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

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ENERGY IN THE MOROCCAN SUGAR SECTOR*

Prepared by

M. Gamgami**

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** Sucrerie Raffinerie de l'Oriental "Sucrafor", Rabat, Morocco.

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ENERGY SAVING IN MOROCCO

The implementation of an energy-saving policy in the various sectors of the Moroccan economy is one of the objectives set in the national energy plan with a view to lightening the impact of the energy bill, which rose from 256 million dirhams (DH) in 1972 to 7,890 million DH in 1983, representing 30 per cent of the value of the country's imports and 50 per cent of the value of its exports.

Thanks to the energy-saving measures taken and to the movement of the cost of petroleum, this bill was, in 1988, brought down to 5,156 million DH, or 13 per cent of the value of the country's imports and 17 per cent of the value of its exports. The quantity of energy products imported rose from 4,976,031 tons in 1984 to 6,263,081 tons in 1988, an increase of 20 per cent, while the energy bill was reduced from 8,992 million DH in 1984 to 5,156 million DH in 1988, a fall of 42.5 per cent over four years.

Energy-saving operations made it possible to save 3,000,000 tons of oil equivalent (toe) from 1979 to 1983, a foreign-currency saving of 5 milliard DH.

Energy savings achieved between 1984 and 1988, simply by converting to coal plant which had been operating on fuel oil, amounted to 921,000 toe, representing a foreign-currency saving of 1,072 milliard DH.

These savings were achieved by means of measures recommended by the various bodies concerned, i.e.:

- The organization of a national energy-saving campaign in 1979 to make the citizens and the various sectors aware of the need to control waste of energy;

- Identification of practical measures which could lighten energy consumption without reducing or causing detriment to economic activity;

- Granting of advantages to businesses which make energy savings by according them (Industrial Investment Code promulgated on 17 January 1983) exemption from customs duties and taxes on products, together with a development subsidy funded by the State;

- The share of energy consumption in the processing industries sector in Morocco, measured by its share in the country's total consumption, amounts to something like 45 per cent in respect of fuel oil and 43 per cent in respect of electricity.

The sectoral distribution of industrial consumption is as follows:

- The building materials sector (including cement works) accounts for nearly half of the fuel oil consumption of industry as a whole, and for nearly one third of the consumption of electricity;

- The food industries come second, more particularly the sugar factories, with 20 per cent of fuel oil consumption and 9 per cent of electricity.

- Other sectors worth mentioning are the textile sector, paper and chemical industries.

In order to save energy, the Ministry of Trade and Industry has drawn up a programme of work, the main measures in which are directed, as a matter of priority, to these sectors. The broad lines of this programme are as follows:

- Setting up of a system of statistical information about energy consumption for the purpose of collecting full data;
- Scheduling of sectoral studies designed, firstly, to analyse energy consumption in detail and, secondly, to suggest possible ways of saving energy;
- Evaluation of the necessary investments and consideration of their profitability in relation to the savings achieved;
- Launching of a campaign to make managers of businesses, their supervisory staff and their technicians aware of the problems, with the object of prompting and promoting energy conservation in industry.

In this connection, all sectors of industry have embarked on energy-saving operations. The principal achievements are:

CEMENT-MANUFACTURING SECTOR:

Conversion from wet process to dry process and conversion from fuel oil to coal.

CHEMICAL INDUSTRIES SECTOR AND OTHERS:

- Use of biomass (wood waste) in place of fuel oil;
- Use of oil cake (olive) as fuel;
- Conversion of furnaces to coal.

SUGAR SECTOR:

Energy-saving operations in the sugar sector, which are discussed in this paper, with particular reference to those carried out by the Sucrerie Raffinerie de l'Oriental "SUCRAFOR", have dealt mainly with:

- The use of coal and bagasse;
- Improvement of the rate of liquid (extraction) from beet pulp;
- Rational use of energy throughout the manufacturing process;
- Modification of certain workstations in the manufacturing process;
- Recovery of boiler gases;
- Use of compressed air instead of steam for cleaning the root choppers;
- Automation of the manufacturing process and computer control;
- Establishment of the energy service.

THE SUGAR INDUSTRY IN MOROCCO

I. PLACE OF THE SUGAR INDUSTRY IN THE NATIONAL ECONOMY

The sugar industry represents one of independent Morocco's principal achievements, providing a striking illustration of the State's determination to develop the country's economy.

It is, moreover, of particular interest since this sector in itself satisfies several of the criteria generally adopted for the setting up of new industries: good use of local raw material, strengthening of the industrial fabric, substitution of national products for imports, and supplying of the local market.

The first beet-sugar mill came into operation in 1963 and the first cane-sugar mill in 1974.

This new activity based on agricultural production in fact supplemented another much older form of industrial activity: the refining of imported crude sugar.

Sugar-beet and sugar-cane now form part of our agricultural landscape. Thirteen sugar mills are at present in operation in the main producing regions.

This industrial potential is run and managed by an entirely Moroccan staff, so that the country has complete control of the industrial set-up and has acquired a considerable knowledge of sugar technology.

In order to consolidate and improve its gains, the sugar sector has, since 1979, had its own specialized Institute for carrying out studies, research and training activities. Its work has already made the industry independent with regard to training. A big research programme has been drawn up for the coming years, concentrating essentially on the adaptation of technology to the specific conditions of the country.

The sector's latest achievement was the establishment in 1981 of a specialized project-engineering company which will enable us in future, when new units are being set up, to decide for ourselves on the types of plant best suited to our needs, drawing increasingly on local industry for building them.

The sugar industry, which already holds a prominent place in the economy, will thus continue gathering strength through the establishment of new units until we are self-sufficient in sugar, and training, research and local industry are all developed to the requisite level of quality.

The sector's importance can also be appreciated in regard to investments, the direct and indirect employment generated by it, the improvement of farmers' incomes and the promotion of animal husbandry, development of which has been stimulated by the production of beet pulp and molasses.

Sugar manufacturing has had further effects on industry through the etablishment of a sector based on the processing of the molasses which is a by-product of the sugar mills. The industrial use of the molasses began in 1977, when units were set up for the production of compound animal-feeding stuffs, or baker's yeast, or alcohol. The sugar sector also exports surplus molasses, thus bringing in fairly substantial amounts of foreign currency.

II. DESCRIPTION OF THE MOROCCAN SUGAR INDUSTRY

The sugar industry comprises:

- Sugar mills producing raw sugar;
- Sugar refineries producing white sugar;
- Refineries converting the raw sugar into white sugar.

The essential features of the sugar works at present in operation are summed up in the table below:

Table 1

SUGAR WORKS IN OPERATION

Region	Unit	Starting year	Raw material	Daily capacity	Annual capacity	Nature of the product
1. GHARB	SUNAB	1963	Sugar-beet	3 000	240 000	White sugar
	SUNAG I	1968	Sugar-beet	4 000	300 000	Raw sugar
	SUNAG II	1968	Sugar-beet	4 000	300 000	Raw sugar
	SUNACAS	1975	Cane	2 500	200 000	Raw sugar
	SURAC	1981	Cane	3 500	420 000	White sugar
2. LOUKKOS	SUNABEL	1978	Sugar-beet	4 000	300 000	White sugar
	SUCRAL	1984	Cane	3 500	400 000	White sugar
3. TADLA	SUTA	1966	Sugar-beet	3 000	240 000	White sugar
	SUBM	1969	Sugar-beet	5 000	400 000	Raw sugar
	SUNAT	1971	Sugar-beet	6 000	480 000	Raw sugar
4. DOUKALA	DOUKALAS	1970	Sugar-beet	4 000	400 000	Raw sugar
	ZEMAMRA	1982	Sugar-beet	4 000	400 000	White sugar
5. MOULOUYA	SUCRAFOR	1972	Sugar-beet	3 000	240 000	White sugar
			Cane	1 000	60 000	

These units are capable of processing 40,000 tons of sugar-beet daily and 10,500 tons of cane daily, or 3,300,000 tons of beet and 1,160,000 tons of cane per manufacturing season, which is equivalent to 530,000 tons of sugar annually, comprising:

- 200,000 tons of white granulated sugar
- 340,000 tons of raw sugar

The existing refinery units are the following:

Units	Starting year	Capacity	Products
1. COSUMAR	1929	340 000 60 000 30 000	Loaf sugar Lumps Granulated
2. SUTA	1966	60 000 20 000	Loaf sugar Granulated
3. CAAMSA	1950	20 000	Granulated

Taken as a whole, the established units have the following production capacity:

- White granulated sugar: 270,000 tons
- Loaf sugar: 400,000 tons
- Lump sugar: 60,000 tons

Total: 730,000 tons

III. PRODUCTION-IMPORTS BALANCE

Morocco, which imported all the sugar it consumed in 1961, at present meets all its requirements from its own sugar mills and refineries and provides nearly 50 per cent of the crude sugar it needs to supply the COSUMAR, SUTA and CAAMSA refineries for the production of sugar in loaf, lump and tablet form.

Morocco imports one third of the crude sugar its consumes to meet the needs of its refineries.

III.1 DEVELOPMENT OF NATIONAL PRODUCTION AND COVERING OF REQUIREMENTS

Since 1960, production and consumption have developed as shown in table 2.

Table 2

DEVELOPMENT OF NATIONAL CONSUMPTION AND COVERING OF REQUIREMENTS

Year	Production	Consumption	Covering of requirements	Deficit
1960	-	358 856	0	358 856
1961	-	363 412	0	363 412
1962	-	371 547	0	371 457
1963	5 400	378 844	1.4	373 444
1964	19 400	348 752	5.5	329 352
1965	21 700	342 131	6.2	320 431
1966	47 500	346 661	13.7	229 161
1967	38 100	348 807	10.9	310 707
1968	99 000	355 041	27.8	256 041
1969	108 000	369 879	29.2	261 879
1970	150 000	387 928	38.6	237 928
1971	222 900	442 628	50.2	220 228
1972	243 600	469 297	51.9	225 697
1973	230 100	473 448	48.6	243 348
1974	263 1[illegible]	489 248	53.7	226 148
1975	254 500	501 049	50.8	246 549
1976	311 500	529 000	58.8	217 500
1977	225 700	592 400	38.1	366 700
1978	376 000	591 900	63.5	215 900
1979	333 900	499 700	55.9	259 800
1980	331 030	611 900	54.0	280 800
1981	339 296	587 300	57.7	248 004
1982	374 700	600 330	62.4	225 630
1983	430 287	646 866	66.5	216 579
1984	405 868	625 674	64.5	219 806
1985	365 251	650 200	56.2	284 949
1986	401 026	698 226	57.4	297 200
1987	414 527	686 760	60.30	272 233
1988	496 182	725 767	68.3	229 585

USE OF ENERGY IN SUGAR WORKS

Sugar mills and refineries use energy mainly in the process of sugar production and, in the case of sugar-beet, for the drying-out of beet pulp for the manufacture of animal feeding stuffs.

In beet-sugar mills, the main energy-consuming items are:

- The boiling operation
- The pulp-drying operation
- The lime kiln

The cane-sugar mills are self-sufficient in thermal energy, as the bagasse remaining after extraction of the sugar from the cane is used for fuel in the boiler rooms. And there is no need for the drying and quick-lime production operations.

In general, sugar works themselves use their sources of energy rationally:

- Production of steam in the boilers (coal, fuel-oil, bagasse);
- Steam expansion to produce the electric energy which supplies the motive power for the sugar mill and drying plant;
- Use of this expanded steam in the multiple-effect evaporator, supplying the various calorie consumers at gradually decreasing energy levels;
- Lastly, a substantial part of the degraded energy is to be found in vacuum-pan vapours and hot water;
- The final degradation is done by condensers.

All in all, this use of energy in several successive stages is remarkably efficient.

In the pulp-drying operation, the degradation of energy takes place in a single stage and almost the whole of the energy of the fuel is contained in the fumes of the drying plant.

In the lime kiln coke is used for heating the limestone and the gases are returned to process.

Research is at present being conducted with a view to reducing energy consumption both in the manufacturing process and in the pulp-drying process.

ENERGY-SAVING MEASURES IN THE SUGAR SECTOR

The very sharp increase in the cost of energy since 1973 has made it necessary for the sugar sector to rethink its energy-saving policy and to take steps to reduce consumption, devoting a substantial share of investment to these purposes.

There are many opportunities for calorie saving in most sugar works.

In sugar manufacture as in any other system, however, overall optimization is generally not to be achieved by merely combining separate optimizations.

The expenditure necessary to bring about these savings must take account of the special features of each possible saving involved, with the particular constraints due to its location. A very full economic optimization study must be made of each specific case.

A. Measures and improvements connected with the motive power

1. Production of the motive power

As an indication, a sugar-beet factory producing white granulated sugar requires steam equivalent to 42 per cent of the sugar-beet used:

- 30 per cent for the production of electric energy;
- The remainder (12 per cent) is expanded and returned to process with the exhaust steam.

The sugar works should seek to:

1. Reduce its steam consumption (12 per cent) so as to avoid injecting high pressure exhaust steam.
2. Increase its production of electricity with the object of feeding it into the grid.

2. Fuel oil substitutes

2.1 Use of coal

Certain sugar factories (SUNAB and SUNAG) are at present equipped to burn anthracite, thus having the advantage of using a local fuel and so saving foreign currency. Apart from the problems of the availability of anthracite in sufficient quantities, however, it is proving to be difficult in practice to extend this measure to other sugar works, as the boilers and drying plant need changing if this is to be done, which involves very substantial investment.

2.2 Use of bagasse

Extension of the production and use of sugar-cane will give rise to steadily increasing production of bagasse.

The first use to which the bagasse so produced can be put is to meet the needs of the cane-sugar works, and a substantial surplus remains over.

Table:

Year	Cane (t)	Bagasse produced (t)	Surplus	Fuel equivalent of surplus
1984	891 000	295 000	89 000	17 000
1985	1 127 000	372 000	110 000	21 000
1990	1 924 000	635 000	190 000	37 000
2000	4 000 000	1 320 000	400 000	77 000

The amount of surplus bagasse becoming available merits careful consideration as a potential source of energy. It does, however, give rise to problems firstly of handling and secondly of conservation (drying, baling, conversion into pellets).

The surplus bagasse can be used as:

(a) Substitute for fuel oil for the starting-up tests of the cane-sugar mill itself;

(b) Fuel for the production of electric energy between manufacturing seasons; the energy so produced can, if appropriate, be fed into the grid;

(c) If the sugar factory processes crude sugar between manufacturing seasons, the excess bagasse allows it to avoid consuming fuel oil;

(d) Use of bagasse in the coal-fired boilers of neighbouring beet-sugar works, subject to the necessary adaptation.

The measures so far taken have been to solve the problems of supplying the cane-sugar works. Once this problem has been solved and there is in fact an excess supply of bagasse available, its processing and packaging will be undertaken.

The foregoing list is not exhaustive, as bagasse can be used as a fuel in other forms as well.

2.3 Feeding of the sugar factories' surplus electric power into the grid

The quantities of steam produced by the sugar works for their manufacturing requirements may incidentally supply surplus electric power which can be passed over to the National Energy Office (ONE) whose medium-voltage lines are connected to the sugar works.

This surplus of electric power varies according to the capacity installed in each sugar works, ranging from 20 to 30 per cent. A sugar mill processing 4,000 tons of sugar-beet a day, for example, may have a surplus of 40 MWh per day, or the equivalent of about 40,000 tons of fuel oil for all the sugar works together during the manufacturing season.

In view of the large number of sugar works, the possibility of making this surplus electric power available to ONE can represent a substantial fuel saving for the country.

B. Measures and improvements connected with the manufacturing process

The processing of sugar-beet and sugar-cane consists essentially in applying energy to the evaporation of the water contained in the juice until the sugar crystallizes out. In order to get rid of impurities, the raw materials, sugar-beet, fuel, limestone, combustion air, added water and intermediate manufacturing products have to be brought up to the temperatures at which the various reactions involved in the sugar-manufacturing process occur.

If substantial energy savings are to be made, attention has to be paid to the vapours given off into the surrounding air, in particular by:

- The pulp-drying plant;
- The cooling tower;
- Energy losses in the manufacturing cycle.

1. The cooling tower

The calories discharged at this stage come from the vapours to be condensed from the evaporator and from the vacuum pans.

Consideration must therefore be given to the distribution of vapours at the evaporation and pan-boiling stages from the point of view of calorific balance and exchange efficiency.

After expansion in the impulse turbines, the steam drawn off is degraded by successive condensations in the tube stacks of the evaporators, boiling apparatus and pre-heating devices.

This degradation should be taken as far as possible, this result being achieved by:

- Correct operation of the apparatus: elimination of uncondensable gases;

- Continuous extraction of condensed water;

- Satisfactory condition of the exchange surfaces: deposits and furring increase the falls in the temperature of vapours produced in the heat drop.

2. Energy losses in the manufacturing cycle

Some of the calories circulating in the factory leave it by radiation and convection or by auto-evaporation, possibly representing a substantial direct loss to the atmosphere.

The sensible heat of the gases produced in the lime kiln runs to waste through the walls of the gas-piping system and in the wash-water. Theoretically, it should be possible to reduce fuel consumption by using some of the calories of the kiln gases to pre-heat the combustion air.

The drawing off of boiler water to reduce the salt concentration represents an enormous loss of calories and ought to receive attention in any energy-saving measures.

Losses also occur through the classic failure to provide proper heat-insulation for the pipe systems, receptacles and apparatus containing steam, hot water and hot intermediate products. Special care should be devoted to this.

3. Savings by way of improved operation of the manufacturing process

Measures in this respect are concerned essentially with the calorific balance of evaporation and the investigation of ways of reducing the water to be evaporated.

Individual optimization of evaporation is achieved if the last body draws no heating steam from the preceding one, giving rise only to auto-evaporation by expansion of the syrup, and if the concentration of that syrup has the desired dry-matter value.

Reduction of the amount of water to be evaporated can be brought about by reduction of the scum-washing water in the diffusion draw-off. The saving is more noticeable where the boiling apparatus is concerned if the volume of water used for washing or melting down the sugar is reduced.

4. Other possible measures connected with the process

4.1 Purification of the juice

This operation, for which resins are used, rids the juice of the lime salts which are responsible for the furring of the exchange systems.

De-liming apparatus, however, generates both a loss of calories due to the effluent, and thermal and organic pollution.

4.2 Automation of the process

Automation improves the operation of the plant as a whole and consequently allows of optimizing energy consumption.

In this connection, the use of microprocessors is becoming more and more common.

PULP-DRYING PLANT IN THE SUGAR WORKS

The energy used for the drying of pulp represents approximately 50 per cent of that consumed by the sugar mill itself.

Since the volume of wet pulp to be stored makes drying absolutely necessary, consideration may be given to several forms of energy saving in the pulp drying process.

1. Drying of part of the pulp produced

It is conceiveable that approximately 30 per cent of the wet pulp produced can be disposed of, without treatment, in the area with which the sugar works is concerned. Experience has shown such an operation to be possible and enables a direct saving of 30 per cent to be made on the consumption of the drying plant.

2. Reduction of the amount of water to be evaporated

The object is to ensure, by mechanical means, that the wet pulp contains as high a rate of dry matter as possible. This is done by the use of presses. Technological advances in this area make it possible to achieve dry-matter rates of about 28 per cent. In Morocco at the present time the rate is 22 per cent.

Improved pressing arrangements, with a reduction of the amount of water to be evaporated, offer the prospect of an energy gain of about 10 per cent on the consumption of the drying plant.

3. Pulp drying with recycling of the vapours released

By recycling some of the vapours released and directing them back to the heating plant of the pulp dryer, the secondary air supply, assumed to be at 20°C, can be replaced by gases at 120°C, thus enabling the fuel consumed by the heating plant to be substantially reduced.

The heat balance of this operation shows a saving of approximately 8 per cent.

4. Pulp drying by hot-water recovery at the sugar works

Surplus hot water (at 90°C) may be used in simple heat-exchangers to pre-heat damp air to a temperature of 65°-68°C. This hot air can be used for the "low temperature" drying of the pulp.

This method of drying avoids the consumption of fuel oil and makes a very appreciable saving possible.

The heat balance shows a consumption of 173 thermal units per ton of pellets as against 2,300 thermal units in a dryer of the classic type.

5. Use of solar energy

Plants for the drying of fodder by solar energy are in operation on an industrial scale in some European countries.

In Morocco, where the sugar-beet season coincides with the sunniest months, this process may have good chances of success.

ENERGY CONSUMPTION IN THE SUGAR SECTOR

Energy consumption in the sugar sector in Morocco amounted to 182,240 toe in 1988 for a production of 741,343 tons of sugar and 169,996 tons of dry pulp.

This consumption can be broken down, by type of processing plant, as follows:

Beet-sugar mills	126 416 toe
Cane-sugar mills	2 544 toe
Refineries	53 280 toe

The types of fuels used are fuel oil, anthracite, bituminous coal and coke. The bagasse used by the cane mills is not included in the above consumption.

The distribution of the various fuels employed is as follows:

Sugar mills:

Fuel oil 2	125 174 tons
Anthracite	24 288 tons
Bituminous coal	26 721 tons
Coke	12 549 tons

Refineries:

Fuel oil 2	55 500 tons

The sugar sector's energy consumption, which can be measured by its share of national consumption as a whole, in 1988 represented 10 per cent for fuel oil, 3.5 per cent for anthracite, and 4 per cent for bituminous coal and coke.

The development of energy consumption in the sugar works is shown in the tables appended.

PROBABLE DEVELOPMENT OF ENERGY CONSUMPTION IN THE SUGAR SECTOR

The goal of self-sufficiency for the purposes of sugar production involves the prospect of substantial energy consumption.

The following table shows the probable development of energy consumption from 1983 to the year 2000.

The increase in consumption may, by 1990, be as much as 17 per cent and, by 2000, approximately 40 per cent.

Table 3

PROBABLE DEVELOPMENT OF ENERGY CONSUMPTION

	1983		1984		1985		1990		2000	
	TP	Fuel oil	TP	Fuel oil	TP	Fuel oil	TP	Fuel oil	TP	Fuel oil
Sugar-beet	2 754 000	143 000	2 791 000	145 000	2 898 000	150 000	3 326 000	173 000	4 200 000	218 000
Sugar-cane	820 000	4 000	891 000	5 000	1 127 000	5 000	1 934 000	5 000	4 000 000	5 000
Refining		57 000		57 000		57 000		60 000		60 000
Total fuel oil	204 000		207 000		212 000		238 000		283 000	

TP = Tonnage processed

Table 4

PRODUCTION PROSPECTS FOR SUGAR MANUFACTURING

Production prospects for sugar-beet (in tons):

Areas	1983	1984	1985	1990	Horizon 2000
Gharb	634 000	602 000	609 000	706 000	800 000
Loukos	185 000	159 000	271 000	300 000	300 000
Tadla	1 085 000	1 060 000	1 078 000	1 200 000	1 500 000
Doukkala	650 000	700 000	700 000	800 000	1 000 000
Moulouya	160 000	180 000	200 000	260 000	500 000
Haouz	40 000	40 000	40 000	60 000	100 000
Total	2 754 000	2 791 000	2 898 000	3 326 000	4 200 000

Production prospects for sugar-cane (in tons):

Areas	1983	1984	1985	1990	Horizon 2000
Gharb	680 000	633 000	783 000	1 404 000	3 000 000
Loukkos	97 000	200 000	284 000	420 000	800 000
Moulouya	40 000	58 000	60 000	100 000	200 000
Total	820 000	891 000	1 127 000	1 924 000	4 000 000

Table 5

PROSPECTS FOR SUGAR PRODUCTION

	1983	1984	1985	1990	Horizon 2000
Beet sugar (t)	385 000	390 000	405 000	465 000	588 000
Cane sugar (t)	82 000	89 000	112 000	190 000	400 000
Total	467 000	479 000	517 000	655 000	988 000

PROSPECTS FOR DRIED PULP AND MOLASSES PRODUCTION

	1983	1984	1985	1990	Horizon 2000
Dried pulp (t)	165 000	167 000	174 000	200 000	252 000
Molasses (t)	160 000	162 000	175 000	280 000	328 000

ENERGY SAVINGS ACHIEVED

Energy saving achieved by the sugar mills:

The energy-saving measures carried out in the past few years by the sugar-manufacturing sector were put in hand after a detailed diagnostic energy study. This thorough examination was conducted in collaboration with local and foreign research departments, the national universities, manufacturers of sugar-works equipment and experts in the subject.

These studies enabled us to:

- Locate the stages in the process at which a reduction of energy consumption could be contemplated;
- Ascertain the means to be used to bring about such reductions and therefore how to achieve energy savings;
- Make a cost-benefit analysis for each of the measures which might be contemplated, compare them with the financial possibilities available, and from that work out a programme for the gradual implementation of the most effective measures, and so plan when to make energy savings.

The measures decided on relate essentially to the following items:

- Use of the sugar works at their nominal daily capacity by improving the system of supply;
- Installation of air-compressors for the cleaning of the root-choppers instead of using steam;
- Use of a pressure-intensive catalytic agent at the diffusion stage to improve the dry-matter content of the pressed pulp and consequently reduce the consumption of energy necessary for the drying process;
- Recovery of the boiler gases for use in the drying of the pulp or bagasse;
- Arrangement of the evaporator stations so that tapping can be used rationally;
- Improvement of the crystallization operation by the use of efficient equipment to reduce the circulation volume and the time required for completion;
- Installation of reliable measuring and regulating devices;
- Optimization of manufacturing parameters by means of computer controls;
- Improvement of equipment maintenance in order to avoid stoppages during the sugar-manufacturing season;
- Insulation of plant to reduce calorie losses;
- Elimination of bottlenecks in the manufacturing process;
- Improvement of the distribution of electric energy.

All the sugar works, without exception, have taken action to reduce their energy consumption. Fuel oil consumption, expressed as a percentage of beet weight, for instance, came down from 4.79 in 1979 to 4.22 in 1988, or a saving of 0.37 per cent beet weight, representing 77,752 tons of fuel oil. The cane mills, which consume fuel oil at the starting-up and stopping stages because the necessary raw materials are not available during the rainy seasons, have also reduced their consumption of fuel oil, which fell from 1.22 per cent cane weight in 1979 to 0.24 per cent cane weight in 1988.

The saving achieved by these mills represents 47,408 tons of fuel oil. The changing picture of the consumption of fuel for energy between 1979 and 1988 is shown in the tables appended.

ENERGY SAVING BY THE SUCRERIE RAFFINERIE DE L'ORIENTAL "SUCRAFOR"

The energy-saving measures taken by SUCRAFOR have been specially studied by the sugar mill's own engineers, who have the advantage of being thoroughly familiar with the factory and its specific problems, drawing on outside contributions for dealing with particular cases.

The various improvements and adjustments to the manufacturing process effected by SUCRAFOR, since 1978/79, for the purpose of energy saving, are as follows:

- Rearrangement of the crystallization plant;
- Adaptation of the process of cane-juice purification;
- Recovery of the boiler gases for the drying of the bagasse and beet pulp;
- Improvement of the rate of water-extraction from pulp;
- Installation of a compressed-air plant for the cleaning of the root-choppers;
- Renovation of the mill train;
- Installation of a continuous centrifuge for the low-grade sugar produced in the crystallization process;
- Installation of variable speed in the fourth mill;
- Equipment of the Agricultural Directorate's vehicle centre with a two-way radio system so as to improve the supply of raw materials to the factory;
- Insulation of the manufacturing equipment in order to reduce heat losses;
- Installation of a computer-controlled numerical regulation system.

Investment in connection with these various measures amounts to DH 19,752,152, broken down as follows:

Rearrangement of the crystallization plant	9 380 154.00 DH
Adaptation of the cane juice purification process	1 645 548.00 DH
Recovery of boiler gases	906 867.00 DH
Installation of a continuous centrifuge	1 795 127.00 DH
Renovation of the mill train	1 600 000.00 DH
Installation of variable speed for fourth mill	617 184.00 DH
Installation of a numerical regulation system for control of the extraction process	2 934 109.00 DH
Improvement of water extraction from pulp	95 260.00 DH
Installation of a compressed-air plant for the cleaning of the root-choppers	777 901.00 DH
TOTAL	19 752 152.00 DH

The saving achieved by these measures in respect of the major consumables (fuel oil, coke and limestone) and of white sugar, as compared with consumption from 1975 to 1978, amounts to DH 50,342,891, broken down as follows:

Heavy fuel oil: boiler plant

Year	Quantity (t)	Amount (DH)
1978/79	1 672	723 320
1979/80	2 712	1 716 018
1980/81	4 224	4 103 616
1981/82	4 948	5 834 186
1982/83	518	746 231
1983/84	2 177	3 384 908
1984/85	1 152	1 965 669
1985/86	1 040	2 123 472
1986/87	2 026	4 161 282
1987/88	2 772	5 693 522
TOTAL	22 205	28 959 762

Fuel oil consumption in relation to white sugar produced came down from 52.43 per cent in 1975/76 to 29.58 per cent in 1987/88, representing a reduction of 43.58 per cent.

COKE

The reduction of coke consumption is due to the changes made in the cane-juice purification process. These consist in converting the defecocarbonation process used for purifying cane juice and saccharates in the sugar extraction plant into one suitable for clarifying the cane juice without saccharates, which requires little lime.

These changes are designed, firstly, to reduce if not entirely eliminate the consumption of such major items as fuel oil, coke and limestone and, secondly, to improve the mill's extraction rate.

The saving on coke since 1985, the year in which the cane-juice purification process was adapted, has been 2,763 tons of coke, amounting to DH 4,339,344, broken down as follows:

Year		Quantity (tons)	Amount (DH)
1985		342	566 106
1986		436	721 868
1987		646	1 069 563
1988		718	1 010 097
1989		621	971 710
	TOTAL	2 763	4 339 344

LIMESTONE

The changes in the cane-juice purification process have also made it possible to reduce the consumption of limestone. There has been a saving of 34,937 tons of limestone since 1985, amounting to DH 1,676,608, broken down as follows:

Year		Quantity (tons)	Amount (DH)
1985		4 331	199 096
1986		5 509	235 675
1987		8 168	398 108
1988		9 077	442 413
1989		7 852	401 316
	TOTAL	34 937	1 676 608

The energy-saving measures taken have also enabled the company to improve the extraction rate. Sincew 1985, 1,181 tons of white sugar have been produced, representing an amount of DH 5,925,945, broken down as follows:

Year		Quantity (tons)	Amount (DH)
1985		46	230 000
1986		168	1 340 000
1987		518	2 590 000
1988		349	1 765 947
	TOTAL	1 181	5 925 947

HEAVY FUEL OIL - DRYING PLANT

Year		Quantity (tons)	Amount (DH)
1983		268	416 700
1984		361	615 978
1985		561	1 145 450
1986		676	1 384 463
1987		1 360	2 793 358
1988		1 507	3 085 281
	TOTAL	4 733	9 441 230

Consumption of fuel oil for the drying plant has been reduced by improving the rate of water extraction from the pulp and recovering the boiler gases for further use.

CONCLUSION

The energy consumption of the Moroccan sugar factories has been appreciably reduced over the past few years.

The investments by which the energy savings have been made possible have very quickly produced returns.

The measures planned for achieving the set goal of 20 to 21 kilograms of fuel oil equivalent per ton weight of beet for the boiling plant, which has already been achieved elsewhere, are now being put into effect.

The improvement of energy consumption depends largely, though not exclusively, on the operating conditions of the mill, the average daily tonnage for normal operation, and the overall processing volume.

To ensure that the processing units obtain all the raw materials they can handle, that they are regularly supplied up to full capacity level, and that the quality of the raw materials is improved, the agricultural development agencies are being gradually divested of responsibility so that the sugar mills themselves can take charge of the growing of their own raw materials.

RECOMMENDATIONS

Substantial energy savings can be achieved by the following measures:

- Further attention to the problem of pulp drying, which is a costly operation because of the high fuel consumption involved;
- Study of the problems of making good use of bagasse, the production of which will increase considerably over the next few years;
- Consideration of the possibility of feeding the surplus electric power that may be produced in a sugar mill into the grid;
- Consideration of the possibility of introducing and operating a solar system, more especially for pulp drying.
- Establishment of a special energy-saving committee for the sugar industry.

PROGRESS OF ENERGY CONSUMPTION IN THE SUGAR SECTOR

COMPARATIVE OVERALL RESULTS OF THE SUGAR WORKS **Table 6**

Operations / Year	Products	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Processing	Sugar-beet	2 122 886	2 134 631	2 055 085	2 247 011	2 514 895	2 447 507	2 175 731	2 555 589	2 677 015	2 902 774
	Sugar-cane	275 260	354 218	592 576	501 787	733 942	774 967	714 082	793 325	833 321	1 091 699
Production	**White sugar**										
	Beet (T)	299 548	296 743	286 244	311 834	348 580	326 507	293 348	329 189	342 338	388 314
	Percentage beet	14.11	13.9	13.95	13.87	13.86	13.34	13.61	12.88	12.78	13.37
	Cane (T)	27 273	30 405	50 018	48 690	72 108	71 479	59 811	71 837	72 189	107 868
	Percentage cane	9.9	8.53	8.44	9.80	9.82	8.7	8.37	9.07	8.66	9.88
	Total	326 821	327 148	336 862	360 524	420 686	397 986	355 942	401 026	414 527	496 182
	Molasses										
	Beet (T)	83 547	92 784	88 723	39 122	111 051	119 102	97 893	116 312	120 014	144 408
	Percentage beet	3.93	4.34	4.31	4.41	4.41	4.8	4.49	4.55	4.47	4.97
	Cane (T)	13 585	13 570	27 106	20 934	28 580	32 404	29 482	31 295	26 427	40 790
	Percentage cane	4.93	3.83	4.57	4.17	3.89	4.18	4.15	3.95	3.17	3.67
	Total	97 132	106 355	115 829	120 056	139 631	151 506	127 375	147 607	146 441	185 198
	Dry pulp (T)	111 265	111 032	98 637	111 714	127 862	134 457	117 602	140 225	146 469	169 996
	Percentage beet	5.24	5.2	4.79	4.97	5.06	5.49	5.4	5.48	5.47	5.85
Utilization rate (As % of nominal capacity)	B.M.	79.5	75	68	67	75	73.7	67	76.47	78.8	89.4
	C.M.	-	85	77	64	73.5	65.3	46.8	56.7	61.9	92.0
Stoppages as % of duration of actual manufacturing season	B.M.	8.4	8.8	7.2	4.97	5.5	2.63	4.58	5.26	3.26	3.65
	C.M.	31.2	23.8	-	25	24.8	28	-	20.8	-	33
ENERGY CONSUMPTION	FUEL OIL EQUIVALENT										
	Beet (T)	101 640	100 366	92 231	103 407	116 094	112 155	92 900	112 158	110 356	122 524
	Percentage beet	4.79	4.70	4.50	4.6	4.61	4.58	4.26	4.38	4.11	4.22
	Cane (T)	3 368	2 292	5 050	3 613	3 357	5 879	2 740	3 063	2 218	2 650
	Percentage cane	1.22	0.60	0.85	0.72	0.45	0.75	0.38	0.38	0.26	0.24
	Total	105 008	102 658	97 281	107 020	119 451	118 034	95 640	115 221	112 574	125 174

B.M. = Beet mills. C.M. = Cane mills.

Table 7

FUEL CONSUMPTION IN THE SUGAR INDUSTRY

Manufacturing season	Fuel oil for sugar-beet				Fuel oil for cane		Total fuel oil equivalent
	Fuel oil tonnage	Coal equivalent	Fuel oil total	% Beet	Tons	% cane	
1979	85 779	15 474	101 640	4.79	3 368	1.37	104 621
1980	81 601	18 766	100 366	4.70	2 292	-	102 658
1981	75 829	16 702	92 531	4.50	5 050	0.86	97 581
1982	80 317	24 551	[illegible] 468	4.60	3 613	0.72	108 481
1983	88 949	27 145	116 094	4.61	3 357	0.45	119 250
1984	80 213	32 335	112 255	4.58	5 879	0.35	118 427
1985	75 227	17 674	92 901	4.26	2 740	0.38	95 641
1986	83 960	28 197	112 157	4.38	3 063	0.38	115 220
1987	87 300	23 056	110 356	4.11	2 218	0.26	112 574
1988	87 503	3[illegible] 021	122 524	4.22	2 650	0.24	125 174

Table 8

CONSUMPTION FOR DRYING

Sugar factories	Fuel oil t	Coal fuel oil equivalent t	Total fuel oil equivalent t	Dry pulp t	Dry pulp %
1979	26 197	5 986	31 683	111 265	28.5
1980	24 530	6 864	31 394	111 032	28.3
1981	20 717	5 251	25 968	98 637	26.3
1982	19 078	8 731	27 809	111 804	24.7
1983	19 690	9 224	28 914	103 811	26.3
1984	24 044	10 395	33 439	133 471	25.0
1985	20 686	5 933	26 619	117 806	22.59
1986	23 418	9 223	32 641	140 225	23.30
1987	23 911	7 533	31 444	146 478	21.46
1988	24 428	11 416	35 844	169 996	21.08

Excluding the tonnage of the Zemamra sugar mill.

Table 9

COKE CONSUMPTION - LIME KILN

Sugar mills	Beet processing	Coke t	Coke fuel oil equivalent t	Coke fuel oil equivalent as % beet weight
1979	2 122 886	8 443	6 163	0.29
1980	2 134 631	8 643	6 236	0.29
1981	2 055 085	8 381	6 118	0.29
1982	2 247 011	9 438	6 889	0.30
1983	2 514 895	10 195	7 442	0.29
1984	2 447 507	10 259	7 489	0.30
1985	2 175 731	8 918	6 510	0.29
1986	2 555 589	11 027	8 049	0.31
1987	2 677 015		8 031	0.30
1988	2 902 774	12 549	9 160	0.31

PROGRESS OF ENERGY CONSUMPTION AT SUCRAFOR

Table 10

ENERGY SAVING

Operations / Year		1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985	1986	1987
Beet processing	T	119 463	177 867	132 651	163 980	172 315	142 863	173 356	21 151	120 809	71 165	90 265	108 385	161 159
Cane processing	T	-	35 119	28 229	20 229	31 559	36 142	32 258	28 095	37 529	26 026	(See 84/85)	33 108	49 087
<u>White sugar production:</u>														
Beet manufacturing	T	4 473	6 621	6 397	7 862	9 933	10 420	14 442	1 939	11 086	5 577	8 914	11 857	16 801
Refining + sugar extraction		12 215	10 551	7 500	12 056	6 892	-	-	-	-	-	-	-	-
Cane manufacturing	T	-	6 905	4 773	4 619	5 547	10 166	10 119	2 262	6 886	3 938	(See 84/85)	3 995	4 502
Total		16 688	24 077	18 670	24 537	22 372	20 586	24 561	4 201	17 972	9 515	8 914	15 852	21 303
<u>Fuel consumption</u>														
Beet manufacturing	T	3 870	5 994	4 736	5 936	6 590	4 648	5 976	1 280	3 818	2 328	3 153	3 828	5 666
Refining	T	4 880	5 259	3 318	3 254	1 310	-	-	-	-	-	-	-	-
Cane manufacturing	T	-	2 008	1 748	1 998	1 180	1 959	2 097	1 449	2 230	888	(See 84/85)	997	635
Total	T	8 750	13 261	9 802	11 188	9 080	6 607	8 073	2 729	6 048	3 216	3 153	4 825	6 301
Percentage white sugar		52.43	55	52.50	45.60	40.58	32.10	32.87	64.96	33.65	33.80	35.37	30.44	29.58
Changes in fuel consumption by reference to the base year 1975/1976 = 100		100	105	100	87	77	61	62	124	64	64	67	58	56

Table 11

ENERGY SAVING

Year / Designations	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1874/85	1985	1986	1987	Total
Price of fuel oil (DH/T)	218.08	285.45	374.39	435	632.75	971.5	1179.1	1440.60	1554.85	1706.31	2041.8	2053.94	2053.94	-
Changes in the price of fuel oil taking 1975/1976 as the base year = 100	100	131	171	199	290	445	540	660	713	782	936	942		-
Fuel oil savings as percentages of figure for 1975/1976	-	-	-	13	23	39	38	-24	36	36	33	42	44	-
Fuel oil saving in terms of quantity in comparison with 1975/1976 (t)	-	-	-	1672	2712	4224	4948	-518	2177	1152	1040	2026	2772	22205
Fuel oil gain (DH)	-	-	-	723320	1716018	4103616	4834186.8	-746230.8	3384908.5	1965669.1	2123472	4161282	5693522.76	28959764
Total for fuel oil (DH)	1908200	3785352.45	3669770.78	4866780	5745370	6418700.50	9518874.3	3931317.4	9403732.8	5487493	6437795	9910260	-	-
Cost of fuel oil per ton of white sugar (DH)	114.34	157.2	196.50	198.34	256.81	311.8	387.56	935.8	523.24	576.72	722.21	625.17	-	-

Table 12

FUEL OIL CONSUMPTION FOR DRYING PLANT

Designation	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Production of dry pulp (T)	9 875	7 825	10 134	1 167	6 468	3 875	5 374	6 083	9 416	9 200
Fuel oil consumption (T)	3 386	2 891	-	519	1 949	967	1 281	1 409	1 868	1 647
Consumption as % dried pulp	34.28	36.94	-	44.47	30.13	24.95	23.83	23.16	19.83	17.90
Fuel oil gain (T)	-	-	-	-	268	361	561	676	1 360	1 507

PROGRESS OF ENERGY PRODUCTION AND CONSUMPTION IN MOROCCO

Table 13

ENERGY PRODUCTION AND CONSUMPTION IN MOROCCO

Designation \ Year	1983	1984	1985	1986	1987
	Quantity	Quantity	Quantity	Quantity	Quantity
Energy production					
Electricity generated (millions KWh)	5 875.1	6 095.1	6 502.4	6 928.5	7 256.3
Comprising:					
Thermoelectric power (millions KWh)	5 394.0	5 728.7	6 016.5	6 285.8	6 431.3
Hydroelectric power (millions KWh)	481.1	366.4	485.9	642.7	825.0
Coal (1 000 tons)	751.0	837.5	774.5	775.0	634.2
Crude oil (1 000 tons)	17.7	16.5	22.2	23.2	18.3
Natural gas (millions m^3)	83.2	83.0	87.0	91.0	73.7
Total refined petroleum (1 000 tons)	4 517.8	4 728.0	4 623.0	4 291.7	4 546.7
Production of the two refineries (in 1 000 tons)					
Regular	112.5	109.0	102.0	97.9	107.6
Premium	230.9	232.7	228.6	220.9	256.2
Diesel	1 203.0	1 142.6	1 269.7	1 192.5	1 371.3
Kerosene	68.1	59.5	55.3	48.3	52.8
Jet propulsion fuel	203.4	197.7	214.0	204.2	194.5
Fuel oil	1 947.5	2 063.4	2 051.9	1 930.0	1 641.0
Butane	169.7	176.0	171.2	178.8	193.7
Propane	29.0	31.0	30.5	25.4	35.6
Total	3 964.1	4 011.9			
Primary energy consumption					
Local coal (1 000 tons)	667.1	648.7	645.2	642.9	666.3
Imported coal (1 000 tons)	282.0	218.0	448.2	817.2	1 014.6
Hydroelectricity (millions KWh)	480.9	366.4	485.9	642.7	825.0
Petroleum products (1 000 tons)	4 116.8	4 170.4	4 174.3	4 191.6	4 149.3
Natural gas (10^6 m^3)	83.2	83.0	81.0	91.0	73.7

Designation / Year	198?		1984		1985		1986		1987	
	Quantity	%	Quantity	%	Quantity	%	Quantity	%	Quantity	%
(1 000 toe)										
Coal	559.7		507.1		657.1		899.4		1 042.8	
Hydroelectricity	125.1		95.3		126.3		167.1		214.5	
Petroleum products	4 116.8		4 170.4		4 174.3		4 191.6		4 149.3	
Natural gas	63.1		63.0		66.1		69.2		56.0	
Total	4 864.7		4 835.8		5 023.8		5 327.3		5 462.6	
<u>Consumption of petroleum products</u> (<u>1 000 tons</u>)										
Premium	234.8		229.7		225.8		234.4		256.4	
Regular	114.8		106.8		104.3		102.3		100.7	
Diesel	1 186.0		1 169.1		1 170.2		1 289.1		1 359.4	
Fuel oil	1 964.9		2 034.4		2 009.0		1 865.5		1 694.3	
Kerosene	61.9		58.2		60.6		49.3		48.3	
Jet fuel	196.9		202.0		220.9		204.7		209.8	
Butane	317.6		330.4		353.2		390.9		419.8	
Propane	20.2		20.6		23.5		24.0		29.3	
Paraffin	15.9		15.9		6.9		16.0		16.0	
Aviation fuel	1.4		1.5		-		1.0		1.2	
Special boiling point spirit	2.5		1.7		-		2.2		2.1	
Total	4 116.9		4 170.3		4 177.4		4 179.4		4 137.3	
<u>Electricity consumption</u> (in millions KWh)										
High- and medium-voltage users										
Agriculture, animal husbandry, fishing	292.6		226.4		318.0		347.1			
Water distribution	230.1		294.7		242.9		250.1			
ONEP	122.6		129.7				146.1			
Mines	540.1		578.8		607.9		583.9			
Charbonnages du Maroc	53.3		60.9		67.3		69.8			
Office Chérifien des phosphates	318.7		326.6		337.2		353.7			
Industries	1 594.7		1 681.9		1 693.9		1 907.8			

Designation \ Year	1983	1984	1985	1986
	Quantity	Quantity	Quantity	Quantity
Cement works	386.6	376.4	390.6	401.7
Fats, canneries, foodstuffs and refrigeration	261.2	272.5	279.2	326.0
Textile industries	320.4	357.4	344.0	359.2
Chemical industries	220.2	252.0	253.6	335.9
Transport and communications	184.6	186.5	224.4	242.7
ONCF	113.7	114.9	149.9	153.1
Other users	502.2	472.8	541.1	563.2
Total: high and medium voltage	3 344.3	3 441.1	3 894.8	3 894.8
<u>Low voltage</u>				
Private use, administrative and domestic	1 276.1	1 325.3	1 463.0	1 554.8
Public lighting	107.5	111.4	125.5	139.3
Heavy power	77.2	77.4	87.7	93.9
Total: low voltage	1 460.8	1 514.1	1 676.2	1 788.0

Table 14

IMPORTS OF ENERGY PRODUCTS AND LUBRICANTS

Products \ Year	1984		1985		1986		1987	
	Quantity (t)	Value (1000 DH)	Quantity (t)	Value (1000 DH)	Quantity (t)	Value (1000 DH)	Quantity (t)	Value (1000 DH)
Crude oil	4 581 284	8 393 659	5 024 916	9 931 245	4 507 338	4 587 379	4 836 221	5 331 477
Raw coal, briquettes and coke	178 708	102 135	451 017	273 878	776 503	353 621	1 058 695	396 210
Petroleum gas and other hydrocarbons	125 886	315 649	166 357	438 272	235 831	322 154	179 850	278 292
Petroleum oil and lubricants	20 736	85 461	9 294	62 363	12 564	70 761	10 965	61 189
Diesel and fuel oil	17 325	25 882	32 952	58 478	5 959	16 688	20 977	50 925
Paraffin waxes	8 636	37 008	5 992	30 863	13 674	67 562	8 769	42 838
Petroleum spirit	3 014	10 569	2 772	11 086	2 856	7 858	1 892	4 344
Other energy products	40 522	470	3 451	356	3 356	3 351	1 156	4 307
Total	4 976 031	8 991 783	5 692 783	10 809 636	5 555 081	5 429 374	6 118 526	6 169 582

Table 15

IMPORTS CLASSIFIED BY USER GROUPS

User groups	1984		1985		1986	
	Quantity (tons)	Value (1000 DH)	Quantity (tons)	Value (1000 DH)	Quantity (tons)	Value (1000 DH)
Food, beverages and tobacco	3 140 435	5 816 962	2 506 558	5 106 021	2 071 914	4 329 442
Energy products and lubricants	4 976 031	8 991 783	5 692 870	10 809 636	5 555 081	5 429 374
Commodities of animal and vegetable origin	703 719	2 668 015	756 939	3 276 088	751 480	2 788 910
Commodities of mineral origin	1 517 307	1 873 084	1 574 977	2 770 488	1 773 502	2 815 529
Semi-manufactured goods	1 601 485	6 494 368	1 582 301	7 422 450	1 564 907	7 526 784
Manufactured goods - agricultural equipment	7 253	214 540	11 419	382 148	14 772	628 215
Manufactured goods - industrial equipment	163 399	6 245 023	159 144	6 150 396	121 950	7 619 858
Manufactured consumer goods	59 940	2 091 744	65 427	2 757 824	67 250	3 469 485
Industrial - (?)	-	-	-	23	-	313

Table 16

PRICE PER TON OF ENERGY PRODUCTS AND LUBRICANTS IMPORTED

DH/TONS

Products / Year	1984	1985	1986	1987
Crude petroleum oil	1 832	1 976	1 018	1 102
Raw coal, briquettes and coke	571.5	607	455	374
Petroleum gas and other hydrocarbons	2 509	2 634.50	1 366	1 547
Petroleum oil and lubricants	4 121	6 710	5 632	5 580
Diesel and fuel oil	1 494	1 824.50	2 800	2 428
Paraffin wax	4 285	5 150	4 941	4 885
Petroleum spirit	3 506	3 999	2 751	2 296
Other energy products	529	7 342.50	9 413	3 725