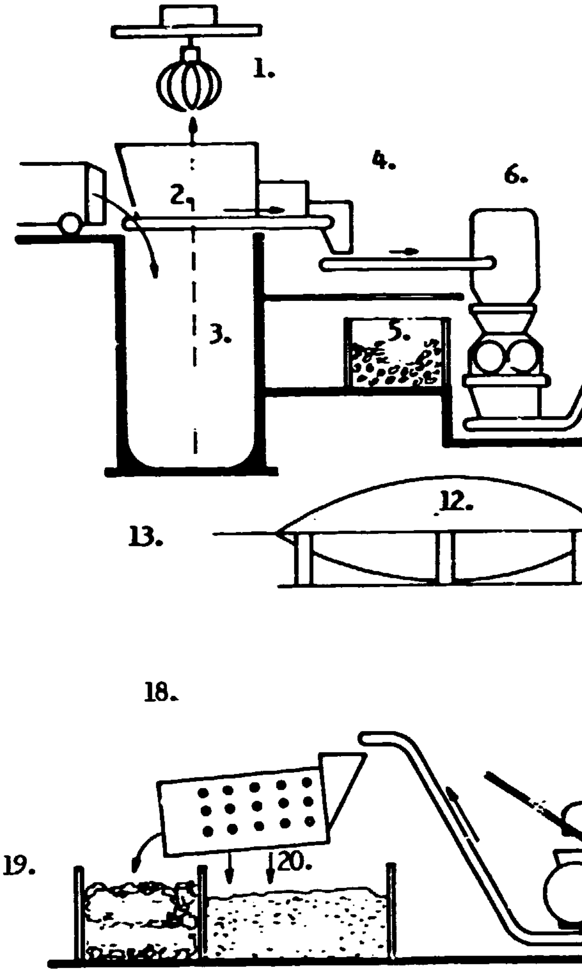
Urban household waste, traditionally considered undesirable, has always been discarded. The primary concern of municipal authorities has been to dispose of waste as cleanly and inexpensively as possible. Recently, however, large towns and cities have been examining ways to reduce disposal costs by making more rational use of waste, either in **agriculture** or in **energy production**.

In practice, the treatment techniques adopted have been those with the best economic performance. An essential criterion is the size of the town or city concerned:

- In small towns (under 10,000 inhabitants, or 3,000 tonnes of household waste per year), controlled dumping is still the least expensive solution.
- In large cities, economies of scale make it profitable to incinerate waste and recover energy in the form of heat. This method is especially viable in cities where urban heating programs exist. Otherwise, the threshold of profitability is around 300,000 inhabitants (100,000 tonnes per year).
- In medium-sized towns, incineration is not profitable, dumping poses environmental problems, and aerobic composting of household waste presents marketing difficulties due to inadequate separation of plastics from the compost. Here, the best solution appears to be methanization of waste whereby it is possible not only to recover energy from fermentable matter (biogas) and combustible matter (heat from incineration), but also to use digested organic matter in farming.

the challenge

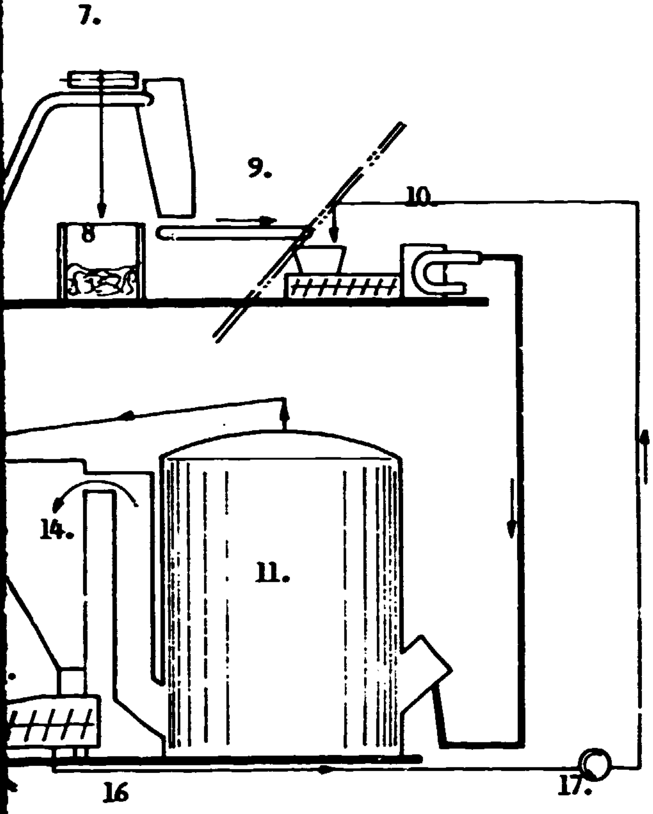
The town of Voiron (Isère department, France), is a representative example of a medium-sized town. Its 25,000 inhabitants create 16,000 tonnes of household waste every year. The town has no communal heating facilities and is situated in a mountainous area: heat recovery from incineration would thus be pointless, and the few available dumps rapidly reach saturation. Methanization of this waste is thus an ideal solution. The design of a methane production plant does, however, pose a large number of problems:

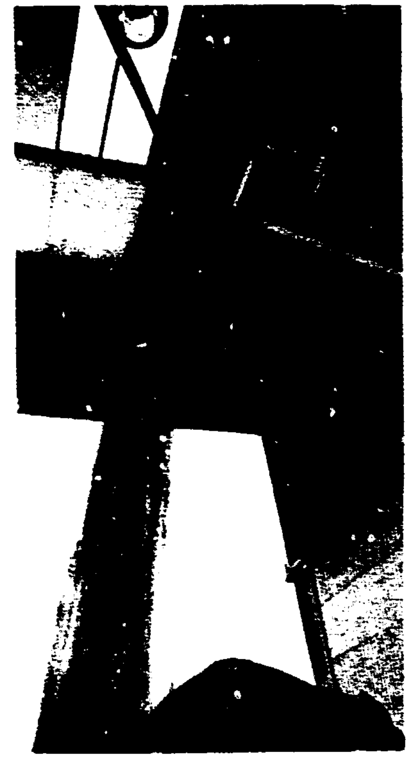


1. Mechanical grab
2. Feed hopper
3. Collection pit
4. Sorting line
5. Coarse rejects
6. Crusher
7. Magnetic separator

8. Scrap
9. Weigh
10. Mixer
11. Diges
12. Gas h
13. Boile

- It is both difficult and costly to sort waste before processing. The plant must thus be capable of processing **raw waste.**
- Economic factors make it necessary to minimize tank size and to maximize biogas production by reducing internal consumption of energy that is used as process heat. These factors point to **continuous fermentation** of waste in 'dry process', with waste being diluted only slightly and retention times being kept as short as possible.
- In order to be able to utilize the digested product in agricultural applications, a **finishing line** is required to separate and condition the organic matter contained in the digested waste. With these objectives in mind, the Syndicat Mixte d'Aménagement du Voironais (regional planning board) commissioned the design and construction of the world's first continuous-process, high-concentration, industrial digester. The unit was designed by Carène





DRY DIGESTED SUBSTRATE
LEAVING REFINING LINE

al
unit
p
r
ed

14. Settling tank
15. Screw-type press
16. Breaker
17. Liquor pump
18. Trommel screen
19. Plastics
20. Digested substrate

the response

Every year, the La Buisse plant, near Voiron, processes 16,000 tonnes of household waste — 8,000 tonnes for composting and 8,000 tonnes (22 T/day) for methane production. The process is in three stages:

- preliminary processing in a **crusher** to reduce fragment size to 50 mm, on a simple **sorting line** (scrap metal removal by magnetic band, followed by screening), and in a **mixer** to increase moisture content of the waste by recycling digestion liquor. The mixing phase reduces dry matter content from 65 to 35%.
- fermentation (digester volume: 500 m^3) in a cylindrical tank within which the substances make one complete rotation during their two-week retention time. The novel feature of the Valorga process is the pneumatic transportation system which maintains the substances in constant motion while they are stirred continuously by the biogas itself. Biogas productivity is particularly high, reaching an average of 5.5 m^3 per cubic meter of tank capacity per day, or 125 m^3 of gas per cubic meter of raw waste treated.
- refining in a press for extracting liquid from the digested substrate (30% dry matter) to leave an organic mass with 70% dry matter. The liquid is recycled to the preliminary process line. The dry organic product is sent to a **breaker** and **trommel screen,** where inert matter is removed. The remaining high-energy waste is then ready to be sold. The methanization process gives the product physical properties whereby it is much easier to remove inert matter than it is from raw waste.

energy breakdown

For one tonne of household waste processed [1]:

Coarse rejects from preliminary line	50 kg
Biogas, CH_4 content: 65% (5.6 th/m³)	125 m³
Inert rejects from refining line (3 th/m³)	250 kg
Refined digested substrate (70% dry matter content)	410 kg

Thus, 70% of the 300 kg of rejects can be considered usable through incineration, since their heat value (3 th/kg) is almost twice as high as that of raw waste (1.6 th/kg). The quantity of energy produced depends on whether heat value (HV) is considered or whether actual efficiency (AE) as a function of energy availability (EA) is taken into account.

The breakdown per tonne of household waste energy is as follows [1]:

	HV (th)	AE (%)	EA (th)
Incineration	1,600	70	1,120
Methanization			
Biogas 125 m³	695	100	695
Rejects 210 kg	630	70	440
TOTAL RECOVERED	1,325	86	1,136
TOTAL (POTENTIAL)	1,600	71	1,136

(1) 1 th=1.16 kWh=10^{-4} TOE =7.33 10^{-4} BOE=4 10^{-3} BTU.
(2) 1 US \$ = 9 FF 1984.

cost breakdown

At present, the Voiron plant processes 8,000 tonnes of raw waste per year to produce 4,000,000 m³ of biogas with 65% methane content (5.6 x 10^6 th, or 556 TOE [1]), 1,680 tonnes of combustible rejects (3.5 x 10^6 th, or 353 TOE available) and 3,280 tonnes of digested substrate with 70% dry matter content.

The situation in Voiron is unfavorable because:

- Heat from the combustion of rejects is not recovered.
- The biogas is not used in 'high-energy' applications (electricity or carburation). The French Gas Board purchases 2,000 m³ per day (73% of output) at FF 0.12 per kWh (FF 1,390 per TOE).
- The refined, digested substrate is sold at FF 80 per tonne. This price corresponds to 'bottom-of-the-range' soil conditioners, while the substrate in fact falls into the organic-mineral fertilizer category.

Investment costs are broken down as follows:

Primary process line	FF 1,950,000
Methane production	FF 3,550,000
Refining line	FF 1,500,000
Civil engineering and buildings	FF 2,200,000
Distribution to Gas Board	FF 500,000
TOTAL	FF 9,700,000

Estimated annual costs with a rate of discount of 10%, amortization over 15 years, and taking into account a 30% investment grant, are broken down as follows [2]:

	expenditure	revenue
Amortization	FF 892,206	
Maintenance, management, and energy other than biogas	FF 950,000	
Digested substrate sales		FF 262,400
Gas sales		FF 564,985
BALANCE	FF 1,014,820	

This deficit can be expressed as processing costs of approximately FF 125 per tonne of raw household waste.

Consultative Committee
UNIDO
November 1984 - Lille (France)
Part 3

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