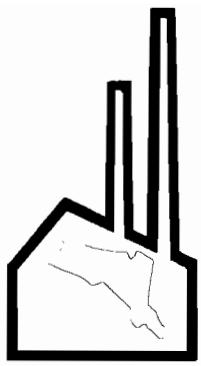

POSSIBILITIES OF INTEGRATED INDUSTRIAL DEVELOPMENT IN CENTRAL AMERICA

UNITED NATIONS

ECONOMIC COMMISSION FOR LATIN AMERICA

POSSIBILITIES OF INTEGRATED INDUSTRIAL DEVELOPMENT IN CENTRAL AMERICA

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EXPLANATION OF SYMBOLS

The following symbols have been used throughout this report:

Three dots (...) indicate that data are not available or are not separately reported.

A dash (—) indicates that the amount is nil or negligible.

A minus sign (—) indicates a deficit or decrease.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

An oblique stroke (/) indicates a crop year or fiscal year — e.g., 1954/55.

Use of a hyphen (-) between dates representing years — e.g., 1950-1954 — normally signifies an annual average for the calendar years involved, including the beginning and end years. "To" between the years indicates the full period — e.g., 1950 to 1954 means 1950 to 1954, inclusive.

References to "tons" indicate metric tons, and to "dollars" United States dollars, unless otherwise stated.

Details and percentages in tables do not necessarily add to totals, because of rounding.

The initials "ECLA" refer to the Economic Commission for Latin America.

INTRODUCTION

The programme for the industrialization of Central America on a regional scale originated in resolution 9 (IV) of the Economic Commission for Latin America, adopted in 1951 by its member Governments. This resolution expressed the intention of promoting the setting up and development of a broad market that would permit the establishment of enterprises that could produce for the whole region, or in any case to meet a demand greater than that represented by the individual market of each country.

From that date until the ratification of the protocol on integration of industries and the preparation of the first studies and informal agreements on specialization in the textile industry, some progress has been made in developing the basic instruments for industrial development in Central America. At present the industrial integration programme has at its disposal the legal instruments essential to its functioning, together with institutions of a regional nature — the Central American Research Institute for Industry (ICAITI) and the Central American Bank for Economic Integration (BCIE) — to undertake industrial research, promotion and financing.

Although notable progress has been made in these fields — and in others no less important — in achieving the necessary economic development and improving Central American living standards, more rapid regional development of manufacturing is needed, on the basis of a Central American industrialization policy not limited by the narrower perspective of the individual national economies. Thus Central America's industrialization policy could be formulated so as to meet both regional and national needs, the industrial basis established would be firmer, and there would be a better use of Central American resources.

As usually happens in most under-developed countries, the industrial sector has played a secondary role in Central America. Although there was a notable increase in the growth rate between the First and Second World War, and although the situation in the industrial sector remained more stable than in other sectors, it has not yet acquired sufficient impetus to stimulate the growth of the rest of the economy. The region's industrial growth rate has been only slightly higher than its over-all growth rate, and the level of industrial diversification is still very low, with the result that there is a shortage of intermediate and capital goods.

Industrial production has, in fact, concentrated on light consumer manufactures, in which the artisan sector predominates. Production of food manufactures, tobacco, beverages, clothing and textiles accounts for about 77 per cent of the value added in the manufacturing sector. Substitution of imports of manufactured goods, which increased as a result of the Second World War, slowed down during the fifties and has not led to any appreciable increase in the share of domestic production in total supply.* This falling-off was sharper in respect of industrial inputs, since imports represent about 40 per cent or more of the supply of intermediate goods.

In the above circumstances, and in the light of the low level of intersectoral dependence, the dynamic impulses originating in external demand, public expenditure and investment inevitably tended to make themselves felt outside the national or Central American sphere, in the form of an increase in imports.

The relative lag in Central American industry is largely attributable to circumstances that had a powerful influence in the past and still affect the sector's development. The national markets for manufactures are extremely small because of the size of the population, the low per capita income levels, the concentration of income and wealth, and the existence of population groups that are cut off from the whole trade economy. The structure of industry has naturally been affected by these circumstances, and consequently there has been small incentive to invest and little possibility of financing new industrial activities; choice of production techniques and plant size has been restricted because of the impossibility of obtaining the external economies or economies of scale provided by mass production.

Strictly speaking, the type of development typical of Central America up to the fifties could be considered unbalanced, and directed basically to external markets. It is hardly surprising, therefore, that until very recently economic policy, production systems and the channelling of capital resources have been directed towards the promotion of traditional exports, to the exclusion of other branches of productive activity. Because of the declining growth of the external sector (since the beginning of this century) the structure of domestic production has been particularly vulnerable to fluctuations in the external market, and has already made it a risky venture to invest in new activities, which appear to be more difficult to establish as they require a certain stability of demand.

In addition, industrialization has been hampered by a failure to develop the economic infrastructure. For example, until the fifties practically no programme existed to improve the road network or the supply of electric power.

Despite all this, during the immediate post-war period there was a relative boom as a result of certain favourable factors that had not been present until then. The war had restricted the external supply of many products that could easily be made in Central America and for which demand was relatively high. Moreover the Governments adopted a much more vigorous policy of promoting

* This share subsequently remained close to 63 per cent.

development of national and regional manufactures than had been pursued in earlier periods.

Thus after 1950 there began a policy of industrial development that tended to go beyond the traditional patterns of the government's approach to economic matters, and this change has been particularly important for the economic relation between the Central American countries in their attempt to overcome the restrictions imposed by the small scale of their resources and of their national markets.

The bilateral free-trade agreements that preceded the General Treaty on Central American Economic Integration, signed in 1960, the establishment of a common tariff policy and a common development policy, and the new attack on Central America's road system — all these have begun to give results. Intra-area trade, for example, increased by 14.2 per cent during the early fifties, and by over 20 per cent during the second half of that decade. There has also been an upsurge in manufacturing, as a result of the broadening of the market, combined with a better use of installed capacity and a rapid increase in intra-area trade in manufactured goods.

A new policy to promote manufacturing has been formulated from a regional standpoint that recognizes — in the light of the experience of other under-developed countries (mainly in Latin America) — that industrial development is directly related to the breaking down of the bottlenecks to economic growth, of which the external sector is the most outstanding example. Thus industrial development is having a rationalizing effect on import substitution and is establishing the bases for an economic development less dependent on the evolution of external demand. Moreover the aim is to avoid the drawbacks of a one-sided industrial development directed towards assembly plants or production of consumer goods, as has happened in many Latin American countries, and the rigid import structure imposed by the need to purchase abroad the intermediate goods that would be needed for an insufficiently integrated industrial structure.

In Central America, where there is already an embryo industrial structure oriented towards the manufacture of non-durable consumer goods, the economic integration treaties make it possible to attack the industrialization problem by developing industrial branches that are closely related and can encourage the initiation of related or ancillary production lines. The study of possible industrial complexes will indicate possibilities with respect to new lines, better use of local products, and reductions in costs and in the need for imported raw materials and intermediate goods, all of which may have gone unnoticed or could not be arrived at through analyses relating to individual plants or countries. These possibilities are revealed because of the interdependence that can be established between industries forming part of a single complex, which can have a powerful influence on their costs and growth rates, as a result of external economies, of the economies of scale made possible by larger and more efficient plants, and of the complementarity of the production processes.

From the standpoint of the existing industrial structure, the execution of programmes to promote complementarity and industrial specialization would also make it possible to avoid certain defects that have prevented the full development of the manufacturing sector. These may be summarized as the duplication of investment in small plants that operate below the recommended level of production capacity, the production of an excessive range of articles by a single enterprise, the surplus capacity that results from the lack of expanding markets, and the low productivity due to these and other factors. All of them can be avoided by proper co-ordination at the regional level. The complementarity and specialization agreements will permit the vertical and horizontal integration of many industries, promote lower production costs, and conduce to better use of installed capacity and to the establishment of industrial modernization programmes that will entail a minimum of dislocations and social burdens.

The strengthening of industrial growth is one of the basic tasks now confronting the Central American countries. They are now attempting to offset the slow growth of their exports by the expansion and rapid diversification of the domestic supply of manufactured goods. But the present efforts are in danger of being neutralized through a failure to take full advantage of the broadening of national markets made possible by the integration agreements. Experience has shown the advantages of plants established as part of regional industrial complexes, as compared with small plants whose very nature precludes the building up of a firm network of inter-industrial relations. Provisional estimates of the evolution of the demand for manufactured products indicates that if the per capita gross internal product increases at an annual rate of 2.5 per cent, the growth rate of manufacturing should be not less than 8 per cent. This degree of industrialization would mean an appreciable increase in the contribution of domestic production and an industrial investment of some 1,000 million dollars over a period of ten years. This means that the growth of inter-area trade in industrial products will depend in future on the establishment of more industrial plants and not on the better use of existing plants.

From the foregoing it emerges that industrial development is called on to play a decisive role in Central America's economic growth. The industrial structure that is built up will determine the growth rate that can be attained in the industrial and in other sectors. Unless there is active investment in new manufacturing lines, especially in lines that can supply the regional market, stability of exchange rates and the goals of economic and social development aimed at by the Central American countries may be endangered.

This makes clear the importance of undertaking research on the main features, probable evolution and future prospects of the manufacturing sector, and, in the context of this aim, the importance of studying industries or industrial complexes of regional scope that will permit the establishing of industrial investment priorities and a proper orientation of public and private action.

The present document contains nine pre-investment studies covering rolled steel, welded tubes, glass containers, sheet glass, electric lamps, caustic soda, chlorine and chlorine insecticides, petroleum products, petroleum

refining, and viscose and acetate rayon. In each of these studies an analysis is made of the main features and development of the regional market, with estimates of its probable evolution during the sixties. The studies also cover questions of production, plant size, volume of investment, manpower requirements, raw materials and estimated cost levels. Some comments are made on the possible effects of the project concerned with respect to generation of value added, import substitution and relations with the development of other industries of interest to Central America.

This document should not in any way be regarded as an exhaustive list of the present possibilities of industrial development. It represents only a series of preliminary investigations, with particular emphasis on market studies, intended to throw some light on the feasibility of investment in the industries concerned by furnishing a preliminary estimate. At a later date the necessary technical analyses and additional research will have to be undertaken, before the draft projects can be considered for purposes of evaluation and financing by Governments or by international financial institutions.

POSSIBILITIES OF INTEGRATED INDUSTRIAL DEVELOPMENT IN CENTRAL AMERICA

I. ROLLED STEEL

The creation of the Central American common market under the integration programme has substantially improved the prospects for the manufacture of rolled steel in the area. This is an industry which, from the standpoint of size of plant, capital investment and the long interval before the plant can actually begin to operate, should be viewed in terms of a growing market and on a regional scale.

The present provisional study examines some of the factors which help to determine the feasibility of a rolled steel industry in the area. The first point taken up is the present market for iron and steel products in the Central American countries, and its possible growth in terms of the accelerated industrial development sought within the integration programme. The aim here is to estimate future requirements for steel products, particularly those used in construction, in order to determine the prospects they offer with respect to the establishment of a rolling-mill in the area.

Consideration is next given to the possibility of establishing a rolling-mill for shapes and rods and, in this connexion, two types of plant are examined. The analysis is illustrative and its purpose is to provide certain criteria as to size, investment, production costs and other factors which must be taken into account in designing a plant suited to the needs of Central America.

In considering present possibilities for the manufacture of rolled steel, account has also to be taken of the prospects offered by the regional market for the establishment of the rolled steel plant as part of an integrated or semi-integrated steel industry. The viability of this industry should be the subject of a careful study once the survey and analysis of the region's iron ore and coal resources are completed.

1. The Central American market for rolled steel products

Consumption of iron and steel products in Central America is virtually identical with imports, since production in the area is very limited. There are at present three small foundries (in Guatemala, El Salvador and Costa Rica); they produce little more than bracing rods, and use local scrap. The combined annual output of the three plants has fluctuated between 3,000 and 6,000 tons in the past few years. The main factor limiting the output and expansion capacity of these plants seems to be the difficulty of obtaining a regular supply of local scrap that would meet the quality and quantity requirements of production on a relatively small scale. Moreover, the limited domestic markets have prevented the establishment of semi-integrated plants sufficiently large to repay the cost of importing part or all of the scrap needed, such as those set up in other Latin American countries.

During the first eight years of the past decade Central American imports of iron and steel products increased rapidly from 61,000 tons in 1950 to 147,000 tons in 1957. They dropped considerably in 1958 and 1959 — to 108,000 tons and 110,000 tons respectively. The total value of these imports was 13 million dollars in 1950 rising to a peak of 37 million dollars in 1957 and dropping to 26 million dollars in 1959 (see table 1).

Table 1

CENTRAL AMERICA: IMPORTS OF IRON AND STEEL PRODUCTS, BY COUNTRY, 1950-60

Year	*Costa Rica*	*El Salvador*	*Guate-mala*	*Honduras*	*Nica-ragua*	*Total*
			VOLUME *(thousands of tons)*			
1950	14.5	11.3	18.1	11.7	5.7	61.3
1951	15.6	18.4	19.8	25.1	8.7	87.6
1952	13.7	11.5	11.6	34.8	12.4	84.0
1953	28.4	13.1	19.2	22.6	15.3	98.6
1954	25.7	22.6	17.3	12.5	17.1	95.2
1955	27.6	25.3	24.9	13.2	15.4	106.4
1956	27.6	29.5	35.3	11.0	17.2	120.6
1957	29.1	29.1	47.7	11.7	19.0	146.6
1958	26.9	21.7	29.3	14.0	16.2	108.1
1959	30.5	21.4	43.0	11.0	12.8	118.7
1960	35.4	29.0	43.3	12.7	11.1	131.4
			C.I.F. VALUE *(millions of dollars)*			
1950	2.7	3.0	4.0	1.9	1.5	13.1
1951	3.3	3.4	4.6	3.9	2.5	17.7
1952	3.3	2.8	3.3	5.9	3.7	19.0
1953	6.1	2.6	4.0	5.0	3.5	21.2
1954	5.2	3.8	3.8	3.3	4.4	20.5
1955	5.5	5.4	5.1	3.5	4.1	23.6
1956	7.1	6.7	8.8	3.1	4.6	30.3
1957	9.1	7.1	10.7	4.0	6.4	37.3
1958	7.8	5.3	7.2	3.7	5.1	29.1
1959	6.0	4.4	8.3	2.5	3.5	24.7
1960	7.0	6.0	8.8	3.0	3.5	28.3

SOURCE: Foreign trade statistics. For further details see table 3.

The pattern of demand for iron and steel products largely reflects the scope of construction activities up to 1957 and the subsequent decline or stagnation can be attributed to the drop in income from exports. This is clearly shown by the imports of shapes and rods which are used only in construction work and represent the main rolled steel items consumed in the area.

The increase in imports of shapes and rods was even more marked up to 1957, when they reached a total of 54,000 tons, three times the figure for 1950 (see table 2). In 1958 and 1959 imports of these items dropped below the figure for 1956.

Table 2

CENTRAL AMERICA: IMPORTS OF SHAPES AND RODS, 1948-59 [a]

Year	Costa Rica	El Salvador	Guate-mala	Honduras	Nica-ragua	Total
			VOLUME *(thousands of tons)*			
1948	0.7	5.7	6.2	1.9	1.3	15.9
1949	1.2	5.0	7.2	0.9	2.4	16.6
1950	2.0	7.3	6.1	1.7	1.3	18.5
1951	2.2	11.1	7.6	1.3	2.3	24.6
1952	3.7	7.6	3.8	2.9	3.7	21.7
1953	8.8	5.8	7.2	3.7	3.4	28.9
1954	7.3	11.5	5.5	3.4	2.8	30.5
1955	9.6	13.0	9.0	3.8	3.2	38.6
1956	6.4	11.8	13.9	2.7	4.5	39.3
1957	9.1	11.8	25.2	2.6	5.2	53.9
1958	9.2	7.2	7.9	3.3	3.4	31.0
1959	8.8	8.9	11.9	2.5	3.5	35.6
			C.I.F. VALUE *(millions of dollars)*			
1948	0.1	0.9	0.8	0.3	0.3	2.4
1949	0.2	0.7	0.9	0.1	0.5	2.4
1950	0.2	0.8	0.6	0.1	0.1	1.9
1951	0.2	1.3	0.8	0.3	0.3	3.0
1952	0.6	0.7	0.5	0.5	0.6	2.9
1953	1.3	0.6	0.9	0.6	0.3	3.7
1954	0.8	1.2	0.6	0.5	0.3	3.5
1955	1.2	1.8	1.2	0.5	0.3	5.3
1956	1.0	1.7	2.2	0.4	0.8	6.1
1957	1.5	1.9	4.1	0.4	1.0	8.9
1958	1.6	1.0	1.1	0.5	0.6	4.8
1959	1.0	1.2	1.5	0.4	0.5	4.6

SOURCE: Foreign trade yearbooks.

[a] This includes joists, beams, angles, shapes, sections, concrete reinforcement bars and rods.

With the exception of Honduras, the pattern of imports of steel products was similar in all the Central American countries, with high rates of growth up to 1957, particularly in Guatemala and Costa Rica, the major consumers in the area.[1] In spite of the decline in subsequent years, imports by these countries, as well as by El Salvador and Nicaragua, amounted in 1959 to about twice the 1950 level (see again table 1).

[1] During the period 1955-59 Guatemala's imports of iron and steel represented 30 per cent of the total for the area, followed by Costa Rica (26 per cent), El Salvador (21 per cent), Nicaragua (14 per cent) and Honduras (9 per cent).

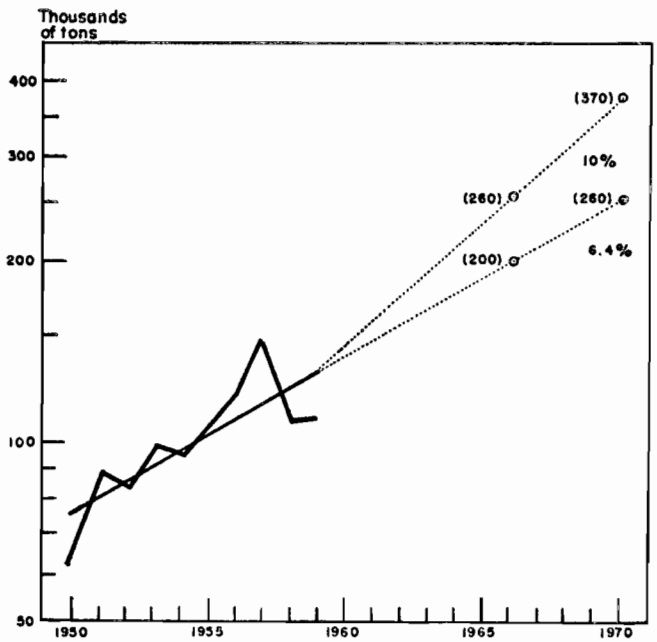
The pattern of imports by Honduras was quite the reverse, dropping from an average of over 27,000 tons in 1951-53 to about 12,000 tons in the following years. The relatively high figure at the beginning of the period is very largely due to imports by the fruit companies of tubing and other steel items for use in drainage works and a system of controlled flooding to combat pests in banana plantations.

Based on a straight-line extrapolation of the import growth trend during the period 1950-59 (6.4 per cent per year), the total Central American demand for steel products may well reach 200,000 tons in 1966 and 260,000 tons in 1970 (see figure I). This then is the first of the two projections made here of the Central American demand for steel.

Figure I

CENTRAL AMERICA: APPARENT CONSUMPTION OF IRON AND STEEL PRODUCTS, 1950-59, AND PROJECTION TO 1970

Semi-logarithmic scale



SOURCE: Table 1.

However, the change which has taken place since 1959 in the factors determining the demand for these products has considerably reduced the value of the past trend as a basis of projection for the present decade. What can therefore be expected, at least in the immediate future, is a slower rate of growth of consumption for these products more or less in line with the foreseeable increase in the capacity to import generated by Central America's traditional exports.

The establishment of the Central American common market within the economic integration programme has produced a drastic change in the prospects for an increase in the area's consumption of iron and steel. The common market is the pathway to a rapid increase in industrial production based on a broad and intensive process of import substitution. Expansion of existing plants and the creation of new industries will create an increase in the

demand for iron and steel products. Moreover, the increased investment in infrastructure works will provide a broader market for steel products used in construction.

A proper projection of the demand for steel products therefore presupposes a careful analysis of the possibilities of import substitution and of the creation of new industries in relation to the regional market and their probable growth in the years to come. The analysis will only be possible after completion of the current studies and projections of the economic development of the Central American countries, which will permit logical assumptions to be made of the future growth of the Central American economy as a whole and of the investment requirements in each sector.

However, some criteria are available on which to base an estimate of the probable pattern of future Central American demand for rolled steel. The future development of the economies of some Central American countries (Costa Rica, El Salvador and Honduras), as estimated on the basis of studies carried out, points to an even higher consumption of steel in the next decade than in 1950-59. These estimates presuppose, among other things, a substantial increase in the investment coefficient, particularly in the manufacturing, electric power, transport and communications sectors, as a prerequisite for attaining an annual growth rate of 2 to 3 per cent in per capita product.

Based on the ratio of steel consumption to investment level recorded over the past decade, the increase in investment assumed in the studies referred to indicates an annual growth rate in demand for steel products estimated at some 10 per cent. Total steel consumption in Central America would thus double within a period of seven years (260,000 tons) and would reach 370,000 tons in 1970 (see again figure I). This estimate, seemingly high in absolute terms, in fact assumes, for the region as a whole, a relatively slow increase in per capita consumption — 26 kg in 1970, well below the Costa Rican figure of 32 kg for 1959. Costa Rica's high consumption of iron and steel, compared with the other Central American countries,[2] is attributable to the higher per capita income and rate of urbanization, which presupposes greater use of these products for building and public works, as well as for the electric power sector (which developed at a relatively rapid rate in Costa Rica in the post-war-period). On the other hand, consumption of rolled steel in the metal-transforming industries was negligible.[3]

If the economy of Central America grows at the assumed rate of 2 to 3 per cent, per capita income for the area as a whole in 1970 would be close to the present level in Costa Rica. Thus, the above projection of steel demand for that year (25 kg) may even be conservative.

It should be pointed out that current steel consumption in Central America is very low (barely 12 kg per capita in 1958 and 1959);[4] it reflects the low level of per capita income and, what is even more significant, the low rate of development of the metallurgical and metal-transforming industries. This explains why imports consist mainly of items such as construction shapes and rods, and wire and tubes. Sheeting, used chiefly in the metal-transforming industry, represented only 17 per cent of total imports in 1958-59 (see table 3).

The limited development of the metal-transforming industry is largely due to the restricted nature of domestic markets, which cannot even absorb the full capacity of the few plants already set up. For example, the area's total consumption of tin plate remained stationary at about 4,000 tons between 1956 and 1959, although the capacity of the existing container factories exceeded the requirements of the domestic markets.[5]

Thus we have two projections of Central American demand for iron and steel products in 1970. The lowest estimated annual growth rate (7 per cent) is based on the past rate of growth, while the highest (10 per cent) which is considered the most probable rate, seeks to take into account the effect of the region's industrial development on steel demand.

The results of the projections can be more readily appreciated by referring to the experience of Mexico and to the ratio between fixed capital investment and steel demand. In recent years this ratio in Mexico has been about 0.20, compared with 0.13 in 1945. In Central America, as might be expected, an increase in investment is accompanied by a smaller rise in steel demand than in the case of Mexico. Available data indicated that the ratio for steel in Central America in 1957 ranged from a high of 0.13 to a low of 0.06.

If it is assumed that in Central America the ratio of investment to steel consumption in 1970 will be 0.13, the same as in Mexico in 1945, the area's annual steel demand in the future would be slightly over 300,000 tons.[6] This would represent a level about midway between the two projections. By 1970 the Central American ratio of investment to steel demand may well rise to 0.15, the same ratio as for Mexico in the early 1950's, in which case the area's steel consumption will be close to the highest projection. For this reason, as well as for those mentioned earlier, there is some justification for estimating that the Central American market for rolled iron and steel will increase by about 10 per cent a year to 260,000 tons by 1966 and 370,000 tons by 1970 (see again figure I).

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[2] In 1959 per capita steel consumption was between 10 kg and 12 kg in Guatemala, El Salvador and Nicaragua, and 6 kg in Honduras.

[3] The value of imports of rolled steel for the metal-transforming industries and transport equipment amounted to barely 800,000 dollars in 1957 out of a total of 9.1 million dollars, worth of rolled steel imported into the country. See *El Desarrollo económico de Costa Rica*, Study No. 2, publications of the University of Costa Rica (San José, 1959), pp. 85-86.

[4] Per capita steel consumption in other countries, in 1958, was as follows: United States, 433 kg; Federal Republic of Germany, 377 kg; Canada, 316 kg; Chile, 67 kg; Mexico, 50 kg; Brazil, 31 kg; Colombia, 11 kg. See *México: 50 años de revolución*, vol. 1 (*Fondo de Cultura Económica*, 1960), p. 223.

[5] See *El desarrollo económico de Costa Rica*, op. cit., p. 84.

[6] According to an ECLA projection, based on official sources, gross investment of fixed capital in Central America in 1970 will be 500 million dollars a year (1950 dollars). Since the Mexican ratio of investment to steel demand was calculated in 1950 dollars, and the price of steel in 1950 was 215 dollars per ton, the calculation is:

$$\frac{0.13 \times 500 \text{ million dollars}}{215 \text{ dollars}} x = 300{,}000 \text{ tons.}$$

Table 3

CENTRAL AMERICA: IMPORTS OF IRON AND STEEL PRODUCTS, 1950 AND 1955-60

(Thousands of tons)

Product	*1950*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*
1. *Tubes* [a]	16.7	20.9	27.2	30.9	21.4	22.6	22.9
2. *Flat rolled products* [b]							
TOTAL	*6.3*	*14.7*	*18.3*	*18.9*	*15.2*	*32.6*	*31.9*
Tin plate	0.3	2.7	4.0	3.6	3.6	4.2	4.6
Other [c]	6.0	12.0	14.3	16.2	11.6	28.3	27.3
3. *Other rolled products*							
TOTAL	*37.7*	*70.8*	*75.2*	*95.8*	*71.5*	*63.5*	*76.5*
Bars [d]	...	1.1	1.9	1.5	0.7	1.0	1.5
Shapes and rods [e]	20.4	38.7	39.2	53.9	31.0	35.6	45.4
Wire [f]	6.2	12.6	12.4	14.1	14.3	11.5	15.1
Rails and accessories to rails [g]	3.1	1.5	2.0	3.4	1.6	2.7	2.1
Secondary products [h]	8.0	16.9	19.7	22.9	23.9	12.8	12.5
4. TOTAL (1 + 2 + 3)	*60.7*	*106.4*	*120.7*	*146.5*	*108.1*	*118.7*	*131.4*

SOURCE: Foreign trade yearbooks.

a Mainly tubes of rolled steel, but also includes tubes of cast iron and accessories (681-13-00; 681-14-00).

b Excludes tubes of rolled steel (681-07-01).

c Includes the primary products produced by cold or hot rolling of steel: plates, band, strip, hoop, and flat bars, whether coated or not (681-05-00; 681-06; 681-07-02 and 03).

d Includes billets, bloom, ingots, and bars (tool-steel bars) (681-03-00).

e Includes concrete reinforcing bars, angles, sections, shapes, rods and unassembled joists and beams (681-04-00).

f Includes wire, wire cables and barbed wire (681-12-00; 699-03-00; 699-05-01).

g (681-08-00; 681-11-00).

h Includes various items including prefabricated structures and houses, nails, bolts, etc. (699-01; 699-07-01; 811-01-02).

With respect to the items which need a regional market for economic operation, the best prospects during the initial stage seem to be offered by items such as tubes, wire, merchant mill shapes and rods for construction. The establishment of plants of a size suitable for the manufacture of other items (rolled sheeting,[7] structural shapes, rails, etc.) requires a considerably larger market than the Central American countries would be able to provide in the near future.

The above projections do not purport to be forecasts; their only purpose is to provide a rough idea of the future steel requirements implied by an accelerated industrial development within the economic integration programme. The extent to which Central American production can meet these requirements depends largely on the co-ordinated policy of promotion and support being undertaken by the member countries. The broadening of the market area and the preferential tariffs resulting from the economic integration treaties are necessary conditions for the establishment of a Central American steel industry, but will not suffice to ensure its success.

As far as regional industries are concerned, the above-mentioned policy has the support and co-operation of the Central American Bank and of the technical and administrative agencies set up under the integration programme. At the same time, national agencies will have to give particular attention to smaller industries which manufacture such items as tin containers, metal furniture, kitchenware, nails and tools, and some parts for motor vehicles. Private initiative will also have an important share in the establishment of the above-mentioned industries, both national and regional.

Central American imports of the items mentioned (tubes, wire, shapes and rods for construction) amounted to an average of 79,000 tons in the period 1957-59 (see table 3). Excluding large diameter pipes and large shapes, the production of which would not be economically feasible in the first stage, would reduce the above figure to some 70,000 tons.[8]

Leaving aside the consumption of locally-manufactured rods, which, it is assumed, will continue to be produced by the existing small foundries, the available market for the new industry will double within a period of seven years, to reach some 140,000 tons in 1966 and over 200,000 tons in 1970, in accordance with the higher assumed growth rate of 10 per cent. The more conservative projection, on the other hand, would result in a

[7] With the possible exception of bands for the manufacture of welded tubes.

[8] This is an approximate figure based on partial data. Tariff classifications in the Central American countries are not sufficiently detailed for a more accurate calculation to be made.

total demand of 112,000 tons in 1966 and over 145,000 tons in 1970, in terms of finished products.

Bearing in mind the considerable interval which must elapse before the industry can begin operations, as well as its other characteristics, the potential demand for rolled steel that can be produced in Central America seems adequate to warrant the installation of an integrated plant in the area. On the basis of the more conservative projection, the plant's basic steel mill should have a capacity of between 150,000 and 200,000 tons of ingots. The plant should also include rolling-mills for the manufacture of small shapes, rods and strip, a wire-drawing machine and a mill for the manufacture of welded tubes.

2. General considerations on the economic feasibility of a steel-manufacturing plant in Central America

On the basis of earlier analyses and data available on the characteristics of the scale of production in other countries, the possibility of establishing an integrated steel-manufacturing plant in Central America does not appear to be limited by the size of the market. Prospects for the industry depend more upon the iron ore and coal resources available in the area. In this connexion, the surveys and analyses undertaken so far are not conclusive. According to recent information there are sizable iron deposits in Nicaragua and Costa Rica, although their precise extent has not yet been fully determined. In Honduras a study has been made of the deposits in the vicinity of Agalteca, some 40 kilometres north of Tegucigalpa. The deposits were found to consist of between 8 million and 10 million tons of high quality ore (with an average iron content of 53 per cent). This large quantity of ore is sufficient for the establishment of an integrated steel-manufacturing plant, and the problem is then mainly one of determining the amount of coal which can be made available to Central America.

In Honduras, coal deposits have also been found in a number of places, within a radius of 100 kilometres from the iron deposits. The results of surveys made in some of them have not been very encouraging as to quantity and quality, and there is therefore some doubt whether the iron ore can be processed in a blast furnace. On the other hand, thought has been given to the possibility of adopting the direct ore reduction process in electric furnaces which use less coal, of a lower quality; a method which, of course, requires an adequate supply of low-cost electric power. A supply may be available from the Lake Yojoa-Lindo River project now under way, of which the total potential has been fixed at 160,000 kW on the basis of three plants and ten units to be installed in stages over a fairly long period because of the market's slow rate of growth. Should the steel-manufacturing plant prove feasible, the additional generating units might be set up more quickly to meet its requirements, estimated at 50,000 kW.

While the outlook in Honduras is promising, the project is still in a very early stage. It is expected that the systematic surveys and analyses now being carried out will have to go on for some time before a final verdict can be reached as to the economic feasibility of a basic steel mill.

In the meantime, a study should be made of the possibility of manufacturing rolled steel in Central America on the basis, in the initial stage, of imported billets or ingots. It must be pointed out that the rolling-mill should be viewed, from the standpoint of capacity and design, as the first unit of an integrated steel combine and not as an alternative to the basic steel mill mentioned earlier. In the last resort, if it is decided that the basic steel mill is not a feasible proposition, one or more semi-integrated plants could still be built, by adding to the rolling-mills electric furnaces for melting down scrap and cast-iron.

This alternative might be suitable within a few years, as more local scrap becomes available. In any case, part of the requirements of the new smelters will have to be met through imported scrap or cast-iron. Mexico's experience with semi-integrated plants shows that the project is feasible if it can operate at an adequate level of production.

As the first unit of an integrated or semi-integrated steel-manufacturing industry, the rolling-mill should have a production capacity sufficient to supply a substantial part of the potential Central American market. As previously suggested, the process might begin with the rolling of small shapes and rods and move in successive stages to the production of wire and strip for welded tubes.[9] The analysis in the following pages will be confined to a rolling-mill for shapes and rods, although this does not rule out the inclusion, from the outset, of a wire-drawing machine.

Total Central American imports of shapes and rods amounted to some 36,000 tons in 1959, a drop of 3,000 tons from the 1955 figure (see again table 2). The 1959 figure can nevertheless be taken as a basis for estimating the available market for the new plant, since it includes some proportion, though small, of large shapes that will not be produced in the initial stage. Allowance is also made for the rods now being supplied by local foundries.

On the basis of the highest of the two assumed rates of growth mentioned earlier (10 per cent), it is estimated that the potential market for the rolling-mill will double in seven years, reaching 72,000 tons in 1966 and over 100,000 tons in 1970. Since steel consumption in the base year (1959) was a little lower than in previous years, the projection produces results similar to those of the extrapolation based on the past trend (see figure II).

It will be recalled that this trend was determined in part by exceptional factors and cannot be maintained in future years if the market for rods continues to depend largely on housing construction. The above projection is based on the assumption that greater use of shapes and rods in the construction of industrial buildings and public works will largely compensate for the lower rate of increase in the consumption of these items for housing construction.

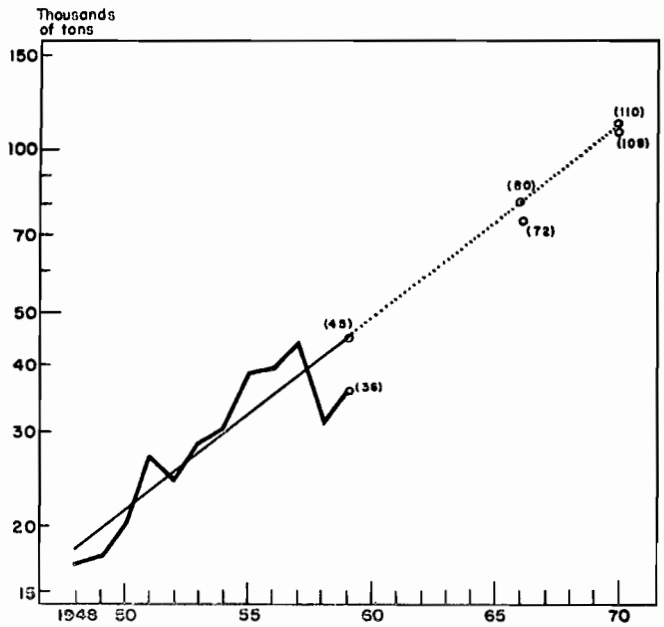
The estimates given above indicate the limits within which the capacity of the new plant can be planned. The extent to which the regional market can be supplied depends upon a series of factors — location, internal

[9] Production of welded tubes in Central America might begin on the basis of imported strip. See below, section II.

Figure II

CENTRAL AMERICA: APPARENT CONSUMPTION OF IRON AND STEEL RODS AND SHAPES, 1948-59, AND PROJECTION TO 1970

Semi-logarithmic scale



SOURCE: Table 2.

transport costs, etc. — which must be carefully studied before the optimum size of the plant can be determined. But in any case, the most important factor is the cost of the plant itself, and this, in turn, is largely in inverse ratio to its size.

It should be emphasized that even a plant capable of supplying the bulk of the Central American market would be exposed to competition from larger and more efficient plants abroad. Moreover, the rolling-mill would, in the initial stage, use imported ingots or billets, thus reducing to a minimum the natural protection represented by the cost of transport from abroad. Both these factors would considerably reduce the margin of operation of the rolling-mill. According to available information, the unit cost (c.i.f.) of billets imported into Central America ranges at present from 100 to 120 dollars per ton, while that of finished items fluctuates between 150 and 160 dollars a ton.

The above consideration is important, although not decisive, if account is taken of the benefits to be derived from the establishment of a rolling-mill as a first step in the creation of an integrated or semi-integrated steel industry in the area. The economic desirability of the new plant depends not only on the direct benefits to be derived (in terms of employment, foreign exchange savings, contribution to the national product, etc.) but also upon the indirect benefits accruing from a future expansion of the steel industry and from the impetus it will give to the development of other related branches of industry.

Obviously these benefits can only be derived if the plant is large enough, from the outset, to allow the industry to develop on a regional scale. From the short-term standpoint it might be better to set up a relatively small plant designed to supply the present Central American market. Such a plant would have the initial advantage of being able to operate at full capacity from the beginning and of requiring only a moderate investment.

A plant with a maximum capacity of 30,000 tons, for example, would require a total investment of 1.3 million dollars, of which 0.3 million dollars would represent working capital requirements.[10] The rolling-mill, operating at full capacity (three shifts), would provide work for 175 persons. Even so, its rolling costs would be relatively high, amounting to some 50 dollars per ton, which is equal to or more than the margin between the c.i.f. price of imported billets and that of the finished product, without taking into account sales costs or profits. A rolling-mill of this size would not be commercially feasible unless it were protected by a fairly high tariff which might even be out of proportion to the benefits which the regional economy would derive from the plant. This type of rolling-mill could only supply 40 per cent of what the regional market is expected to require within a few years. At the same time, since the industry does not lend itself easily to sub-division, the existence of a plant of this capacity would be likely to prevent the installation of a new plant large enough to operate under relatively efficient conditions, with better prospects for the development of the rolled steel industry in Central America.

Two large plants with different levels of mechanization are examined below. A comparison of the two plants will clarify the questions of plant size, investment, manpower, manufacturing costs and other factors that have to be taken into account in designing a plant suitable to the conditions obtaining in Central America.

3. POSSIBILITIES OF A HIGH-SPEED AUTOMATIC ROLLING-MILL

Assuming that by 1966 the new rolling-mill were to supply 70 per cent of the regional market, its annual capacity should not be less than 50,000 tons. Moreover, since the economic life of the plant is at least ten years, a considerably higher capacity could be planned for 1970, when the area's total demand will exceed 100,000 tons. In addition favourable conditions will be required with respect to location and intra-regional transport costs in order to compete with the imported product on a reasonable economic basis and without undue tariff protection.

In this connexion, it should be pointed out that the Central American rolling-mill would produce a limited number of construction items (small shapes and reinforcing rods) so that savings on production costs could be effected by operation on an adequate scale. The calculation of unit production costs made below is based on experience with plants which produce a wide range of rolled steel items (see table 4). Costs for the Central American plant might therefore be somewhat lower.

In view of the above considerations, an automatic continuous rolling-mill of sufficient capacity to meet the requirements of the present Central American market is

[10] See ICA, *Operational Data, Small Steel Rolling Mill* (Washington D.C., February 1958). The above estimates, expressed in 1957 prices, are for a plant established in the United States.

Table 4

COMPARISON OF TWO ROLLING MILLS PRODUCING SHAPES AND RODS

	Automatic rolling mill	*Semi-automatic rolling mill*
Capacity (tons)	60,000 (two shifts)	50,000 (three shifts)
Annual output (tons) [a]	50,000	50,000
Total investment (in millions of dollars)	8.0	3.0
Fixed capital	6.5	2.0
Working capital	1.5	1.0
Number employed	100	300
Direct workers	75	250
Indirect workers	25	50
Rolling cost per ton (dollars) [b]	30	40
Fixed investment per worker (dollars)	65,000	7,000

SOURCE: Study of experience in Mexican rolling mills.

a Output has been assumed to be the same in both cases for purposes of comparison.

b This relates to the cost of transforming the billets or ingots into shapes and rods, and does not include profits or sales costs. Depreciation, calculated on the basis of a useful life of ten years for the mill, is 13 dollars per ton for the automatic mill and 4 dollars a ton for the semi-automatic mill.

considered first. Experience with this type of plant set up in Mexico and other Latin American countries is most useful for purposes of illustration.

According to experts in some Latin American steel-manufacturing plants, the installation of such an automatic rolling-mill in Central America would require an investment of some 8 million dollars (6.5 million dollars for the plant and equipment and 1.5 million dollars for working capital. The plant would have modern high-speed equipment, and both the rollers and reheating furnaces would be operated by electricity. Two rollers would be needed, since one would not provide sufficient output, and imported billets of good quality would have to be used.

The annual output of the plant, operating on a two-shift basis, could be as much as 60,000 tons, and its capacity would be sufficient to supply the Central American market for the next ten years. It would provide relatively little employment, because of its high degree of mechanization; labour requirements are estimated at 100 persons, three-quarters of whom would be plant workers.

The estimated cost of a regional automatic rolling-mill is based on data provided by Mexican producers familiar with the production conditions likely to obtain in Central America. Assuming that annual output will amount to 50,000 tons, production costs are estimated at 30 dollars a ton, which is well below the figure given for the smaller plant mentioned earlier (see table 4).

In view of the substantial capital investment needed to set up the plant, depreciation charges will constitute the major cost factor in the initial stage. Assuming, for accounting purposes, that the useful life of the plant is ten years, depreciation charges will represent nearly half of the rolling cost. It should be pointed out that plants now operating in Latin America have a useful life of more than ten years, in both real and accounting terms. If the proposed Central American plant adopts a longer period of depreciation, capital costs will be somewhat lower. It should also be borne in mind that after a time capital costs are likely to increase because of greater expenditure on plant and equipment maintenance.

The proposed automatic rolling-mill for Central America has both advantages and disadvantages. One of its advantages is the relatively low cost of operation compared with a less automatic plant (see again table 4). The rolling cost of 30 dollars a ton might make the operation economically feasible in view of the existing margin between the price of imported billets and imported finished products. Secondly, an efficient modern rolling-mill might later become part of an integrated or semi-integrated steel industry. Lastly, if the rolling-mill operates on a three-shift basis it could produce at least 90,000 tons a year, which would be enough to meet the requirements of the Central American market as estimated for the next decade.

One of the major disadvantages is the fact that an automatic rolling-mill will need highly qualified technicians who would have to be contracted abroad, at least during the initial stage. Experience in Latin America shows that even with these technicians the cost of maintaining a plant of this type is higher than that of other types of installation. Secondly, a rolling-mill of the kind described operates more efficiently when it produces a single item on a mass-production basis. Production of the range of items needed in Central America would therefore be more costly. Moreover, in order to prevent damage to the machinery of an automatic plant, only high quality billets should be used, and this again raises the cost. Lastly, the automatic plant requires such a high capital investment per worker that, as previously indicated, manpower absorption is low.

Considering the above pros and cons and the present degree of industrial development in Central America, thought should first be given to a less mechanized plant that would involve a smaller capital investment, provide more employment and be better adapted to the conditions under which Central American industry operates.

4. POSSIBILITIES OF A SEMI-AUTOMATIC ROLLING-MILL

To judge from Mexico's experience with rolling-mills, the cost of installing a semi-automatic rolling-mill in Central America (with an output of 50,000 tons a year based on three shifts) can be estimated at 3 million dollars (2 million dollars for the plant and equipment and 1 million dollars for working capital). The plant would need two rollers of the reversing rather than the continuous type. Operating at full capacity, it would use 300 workers, of whom 250 would be plant workers.

Rolling costs per ton would probably be higher than for an automatic rolling-mill but lower than for the smaller plant mentioned earlier. Moreover, the semi-automatic rolling-mill can use ingots instead of billets, thus reducing unit costs. It should also be borne in mind that because of the high maintenance cost, the operating cost of a highly mechanized rolling-mill might exceed the estimated figure.

Estimated rolling costs for the semi-automatic plant would amount to around 40 dollars a ton under present price conditions. Depreciation charges, based on a useful life of ten years, would be relatively low (4 dollars a ton). Total unit rolling costs would probably be such as to make it impossible for the plant to operate within the margin allowed by the difference in the price of imported billets and imported finished products, and therefore its establishment would require a higher tariff protection.

One important advantage of the semi-automatic rolling-mill is its higher manpower absorption compared with an automatic plant. Assuming that both plants operate at full capacity, the less mechanized plant would use twice as many workers and employees. For the automatic rolling-mill, the labour force would be even smaller during the early years because it could only use two shifts, in view of the ratio between its capacity and the size of the market.

A non-continuous rolling-mill is more suitable for the manufacture of a range of items. The cost of changing the rollers and shapers needed to produce bars of different sizes would be lower in a plant of this type and production on a smaller scale would likewise be more feasible.

The semi-automatic rolling-mill with an output of 50,000 tons could supply a substantial part of the future Central American market. However, its capacity in 1970 would be well below the estimated demand for that year. A careful study will have to be made of the cost of intra-regional transport in order to determine what proportion of the Central American market could be supplied by a new plant of this type. Such a study might indicate that a larger semi-automatic plant (e.g. with a capacity of 50,000 tons operating initially on a two-shift basis) would be more suitable.

Lastly, on the basis of the information available it seems that a larger semi-automatic rolling-mill could also form part of a basic steel plant, assuming that such a plant can be established. However, the reduced speed of the semi-automatic process might make integration difficult, a problem which would not arise with an automatic plant.

5. Conclusions

The combined market of the five Central American countries for rolled steel, as estimated for the next ten years, should make possible the establishment of an integrated steel plant which, using iron ore, could manufacture the rolled products most in demand in the area, such as small shapes, rods, wire and welded tubes.

The possibility of setting up a basic steel plant therefore depends essentially on the prospects of the industrial development of the region's iron and coal resources. While the results of surveys and analyses carried out so far are not conclusive, they are nevertheless sufficiently promising to warrant their continuation on an intensive scale.

The experience of other Latin American countries shows that the manufacture of rolled steel is feasible in semi-integrated plants using local or imported scrap. This is a step worth considering as a possible alternative within the next few years as available stocks of local scrap — perhaps as a last resort supplemented by imported scrap or cast-iron — expand.

Meanwhile the possibility of setting up rolling-mills which would begin by using imported ingots or bars and would later form part of an integrated or semi-integrated steel-manufacturing complex should be studied. The first step might be the rolling of small shapes and bars, the items most in demand in the area.

Analysis of the demand for these products shows that the regional market would justify the establishment of a single plant of sufficient size to operate under economically reasonable conditions. Such a plant could be either a high-speed automatic rolling-mill or a semi-automatic plant. The latter would require a much smaller investment and would provide jobs for a much greater number of workers and employees. An automatic plant, on the other hand, would have much lower production costs and could probably be integrated into a basic steel-manufacturing plant more easily.

It follows from the foregoing considerations that the development of an economically viable steel industry in Central America is hardly conceivable unless the countries concerned, as a matter of policy, join forces in promoting and supporting it. Such a policy can only hope to be successful if it rests on co-ordinated programming of the development of the industry at each stage and is based on preliminary studies ranging from the area's potential market and mineral resources to the final plans for the production units. Unless this is done all that can be expected is the establishment of a number of small highly protected plants, which will considerably delay or even prevent the establishment of an integrated industry capable of satisfying, with relative efficiency, the area's requirements for steel products.

II. WELDED TUBES

The following section represents a preliminary survey of the possibility of manufacturing in Central America the welded tubes now being imported into the area. In addition to an evaluation of the Central American market, data are provided on a plant using the electric resistance welding method. The information gives some idea of the investment, labour, and production costs needed for the smallest possible installation able to supply a substantial part of the present regional market. The estimated increase in the demand for tubes over the next ten years might justify a larger plant or, alternatively, the establishment at some future date of a second plant on a regional scale. Any decision taken in this respect will require a careful study of transport and distribution costs in the region and of the economies of scale which might be effected in the production costs of plants of various sizes.

The present note is confined to the manufacture of small diameter tubes — possibly based on imported steel

billets during the initial stage. This could be expanded, as the regional market grows, to include the production of medium diameter tubes. Expansion of the industry might make it worth while later for the rolling of steel billets to be carried out in the area itself. As pointed out [11] the welded tubing plant, together with the rolling-mills for sections, rods and wire, might provide the basis for the establishment, at some future date, of an integrated or semi-integrated steel manufacturing industry in Central America.

1. The Central American market

In 1959 the demand for iron and steel tubing on the Central American market amounted to 23,000 tons, with a c.i.f. value of 5.2 million dollars.

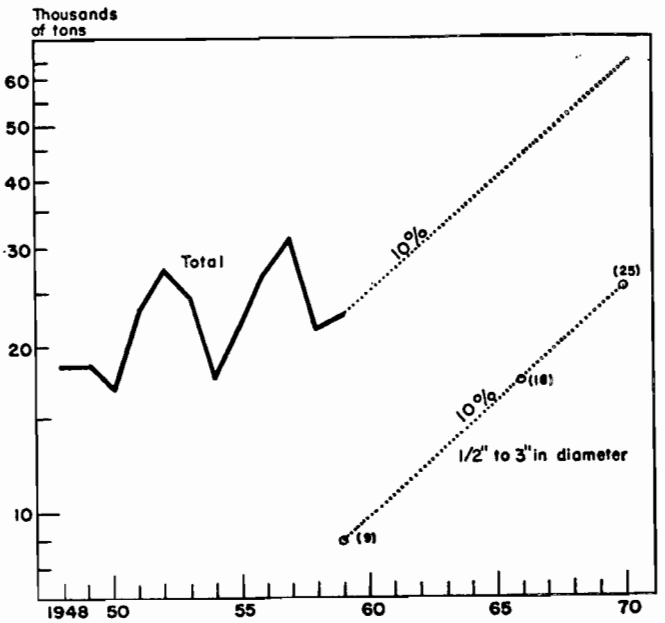
Between 1948 and 1953 imports into Honduras were exceptionally high, largely as a result of investment by the fruit companies. Leaving these imports aside, the market for iron and steel tubes in the other countries has been steadily and rapidly increasing, rising from under 7,000 tons in 1948 to over 28,500 tons in 1957, then declining to 17,200 tons in 1958 before staging a partial recovery to 20,500 tons in 1959 (see table 5).

[11] See above, section I.

Figure III

Central America: Apparent consumption of iron and steel tubes, 1948-59, and projection to 1970

Semi-logarithmic scale



Source: Table 5.

Table 5

Central America: Imports of iron and steel tubes, 1948-60 [a]

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Total for Central America	Panama	Total for Central America and Panama
				Volume *(tons)*				
1948	2,872	1,190	2,189	11,595	712	18,558	...	...
1949	3,824	1,361	4,832	7,360	1,133	18,510	3,834	22,344
1950	1,456	1,682	5,994	6,913	705	16,750	1,701	18,451
1951	2,862	2,175	3,361	13,943	881	23,222	3,293	26,515
1952	3,067	2,290	2,960	17,865	1,384	27,566	3,048	30,614
1953	5,303	1,525	6,601	9,581	1,451	24,461	2,127	26,588
1954	5,076	3,409	4,408	2,963	1,628	17,484	2,395	19,879
1955	6,193	3,692	7,062	1,807	2,141	21,615	3,784	25,399
1956	8,593	5,343	8,986	2,612	1,660	27,194	4,670	31,864
1957	11,974	3,494	9,833	2,376	3,221	30,898	6,667	37,565
1958	3,294	3,682	8,143	4,195	2,083	21,397	5,394	26,791
1959	4,709	3,481	10,766	2,141	1,535	22,632	3,949	26,581
1960	7,758	3,988	7,894	1,727	1,580	22,947	4,698	27,645
				C.i.f. value *(thousands of dollars)*				
1948	555	313	597	1,772	193	3,430	...	...
1949	722	440	1,260	1,195	322	3,939	1,894	5,833
1950	309	436	1,167	1,016	191	3,119	290	3,409
1951	557	616	944	1,995	359	4,471	728	5,199
1952	538	596	757	2,710	489	5,090	738	5,828
1953	922	404	1,305	1,567	415	4,613	418	5,031
1954	844	832	969	675	505	3,825	489	4,314
1955	1,314	841	1,288	489	594	4,526	792	5,318
1956	1,898	1,265	2,568	726	523	6,980	1,125	8,105
1957	2,129	1,013	2,599	672	1,280	7,693	1,217	8,910
1958	1,048	934	1,887	1,230	731	5,822	1,817	639
1959	1,234	852	2,206	606	480	5,378	808	6,186
1960	1,609	932	2,053	528	582	5,704	936	6,640

Source: Foreign trade statistics.

[a] Includes iron and steel tubes, whether coated or not, and pipes and fittings of cast iron (NAUCA, 681-13-00 and 681-14-00).

The annual rate of growth was thus over 10 per cent, calculated on the basis of the trend line of imports in the period 1948-59 [12] (see figure III). A similar trend was noted for Central America as a whole between 1953 and 1959, when Honduras imports developed at a rate more or less in line with that of the other Central American countries.

The rapid rise in Central American consumption of tubes reflects the high growth rate of the construction industry which — to judge by the consumption of cement — was about 10 per cent a year between 1950 and 1959. Subsequently construction activities have tended to become stabilized as income from exports declined or remained at a standstill.

For over ten years the Central American market for steel tubing has increased at a more rapid rate than the market for iron and steel products in general. While the annual growth rate of tubing imports was 10 per cent between 1948 and 1959, the rate of growth of iron and steel products as a whole was only 6.4 per cent.[13] The higher growth rate of the market for tubing is presumably connected with the relative volume of the input of tubes per unit of total construction and to the replacement needs in existing constructions.

On the basis of certain conjectures as to the possible behaviour of the construction industry during the present decade, it was estimated in the previous section that consumption of iron and steel products might increase at an annual rate of 10 per cent. Since in the past the market for welded tubes has grown more rapidly than the market for rolled iron and steel, a similar assumption (10 per cent) with respect to the foreseeable growth of demand for tubes might be conservative.

While the pattern of the construction industry during the past few years cannot be measured directly in quantitative terms for lack of data, and its future development cannot be projected in reasonably accurate form for lack of figures, certain significant signs — such as the existence of new sources of external financing, the specific orientation of the processes of mobilization of domestic resources, and the institutional development of the Central American countries — point to a substantial expansion of housing programmes in an attempt to meet the needs deriving from the population growth and gradually to reduce the housing shortage. Moreover, investment in industry and the construction of public works will increase more rapidly during the next few years and thus produce an appreciable rise in related housing and construction activities.

Hence, there is reason to believe that a corresponding increase will occur in the demand for tubing to meet the requirements of housing, industry and infrastructural works. This is the basis for the assumption that there will be at least a moderate increase in the future demand for tubing. While much of this demand may be met by copper tubing — as it is in Mexico and Panama for low-cost housing — the share of welded steel tubing and the increase in demand for this item are likely to remain relatively high.

Since there are insufficient background data to permit a more accurate estimate of the future growth of the Central American market for welded tubing, it is assumed that demand will grow at an annual rate of 10 per cent. This means that the volume of demand will double within seven years and reach 65,000 tons in 1970 (see again figure III).

These figures cover tubing of every type. From a more detailed breakdown for some countries in the area, it is estimated that welded tubing represents nearly 80 per cent of the total. Application of this coefficient to the corresponding imports indicates that the consumption of welded tubing in 1959 was some 18,000 tons, which is not enough to warrant the establishment of a relatively expensive plant capable of manufacturing tubing of every size.

A Central American plant would therefore have to confine itself, at least in the initial stage, to the manufacture of ½-inch to 3-inch tubing. On the basis of the figures for Guatemala, which provide detailed data on small diameter tubing, it is estimated that this type of tubing represents about 50 per cent of the total imported, i.e., some 9,000 tons in 1959 for Central America as a whole. In line with the assumed annual rate of demand growth of 10 per cent, annual consumption of small diameter tubing would amount to about 18,000 tons in 1966 and could exceed 25,000 tons in 1970 (see again figure III).

During the first stage, larger diameter tubing would still be imported. In the past, demand for this type of tubing has been subject to wide annual fluctuations since it was largely determined by public works in the field of irrigation, electric power generation and water supply. It should be pointed out, moreover, that for the past few years cast steel or iron tubing has been profitably replaced for such uses by asbestos-cement tubing currently produced in the area, which has the advantage of being much cheaper. In other countries, such as Mexico, large diameter steel tubing has been chiefly used for the construction of oil and gas pipes for the petroleum industry.

2. Size of plant

In the United States the manufacture of welded tubing is usually part of the activities of integrated steel plants. Out of the total sales of welded tubing in 1954 (1,551 million dollars), only 30 per cent (466 million dollars) was produced by special plants using purchased rolled steel.[14]

Of the 88 special plants operating in 1954, 41 were small (fewer than 100 employees), 33 were of medium size (between 100 and 150 employees) and 14 were large (over 500 employees). The small plants produced in 1954 less than 6 per cent of the total output of the 88 plants (204 million dollars).[15] It would therefore seem that either a medium-size or large plant, capable of producing tubing

[12] In calculating the trend line, allowance was made for part of Costa Rica's exceptionally high imports in 1957 of large diameter tubes for the La Garita hydroelectric dam.

[13] See above, section I.

[14] United States Department of Commerce, Bureau of the Census, *Census of Manufactures, 1954*, vol. II, group 33 D, table 5 A.

[15] *Ibid.*, table 4.

of every size, would be economically desirable where a broad market exists.

Production of small diameter steel tubing in Mexico began in 1947. Six companies are now in operation and a wide range of tubing is manufactured. Only a very small part of the output of the country's major steel producer consists of tubing. Another plant — the largest, which uses its own ingots — produced in 1959 a little over 100,000 tons, most of which was large diameter tubing used chiefly by the petroleum industry. This plant represents a total investment of 16 million dollars.[16]

In Peru, which has a market equal to that of Central America as a whole, production of small diameter tubing — ½-inch to 2 inches — began in 1955 with a plant which has an annual output capacity of about 9,000 tons and uses imported steel strip already cut to specified size.[17]

The approximate breakdown of the fixed investment in a plant installed in the United States, with an annual capacity of 9,500 tons, operating on a single-shift basis, would be as follows: [18]

	Dollars
Pipe mill	230,000
Galvanizing bath	42,000
Auxiliary machinery for slitting, cleaning and other equipment	168,700
EQUIPMENT TOTAL	440,700
Buildings	210,000
FIXED INVESTMENT TOTAL	650,700

The fixed investment total for a plant of the same size set up in Central America would be from 20 per cent to 25 per cent higher, i.e., about 800,000 dollars, assuming that the equipment is imported from the United States.

The plant would employ 48 persons, of whom 22 would be skilled workers (direct labour) and the rest executive, supervisory, office and maintenance personnel.

Working on a two-shift basis, the plant would produce 19,000 tons a year, more than enough to meet the requirements of the Central American market as a whole as estimated for 1966. The capacity of the plant could be expanded by increasing the size of the welding transformer and thus increasing the speed of the pipe mill. The equipment would use the resistance welding process. Inductive welding would require more expensive equipment with an increase of approximately 500 per cent of rated capacity, far more than the estimated requirements of the Central American market in 1970.

The above considerations on the possibility of expanding capacity are based, *inter alia*, on the assumption that transport costs within the area will be such as to allow a single plant to supply economically the bulk of Central America's requirements. If not, it might perhaps be better to set up, by 1970, two plants in the vicinity of the main consumer centres.

3. Capital requirements

Total capital requirements for a plant of the type mentioned, with an annual output of 9,500 tons, are estimated at some 900,000 dollars, of which 240,000 dollars would be for working capital and 650,000 dollars for fixed investment. These figures are based on 1956 prices in the United States.

The estimate for working capital is based on a raw materials inventory sufficient for one month of production, but in view of present transport conditions in Central America a three-month supply of raw materials would have to be stocked. This circumstance, plus the higher transport costs for raw materials and equipment, would raise working capital requirements to some 300,000 dollars. The additional fixed investment costs would bring the total capital requirements to about 1.1 million dollars.

4. Raw materials and production costs

The main raw materials needed for the production of welded tubing are strip steel and zinc for galvanizing. Also required are sulphuric acid and small quantities of cooling and cutting compounds. The following raw materials would be required for a monthly output of 800 tons:

Strip steel	800 tons
Zinc	64 tons
Sulphuric acid	14 tons
Cooling compound	954 litres
Cutting compound	764 litres
Zinc bath flux	229 kg

Raw materials constitute the main item of production costs. The breakdown of costs per ton of production for a plant of minimum size in the United States is shown in table 6. On an average, raw materials costs represent nearly 80 per cent of the total.

Table 6

UNITED STATES: ESTIMATED COST OF PRODUCTION PER TON OF GALVANIZED WELDED TUBES [a]

	Dollars [b]	*Percentage*
Raw materials	*123.7*	*79.9*
Strip steel	99.0	64.0
Zinc	19.4	12.5
Other (sulphuric acid, lubricants, etc.)	5.3	3.4
Labour	*26.0*	*16.8*
Direct labour	11.5	7.4
Indirect labour	14.5	9.4
Depreciation	4.4	2.8
Power, fuel, etc.	0.7	0.5
TOTAL	*154.8*	*100.0*

[a] Calculation based on ICA, op. cit., pp. 7-11.

[b] Calculated at 1956 prices for a plant of minimum size with an annual output of 9,500 tons of small-diameter welded tubes (up to 3 inches).

[16] Latin American Iron and Steel Institute (Santiago, Chile), *Repertorio de las empresas siderúrgicas latinoamericanas, 1960-61*, pp. 153 *et seq.*

[17] *El desarrollo industrial del Perú* (E/CN.12/493), United Nations publication (Sales No. : 59.II.G.2), p. 145.

[18] Calculated at 1956 prices. See International Co-operation Administration (ICA), *Operational data, Galvanized steel pipe*, Washington D.C., May 1957.

Since most of the raw materials must be imported, the unit cost of production would be higher in Central America, although specific figures cannot be given for lack of sufficient data. A somewhat arbitrary estimate — assuming that the cost of raw materials in Central America is 25 per cent higher than in the United States — would be 180 dollars per ton.[19]

Labour costs would be probably lower in Central America. While no specific figures can be given, it can reasonably be assumed that, since labour costs are only a small fraction of the total cost of production, the difference in labour costs would not appreciably affect the total cost or the yield of the plant.

5. Annual sales

An average cost of 180 dollars per ton is relatively low considering the c.i.f. unit cost of imported tubing which, on an average for the five countries concerned, amounted to 262 dollars in 1956. This would leave a fairly ample margin for transport, sales and administration costs, interest, taxes, insurance and profits. The following estimate, made for purposes of illustration, is based on a sales price equal to the average c.i.f. unit value of tubing imported in 1956.

	Dollars
Annual income from sales (9,500 tons × 260 dollars)	2,470,000
Less: cost of manufacturing (9,500 tons × 180 dollars)	1,710,000
Gross profit ex-plant	760,000

The margin of 760,000 dollars left to cover administration and sales costs, taxes and profits for a plant producing 9,500 tons on a single-shift basis would amount to 80 dollars a ton. This compares favourably with the United States, where 57 dollars per ton is allocated for those items.[20]

It should be pointed out that c.i.f. unit cost of tubing imported into Central America in 1956 (260 dollars per ton in round figures), used for the above estimate,[21] reflects differences which range from a low of 204 dollars per ton in El Salvador to a high of 313 dollars in Nicaragua. These variations are due, among other things, to differences in quality, country of origin, and the proportion of galvanized or black tubing in each country's imports in 1956. An estimate of possible sales prices would require a careful study of the present sales price of tubing imported into the countries concerned, intra-regional transport costs and other factors affecting the cost of tubing when it finally reaches the consumer.

6. Conclusions

From the standpoint of the size of the market, and taking into account the minimum size of an economic installation, the manufacture of small-diameter welded tubing in Central America appears to be feasible. The market for the next five years (1961-66) would justify the establishment of a single plant of economic size in the area. The possibility of manufacturing medium-diameter tubing should only be considered after a more careful analysis of the market potential has been made. The high content of imported input provided for, at least in the first stage, calls for a more thorough study of the cost of transport from possible sources or raw material abroad and of distribution costs within the area.

The establishment of a welded tubing industry, at least during the first years of operation, will not make an appreciable contribution to greater import substitution since the high content of imported ingredients in the final product will mean a relatively low value added. However, this is not a sufficient argument to reject *a priori* the manufacture of welded tubing in Central America. In fact, a broader view of its significance for the industrial development of the area would take into account the impetus it will provide to the establishment of other branches of industry, such as the manufacture of steel appliances and furniture. The establishment of a tubing plant would substantially increase the prospects of manufacturing rolled products in the area, and would contribute to the expansion of activities now using steel tubing by ensuring a steady and prompt supply.

[19] The minimum transport cost for raw materials is estimated at about 27 dollars per ton. This includes ocean freight from a Pacific Coast port in the United States to a Pacific Coast port in Central America, plus harbour charges. Ocean freight from other ports in the United States or Europe to Central America would be about 10 per cent higher than the estimated cost from the West Coast.

[20] ICA, op. cit., p. 12.

[21] Import prices for 1956 have been used since they are directly related to the production costs of the United States plant, calculated on the basis of prices for that year.

III. GLASS CONTAINERS

The following note constitutes a preliminary survey of the possibilities for the establishment of a glass container industry in Central America to supply the whole of the regional market. The evaluation of the market is based mainly on available import statistics. No explicit consideration is given to the question of how far the market would be affected by the substitution of containers manufactured from other materials for those made of glass. Nor has it been possible to determine the economic conditions in respect of plant size, investment costs, productivity and production costs that might in practice characterize the situation in Central America. The statistics and evaluation presented here for illustration purposes are based on a hypothetical factory with a capacity lower than the size of the available market would seem to warrant.

Central American demand for glass containers, at present met by imports, gives rise to a fairly substantial

outflow of foreign exchange. In 1959, the value of the five countries' purchases abroad was 2.2 million dollars. The articles in question are of some importance for the development and expansion of other productive activities, the major consumers today being the industries producing beer, soft drinks, milk products and edible oils and fats.

For an analysis of existing possibilities for the production of glass containers in Central America, the probable development of the total market must be assessed in quantitative terms, and Central America's potential share in it determined. Another essential step is to look into plant size requirements, the amount of investment needed and the probable production costs.

As regards the viability and importance of the industry from the standpoint of the integrated economic development of Central America, the aspects of the question to be investigated include those relating to the competitive position of the industry in Central American conditions, and the possible impact of its establishment on employment, on the saving of foreign exchange, on the integration of the manufacturing sector at the regional level and on the satisfaction of the requirements of industrial activities using glass containers.

1. The Central American market

Consumption of glass containers in the five Central American countries stood at 12,000 tons in 1959, with a c.i.f. value of 2.2 million dollars (see table 7). During the period 1950-59, demand increased at an annual rate of 9.3 per cent. Broadly speaking, its growth was steady, except for the downward movements registered in 1955 and 1958. As in the case of other goods, a peak was reached in 1957, when over 12,700 tons were imported. Of the five countries, Guatemala was the biggest consumer in 1959, when it accounted for 36 per cent of the regional total, followed by Costa Rica (23 per cent), Nicaragua (15 per cent), Honduras (14 per cent) and El Salvador (12 per cent).

The rapid expansion of the Central American market for glass containers reflects the growth of the leading consumer industries during the last few years. Between 1950 and 1959, consumption of beer and soft drinks

Table 7

Central America and Panama: Imports of glass containers, 1950-60

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Total for Central America	Panama	Total for Central America and Panama
				Volume *(tons)*				
1950	997	1,992	1,373	748	323	5,433	1,487	6,920
1951	1,127	1,984	2,243	842	619	6,815	1,341	8,156
1952	999	2,173	1,569	1,846	1,103	7,690	1,715	9,405
1953	2,146	2,535	1,684	1,618	997	8,980	1,562	10,542
1954	2,048	1,939	2,819	1,251	1,637	9,694	1,236	10,930
1955	2,304	1,444	1,884	1,437	1,961	9,030	2,230	11,260
1956	2,247	2,129	2,730	1,161	2,336	10,603	1,776	12,379
1957	2,223	2,491	4,069	2,330	1,631	12,744	2,240	14,984
1958	2,034	2,083	3,318	2,293	1,926	11,654	2,757	14,411
1959	2,768	1,399	4,243	1,753	1,789	12,952	2,579	14,531
1960	2,770	1,850	5,566	1,266	2,096	13,548	2,958	16,533
				C.i.f. value *(dollars)*				
1950	161	340	179	176	48	904	212	1,116
1951	219	363	312	83	115	1,092	192	1,284
1952	187	503	227	209	157	1,283	297	2,864
1953	423	515	220	135	158	1,451	261	1,712
1954	430	446	391	167	267	1,701	207	1,908
1955	423	302	238	250	310	1,523	325	1,848
1956	410	434	360	238	448	1,890	289	2,179
1957	419	499	537	398	334	2,187	398	2,585
1958	490	400	415	428	411	2,208	473	2,617
1959	552	314	662	345	361	2,163	509	2,672
1960	572	406	1,007	290	428	2,703	556	3,259

Source: Central American foreign trade statistics.

Note: The statistics for Costa Rica, El Salvador, Honduras and Nicaragua include glass containers of all types (with or without caps), except fancy containers NAUCA item 665-01-00 or the equivalent); for Guatemala, the series includes only beer and aerated water bottles. This country's imports of glass containers of all types amounted to 4,420 tons in 1958; consequently, in that year Central America's total imports reached 12,756 tons. For 1959 the total for item 665-01-00 was 5,238 tons. The figures for 1960 cover the whole of item 665-01-00 because no break-down was available. The Panama series covers only "glass bottles" and is comparable to that of Guatemala.

— the two industries which, according to an earlier ECLA secretariat study,[22] absorb 60 per cent of total imports of glass containers — increased at annual rates of 9 and 8 per cent, respectively.

In turn, the growth of demand for beer and soft drinks is closely related to the rise in real per capita income. During the period referred to above, the ratio was 1 to 3, i.e., every 1 per cent increment in real per capita income was accompanied by an average increase of 3 per cent in per capita consumption of beer and soft drinks.

The ratio between income and consumption was highly stable during the period under study. If it were maintained throughout the present decade, if the annual rate of growth of real per capita income were 2-3 per cent and if the population increased as projected, total consumption of beer and soft drinks might well expand at an annual rate of 14 per cent, which would be 50 per cent higher than the rate recorded during the fifties. Conversely, if the cumulative growth rate of real per capita income in Central America were the same as in the recent past (about 1.5 per cent per annum) and the other conditions described above remained unchanged, the consumption in question would probably continue to expand at the previous rate of about 10 per cent.

Hence, as in the past the rates of growth of the products referred to and of their containers have been identical, market expansion possibilities in respect of glass containers for beer and soft drinks in 1960-70 can be taken as lying between 10 and 14 per cent annually.

Insufficient data are available on the current level and future prospects of the demand for glass containers for the milk products and vegetable oils and fats industries. In all likelihood, these industries will undergo substantial expansion during the next few years. Currently, the output of pasteurized milk represents barely 5 per cent of the total volume produced; and imports of oils and fats from outside Central America constitute an important item in the Central American countries' total purchases abroad.

Both the available natural resources and the size of the market suggest that there are ample possibilities for expanding domestic production of milk products and vegetable oils and fats. In the case of the milk processing industry, the studies already undertaken under the economic integration programme might promote and encourage investment in the relatively near future. These growth trends in the processed food industries would strengthen the possibilities of improving upon former rates of increase of demand for glass containers.

The analyses which follow are based on a working hypothesis which postulates an annual rate of expansion of 14 per cent for the Central American glass container market. This would give total markets of about 30,000 tons by 1966 and 50,000 tons by 1970.

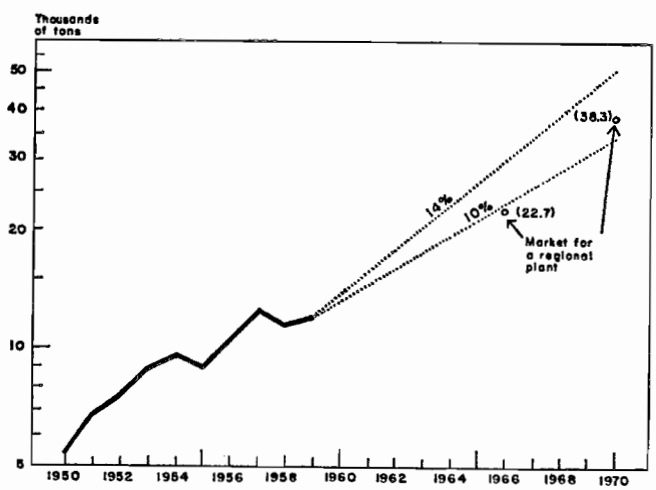
Such a working hypothesis calls for careful evaluation. On the one hand, it would be no easy matter for per capita income in Central America to rise at an average annual rate of between 2 and 3 per cent during the present decade. Furthermore, the hypothesis assumes that the total volume of the glass container market will develop as dynamically as its principal component — the beer and soft drinks industries. On the other hand, provided that an energetic development and import substitution policy were pursued in the other branches of industry mentioned above, the possibility of attaining even higher rates of increase in the volume of milk and of vegetable fats and oils processed would not seem unduly remote, given the relatively low level of current output and the comparatively wide margin for expansion offered by the available market. Another factor that must be taken into account is the favourable influence which might be exerted on demand by the establishment of a glass container industry in Central America, both because such containers could be manufactured at unit prices considerably lower than the c.i.f. import prices and because supplies would be assured and deliveries more punctual. Peru's domestic production, for example, satisfies over 90 per cent of demand; its population is slightly smaller than Central America's and its per capita income level is much the same, but its current per capita consumption of glass containers is almost twice as high.

It seems likely that, at any rate in the initial stages, the Central American market will not be supplied entirely by the area's own output, since the countries concerned will probably continue to import at least the most specialized types of glass containers. Given the present size of the market, the production of a wide variety of containers might involve technical difficulties and push up costs. It would be advisable at first to concentrate the production effort on the types for which the volume of demand was greatest, i.e., those used in the beer, carbonated beverages, pasteurized milk and edible oils industries. By 1970 the market available for Central American production would be equivalent to approximately 75 per cent of the total aggregate market, that is, some 38,000 tons, with an ex-factory value slightly exceeding 7 million dollars (see figure IV).

Figure IV

CENTRAL AMERICA: APPARENT CONSUMPTION OF GLASS CONTAINERS, 1950-59, AND PROJECTION TO 1970

Semi-logarithmic scale



SOURCE: Table 7.

[22] See *La integración económica centroamericana: desarrollo y perspectivas* (E/CN.12/422, United Nations publication, Sales No.: 56.II.G.4, p. 120).

2. General characteristics of production of glass containers

In countries with broad markets, glass containers are generally manufactured in large plants. In the United States, for instance, the average number of workers employed per establishment in this industry was 581 in 1954, as against an average of 55 in manufacturing industry as a whole. Of the 85 plants in operation, only four were in the category described as small (i.e., employing under 100 workers each), and their contribution to the total value of the industry's output in that year was less than 5 per cent. The 35 large plants (employing over 500 workers each) produced more than 75 per cent of total output, in terms of value added.[23]

In Mexico, although the market is much smaller, production of glass containers is highly concentrated, and as a rule they are manufactured in plants employing over 500 workers. While small factories do exist, their production is either marginal and based entirely on waste glass, or highly specialized, consisting in the manufacture of medicine bottles on the basis of purchased or imported tubing.

The concentration of production of glass containers in plants of large dimensions is partly attributable to the economies of scale that can be achieved in the initial stages of operation, in terms of tons produced. In the United States, for example, the unit cost of production in a plant of quite modest size (twelve moulding-machines) is 33 per cent less than in a factory of minimum dimensions operating with only one moulding-machine (see table 8).

Table 8

UNITED STATES: ESTIMATED COSTS OF PRODUCTION OF BEER BOTTLES, BY PLANT CAPACITY [a]

(Dollars per gross, packed, at 1957 prices)

	Number of bottle moulding machines				
	1	*2*	*4*	*6*	*12*
Raw materials [b]	2.40	2.40	2.40	2.40	2.40
Manpower	3.09	2.31	1.93	1.80	1.67
Costs relating to capital [c]	3.02	2.54	2.13	1.93	1.62
TOTAL	*8.51*	*7.25*	*6.46*	*6.13*	*5.69*

SOURCE: "Problems of size of plant in industry in under-developed countries", *Industrialization and Productivity*, Bulletin 2 (New York, March 1959), United Nations publication, Sales No.: 59.II.B.1, table 2, p. 14.

[a] As little published information is available on cost structure in the United States glass container industry, the figures are approximate and in the nature of orders of magnitude only.

[b] Including sand, lime, chemicals, electric power and cartons.

[c] Including depreciation, maintenance, taxes, insurance, interest, miscellaneous charges and the normal remuneration of capital, this last item being estimated at an annual rate of 12 per cent.

The production capacity of the plant is determined by the capacity of the melting furnace and the number of moulding-machines. There are highly specialized moulding-machines which produce only one or two kinds of containers; others are adaptable enough to produce as many as twenty types of different sizes and designs. The effective capacity of these machines depends upon the number of types of containers manufactured and the proportions in which they are produced over a specific period of operation. That of a standard machine, for instance, may vary from 15 to 30 tons daily. The efficiency of the plant depends upon the degree in which the capacity of each of its machines is utilized, and is obviously greater in periods when demand is such that each can be used for the manufacture of a single type of container.

In these circumstances, the manufacture of glass containers may be economic even in the case of total markets smaller than those mentioned above. In Peru, for example, domestic production in 1955 amounted to 46.5 million units (some 23,000 tons), or, in other words, three times the volume of Central American consumption for that year. About 24 million of these containers were bottles for beer, soft drinks, wine, spirits and oil.

Value added in the industry is high. According to a study carried out by the International Co-operation Administration, now Agency for International Development,[24] the value added in the case of a United States plant of minimum economic dimensions constitutes 66 per cent of the total, excluding factory profits. This is an activity in which the utilization of manpower is intensive, representing more than half the total cost of production. Basic raw materials (silicious sand, sodium carbonate, limestone and feldspar) account for only 21 per cent.

Owing to the nature of the product, the cost of transport of glass containers is very high. In 1959, the c.i.f. value of Central American imports was about 185 dollars per ton (see again table 7). In the case of imports from the United States, freight amounted to 40 dollars, or more than 20 per cent of the c.i.f. value.

3. Minimum economic dimensions of the plant

The data and analyses presented below relate to a plant of minimum economic dimensions, capable of producing the narrow-necked and wide-mouthed containers used by the industries in which the available Central American market is concentrated. The plant in question consists of a melting furnace with a daily capacity of 30 tons of glass, and a single moulding-machine. Its maximum production capacity is 9,500 tons yearly, but this figure, if adjusted for defective containers and breakages, falls by 15 per cent to 8,160 tons.[25] Such a capacity would be well below the size of the available market as projected for 1966 (22,700 tons) and for 1970 (38,000 tons).

Accordingly, the following data and analyses are offered purely for illustrative purposes. More detailed research might lead to the conclusion that one or more plants of greater capacity should be established. As

[23] United States Department of Commerce, Census Bureau, *1954 Census of Manufactures.*

[24] United States International Co-operation Administration, *Plant requirements for manufacture of glass containers*, Washington, D.C., May 1959, p. 2.

[25] *Ibid.*

already stated, it must be borne in mind that in this industry considerable economies of scale can be achieved. The determination of optimum dimensions and the decision as to whether one or several plants should be established will have to be based, *inter alia*, on fuller knowledge of the extent of such economies, the size and composition of the market and the cost and quality of intra-Central American transport. To judge from the available data, it would seem that even in a plant of minimum size, production of glass containers in Central America would be an economically sound proposition.

The investment required to set up such a plant in the United States is estimated at 1.2 million dollars — 1.05 million dollars fixed capital and 150,000 dollars working capital. In addition to the main equipment — the glass melting furnace and the moulding machine — a Diesel generator would be needed as a precaution against interruptions of the electric power service which might cause substantial losses in the course of the production process.

The breakdown of the fixed capital investment is as follows:

	Dollars
Site and buildings	250,000
Production equipment	500,000
Other equipment, services for building and Diesel generator	300,000
TOTAL	1,050,000

In Central American conditions, investment costs would be higher owing to heavier freight and installation costs. On the basis of experience in other types of plants already established in the area with United States machinery, it is estimated that the difference might be 25 per cent. Working capital requirements would also be greater, in a similar proportion, partly because inventories would have to be larger to ensure uninterrupted output. All this would bring investment in a Central American glass container factory up to a total of approximately 1.5 million dollars.

The cost of investment might be reduced if the equipment, instead of being imported in its entirety, were manufactured in part at least in Central America. This has been done in some Latin American countries. In Mexico, for example, the glass manufacturing industry has made its own equipment, adapting it to local conditions. By this means, installation costs have also been cut, and, in all, investment costs have been brought down to a level 30-35 per cent lower than in plants of the same capacity in the United States. An interesting possibility for Central America thus emerges, and should perhaps be studied by the Central American Research Institute for Industry (ICAITI).

4. PRODUCTION COSTS

Manufacturing costs in a plant of minimum economic size in the United States, at 1958 prices, are estimated at 108 dollars per ton,[26] broken down as follows:

United States of America: Production costs per ton of glass containers

	Dollars	*Percentage*
Raw materials	20	19
Manpower	51	47
Depreciation	14	13
Fuel, power, water and other supplies	9	8
Other manufacturing costs (interest, insurance, legal expenses and unforeseen items)	14	13
TOTAL	108	100

The estimate relates to an annual volume of output of 6,400 tons. It is assumed that the factory would work twenty-four hours a day for fifty weeks of the year. Its glass melting capacity — 27.2 tons daily — would be only partly utilized, because of the adjustments that would have to be made in the equipment to produce the various types and sizes of containers.

In a Central American plant, manufacturing costs would probably be different. As far as the raw materials were concerned, the silicious sand, sodium carbonate and feldspar would have to be imported; the limestone and waste glass could be obtained from within the area. The imported components would then account for about 66 per cent of the total raw materials. This would tend to force up costs by an estimated 50 per cent in relation to those of a United States plant,[27] raising them to some 30 dollars per ton.

The figure is consistent with data on the cost of transport of raw materials, such as silicious sand, from the United States to Central American ports. Freight charges range from 12 to 16 dollars per ton.

With regard to manpower, which, as previously stated, is the main item in manufacturing costs in the United States, the Central American plant would enjoy considerable advantages. In the United Nations study referred to above, it is estimated that, given the conditions prevailing in the area, the cost of manpower would be barely one third as much as in a United States plant. The estimate takes into account current monetary wage and salary rates, levels of productivity and the need to recruit a considerable number of technicians. On that basis, direct and indirect manpower costs might work out at about 17 dollars per ton.

The economic life of the fixed investment in the plant would range from twenty years for the buildings to five years for the regenerating furnace, on the assumption of partial repair of the refractory brick lining. If an annual depreciation rate of 10 per cent were adopted and applied to the amount of 1.25 million dollars, the corresponding charge would be 20 dollars per ton. The rest of the manufacturing costs would be virtually the same as in the United States plant.

In these circumstances, costs in a Central American glass container factory are estimated at 90 dollars per ton. broken down as follows:

[26] *Ibid.*

[27] This estimate is based on the calculations presented in United Nations, "Problems of Size of Plant in Industry in Under-developed Countries", *Industrialization and Productivity*, Bulletin No. 2, March 1959, p. 15.

Central America: production costs per ton of glass containers

	Dollars	Percentage
Raw materials	30	33
Manpower	17	19
Depreciation	20	22
Fuel, power, water and other supplies	9	10
Other manufacturing costs (interest, insurance, legal expenses and unforeseen items)	14	16
TOTAL	90	100

Manufacturing costs in Central America would thus be 17 per cent lower than in the United States, mainly as a result of the difference in manpower costs.

In 1959, the c.i.f. unit value of Central America's imports of glass containers was 185 dollars per ton.[28] Should the situation remain unchanged in this respect, a local plant would have a margin of about 95 dollars per ton to cover profits, taxation and internal freight. Although such a margin would be relatively wide, the evaluation of the feasibility of the project would not be complete without a thorough study of intra-Central American transport costs, which would undoubtedly be high.

The establishment of a Central American glass container industry would seem to be advisable on certain general grounds. Of these, the most significant are its high added value, its labour-intensive character and the fact that its output consists of production goods which are important for the establishment and expansion of other industries of regional interest.

With respect to import substitution, production in Central America would imply a saving in foreign exchange expenditure estimated at 1.0 and 3.9 million dollars in relation to the market available in 1959 and that projected for 1970, respectively. It would create employment for at least 350 workers by the end of the period, if both direct and indirect manpower requirements are reckoned. It would meet the increasing demands and facilitate the expansion of branches of industry which, like the manufacture of beer and soft drinks or the processing of milk products, oils and fats, constitute so many more directions in which Central America's manufacturing sector can develop.

5. CONCLUSIONS

One of the most important prerequisites for ascertaining the technical and economic feasibility of establishing a glass container industry in Central America would be a detailed analysis of economies of scale — including those relating to transport as well as production — and the determination of the most economic procedure for supplying the Central American market from within the area. More than one possibility suggests itself; a single central plant might supply the whole of the market available for Central American output, or, again, smaller plants might be established, of which the number and capacity would have to be determined, and in which transport economies might absorb the relative reduction in economies of scale resulting from their lesser dimensions.

The findings of the analysis carried out on these bases are given below:

(*a*) In 1959, Central American imports of glass containers amounted to 12,000 tons, with a c.i.f. value of 2.2 million dollars. Between 1960 and 1970 the regional market might expand by 14 per cent yearly. Its total absorption capacity would thus reach 20,000 tons by 1966 and a little over 50,000 tons by 1970. Estimates suggest that in the present decade Central American production might cover 75 per cent of annual requirements. By 1970 output would have risen to about 38,000 tons, with an ex-factory value of over 7 million dollars at 1959 prices;

(*b*) A plant of minimum economic size, working at full capacity, could produce about 8,100 tons per annum. The total investment required would be approximately 1.5 million dollars. Investment costs might be reduced if part of the equipment were manufactured in Central America. The labour force employed would number some sixty workers;

(*c*) To begin with, about 66 per cent of the raw material would have to be imported. This would tend to raise production costs. But given the intensity of manpower utilization in the glass container industry, and as conditions in Central America seem to be comparatively advantageous in respect of this cost component, there are signs that even a plant of minimum economic dimensions might operate on favourable competitive terms in relation to the price of the imported article. Indeed, manufacturing costs might actually prove to be lower in such a plant than in one of the same size in the United States;

(*d*) By about 1970, the estimated net saving in foreign exchange expenditure made possible by the existence of a Central American glass container industry, producing in the conditions projected above, would be 4 million dollars (at 1959 prices), and employment would be provided for over 350 persons.

[28] Wide variations in the c.i.f. unit values of Central American imports were observable in the year in question. The breakdown by countries was as follows: El Salvador, 224 dollars per ton; Nicaragua, 202 dollars; Costa Rica, 199 dollars; Honduras, 197 dollars; and Guatemala, 151 dollars.

IV. SHEET GLASS

Sheet glass is used mainly for window-panes of different types and thicknesses; it is not produced in Central America at present, and the market is supplied by imports. Below we give a preliminary review of the possibilities for the establishment of a factory in the area.

To judge from the experience of other Latin American countries, a Central American plant would be unable to satisfy local consumer requirements entirely, since part of the existing demand is for specific types of window glass which are difficult and costly to manufacture. The

present and future sheet glass market is therefore studied, and an indication is given of the part of it that local production could supply. The note also includes an analysis of investment and a brief survey of production costs in a plant of minimum economic dimensions in Central American conditions. Consideration is also given to the prospects for two plants of this size, given the estimated expansion of demand and taking into account the likelihood of very high internal transport costs for sheet glass.

1. The Central American market

Consumption of sheet glass in Central America is equivalent to total imports, which in 1959 amounted to about 4,600 tons, with a c.i.f. value of 1.2 million dollars (see table 9). During 1953-59, demand increased steadily, except for a decline registered in 1957. The annual rate of growth for the same period, calculated on the basis of the trend curve, was 11.5 per cent. The leading Central American consumer is Guatemala (34 per cent of the total), followed in order of importance by El Salvador (27 per cent), Costa Rica (22 per cent) and Nicaragua and Honduras (10 and 7 per cent, respectively).

The price-elasticity of demand seems to be low where sheet glass is concerned, partly because it represents only a small proportion of total building costs, and partly because it has no substitutes. The relatively wide fluctuations in the unit value of imports during the period 1953-59 did not interrupt the remarkably regular trend of the series.

It will necessarily depend upon the building industry — which in recent years has shown a tendency to stagnation — whether the rate of expansion registered for the Central American sheet glass market between 1953 and 1959 can or cannot be kept up during the sixties.

In the past, the level of activity in the construction sector has been closely related to the evolution of the capacity to import in each of the Central American countries. Export earnings have been one of the main determinants of the demand for building, and foreign exchange income has conditioned the possibilities of financing the import component of the investment concerned.

To judge from the relatively unfavourable world market prospects for Central America's traditional exports, the rate of increase of the Central American countries' capacity to import during the next decade (on the basis of available data) is unlikely to exceed 3 per cent, which is lower than the rates registered during the early post-war years. If ratios were to remain the same as in the past, this would mean an expansion in the demand for sheet glass at a cumulative annual rate of 8 per cent (which is also lower than that recorded in 1953-59). However, according to the same data, if exports to the rest of the world were diversified and intra-area trade substantially expanded, the Central American

Table 9

CENTRAL AMERICA: IMPORTS OF SHEET GLASS, 1953-60

Year	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Total for Central America	Panama	Total for Central America and Panama
				VOLUME *(tons)*				
1953	860	413	225	235	571	2,304	577	2,881
1954	763	544	205	364	757	2,633	586	3,219
1955	866	581	289	446	993	3,175	736	3,911
1956	1,316	672	323	438	952	3,701	960	4,661
1957	973	770	354	453	928	3,478	1,354	4,832
1958	1,312	826	357	453	1,049	3,996	809	4,805
1959	1,566	1,240	307	452	1,017	4,582	1,243	5,825
1960	1,851	939	493	482	1,321	5,086	1,543	6,629
				C.I.F. VALUE *(thousands of dollars)*				
1953	266	131	73	95	131	696	206	902
1954	228	171	82	131	161	773	216	989
1955	286	199	87	97	203	872	247	1,119
1956	455	210	115	110	239	1,129	308	1,437
1957	374	236	118	124	226	1,078	380	1,458
1958	466	264	120	109	344	1,303	245	1,548
1959	398	351	107	128	249	1,239	368	1,607
1960	381	250	111	118	314	1,174	382	1,556

Note: The table covers NAUCA items 664-03-00, 664-04-00, 664-05-00, 664-07-00 and 664-08-00. For the purpose of conversion into tons, a net weight/gross weight coefficient of 0.80 was applied. In the case of Panama, the corresponding coefficient was 0.82 in 1953 and 1958. For the purpose of conversion from f.o.b. to c.i.f. values, the ratio registered in Guatemala in January-September 1957 was applied to each item. The countries affected were Guatemala (up to 1958), Honduras (throughout the period) and Nicaragua (up to 1954).

countries' capacity to import might increase between 1960 and 1970, at an approximate annual rate of 5 per cent, compatible with an annual growth rate of 13 per cent for the Central American sheet glass market that would compare favourably with the 11.5 per cent registered between 1953 and 1959.

On the basis of an annual increase in Central American demand for sheet glass of between 8 and 13 per cent during the current decade, it seems reasonable, for the purposes of the following considerations, to adopt the hypothesis that the Central American sheet glass market will expand at an annual rate of 10 per cent during the next few years, reaching about 13,000 tons by 1970. Moreover, in proportion to the advances made in the Central American economic integration process, the extent to which development in these countries depends on the behaviour of world markets for traditional export commodities will tend to decrease, and the building industry will be no exception to this rule — on the contrary; attention has already been drawn [29] to a number of factors which augur well for a considerable expansion of official housing programmes, with the consequent stimulus to the additional demand for sheet glass that might derive from the projected growth of the capacity to import.

Preliminary estimates suggest that the Central American countries might establish as a target for the next ten years — modest enough in relation to requirements — the construction of 25,000 low-cost housing units annually, with approximately 1.5 million square metres of floor space, in which the sheet glass component would be equivalent to 15 per cent of that area. The glass in question would be only 2 millimetres thick, and would represent a volume of 1,300 tons per annum, which would raise the demand for sheet glass estimated above to some 14,300 tons by the end of the period, and would bring the annual growth rate up to 11 per cent between 1959 and 1970.

The foregoing estimates do not take into account the additional demand that might derive, in consequence of the regional development process itself, from the building of commercial and industrial establishments, in the construction of which the sheet glass component is greater than in low-cost housing units.

This study of demand for sheet glass takes into account a wide variety of types; plate glass for windows, mirrors, showcases and shop windows; rolled, fluted, impressed, waved, ground or frosted and figured glass; safety glass, and laminated glass, tinned, silvered, or coated with platinum. In all probability, in its initial stages a Central American plant could produce only specific types of sheet glass, with a limited range of thicknesses. Furthermore, the relatively high cost of internal transport in Central America might mean that supplies would still have to be obtained from external sources in places a long way from the site of first plant.

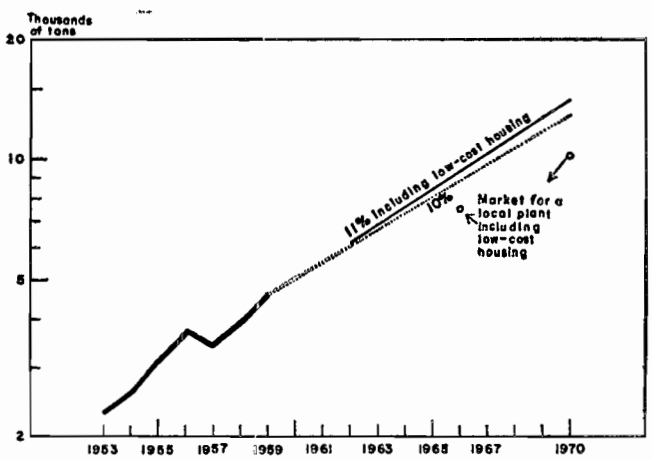
In Mexico, for example, only plate glass from 2 to 6 millimetres thick was produced up to 1957; the manufacture of safety glass was not embarked upon until recently. In Peru, at any rate by 1957, import substitution in respect of glass over 4 millimetres thick was not yet complete, and production of glass with a thickness of more than 6 millimetres [30] had not even begun.

On the basis of the available background data and a brief analysis of the composition of imports of sheet glass (out of a total of 4,600 tons imported in 1959, window-glass accounted for 3,240 tons), it may reasonably be assumed that a Central American plant would be able to supply about 70 per cent of the regional market. On this assumption, and in accordance with the total projection referred to above, such a plant should satisfy a market of approximately 7,600 tons in 1966 and 10,500 tons in 1970 (see figure V).[31]

Figure V

CENTRAL AMERICA: APPARENT CONSUMPTION OF SHEET GLASS, 1953-59, AND PROJECTION TO 1970

Semi-logarithmic scale



SOURCE: Table 9.

2. CHARACTERISTICS OF THE SHEET GLASS INDUSTRY

The production process is complicated in the case of sheet glass, the manufacture of which entails the mixing of the raw materials in exact proportions, and, consequently, the establishment and maintenance of strict control systems.

The principal raw materials (silicious sand, sodium carbonate, limestone and magnesite) are melted in furnaces and fed into the rolling-machines. The production capacity of a sheet glass plant depends mainly upon the size of the furnace. Where the dimensions of the market warrant it, the use of each rolling-machine for glass of one thickness represents a substantial saving. In small plants, the adjustments that have to be made in order to produce different thicknesses in the same machines may prove costly. In Central America's case, the type of plant chosen will necessarily be determined by the volume and composition of demand within the area.

[29] See section I above.

[30] See *Analyses and projections of economic development, vol. VI. The industrial development of Peru*, United Nations publication, Sales No.: 59.II.G.2, pp. 126-127.

[31] These figures include the requirements in connexion with projected official low-cost housing programmes as referred to above.

According to available data, the refractory brick lining of the furnace needs renewal every five years, which in practice means that the lifetime of the furnace — which, as already stated, is the main component of the equipment — is short. This is of particular significance for Central America. If current demand were sufficient, a plant could be installed without reference to market requirements throughout the whole of the sixties. After five years of operation, substantial changes would have to be introduced, and this would provide an opportunity for adapting the plant to the existing demand situation and increasing its capacity accordingly.

Large-scale plants are common in the United States. The 1954 census showed that the industry consisted of thirty-two plants, employing, on an average, 767 workers each.[32] In the manufacturing sector as a whole, the average number of workers per plant was only fifty-five. The eight biggest establishments in the sheet glass industry — representing 25 per cent of the total — were run on an average basis of over 1,000 workers each (operatives and other employees), provided work for 64 per cent of the personnel employed in the industry, and contributed 72 per cent of the value added in this activity.

Smaller plants also exist in the United States. Eleven establishments (constituting 35 per cent of the total) were operating with fewer than 250 workers per plant in 1954. The value of the sales effected by establishments employing over 50 and under 250 workers averaged 1.1 million dollars, a sum comparable to the c.i.f. value of Central America's imports of sheet glass in 1959. No information is available as to whether the smaller United States plants are highly specialized or produce a wide variety of thicknesses of window glass, such as might be needed in the case of the Central American market.

United States census data suggest that the manufacture of sheet glass involves heavy electric energy consumption. Average consumption per establishment was 19.6 million kWh, as compared with only 0.9 million kWh in manufacturing activity as a whole.[33]

The industry also seems to employ a good deal of labour. In 1954 wages and salaries corresponded to 36 per cent of the total value of sales — a very high proportion in comparison with the following figures for other industries: sugar refining, 8 per cent; beer, 23 per cent; cigarettes, 6 per cent; and cement, 21 per cent.

The experience of some Latin American countries is similar to that of the United States. In Mexico, where the market is much smaller, the sheet glass industry is based on two relatively large establishments whose output satisfies the country's requirements almost in their entirety. In 1959 the two plants together produced 32,000 tons and provided employment for 800 to 1,000 workers in all. The capacity of one of them — 18,000 tons per annum — has been doubled recently with the installation of a larger furnace.[34]

In Peru only one small plant was operating up to 1956, in which year it produced about 2,000 tons. Peru's apparent consumption of sheet glass amounted to some 6,000 tons in the same period.[35]

Both in Mexico and in Peru, in the initial stages, the plants encountered technical and in one case economic difficulties, consisting mainly in production process deficiencies deriving from the high degree of precision required in respect of both temperature control and the proportions in which the raw materials have to be mixed.

3. Preliminary remarks on the viability of a sheet glass plant in Central America

The size of plant that would best suit the requirements of the Central American market is that described in a leaflet published recently by the International Co-operation Administration of the United States Government.[36] It is a plant of minimum economic dimensions with an annual production capacity of 5,430 tons of window-glass (2 millimetres thick). The Fourcault production process is used, with a rolling-machine and furnace operating 24 hours a day for 350 days in the year.

The factory employs 84 operatives (direct labour) and 11 other workers (indirect labour). In the United States, investment would total 1.2 million dollars, of which 200,000 dollars would be working capital (all this at 1958 prices). Output would suffice to meet 70 per cent of Central American market requirements in 1966.

Consideration will now be given to possible investment and production costs in the event of the establishment of such a plant in Central America.

(a) *Investment*

Fixed investment costs would probably be higher than in the United States. The site and buildings would be less costly, but equipment would be more expensive on account of heavy freight and installation costs. Total fixed investment might thus be 25 per cent higher than in the United States, or 1,250,000 dollars.

More working capital would also be needed, since it would probably be advisable to keep in stock sufficient raw materials for ninety days instead of for sixty, as is the practice in the United States. This would raise the corresponding figure to at least 250,000 dollars, which, added to the fixed capital, gives a total investment of approximately 1.5 million dollars.

(b) *Production costs*

The data available on the United States sheet glass plant described above may serve as a starting point for a few observations on the level and structure of production costs in a similar plant established in Central America. In 1958, these costs in the United States were broken down as follows: [37]

[32] United States Department of Commerce, Census Office, Census of manufactures, 1954.

[33] *Ibid.*

[34] Data obtained by direct research.

[35] *The industrial development of Peru*, op. cit., p. 127.

[36] ICA, now Agency for International Development, *Plant requirements for manufacture of sheet glass*, Washington, D.C., May 1959.

[37] *Ibid.*

United States of America: Sheet glass production costs per ton (ex-factory)

	Dollars	Percentage
Raw materials	24	14
Labour	95	55
Depreciation	19	11
Administrative expenses (interest, insurance, legal services, auditing, etc.)	27	15
Other costs	9	5
TOTAL	174	100

The most costly ingredient is the sodium carbonate, which absorbs 37 per cent of the total value of raw materials, while the sand and limestone account for 22 and 24 per cent, respectively. None of these raw materials are yet produced in Central America on a commercial scale,[38] but experience in Canada and in Mexico, for example, suggests that sheet glass plants can operate successfully even if some or all of the raw materials are imported, since labour is the principal component of production costs.

The cost of transport of raw materials from United States to Central American ports is at present about 26 dollars per ton, but it is estimated that for large and regular shipments this figure might be reduced to 16 dollars. In accordance with this calculation, raw materials would work out at an average of about 40 dollars per ton, and would then represent 27 per cent of factory costs in Central America, as compared with only 14 per cent in the United States.

These higher raw material costs would probably be more than offset by the fact that labour costs would be far lower than in the United States. No exact data are available in this connexion, but on the basis of statistics relating to wages of industrial workers in the Central American countries and of wage and productivity comparisons between Central America and the United States,[39] it may reasonably be assumed that in the Central American plant labour costs per ton of sheet glass would amount to some 45 dollars, or 30 per cent of manufacturing costs, as against 55 per cent in the United States.

Depreciation charges are estimated at 23 dollars per ton of sheet glass, on the basis of linear application of an annual rate of 10 per cent — the same as the estimated depreciation rate given in the study by the International Co-operation Administration, in which the corresponding figure works out at only 19 dollars. The discrepancy is due to the larger amount of fixed investment projected with reference to Central American conditions. In any event, the depreciation charges in question are included only for purposes of illustration. Obviously, the problem is a complex one, and its solution will necessarily depend upon the type of policy adopted by Governments in this connexion and on the specific details of plant characteristics and requirements as regards replacement of the various components of the equipment.

In the hypothetical United States plant, administrative expenses (interest, insurance, legal services, auditing and unforeseen expenditure) are estimated at about 27 dollars per ton, but they would probably exceed this figure in Central America, where interest rates and insurance premiums are higher. Hence they are estimated at some 30 dollars per ton.

The foregoing considerations suggest the following breakdown of estimated costs in a Central American plant, at 1958 prices:

Central America: Sheet glass production costs per ton (ex-factory)

	Dollars	Percentage
Raw materials	40	27
Labour	45	30
Depreciation	23	15
Administrative expenses (interest, insurance, legal services, auditing, etc.)	30	20
Other manufacturing costs	12	8
TOTAL	150	100

If the assumptions and background data on which these considerations are based can be taken as correct, sheet glass manufacturing costs in Central America (about 150 dollars per ton) might be approximately 15 per cent lower than in the United States. The sole explanation of this advantage is to be found in the assumptions as to differences in labour costs and productivity.

In 1959, the weighted c.i.f. unit value of sheet glass imports was 270 dollars for Central America as a whole.[40] This would leave a margin of approximately 120 dollars (plus that resulting from the application of the Standard Customs Tariff) to cover intra-regional freight costs and sales expenses. Freight costs, defined as the amount whereby internal transport costs for the imported product are exceeded, are estimated at some 25 dollars per ton.[41] It would seem, therefore, that a reasonable margin exists to allow for economic operation in the manufacture of sheet glass in Central America.

[38] According to a document presented to the Central American Committee on Industrial Projects at its first session, experiments carried out in Guatemalan territory suggest that in all probability Guatemala possesses silicious sand deposits. A preliminary report prepared by an expert from the United Nations Bureau of Technical Assistance Operations, and entitled *Industrias de materiales de construcción en el Istmo Centroamericano*, states that in all the Central American countries there are signs of the existence of deposits of this raw material. In Costa Rica it is exploited on a small scale, and it has been exploited in Honduras in the past. In Nicaragua there are proven indications of its presence, but complete studies have not been carried out. Prospecting is being undertaken in both Nicaragua and Guatemala.

[39] See, for example, "Problems of Size of Plant in Industry in Under-Developed Countries", *loc. cit.*, p. 15.

[40] The figures vary considerably from one country to another. In 1959, the average stood at 245 dollars in Costa Rica and 394 in Honduras. A statistical defect deriving from the conversion of f.o.b. to c.i.f. values may possibly account for the high figure in the case of the latter country. If Honduras is excluded, the variations range from 245 to 283 dollars (El Salvador) and the average works out at 262 dollars.

[41] On the basis of an average tariff of 0.04 dollars per ton/km, these costs are estimated as varying between 15 and 35 dollars per ton, according to the hypothetical site chosen.

4. Alternative possibilities for the establishment of the sheet glass industry in Central America

A plant of minimum economic dimensions with the characteristics just reviewed would have an annual capacity of approximately 5,400 tons, operating 24 hours a day for 50 weeks in the year, and would be unable to cover the requirements of the regional market capable of being met by Central American production of the type assumed — some 7,600 and 10,500 tons by 1966 and 1970, respectively.

Several alternative possibilities may therefore be considered. First of all, a plant with a higher capacity might be established at the outset. The relative merits of this alternative depend upon factors which include the economies of scale that could be achieved and the disadvantages deriving from the existence of a certain proportion of capacity not utilized during the early years of operation.

As a second alternative, a plant of minimum economic dimensions might be established to begin with, and its capacity expanded when the market warranted such a step. This could be done by installing a larger furnace, since, as already pointed out, in practice the furnace has to be replaced at the end of five years. Lastly, a second plant might be established when the capacity of the first proved inadequate. How far each of these solutions is desirable will depend upon the relative importance of economies of scale in the sheet glass industry and of intra-area transport costs. Given similar conditions as regards the scale of production, the possible savings on freight costs would perhaps make the establishment of a second plant in another Central American country advisable.

5. Conclusions

It is estimated that during the present decade the Central American sheet glass market might expand between 10 and 11 per cent annually, which would imply a total demand of over 13,000 tons by 1970. Demand in 1960 stood at 4,600 tons.

From a study of the types of sheet glass consumed in Central America, it may be deduced that the proportion of the market which could be covered by the region's own production would represent some 7,600 tons in 1966 and about 10,500 tons in 1970.

The installation of a plant that could produce approximately 5,400 tons per annum, operating at full capacity, would involve investment in fixed and working capital totalling approximately 1.5 million dollars, and it would provide employment for about 95 workers.

Although during the initial stage the raw materials would have to be imported almost in their entirety, the project would give scope for economic operation at cost levels lower than those prevailing in the United States, owing to the lower cost of labour, the factor constituting the most important component of the cost structure in the plant.

For this reason, and to a lesser degree because relatively large quantities of electric power are used, value added in a plant such as that described may be estimated at nearly 60 per cent of the total value of the manufactured product. In existing market conditions, this fact represents a volume of import substitution equivalent to about 700,000 dollars, and by 1970 might mean a foreign exchange saving of 2.1 million dollars (at 1959 prices), in consequence of the expansion of Central American production. It should not be forgotten that the manufacture of sheet glass entails rigid requirements in respect of temperature control and the processes of mixing and melting the raw materials. The experience of other Latin American countries indicates that these requisites might give rise to technical difficulties during the early years of the operation of the industry.

The capacity of the plant studied would not suffice to meet Central America's projected needs in 1966 and 1970. In order to take advantage of market opportunities during the second half of the present decade, one plant of greater capacity might be established at the outset; or a first plant of minimum economic dimensions might be constructed and its capacity expanded later; or a second plant might be installed in another Central American country, when the capacity of the first began to prove inadequate. Before any decision as to the most suitable of these alternatives can be adopted, fuller knowledge of economies of scale of production in the industry and of the relative magnitude and significance of intra-Central American transport costs will be essential.

V. ELECTRIC LAMPS

At present the consumption of incandescent lamps in Central America is met wholly from imports. The present study thus represents a preliminary investigation of the possibilities of establishing a plant to produce or assemble this article. The inquiry will be confined to the manufacture of ordinary incandescent lamps, since the limited size of the market would prevent the plant in question, at least during the initial stage, from producing more specialized products such as fluorescent or mercury lamps.

The data that follow relate to an assembly plant and a separate manufacturing plant for incandescent lamps, although at present the market is not large enough to justify the second plant. The assembly plant would enjoy the benefits of intra-Central American free trade, and once the size of the market made the actual manufacture of the lamps economically possible, this activity might eventually be included among the so-called integration industries.

1. The Central American market

An idea of the size of the Central American market can be obtained from the import statistics given in table 10. In 1959, the most recent year for which information is

Table 10

CENTRAL AMERICA: IMPORTS OF ELECTRIC LAMPS, 1949-60

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Total for Central America	Panama	Total including Panama
				VOLUME *(tons)*				
1949	49	(31)	50	24	(21)	175	20	195
1950	58	(38)	62	20	21	199	29	228
1951	59	(45)	78	28	22	232	33	265
1952	66	(53)	49	35	41	244	26	270
1953	63	52	62	30	65	272	28	300
1954	86	54	64	19	27	250	35	285
1955	80	77	75	32	55	319	34	353
1956	81	110	93	34	52	370	38	408
1957	101	88	104	40	59	392	44	436
1958	105	98	132	40	63	438	55	493
1959	122	88	125	41	59	435	60	495
1960	114	97	134	41	64	450	64	514
				C.I.F. VALUE *(thousands of dollars)*				
1949	100	(82)	135	58	(72)	447	77	524
1950	126	(101)	170	44	72	513	87	600
1951	136	(116)	202	61	63	578	109	687
1952	165	(136)	126	67	114	608	90	698
1953	156	138	185	78	100	657	87	744
1954	200	161	187	55	88	691	118	809
1955	176	201	208	43	135	763	107	870
1956	182	256	237	82	138	895	133	1,028
1957	224	214	275	101	147	961	149	1,110
1958	232	238	376	110	159	1,115	169	1,284
1959	255	210	314	101	150	1,030	177	1,207
1960	242	224	321	95	162	1,044	198	1,242

SOURCE: Central American foreign trade statistics.

Note: NAUCA item 731-03. This includes arc lamps and fluorescent lamps, but imports of arc lamps are believed to be negligible. The figures in parentheses are estimates.

available, the five countries imported about 425 tons of incandescent lamps, with a c.i.f. value of 1 million dollars (see table 10). In terms of lamps, total consumption in 1959 can be conservatively estimated as about 10 million.[42] The annual cumulative growth rate was between 9 and 10 per cent, and reflects the rapid increase in power consumption during the period in question. Thus it can be calculated that the demand in the Central American market in 1960 would amount to about 11 million lamps.

Although per capita consumption of lamps in the region tripled during the last decade (8 million Central Americans used 3 million lamps in 1950, whereas 10 million used 11 million lamps in 1960), the average per capita consumption of electricity, and thus of lamps, is rather low. This is due to two factors: the relatively low per capita income prevailing in the region (200 dollars in 1960) and, what is probably more important, the high cost of electric power to the consumer.

A comparison of Costa Rica with the rest of Central America is a good illustration of the influence of these two factors. Costa Rica has a much higher per capita income, and its power rates are by far the cheapest in the area. As a result, in 1959, per capita consumption attained an average of 2.5 lamps, compared with an average of 0.75 for the rest of the area. There are great differences between the electricity costs of the five countries; Costa Rica is at one extreme, with a cost of 1.5 dollar cents per kWh of domestic-commercial power, and Honduras at the other, with a cost of 9.2 dollar cents. There are also great variations between the other countries; for example, domestic power costs 3.4 dollar cents per kWh in El Salvador and 5.2 in Nicaragua.[43]

In view of the proposed programmes for the expansion of the production of electric power in Central America, it is reasonable to assume that, except in Costa Rica, the costs of power to the consumer in the area during the present decade will undergo similar decreases to those that took place in El Salvador as a result of the Rio Lempa hydroelectric programme. This, in conjunction with the expected growth in per capita income (an annual average of between 2 and 2,5 per cent), will make it possible to maintain an annual growth rate of at least 10 per cent in the consumption of lamps. As electric

[42] It is calculated that a ton represents about 24,000 lamps.

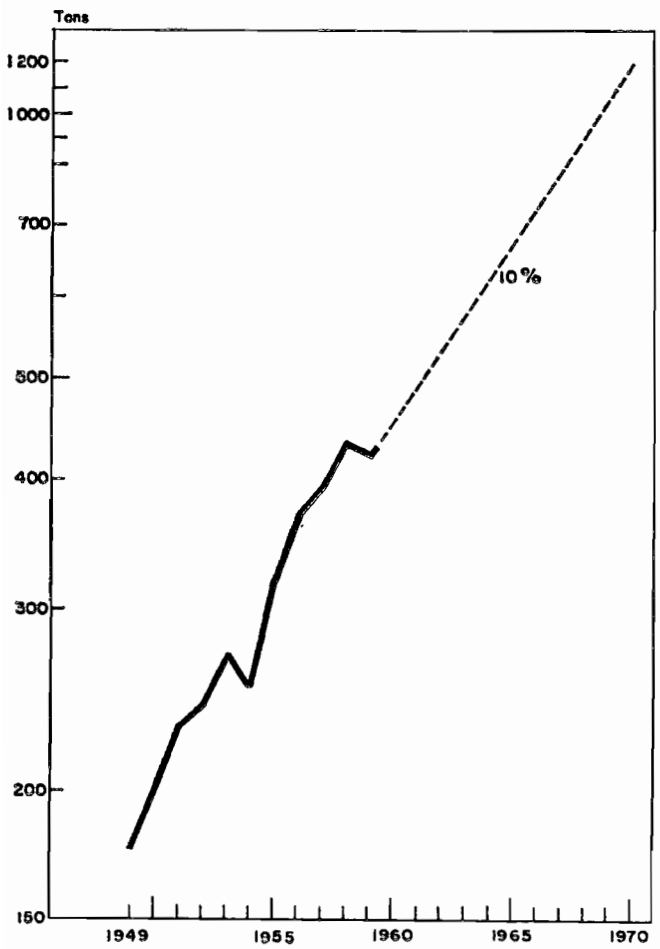
[43] See *Estudio comparativo de costos de la energía eléctrica en Centro-américa y Panamá*, 1959 (E/CN.12/CCE/SC.5/6; TAO/LAT/31) pp. 1 and 2.

power consumption has increased more rapidly (at a rate of 11.5 per cent during 1950-59), the growth rate of lamp consumption forecast can be regarded as conservative. This is confirmed by the fact that projects for expansion of electric power generating capacity in the area appear to indicate that the past growth rate will be maintained and that service for household consumption will be supplied at decreasing cost (see figure VI).

Figure VI

CENTRAL AMERICA: APPARENT CONSUMPTION OF ELECTRIC LAMPS, 1949-59, AND PROJECTION TO 1970

Semi-logarithmic scale



SOURCE: Table 10.

2. MANUFACTURING AND ASSEMBLY PROCESSES

The main parts of an electric lamp are: (*a*) glass bulb; (*b*) tungsten filaments; (*c*) lamp cap (socket or base); (*d*) inner glass tubes (or stem); (*e*) inner support wires, of molybdenum (anchors) or copper (lead-in wires); (*f*) argon and nitrogen inside the lamp.

In the manufacture of incandescent lamps the filament is made from powdered tungsten, which is formed into a solid bar, and then reduced to the diameter of a fine wire of the required dimension. In the light of experience in other Latin American countries it is assumed that a Central American plant that could produce the other parts of the lamp would still have to import the tungsten filament.[44]

The lamps caps (or bases) are made of brass plates that are drawn, pierced, stamped, fitted and joined for this purpose. The stem, made of glass, contains the tube by which the air is extracted, and carries the support wires and the filament. The bulb is of blown glass. In the final operation the bulb and stem are joined and sealed; a vacuum machine extracts the air, and the bulb is then rinsed, internally with nitrogen and filled with argon. The cap, or base, is then joined to the bulb. As all the operations are performed by a highly automatic process, it is only at later stages, notably packing, that labour costs become relatively important.

3. SIZE OF PLANT

Information obtained from sources connected with the lamp industry in Mexico, some of them with wide experience in other countries, indicates that a market of some 25 or 30 million lamps is needed to justify the local manufacture of the various parts, and thus it would not be economic to manufacture them in Central America at present.

In the United States there are small plants side by side with large ones. According to 1954 census data, out of a total of 66 plants, 23 had less than 100 workers; this should be compared with the 70 and 600 workers, respectively, that would be employed by the assembly plant and the manufacturing plant in Central America. However, it is not known how many of the United States plants were manufacturing plants and how many were assembly plants. It is also possible that many of those plants were engaged in the specialized production of certain types of lamps, since American industry uses and produces many different categories. Thus in 1957 the production of ordinary lamps (mainly up to 150 W) amounted to some 900 million, whereas the total output of incandescent lamps was 2,300 million.[45] The average ex-factory sales price of an ordinary size of lamp in 1957 was 12 dollar cents.

In Canada in 1958 the electrical industry produced 22 million dollars worth of incandescent lamps and over 5 million fluorescent tubes. Of the incandescent lamps, 60 per cent were of the normal size, amounting to 80 million units with an average sales price of 16 dollar cents.[46]

Mexican experience indicates that manufacturing plants are generally preceded by assembly plants, and also that as a rule the industry usually operates substantially below its installed capacity. The present Mexican market amounts to about 40 million incandescent lamps a year, and the four existing factories all began as assembly plants. Two were only recently transformed into manufacturing plants. The larger of the two, which could supply the whole of Mexico's demand for lamps, is

[44] Brazil is the only Latin American country where filaments are made.

[45] United States Department of Commerce, Bureau of the Census, *Census of manufactures*, 1954 and 1957.

[46] Dominion Bureau of Statistics, *Electrical apparatus and supplies industry, 1958.*

operating below capacity; the other plant, which until recently assembled 10 million lamps a year, has just installed machinery for manufacturing 30 million lamps a year, which means that for a number of years the industry will have considerable surplus capacity.

Thus a market for 11 million lamps a year is sufficient for a Central American plant, but only for assembly. A market of double this size, as estimated for 1967, would make it possible to replace some imported parts by locally manufactured parts.

Mexican experience indicates that the replacement of assembly operations by manufacture is a gradual process. The same should apply in Central America. Once the assembly plant has been established for a few years, and demand increases, the manufacture of one of the parts (perhaps the cap) should be undertaken, followed later by the production of the glass bulb. Consequently any assembly plant established in the area in the near future should bear in mind the projected rapid growth in the demand for lamps and the possibility of an early replacement of imported parts by parts made at the plant itself.

4. An assembly plant for Central America

There follows an analysis of the possibility of establishing an assembly plant that would enjoy the benefits of free trade and which could be converted into a manufacturing plant as demand increases.

On the basis of the recent experience in Latin American countries referred to above, it would be possible to establish in Central America a plant of minimum economic size, for a market for 11 million lamps, for a total investment of about 300,000 dollars. The machinery is essentially a single piece of equipment which assembles the various parts successively and finishes the lamp. In addition compressors are needed to fill the lamps with gas under pressure. As any interruption in the supply of power may damage the lamps which happen to be on the assembly machine, it is essential to have a diesel plant for emergencies. A building of adequate size will be needed for the plant and for storage. The probable fixed investment costs, in dollars, would be:

Machine for assembling the lamps	130,000
Compressors, emergency diesel plants, etc.	70,000
Building	100,000
Total	300,000

These prices refer to the machinery installed in Central America, on the assumption that the plant would be established near a port with adequate facilities. It is also assumed that the imported machinery would not be subject to duties or similar charges. These are approximately the fixed capital costs of a lamp plant established recently in Colombia with a capacity similar to the present size of the Central American market.

The plant would have a sufficient capacity to supply the present market, and also to absorb future increases. With three shifts a day production would be some 15 million lamps, and with two shifts the present demand could be fully met.

The machinery is of the type that produces lamps of from 15 to 300 W; this does not constitute a limiting factor, since the most frequently used lamps are those of between 25 and 60 W.

The total sales price ex-factory for the Central American plant might be distributed as follows, on the basis of experience in other Latin American countries:

	Percentage
Glass bulb	25
Tungsten filament	15
Cap	5
Inner glass tubes (or stem)	5
Packing	10
Labour, sales and other local costs	30
Depreciation	5
Net profit	5
	100

Sources connected with the Latin American lamp industry estimate that in Central America the retail price of each lamp produced might be about 12 to 15 dollar cents, or about half the present price, and close to the price of those made in the United States, which according to the 1957 census was 12 cents. Although this price refers to 60 W lamps, manufacturing costs are similar for all lamps of less than 100 W. When the use of electricity first begins to spread, the demand is more for lamps of from 25 to 40 W, but later more powerful lamps are preferred. In Mexico the most widely used is the 60 W lamp, but there is an increasing demand for the 100 W lamp.

Assuming an annual production of 11 million lamps, and an ex-factory price of 13 dollar cents, the operation would involve an annual sales value of over 1.4 million dollars and a probable profit of some 70,000 dollars. This rate of profit of 5 per cent on the sales may appear small, but both the United States and the Mexican industries regard electric lamp manufacture as an activity yielding a low unit profit and requiring a large turnover.

The investment required would be 300,000 dollars for the plant and equipment. Working capital, to provide for a reserve of raw materials sufficient for three months' output, would amount to 200,000 dollars. This makes a total capital of 500,000 dollars.

An assembly plant of the right size to meet present demand in Central America would employ about 70 people. The assembly operation requires some highly qualified technicians, but most of the workers would be engaged on the operation of putting the bulbs into cartons and packing them up. This part of the assembly process is not automatic, and requires a considerable number of unskilled workers.

5. Manufacturing plant for Central America

It may be of interest to present data on the investment, labour and manufacturing costs for a manufacturing plant whose establishment might be envisaged within ten years. The information is based on the experience of the Mexican and United States industries.

A manufacturing plant capable of producing 35 to 40 million incandescent lamps a year (representing the

expected demand in Central America in 1970, plus a percentage of surplus capacity to meet increases in future years) would cost about 3 million dollars in fixed capital, assuming that the machinery, although automatic, would not be the latest high-speed models, which cost three times as much.[47]

The working capital requirements would also be high, to judge by experience in Latin American factories — not less than 1 million dollars. Thus the total investment requirements would amount to about 4 million dollars for a manufacturing plant that could meet the demand in 1970 and operate at full capacity in 1972 or 1973. As previously stated, the tungsten filament would continue to be imported, but the plant would include the manufacture of the glass itself and the equipment for producing the brass caps and other parts.

A plant of this type would employ about 600 workers, including a small group of highly specialized technicians. Machinery maintenance would be one of the highest costs in the industry, because of the extreme delicacy and complexity of the equipment.

Some idea of the costs of production can be obtained from the operation of the United States lamp industry.[48] According to the census data, which includes all factories, whether large or small, the percentage breakdown of the ex-factory sales price is as follows:

Wages and salaries		24
Direct labour	19	
Indirect labour	5	
Materials		32
Power and fuel		1
Profits, and other costs and expenditure		43
		100

The above costs are comparable with those of other United States industries such as sugar refining, beer, cigarettes and cement. Of all these, the lamp industry has the highest labour cost component; it is next to last as regards the incidence of the cost of materials, and second as regards the percentage reserved for other costs and for profits.

Although the labour costs of a lamp manufacturing plant in Central America would be considerably lower than those for a similar plant in the United States, the costs of materials that are not found or produced in the United States, the costs of materials that are not found or produced in the area (such as brass and the gases required) would be much higher. Whether the glass would cost more or less would depend partly on availability of the necessary materials in the area. The tungsten filaments would necessarily cost more, as they would have to be imported. Other costs, such as those for power and fuel, might be similar to those in the United States, and the proportion reserved for profits, depreciation and other costs will necessarily be higher in Central America. However, it should be borne in mind that the manufacture of lamps is not an immediate possibility in the area, and that for the present it is sufficient to bear in mind that the industry is one with a high proportion of labour costs, largely relating to the manufacture of the glass.

[47] This type of high-speed machinery, moreover, would be unsuitable for Central America, where the market calls for the production of lamps of various sizes, since these machines are designed for the mass production of a given size of bulb, and the changeover to another size would be very costly.

[48] United States Department of Commerce, Bureau of the Census, *Census of manufactures*, 1954.

6. Conclusions

The Central American demand for incandescent lamps has grown in the last ten years at an annual rate of 10 per cent, and it is expected that growth will continue at the same or a higher rate. The calculations of future electricity consumption indicate that the forecast of a 10 per cent growth rate may prove to be too low.

The present market, amounting to 11 million lamps in 1960, is sufficient to ensure the economic operation of an assembly plant but not a manufacturing plant. The assembly plant could be established for a total investment of 0.5 million dollars, and would more than suffice to meet the present demand in Central America. This plant would employ about 70 workers, and it is calculated that it could sell its products at factory prices comparable with those of imported lamps. Although the savings in foreign currency would not be substantial, since 60 per cent of the costs of production relate to parts that would have to be imported, in one year of operation at full capacity they would amount to a sum sufficient to cover the total value of the investment, including both fixed and working capital. Plants of a similar size to that proposed for Central America are now operating in Colombia and Peru, and demand in Central America is comparable to the demand in those countries.

As for the proposed manufacturing plant, since present demand is expected to double within seven years, and to amout to 30 million lamps a year in 1970, and since the plant should have sufficient capacity to meet, in addition, the increases in demand envisaged for the three or four following years, an investment of 3 million dollars in machinery and buildings would be required, and 1 million more for working capital. The machinery would not be of the most modern and highly automatic type, since it would not be suitable for the type of production needed. About 600 workers would be employed. The savings in foreign currency would be considerable, because the time would come when only the tungsten filaments would still have to be imported.

Thus it appears that it would now be economically feasible to establish a plant for the assembly of lamps for sale in Central America on the basis of the free-trade benefits. Within ten years the market would be large enough to justify the manufacture of most of the parts, and the plant could then be designated as an integration plant enjoying the benefits of the system established for industries so classified.

VI. CAUSTIC SODA, CHLORINE AND CHLORINE INSECTICIDES

The possibility of manufacturing insecticides in Central America is a matter to which the Central American Economic Co-operation Committee has given its attention almost from the outset of the integration programme. In this respect the Committee has approved, at various meetings, resolutions 27 (CCE), 40 (CCE) and 87 (CCE). In compliance with these resolutions, the ECLA secretariat first of all submitted a note on insecticides and fungicides in the study *Central American economic integration: development and prospects.*[49] Subsequently a United Nations technical assistance expert prepared a report entitled *Informe sobre el uso y la posible fabricación de pesticidas en Centroamérica* (TAO/LAT/24). More recently the Central American Research Institute for Industry (ICAITI) prepared a study for the meeting of the *Ad Hoc* Working Group on Industrial Development entitled *Plantas conjuntas de BHC, DDT y sosa cloro* (E/CN.12/CCE/GT/IND/6).

With the above studies as a starting point, further considerations are presented here with respect to the technical and economic features of the soda-chlorine-insecticides industrial complex, the present and potential market for these products, and the economic feasibility of establishing an industrial complex of this type in Central America.

1. Features of the industry

The above-mentioned reports have made it clear that the possibility of manufacturing insecticides should be studied as part of a broader investigation of the feasibility of producing chlorine and caustic soda simultaneously in an integrated industrial complex. There can be no question of manufacturing chlorine insecticides on the basis of imported chlorine, as the cost would be prohibitive. The chlorine would have to be transported in pressure-resistant steel cylinders, which would have to be returned empty, an operation which would amount to the transport of nearly four times the weight of the chlorine transported. Thus it will be necessary to produce it in Central America, which at once raises the question of the production of caustic soda, since the two products are part of the same industrial process.

Seen from this standpoint, the problem is one of the prospects of introducing in Central America the manufacture of two basic chemical products of great importance to the development of other branches of industry. Consequently any study of the question should include matters relating not only to the production of and market for insecticides, but also to other industries that use chlorine or caustic soda.

One of the main requirements for the economic operation of integrated soda-chlorine-insecticide plants, where the products are intended for the domestic market, is a reasonable balance between the production and consumption of caustic soda and chlorine. As will be shown below, this has an important effect on the possibility of establishing and developing the industry, since the demand for the two products tends to increase at different rates.

In the United States, for example, the development of the soda-chlorine industry has been determined by the rapid growth in the demand for chlorine for the manufacture of synthetic chemicals, which in 1956 absorbed 82 per cent of the total output.[50] Meanwhile the demand for caustic soda has increased more slowly than that for chlorine. The result is that in the United States, as in other industrial countries, there is an excess production of soda, and the prices of soda on the world market are highly competitive. In Central America, for instance, c.i.f. import prices have remained relatively stable since 1952 at an average of about 100 dollars per ton. The data available indicate that in 1960 the price fell considerably in some countries of the area.

In less industrial countries the demand for caustic soda is much less dynamic than the demand for chlorine. This creates a different situation, in which the possibilities of production are much reduced, since the high cost of transporting chlorine makes it difficult to export it in sufficient volume to offset the imbalance in the domestic demand for the two products. This can be seen from recent experience in Mexico, where there are now eleven plants manufacturing caustic soda, of which ten are electrolytic and the other, which is the largest, uses the causticizing method. Most of the electrolytic plants were established after 1954, when the country's total annual production capacity was 25,000 tons. In 1960 total capacity amounted to some 134,000 tons, but production in that year was only 65,900 tons, less than half the installed capacity. Of that total only 22,800 tons was produced by the electrolytic plants.[51] Production was limited by a number of factors, including transport problems which made it difficult to supply the frontier areas in the north of the country on an economic basis, and in some cases difficulties in the supply of raw materials. But the most important limiting factor is the fact that the use of chlorine and hydrochloric acid is still small. This problem is being solved by means of the stimulus now being given to the petrochemical industry.

In Central America the situation with respect to the growth trends in the demand for caustic soda and chlorine is similar to that in Mexico, the demand for chlorine being less dynamic. A Central American plant designed to supply the regional caustic soda market, with most of the chlorine produced remaining unused, would probably result in much higher costs than those for the imported product, and economic operation would be difficult.

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[49] E/CN.12/422, pp. 156-162; this document also contains resolution 27 (CCE), pp. 258-260. Resolution 40 (CCE) and 87 (CCE) are contained in the reports of the Committee's fourth and sixth sessions (E/CN.12/431, United Nations publication, Sales No.: 57.II.G.7, and E/CN.12/533, Sales No: 59.II.G.5).

[50] See William H. Martin, "Potential competition and the United States chlorine-alkaly industry", *Journal of Industrial Economics*, July 1961, pp. 240-241.

[51] See "La fabricación de sosa en México", in Nacional Financiera, *El Mercado de Valores*, vol. XXI, No. 26, 26 June 1961, pp. 318-320.

In this connexion, although the consumption of chlorine (for cleaning and bleaching) would be less than 200 tons, the possibility of producing chlorine insecticides for the regional market provides a basic potential demand for chlorine sufficient for the introduction of the manufacture of caustic soda. However, its future development would depend on the evolution of the consumption of chlorine, and consequently it would be advisable to encourage other chlorine-using industries, as well as the manufacture of insecticides. The following section attempts to assess the potential market for the two basic products.

2. Demand for caustic soda and chlorine

(a) *Caustic soda*

The consumption of caustic soda in Central America, as indicated by the import figures, has increased very rapidly and fairly regularly, and almost tripled between 1949 and 1959 (see table 11).[52] Total Central American imports amounted to 6,128 tons (including containers) in 1959, or approximately 5,800 tons in terms of net weight. On the basis of the trend in previous years, the regional demand in 1960 can conservatively be estimated as about 6,600 tons. The annual growth rate, calculated in accordance with the trend curve between 1949 and 1959, was 12.1 per cent. If the past trend is extrapolated in a straight line, the result indicates a regional demand of over 11,000 tons in 1965 and 19,500 tons by 1970.

It would be incorrect to project the future consumption of caustic soda on the basis of the growth rate observed during the last decade without allowing for possible changes in Central America's industrial structure. The main industries using caustic soda in the area at present are those producing soap, fats and vegetable oils, which account for about 80 per cent of total consumption, and it is in fact the rapid development of these industries in the post-war period, based largely on import substitution, which explains the equally rapid growth in the consumption of caustic soda.

The regional market for soap, fats and vegetable oils during the next decade must be envisaged as more dependent on the growth of per capita income and population. ECLA studies and projections of the economic development of some countries of the area indicate that the demand for these products may increase at the rate of over 7 per cent annually during the next decade, if allowance is also made for the fact that there is still a margin for import substitution.[53] Similar projections can be made for existing industries that use caustic soda as a cleansing agent (textiles, sugar refining, carbonated beverages, etc.), but all these together do not, in any case, absorb more than 20 per cent of the total consumption of the area.

Table 11

Central America: Imports of caustic soda [a], 1950-59

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Total
			Volume *(tons)*			
1949	424	362	737	59	566	2,148
1950	393	433	258	90	352	1,527
1951	664	768	767	361	532	3,092
1952	336	532	682	433	762	2,745
1953	110	805	470	773	420	2,577
1954	470	970	751	517	606	3,314
1955	472	1,365	1,045	412	654	3,948
1956	523	796	1,104	466	914	3,803
1957	531	1,508	1,137	740	960	4,875
1958	594	1,403	1,643	643	872	5,154
1959	656	1,975	1,807	722	968	6,128
			C.I.F. value *(thousands of dollars)*			
1949	55	40	84	6	49	232
1950	36	40	19	15	23	132
1951	84	123	100	43	89	439
1952	38	55	70	44	70	276
1953	14	80	43	65	34	236
1954	46	95	61	41	49	291
1955	49	130	82	40	63	364
1956	60	80	104	40	97	381
1957	69	161	117	68	108	524
1958	74	139	151	66	90	520
1959	68	191	172	75	107	613

Source: Central American foreign trade statistics.

[a] NAUCA item 511-03-00 (sodium hydroxide).

If the demand for caustic soda is projected at an annual rate of 7 per cent, on the assumption that input proportions remain constant, the demand for caustic soda will nearly double in ten years, and in 1970 will amount to about 13,000 tons. This projection should be regarded as conservative, since it does not allow for the development of new industries using caustic soda (petroleum refining, rayon, pulp and paper, detergents, etc.) which are now being introduced into the region, or for which there are opportunities or projects already at an advanced stage.

It is not possible on the basis of the available information to estimate the total additional demand for caustic soda that would result from the introduction of these new industries, but it is not difficult to foresee that they would help to ensure a growth rate in the total consumption of soda at least equal to that observed during the last decade, resulting in a regional market of close to 20,000 tons by 1970. By way of illustration, it should be noted that the viscose rayon industry alone, for example, might require some 4,400 tons of soda annually for its initial production, that is, with no allowance for possible expansion during the next decade.[54]

[52] The sharp decline in imports in 1950, which was offset in the following year, may have originated in supply difficulties due to the Korean conflict.

[53] The projections are based on the assumption that per capita income can increase at an annual rate of between 2 and 3 per cent which, in conjunction with the population growth (3 per cent annually), would give rise to an annual increase in the demand for the above-mentioned products of between 5 and 6 per cent. The income elasticity of demand for soap and fats recorded in the area during the last decade is approximately 1 per cent. It is believed that the possibilities of import substitution would lead to an additional annual demand of between 1 and 2 per cent.

[54] The estimate refers to a rayon plant with an initial capacity of 4,500 tons of rayon and 400 tons of cellophane a year, which represents the present demand for these products in the region. See United Nations, *Informe preliminar sobre la industria textil centroamericana* (TAA/LATT/8), April 1957, pp. 205-208.

If a rayon plant on the scale indicated is established in the next few years, its consumption of soda, plus the foreseeable increase in demand from the existing industries, would raise the region's total consumption of soda to more than double the present level, or about 13,600 tons. If, as in the case of the soap and fats industries, the demand for rayon fibres increases at an annual rate of 7 per cent,[55] the new factory could duplicate its production by 1970. This would bring the total derived demand for caustic soda to some 21,800 tons in 1970, as can be seen from the following calculation:

	Existing industries	*Rayon industry*	*Total*
		(Tons)	
Consumption in 1960	6,600	—	6,600
Projection for 1965	9,200	4,400	13,600
Projection for 1970	13,000	8,800	21,800

The above projection shows the dynamic way in which the demand for caustic soda may expand as a result of the introduction and operation of a new industry such as the viscose rayon industry. It should be stressed that this projection is purely illustrative, in view of the problems attaching to the manufacture of rayon, especially those relating to the extra investment required in the textile industry to absorb the output of this fibre and to promote the supply of rayon fabrics on the basis of import substitution. But if allowance is made for the potential consumption of caustic soda in other industries that may be established in the region during the present decade, it would not be rash to assume that the demand will increase more rapidly than in recent years.

(b) *Chlorine*

The production of electrolytic soda for supplying the whole Central American market, in accordance with the previous projections — 13,000 and 20,000 tons respectively for 1965 and 1970, in round figures — would result in the accompanying production of chlorine amounting to some 11,500 tons in 1965 and 17,600 tons in 1970. As the high cost of transport will make it difficult to export this production outside the area, an outlet will have to be found for it in the regional market. Consequently, quite apart from other factors that determine the effective market for caustic soda in Central America, limits will be set to the development of the industry by the potential demand for chlorine.

Generally speaking it can be said that the consumption of chlorine in Central America will increase during the next few years, but less rapidly than the demand for caustic soda, since there does not yet seem to be any basis for the introduction in the near future of the manufacture of synthetic organic chemicals.

Very little information is available on the present consumption of products for which chlorine is used and that could be manufactured in the area. Hence the estimates that follow are tentative, and refer only to certain market possibilities.

[55] In the study on viscose and acetate rayon in section IX below an annual cumulative growth rate of 7.5 per cent is estimated for 1959 to 1970.

(i) *Insecticides.* The technical assistance expert's study (TAO/LAT/24) contains a detailed analysis of the Central American market for insecticides, fungicides and pesticides for the agricultural year 1957/58, and it is estimated that in that period the consumption of the chlorine insecticides DDT and BHC (benzene hexachloride) was 1,770 and 460 tons, respectively. The report also contains two basic projections of this consumption for 1963 and 1968, based on assumptions as to future trends with respect to the area devoted to cotton production — cotton being almost the only crop for which the said products are used — and to changes envisaged in the proportion of chlorine insecticides used.

The first projection envisages a considerable decline in the consumption of DDT and BHC, based on an appreciable reduction in the area used for cotton growing, in view of the relatively unfavourable outlook that seems to have prevailed for the past three years for exports of cotton to the world market. The second assumes a moderate increase in the area given to cotton, calculated by ECLA (211,000 hectares for 1968), but also gives a decline in the consumption of DDT and BHC, in view of their possible replacement by arsenical insecticides, which are regarded as equally effective and cheaper.

These projections have to be revised in the light of developments between 1958 and 1960. A number of relevant facts need to be taken into account. Firstly, the cotton outlook on the world market has improved appreciably, as a result of the measures taken by the main producer countries to ensure greater price stability. The total area given to cotton growing in Central America, which had decreased appreciably in 1959/60, increased to nearly 150,000 hectares in 1960/61, and in 1961/62 to over 175,000 hectares (see table 12).

Table 12

CENTRAL AMERICA: AREA UNDER COTTON, 1950/51 AND 1957/58 TO 1961/62

(Thousands of hectares)

Country	*1950/ 1951*	*1957/ 1958*	*1958/ 1959*	*1959/ 1960*	*1960/ 1961*	*1961/ 1962 a*
Costa Rica . . .	—	3.0	3.2	2.6	2.8	3.0
El Salvador . . .	19.3	39.9	53.4	43.2	56.3	70.0
Guatemala . . .	0.3	17.6	27.6	17.7	25.9	27.0
Honduras	1.2	9.8	8.1	2.1	1.7	2.1
Nicaragua . . .	16.7	88.2	74.0	66.2	62.9	73.3
TOTAL	*38.5*	*158.5*	*166.3*	*131.8*	*149.6*	*175.4*

SOURCE: For 1950/51, 1957/58 and 1958/59: *Compendio estadistico centroamericano* (E/CN.12/597, United Nations publication, Sales No.: 61.II.G.3), table 8. For 1959/60 to 1961/62: United States Department of Agriculture, *Foreign Crops and Markets*, 23 February 1961, and direct information from Central American official sources.

a Preliminary estimates.

Secondly, according to a direct survey carried out by ICAITI the possibility that chlorine insecticides may be replaced by arsenicals appears doubtful. It is maintained that the latter act only upon the digestive system of the pests concerned, and this, in conjunction with the rainy climate in the cotton-growing areas, would make their

use expensive, since several applications would be required to ensure satisfactory results.

Lastly, available information seems to indicate that the consumption of chlorine insecticides has continued to increase, instead of falling off. There was in fact a sharp increase in the Central American imports of DDT from the United States in 1959, which amounted to 2,708 tons; in 1960 the total fell to 1,774 but this was still above the 1958 total (see table 13). Since United States exports supply about 90 per cent of the Central American market for DDT, it can be calculated that the total imports for the region were of the order of 1,700 tons in 1958, 3,000 in 1959 and 2,000 in 1960. The figure for 1958 is very close to the total consumption of DDT estimated by the technical assistance expert to the agricultural year 1957/58 (1,770 tons). The total consumption for the two following years can be estimated as an average of 2,500 tons, on the assumption that part of the large imports in 1959 were used for the 1960/61 crop. This figure represents an increase over 700 tons compared with the consumption of DDT in 1957/58, despite the appreciable reduction in the area given to cotton (see table 12 above).

Table 13

UNITED STATES: EXPORTS OF DDT AND BHC TO CENTRAL AMERICA, 1957-60

	1957	*1958*	*1959*	*1960*
DDT: [a]				
Volume (tons)	...	1,535	2,708	1,774
F.o.b. value (thousands of dollars)	...	1,185	1,849	1,530
BHC: [b]				
Volume (tons)	267	103	132	42
F.o.b. value (thousands of dollars)	943	183	178	57

SOURCE: United States Department of Commerce, *United States exports of domestic and foreign merchandise*, Report No. FT 410 (Washington, D.C., 1961).

[a] Mainly technical DDT (item 82-062); also includes formulas containing 75 per cent or more of DDT (82-070) and those containing from 20 to 74 per cent of DDT (82-065), both of which were converted into units of technical DDT by using conversion factors of 80 and 35 per cent respectively.

[b] Includes technical BHC (benzene hexachloride) and formulas containing 6 per cent or more of the gamma isomer of BHC (item 82-075).

On the other hand, information is available to show that the consumption of BHC has declined rapidly in the last three years. The figures for United States exports of this product to Central America, although incomplete, confirm this, there being a sharp drop from 267 tons in 1957 to 42 tons in 1960 (see table 12 above).[56] On the other hand there are indications that the consumption of toxaphene has increased substantially, as a result of its having replaced BHC, but it has not been possible to obtain any figures on this point.

It is difficult to make an accurate projection of the potential Central American market for chlorine insecticides with the information available. However, it appears from the facts and data given above that demand will probably continue to increase during the next few years, or will at least remain at about the same level as that most recently recorded.

It is even more difficult to foresee the composition of future demand for these insecticides. As noted above, for DDT the starting point is provided by the fact that the total consumption of the region was about 2,500 tons in 1960, when the area under cotton was 150,000 hectares. According to the above-mentioned projection, envisaging a moderate expansion in the area devoted to cotton growing (211,000 hectares for 1958), it can be estimated that the Central American market for DDT would amount to some 3,000 tons within the next five years, and to 3,500 tons for 1970. However, it would be rash, for a number of reasons, to assume that the relative use of DDT in cotton growing will be constant during the next decade. Moreover, bearing in mind the fact that a Central American plant might perhaps not be able to supply the whole of the regional market, it would seem prudent to regard present consumption (2,500 tons) as the effective potential market for the regional production of this insecticide during the present decade. This production would require about 4,200 tons of chlorine.

With respect to BHC, the falling off in imports in recent years makes it difficult to form views on the size of the market or the possibility of economic production in future years. A detailed study of the reasons for the decrease in consumption would be needed, and if the trend were confirmed, the possibility of production in Central America would have to be ruled out.

At the same time, consideration might be given to producing chlorine insecticides with a camphene base, for which there was a considerable demand in 1957/58, amounting to 483 tons, of which 80 per cent was for cotton cultivation. In view of the foreseeable increase in the area given to cotton in the region, a substantial increase in the demand for such insecticides is to be expected in future years, provided that it can be shown that their use in recent years as a replacement for BHC is due to such factors as greater economy and efficiency, and not to temporary circumstances. By way of illustration, it can be assumed that total demand will be triple that estimated for 1957/58, or about 1,450 tons, an output that would require some 1,800 tons of chlorine. This projection may even be conservative if it is confirmed that toxaphene is replacing BHC in the cotton area.

The demand for chlorine for the manufacture of insecticides for the market for the whole region can thus be estimated as about 6,000 tons a year.

(ii) *Pulp and paper*. Next to insecticide production, the pulp and paper industry would be the largest potential consumer of chlorine. A variant of the basic project for the manufacture of pulp in the Olancho area in Honduras envisages the production of 38,500 tons of bleached pulp, which would require the consumption of 3,360 tons of chlorine a year.[57]

[56] The total consumption of BHC in Central America in 1957/58 was estimated, as indicated above, as 460 tons, and consequently the figures for United States exports should be taken as indications of a trend rather than as a decline in absolute terms.

[57] *Proyecto para la fabricación de celulosa y papel en Centroamérica. Informe final* (FAO/CAIS/59/1; TAO/LAT/23), August 1959, pp. 178-179.

(iii) *Plastics*. The plastics industry, which is beginning to develop in the region, may also give rise to a certain demand for chlorine. In this case the possibility of manufacturing polyvinyl chlorine, which would require large amounts of chlorine, should be investigated; in addition this product can be used for the manufacture not only of such articles as cable linings, textile processing, and plastic floor tiles, but also of irrigation pipes for agriculture, which could be widely used in Central America. A plant of the minimum economic size for the production of this resin would have an annual capacity of 1,800 tons, and would consume about 1,200 tons of chlorine.[58]

(iv) *Rayon*. Another use of chlorine would be for the bleaching of cotton linters, either for the manufacture of viscose rayon in the region, or for export. In the study on the textile industry in Central America previously referred to, it is estimated that at the outset 2,000 tons of cotton linters could be treated, to be used as part of the raw material for the manufacture of viscose rayon. The treatment could be extended to some 7,000 tons, to include bleached linters for export, and would require about 1,260 tons of chlorine.[59]

(v) *Other uses*. Lastly, the ICAITI study estimates a total demand of 800 tons (in the form of liquid chlorine and sodium hypochlorite) for other uses of chlorine (water purification, cleaning, bleaching and disinfection).

If the chlorine requirements dealt with in the foregoing paragraphs are added, they give a total demand of the order of 12,600 tons. This would absorb the chlorine production from one or more electrolytic plants with a capacity large enough to supply the Central American market for caustic soda foreseeable for 1965 or 1966. However, if the capacity to produce soda continues to grow as the market increases, without a corresponding additional increase in the demand for chlorine over and above the estimates given above, by 1970, there would already be an excess production of chlorine of the order of 5,000 tons.

3. Short-term outlook for the production of caustic soda, chlorine and insecticides

The foregoing assessment of the potential demand for chlorine in Central America is based on a number of possibilities of establishing new industries that use chlorine, although some of these possibilities have not yet been studied. Moreover, even in the case of the pulp and paper project, which has been the subject of detailed studies, there can be no certainty as to the demand for chlorine before it is known what decisions may be taken with respect to the structure of production. Another very important factor that may limit the effective market for a soda-chlorine plant is the cost of transport and distribution within the area. Since for chlorine the cost is relatively high, the pulp and paper industry may find it more convenient to install its own soda-chlorine plant.

It is likely that the chlorine market available for the first electrolytic plant in the region for the next five years would be considerably smaller than the potential market estimated above. From the practical standpoint the capacity of the new plant at the initial stage would be determined essentially by the consumption of chlorine for the manufacture of insecticides, leaving some margin for other uses.

The chlorine market available to the first plant might be of the order of 7,000 tons, of which about 6,000 tons would, as already indicated, be for the manufacture of insecticides. A plant producing this amount of chlorine would produce about 7,900 tons of caustic soda annually, which would involve a daily capacity of 26 tons on the basis of 300 actual working days a year. The plant would have an ample market for the caustic soda output, since the projected demand for the region is 13,000 tons for 1965 and over 20,000 tons for 1970.

Another point is that it might be advisable for the insecticide plants to be integrated with the electrolytic plant as part of an industrial unit. This would not only make possible economies through the establishment of certain common services, but there would also be greater certainty as regards the utilization of the chlorine. Thus there would be a better chance for the soda plant to operate at the optimum capacity for competing on an economic footing.

There is not sufficient information available to assess the economic feasibility of an industrial complex for soda-chlorine and insecticide production on the scale indicated. The production cost calculations in the ICAITI study refer to a considerably smaller plant, the daily capacity of the caustic soda plant being 18 tons.

According to these calculations, the viability of the joint soda-chlorine and insecticide plants will depend essentially on the availability of electric power and salt at economic prices. ICAITI's calculations with respect to these inputs are hypothetical. It is assumed that the electrolytic plant can obtain electric power at 1 dollar cent per kWh, which is considerably lower than the general average price of power in the region.[60] It is maintained that the new plant will merit special treatment with respect to rates, as an important consumer.[61] In addition, its continuous use of power at an almost constant level throughout the 24 hours will help to raise the load factor of the generating plant and reduce the unit cost of the power produced.

It is assumed, in the light of the experience in other countries, that salt can be obtained at a cost of 10 dollars a ton; in Italy, for example, the price of salt for industrial use is 8 dollars a ton, and in Mexico it has fluctuated between 4 and 16 dollars a ton.

During the first stage the production of soda can be based on imported salt. Later the new soda-chlorine

[58] See United Nations, *Analyses and projections of economic development. VI. The industrial development of Peru* (United Nations publication, Sales No.: 59.II.G.2, p. 224).

[59] *Informe preliminar sobre la industria textil en Centroamérica*, op. cit., pp. 207-208.

[60] In 1959 the average price per kWh varied between a minimum of 1.4 dollar cents in the central area of Costa Rica and a maximum of 7.5 dollar cents in Honduras; see *Estudio comparativo de costos de la energía eléctrica en Centroamérica y Panamá*, 1959 (E/CN.12/CCE/SC.5/6), p. 19.

[61] 4,200 kWh are required for the production of 1 ton of chlorine and 1.12 tons of caustic soda.

undertaking might consider it advisable to undertake the industrial production of salt, as an additional activity, in order to ensure a supply of this raw material at reasonable cost. It would be necessary to introduce technical improvements in the traditional salt production processes in the region, where at present production is mainly for human consumption. These matters require detailed study, since an economic supply of salt is a determining factor for the viability of the soda-chlorine plant and hence for the insecticides plant.

An industrial complex on the scale indicated above could supply a considerable part of the regional market for chlorine and insecticides, but only about 60 per cent of the potential demand for caustic soda projected for 1965 or 1966. Later the foreseeable expansion in the demand for chlorine would make it possible to increase the capacity of the first soda-chlorine plant, or to establish a second plant. The decision taken in this respect would depend not only on the size of the total regional demand for both products, but also on its distribution among the various countries and the costs of transport to the main consumer centres.

VII. PETROLEUM PRODUCTS

In resolution 27 (CCE) of the Central American Economic Co-operation Committee, the petroleum products industry was declared to be of interest for the purposes of the economic integration of Central America. Projects are well under way in most of the Central American countries, and in some of them a start has been made on the building of refineries, almost all designed to meet some of the requirements of the domestic markets concerned.

The ECLA secretariat discussed this subject in the study entitled *The economic integration of Central America* (E/CN.12/422).[62] Experts from the International Labour Office also drafted a report on *La refinación de petróleos en Centroamérica* (E/CN.12/CCE/GT.IND/3), for the session of the *Ad Hoc* Working Group on Industrial Development. Only some additional considerations are formulated here on the size and structure of the Central American market and on certain implications of the industry's technical and economic characteristics in relation to the establishment and expansion of production in Central America.

1. The Central American market

In 1959, apparent consumption (imports) of petroleum products amounted to 1.1 million tons, with a c.i.f. value of more than 37 million dollars (see table 14). The proportion of the import budget absorbed by such products was considerable: 7.8 per cent in 1959 in the area as a whole, with a minimum figure of 5.3 per cent in Costa Rica and a maximum of 9.4 per cent in Nicaragua. The prospect of a slackening of the dynamic impetus of Central America's capacity to import — even on the most optimistic hypothesis — and the high rate of growth which consumption of petroleum products would have to attain for the achievement of even a moderate rate of economic development suggest that this proportion is likely to increase substantially, perhaps rising to 13 or 14 per cent by 1970.

In terms of total imports, Guatemala is the leading consumer of petroleum products in the area, having absorbed more than one-third of the imports in question in the three-year period 1957-59. The shares of the other four countries during the same period varied between 13 and 18 per cent.

In terms of per capita imports, Costa Rica came first in 1957-59, with an annual consumption of 138 kilogrammes. Next in order of importance followed Nicaragua, Guatemala, Honduras and El Salvador, with 121, 113, 108 and 75 kilogrammes, respectively. For the area as a whole, average annual consumption during the same period amounted to 107 kilogrammes, a very small volume in comparison with that registered for most of the Latin American countries (see table 15). In 1956, per capita consumption in Central America had represented barely one-third of the figure recorded for the rest of Latin America.

Between 1948 and 1959 the volume of imports of petroleum products in Central America increased at a cumulative annual rate of nearly 6 per cent. Broken down by countries, it can be seen to have expanded much faster in Nicaragua than in the rest of the area. Next in order of importance came El Salvador, Costa Rica, Guatemala and Honduras, the rate of growth in the last three falling below the average for Central America.

Consumption of the various items included in the petroleum products category expanded at different rates, and this was reflected in a noteworthy change in the composition of imports, as a result of which the relative significance of imports of petrol rose from 20.4 per cent in 1949-50 to 31.1 per cent in 1957-59. Correlatively, the share of diesel oil and fuel oil declined from 71.3 to 56.9 per cent between the same years.

In Central America as a whole, during the period 1948-59, the cumulative annual growth rates of consumption of the various types of petroleum products, computed in accordance with the gradient of the corresponding curves, were as follows:

	Annual growth rate (percentage)
Petrol	12.5
Kerosene	15.9
Diesel oil and fuel oil	2.8
Lubricants (oils and grease)	4.9
Petroleum asphalt, etc.	14.6

[62] Op. cit., pp. 91-108. The text of resolution 27 (CCE) is reproduced in the same document, pp. 258-259.

Table 14

CENTRAL AMERICA: IMPORTS OF PETROLEUM PRODUCTS, 1948-60

(Volume in tons; c.i.f. value in thousands of dollars)

Year	Petrol		Kerosene		Diesel oil and fuel oil		Lubricants (oils and grease)		Petroleum asphalt, pitch, resin, etc.		Total	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
CENTRAL AMERICA												
1948	122,313	5,169	18,845	926	470,162	8,872	11,402	1,684	5,630	215	628,352	16,866
1949	127,353	5,557	18,844	741	446,935	7,400	23,868	1,583	7,316	277	624,316	15,558
1950	142,755	6,545	24,644	827	499,037	6,840	15,027	1,529	20,996	499	702,459	16.240
1951	152,734	8,774	29,239	1,049	481,140	8,320	17,261	2,231	6,506	216	686,880	20,590
1952	190,505	8,833	33,324	1,246	485,277	9,358	13,166	2,171	14,461	467	736,733	22,075
1953	225,824	10,113	41,703	1,564	546,784	12,459	22,114	2,235	17,095	575	853,520	26,946
1954	232,303	11,424	46,755	1,786	483,358	9,476	26,014	2,851	11,861	394	800,291	25,931
1955	264,217	11,956	54,844	1,875	456,774	8,996	19,000	2,879	23,678	663	818,513	26,369
1956	308,682	14,262	60,368	2,239	538,638	12,494	19,193	3.238	19,018	536	945,899	32,769
1957	334,775	15,685	72,316	2,744	586,244	14,503	20,756	3,626	24,562	808	1,038,653	37,366
1958	349,267	16,006	81,288	2,921	648,323	14,851	27,868	4,391	29,518	952	1,136,264	39,121
1959	240,447	15,020	83,368	3,161	639,623	14,094	24,365	4,155	31,331	1,118	1,119,134	37,548
1960	371,120	15,215	101,571	3,542	717,342	13,982	25,110	4,386	27,178	763	1,242,321	37,888
COSTA RICA												
1948	22,865	993	3,733	147	67,449	1,576	2,024	315	1,081	28	97,152	3,059
1949	21,589	968	1,962	97	58,821	1,081	3,415	334	1,949	50	87,736	2,530
1950	29,115	1,368	4,528	150	60,390	1,065	2,652	337	1,538	52	98,223	2,972
1951	28,188	1,349	4,846	184	64,062	1,420	3,574	419	1,952	84	104,622	3,456
1952	42,813	1,550	4,150	161	83,622	1,698	2,904	480	3,369	177	136,858	4,066
1953	52,637	1,797	7,417	221	143,224	4,909	3,532	389	5,023	256	211,833	7,572
1954	43,333	2,580	4,569	174	84,613	1,772	4,245	493	5,077	218	141,837	5,237
1955	39,628	1,846	5,898	202	66,130	1,405	3,383	596	3,122	124	118,161	4,173
1956	44,790	2,074	6,948	255	103,973	2,472	3,043	559	3,744	153	162,498	5,513
1957	52,766	2,555	8,014	306	87,849	2,828	4,278	838	7,574	277	160,481	6,804
1958	50,261	2,419	7,902	331	87,464	2,572	5,924	804	5,317	273	156,868	6,399
1959	48,854	2,229	7,882	326	66,515	2,097	4,526	840	3,841	138	131,618	5,630
1960	73,634	2,273	13,687	402	95,847	2,064	5,166	901	5,622	179	193,956	5,819
EL SALVADOR												
1948	19,935	922	3,518	154	48,367	953	1,449	199	1,113	66	74,382	2,294
1949	23,186	1,084	4,297	177	51,616	1,068	1,299	200	3,373	143	83,771	2,672
1950	31,345	1,510	4,921	178	54,141	767	1,370	203	918	22	92,695	2,680
1951	38,245	1,821	6,573	260	63,299	1,120	2,741	408	1,441	31	112,299	3,640
1952	44,049	2,291	9,458	368	76,597	1,578	2,344	367	1,746	48	134,194	4,652
1953	49,398	2,482	12,942	486	71,514	1,418	2,147	350	3,469	98	139,470	4,834
1954	53,730	2,639	14,403	575	79,349	1,520	3,371	547	—	—	150,853	5,281
1955	59,897	2,873	15,392	579	69,009	1,296	2,839	454	—	—	147,137	5,202
1956	67,418	3,281	17,174	646	78,883	1,732	4,023	673	30	4	167,528	6,336
1957	71,923	3,536	22,684	907	82,719	2,062	3,818	655	—	—	181,144	7,160
1958	76,485	3,547	26,174	1,012	74,399	1,665	4,442	784	—	—	181,500	7,008
1959	74,709	3,345	29,506	1,108	78,402	1,676	3,460	628	104	24	186,181	6,781
1960	73,921	3,217	27,204	1,088	88,932	1,899	3,800	714	215	40	194,072	6,958
GUATEMALA												
1948	48,645	1,914	6,939	446	208,994	3,581	3,528	477	3,223	111	271,329	6,529
1949	50,201	2,084	7,050	266	188,129	2,460	2,669	399	775	23	248,824	5,232
1950	46,507	2,051	8,179	257	218,997	2,461	2,611	354	14,681	373	290,975	5,496
1951	44,541	2,469	9,446	305	190,212	2,641	4,473	636	2,270	67	250,942	6,118
1952	56,418	2,673	11,258	389	126,772	2,249	2,761	419	6,869	132	204,078	5,862
1953	66,250	3,031	9,799	415	152,851	2,567	4,000	543	6,208	133	239,108	6,689
1954	69,514	3,020	13,202	454	166,495	2,808	4,984	678	4,210	95	258,405	7,055
1955	86,654	3,739	14,017	471	199,470	3,425	5,002	665	18,822	481	323,965	8,781
1956	112,017	4,892	16,274	544	194,117	4,013	5,559	814	11,557	237	339,524	10,500
1957	116,260	4,947	20,977	653	209,788	4,100	6,235	905	12,070	293	365,330	10,898
1958	121,970	5,193	22,764	662	231,051	4,292	7,636	1,139	17,656	360	401,077	11,646
1959	119,062	5,087	22,229	800	270,652	5,081	6,224	1,080	19,515	494	437,682	12,542
1960	123,479	5,168	33,213	1,041	295,331	4,973	6,229	1,095	15,673	324	473,925	12,601

Table 14 *(continued)*

CENTRAL AMERICA: IMPORTS OF PETROLEUM PRODUCTS, 1948-60

(Volume in tons; c.i.f. value in thousands of dollars)

Year	Petrol		Kerosene		Diesel oil and fuel oil		Lubricants (oils and grease)		Petroleum asphalt, pitch, resin, etc.		Total	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
HONDURAS												
1948	14,547	629	1,307	57	123,993	2,176	2,278	321	213	10	142,338	3,193
1949	14,528	623	1,966	82	112,268	1,984	14,855	359	1,219	61	144,836	3,109
1950	16,912	756	2,316	85	127,021	1,800	6,758	353	172	13	153,179	3,007
1951	16,980	1,923	2,221	84	130,149	2,219	1,897	314	110	11	151,357	4,551
1952	21,452	1,003	1,737	77	144,428	2,594	2,353	393	113	5	170,083	4,072
1953	25,608	1,235	2,307	118	128,933	2,291	10,024	546	144	7	167,016	4,197
1954	27,802	1,363	2,425	115	102,409	2,020	10,005	548	1,591	53	144,232	4,099
1955	33,108	1,464	2,993	150	57,571	1,270	2,338	379	40	9	96,050	3,272
1956	32,856	1,519	4,594	209	109,946	2,515	3,078	510	1,305	67	151,779	4,820
1957	39,940	1,924	4,987	223	143,488	3,237	3,081	556	1,526	128	193,022	6,068
1958	42,643	2,172	6,539	260	140,715	3,177	5,749	800	2,327	156	197,973	6,565
1959	39,404	1,724	7,471	305	143,832	3,171	6,388	874	2,218	262	199,313	6,336
1960	38,177	1,734	10,837	396	144,941	2,804	6,154	934	734	45	200,843	5,913
NICARAGUA												
1948	16,321	711	3,348	122	21,359	586	2,123	372	*a*	*a*	43,151	1,791
1949	17,849	798	3,569	119	36,101	807	1,630	291	*a*	*a*	59,149	2,015
1950	18,876	860	4,700	157	38,488	747	1,636	282	3,686	39	67,387	2,085
1951	24,780	1,212	6,153	216	33,418	920	2,576	454	733	23	67,660	2,825
1952	25,773	1,316	6,721	251	53,858	1,239	2,804	512	2,364	105	91,520	3,423
1953	31,931	1,568	9,238	324	50,262	1,274	2,411	407	2,251	81	96,093	3,654
1954	37,924	1,822	12,156	468	50,492	1,356	3,409	585	983	28	104,964	4,259
1955	44,930	2,034	16,544	473	64,594	1,600	5,438	785	1,694	49	133,200	4,941
1956	51,601	2,496	15,378	585	51,719	1,762	3,490	682	2,382	75	124,570	5,600
1957	53,886	2,723	15,654	655	62,400	2,276	3,344	672	3,392	110	138,676	6,436
1958	57,908	2,675	17,909	656	114,694	3,145	4,117	864	4,218	163	198,846	7,503
1959	58,418	2,635	16,280	622	80,222	2,069	3,767	733	5,653	200	164,340	6,259
1960	61,909	2,823	16,600	615	92,291	2,242	3,761	742	4,934	175	179,525	6,597

SOURCE: Foreign trade yearbooks.

a Included in the other items.

Table 15

LATIN AMERICA: APPARENT CONSUMPTION OF PETROLEUM PRODUCTS, 1956

Country	Total consumption (thousands of tons)	Per capita (kilogrammes)
Argentina	12,540	643
Bolivia	280	82
Brazil	9,850	165
Chile	1,860	268
Colombia	2,190	166
Ecuador	370	97
Mexico	11,000	360
Peru	1,820	189
Uruguay	1,170	442
Venezuela	8,440	1,388
Other non-Central American countries	3,104	211
Costa Rica	162	164
El Salvador	168	78
Guatemala	339	101
Honduras	152	89
Nicaragua	125	97
Latin America	*53,570*	*298*
Central America	*946*	*100*
Rest of Latin America	*52,624*	*309*

Both the rate of growth of total consumption of petroleum products and the changes registered in its composition are to some extent indicative of the scale and nature of the area's economic development during the past decade. The remarkable expansion of demand for petrol closely paralleled the still larger increase (which took place at a cumulative annual rate of 15 per cent) in the number of vehicles in circulation. Both phenomena are a reflection of several characteristics of economic activity in the Central American countries. In the first place, the rise in the income of the export sector resulted in large-scale imports of passenger cars for private use. Thus, in Central America as a whole, the number of cars in circulation virtually trebled between 1951 and 1959. Secondly, the improvement and expansion of the highway network and the development of the transport sector in general, as well as the rapidity of the urbanization process, led to a similarly substantial increase in imports of lorries and omnibuses, the numbers of these vehicles in circulation rising by 129 and 123 per cent, respectively, between the above-mentioned years.

The upward trend in demand for petrol would have been still sharper but for the decrease in the input of petrol per vehicle from 4.8 tons in 1950 to 3.3 tons in the year 1958, when vehicles that were more economical in the use of fuel were introduced.

While consumption of petrol increased at the high rate indicated above, imports of Diesel oil and fuel oil fluctuated widely up to 1954, within a general trend towards stagnation or very slow growth. It should be pointed out that from 1948 to 1954, new investment in projects for the generation of electric energy on the basis of Diesel oil was effected on a small scale, since the use of the product in this branch of economic activity — one of the principal consumers of Diesel oil in Central America — received no particular encouragement. Between 1950 and 1959, the corresponding installed generating capacity increased by 231 per cent (from 18,480 kW to 61,200 kW). Of the total increment, 33,510 kW (78.4 per cent) were installed after 1954. This resulted in a striking acceleration of the growth rate of Diesel oil consumption, which reached 9 per cent per annum between 1955 and 1959. Another factor contributing to this increment was the use of Diesel oil for transport facilities, which seems to have been intensified during the last five years of the period under review.

Lastly, the rapid expansion of consumption of kerosene and petroleum asphalt — 15.9 per cent and 14.6 per cent annually, between 1948 and 1959 — reflects, in the first case, the growing tendency to substitute kerosene for other household fuels, and the rise in per capita income, as well as the more widespread use of this product in the operation of agricultural machinery. The upswing in imports of asphalt was linked to the intensification of programmes for the improvement and expansion of the Central American road network, whose total extent was doubled between 1952 and 1959, increasing from 18,830 to 37,826 kilometres.

In an effort to estimate the prospects in respect of demand for petroleum products, it might be assumed, to start with, that the long-term trend registered for total demand in the past — a cumulative annual growth rate of 6 per cent — will remain unchanged, and that the structure of demand will also be the same as at present, since it has been fairly stable during the last few years and is similar to that prevailing in other countries, such as Mexico and Peru (see table 16). This would give an apparent consumption of 1.7 and 2.2 million tons in 1966 and 1970, respectively.

Table 16

CENTRAL AMERICA AND SELECTED COUNTRIES: COMPOSITION OF DEMAND FOR PETROLEUM PRODUCTS

(Percentages)

Product	*Central America (1957-59)*	*Bolivia (1956)*	*Chile (1959)*	*Mexico (1960)*	*Peru (1956)*	*United States (1940)*
Petrol	31	43	47	29	29	44
Kerosene . . .	7	10	9	11	17	6
Diesel oil and fuel oil . . .	57	47	44	57	51	38
Lubricants (oils and grease) .	2	—	—	1	1	3
Petroleum asphalt, etc.. .	3	—	—	2	2	9
TOTAL	*100*	*100*	*100*	*100*	*100*	*100*

Demand for petroleum products, however, could only be satisfactorily projected on the basis of the changes in its level and composition that might be expected to result from the evolution of the capacity to import and from the variations in rates of growth and modifications of the structure of the economy — especially in the industrial and agricultural sectors — to which the probable orientation of development policy might give rise.

Extrapolation of the historical trend referred to above suggests that by 1970 per capita consumption of petroleum products in Central America would reach barely 133 kilogrammes, a level far below that already attained in 1956 in Costa Rica, and, of course, in the rest of Latin America as a whole. These results might not prove consistent with predictable changes in the area during the next ten years, especially in view of the prospects for the economic integration programme.

It must be borne in mind that normally, in developing countries, consumption of petroleum derivatives expands a good deal faster than the gross product. Even in Central America, where the gross domestic product rose at an annual rate of barely 3.4 per cent between 1948 and 1959, consumption of petroleum products increased, as already shown, at an annual rate of 6 per cent during the same period. This implies a very high elasticity of demand for petroleum products, which might be roughly estimated at about twice the income increment.

ECLA secretariat studies suggest that during the present decade an energetic economic development policy might raise the cumulative annual growth rate of the gross product to between 5 and 6 per cent. If the income-consumption ratio referred to above were to be maintained, the rate of expansion of demand for petroleum products would undoubtedly be higher than in the past and might well reach 10 or 12 per cent per annum. This is yet more likely in view of the changes that would have to take place in the structure of the Central American economies before the gross product could increase at the rate mentioned.

Industrial production would have to expand at an annual rate of about 9.7 per cent, in any case much higher than that registered in recent years, to enable import substitution to be effected and the increment in demand satisfied. The energy sector would also develop quickly, in order to supply a demand of which the residential and especially the industrial components are expected to be extremely dynamic. It is estimated that the necessary increase in installed generating capacity will probably be about 400,000 kW up to 1970, or 134 per cent in relation to total installed capacity in 1959. Furthermore, the need to complete the Central American communications network in successive stages — in conformity with the requirements of the Central American common market — as well as the progress likely to be made in urbanization as a result of the rapid industrialization process alluded to above, would also speed up the growth of the transport sector. Obviously, all these characteristics of the economic development of the area will be reflected in a sharper upward trend of demand for petroleum products.

The foregoing considerations were taken into account in the formulation of an alternative projection of demand for 1966 and 1970. In the case of petrol, it is estimated

that consumption will continue to expand rapidly, although not so fast as in 1948-59. This forecast is based on the twofold assumption that the yearly increase in the total number of petrol-driven vehicles in circulation will be about 10 per cent — instead of the 15 per cent registered in 1948-59 — in consequence of possible restrictions on imports (particularly of passenger cars) determined by the relatively slow rate of growth of the capacity to import,[63] and that consumption per vehicle will remain at the lower levels noted in recent years.

The factors that determined the drastic fall in consumption of petrol per vehicle during the later years of the period under review will probably continue to operate. But their effects may be neutralized by more intensive utilization of vehicles as a result of the improvement in roads and highways, the construction of new means of communication, and the expansion of intra-Central American trade. The projection gives an annual growth rate of 9.4 per cent for petrol consumption, which would raise the total consumption figure for 1959 — 340,000 tons — to 720,000 tons in 1966 and a little over 1 million tons in 1970.

It is considered that consumption of Diesel oil and fuel oil will continue to increase during the present decade at a high rate, similar to that of 9 per cent registered since 1955. In view of the type of development contemplated in the energy sector during the next few years, mainly on the basis of the construction of hydroelectric power stations, demand for the products in question may not be further stimulated until the later years of the decade, when it may be given strong additional impetus by investment in thermoelectricity (installed capacity and production). However, the installation of additional thermal generating capacity seems likely to continue, although at much slower rates, as a means of reinforcing hydro potential and covering emergencies and peak load periods.

The factor that will do most to maintain these growth rates for the consumption of petrol, Diesel oil and fuel oil seems to be the noteworthy expansion projected in the transport sector. Intra-Central American trade, which in the three-year period 1957-59 increased at annual rates of 25-30 per cent, will continue to grow as economic activity is directed more and more towards the satisfaction of common market requirements. As road transport facilities will still be much used in intra-area trade, there will be an increase in demand for vehicles over and above the increment that is bound to result in the individual countries from the internal urbanization and development process itself. Again, in view of the rather discouraging prospects for the capacity to import and of relative fuel prices, the demand in question may possibly be satisfied to a steadily increasing extent with Diesel vehicles. Much the same is likely to take place in the agricultural sector at the current and predictable levels of mechanization of production.

Thus, without explicitly reckoning with the consumption increment that is sure to derive from the projected expansion of the manufacturing sector, it is estimated that demand for Diesel oil and fuel oil may amount to 1.2 and 1.7 million tons in 1966 and 1970, respectively.

To sum up, the results of the projection of Central American consumption of petroleum products in 1966 and 1970 are as follows:

	1959	1966	1970	Annual growth rate 1948-59	Annual growth rate 1959-70
	(thousands of tons)			(percentage)	
Petrol	340	720	1,023	12.5	9.4
Kerosene	83	162	237	15.9	10.0
Diesel oil and fuel oil	640	1,170	1,651	2.8	9.0
Lubricants (oils and grease)	24	41	54	4.9	10.0
Petroleum asphalt, etc.	31	60	88	14.6	10.0
TOTAL	*1,119*	*2,153*	*3,053*	*6.0*	*9.5*

In the aggregate, consumption of petroleum products will probably increase at a cumulative annual rate of 9.5 per cent, which exceeds that registered in the past by more than one-third. If the economic development of the Central American countries were to be such that the growth rate of the gross product reached 5 or 6 per cent, this projection might well prove fairly conservative, in the light of the ratios observable between income and consumption of petroleum derivatives and the magnitude of the structural changes likely to take place in the Central American economies.

2. VIABILITY AND ECONOMIC IMPORTANCE OF THE PETROLEUM REFINING INDUSTRY IN CENTRAL AMERICA

There are indications of the existence of deposits whose development would enable Central America to begin producing petroleum and petroleum products. Prospecting started in some countries several years ago. Although the findings obtained are not so far conclusive, there is no reason to dismiss the possibility of an integrated petroleum industry's being ultimately established in the area.

In the meanwhile, progress might well be made in the refining of imported crudes. Both the over-all studies available and the specific projects already formulated and in process of execution have served to demonstrate the practical viability of installing refineries in Central America.

In the ILO study mentioned at the beginning of this section (E/CN.12/CCE/GT.IND/3, reproduced as section VIII of the present document), it was possible to confirm the existence of considerable economies of scale in the petroleum refining process, so that increases in plant dimensions entail less than proportional increases in investment. Thus, for example, according to a rule that seems clearly established in the industry, investment requirements for the installation of a refinery with a daily capacity of 50,000 barrels would be only about 2.2 times greater than for one with a capacity of barely 10,000 barrels. It was shown that the current trend in several countries is favourable to the construction of refineries with medium or high capacities, starting from 20,000-30,000 barrels a day.

Eight refineries were in operation in Mexico in 1960, their average daily capacity slightly exceeding 40,000

[63] The estimate is also based on an analysis of the number of vehicles per capita in each of the Central American countries and of the experience of other Latin American countries.

barrels. Owing to high transport costs, supplies were still obtained from abroad in certain parts of the country, especially the north-west. In the same year Cuba possessed three refineries, with a joint daily capacity of some 90,000 barrels and a total cost of 100 million dollars.

The market for petroleum products in Chile — approximately 1.3 million tons in 1959 — is about the same size as that of Central America. There is only one refinery, under the direction of a State enterprise. It entered operation in 1956, with a capacity of slightly under 20,000 barrels a day. This capacity was more than doubled in 1959, the input of crude petroleum rising to about 44,000 barrels daily; to achieve this, an additional investment of 15 million dollars was effected, which, taken together with the previous depreciated assets, gives a total of 34 million dollars. All the crude oil used comes from Chilean sources, and practically the whole of the output of petroleum products is destined for the domestic market; about 25 per cent of consumption of such products — consisting mainly of very special types — is met with import.

Crude oil represents the chief component of the production cost of refined petroleum. In small and medium-sized plants, the proportion of the total cost absorbed by this raw material fluctuates between 60 and 80 per cent, according to the capacity of the refinery.

Moderate changes in the price of crude are reflected in substantial variations in the minimum economic size of plants. At given price levels, however, the economies of scale mentioned above result in lower unit costs as the size of the plant increases; undoubtedly, too, the smaller the capacity of the refinery concerned, the greater will be the effect of price increments. Hypothetical calculations suggest that if the price of crude were 2.75 dollars per barrel, the cost of the refined product would be 20 per cent lower in a plant with a daily capacity of 60,000 barrels than in one with a capacity of 10,000 barrels (3.61 as against 4.47 dollars). Again, if the price of crude were to rise by about 10 per cent, to 3 dollars per barrel, the result would be a 66 per cent increase in the minimum economic size of the refinery (from a little under 30,000 to over 50,000 barrels daily). The economic viability of petroleum refineries thus depends mainly on the price of crude oil supplies, and, in lesser measure, on plant dimensions.

To judge from the analysis and projection of the market for petroleum products and other relevant factors, the refining capacity needed to supply Central American demand would seem to have been 25,000 barrels of crude daily in 1959, and will probably be about 70,000 in 1970. Since it is unlikely that demand for petroleum products could be satisfied solely on the basis of refining in Central America, in the ILO report the characteristics of a single refinery with a daily capacity of 38,000 barrels were studied, and its possible costs computed, the price of crude being taken as 3 dollars per barrel, and specific estimates being postulated for other items, on the basis of experience elsewhere in the world. Comparison of the results obtained with those corresponding to smaller plant sizes suggested, as was to be presumed, that such a refinery would offer considerable advantages in respect of ex-factory prices for the refined product.

To reach a more reliable conclusion on this aspect of the problem, account should be taken of the comparative costs of the refined product not only when imported and when produced in one Central American refinery, but also when processed in more than one Central American plant. No light could be shed on this last point either in the ILO study or in the present research.

The problem lies in determining whether the economies that would be achieved by the installation of a single regional refinery might or might not be cancelled out by diseconomies deriving from the higher costs of distributing petroleum products from the refinery to supply centres in the rest of the area. According to hypothetical estimates, at a given price for crude, the refining of 50,000 barrels daily would be more economic in a single plant than in five plants with a capacity of 10,000 barrels each, provided that the distribution costs differential did not exceed 80 cents per barrel.

Furthermore, the competitive capacity of the product refined in a single Central American plant vis-à-vis its imported counterpart will depend upon whether the additional costs of distribution to the other countries of the area are or are not offset by lower refining costs, and, above all, by a sufficient difference between crude oil prices and those of derivatives refined abroad. Failing this, thought would have to be given to the possibility of installing the necessary refining capacity distributed among several small plants. But even if diseconomies of scale were not so great as to prevent economic operation — partly because supplies of crude petroleum were sufficiently cheap — it would have to be considered whether the installation of such plants would allow the whole range of derivatives comprised by the Central American market to be produced in the necessary proportions.

The development of the petroleum refining industry in Central America would involve relatively heavy investment, possibly fluctuating between 800 and 1,000 dollars per barrel of capacity, and would provide employment for about 500 persons in the event of installation of the refinery with a daily capacity of 38,000 barrels studied by the ILO experts.[64] The result would probably be a more reliable supply, since it would seem easier to obtain uninterrupted supplies of crude than of derivatives, especially in times of emergency. The establishment of the refining industry in economic conditions would also encourage the expansion or installation of other industries using petroleum products as raw material, besides substantially furthering the creation of a properly integrated industrial sector in the area.

The progress that could be achieved in the field of import substitution through regional production of derivatives on the basis of imported crude would be considerable, although not spectacular. This reflects the sizable proportion of the total cost represented by the imported component, and the relatively limited value

[64] See section VIII below.

added in the refining process. The gross value added in a refinery with a daily capacity of 50,000 barrels has been estimated, for purposes of illustration, at approximately 20 per cent. The saving of foreign exchange would be still less, since the replacement and, in part, the maintenance of equipment would necessarily entail heavier expenditure on imports, irrespective of remittances of profits abroad if investment were wholly or partly financed with funds from external sources. In the case of the foregoing example, it was estimated that the net saving of foreign exchange might be a little under 15 per cent in relation to the cost of imported derivatives.

The vital significance of these facts is obvious if it is borne in mind that, should existing supply conditions be maintained, the consumption of petroleum products projected for 1970, at 1959 prices, would give rise to foreign exchange expenditure amounting to over 100 million dollars, a sum equivalent to 14 per cent of the capacity to import generated by the exports projected for that same year.

VIII. PETROLEUM REFINING *

The present study deals with the problems of petroleum refining in Central America from the standpoint of industrial productivity and efficiency rather than from the broad economic viewpoint.

1. Market

(a) *Over-all consumption of petroleum derivatives in Central America*

In the light of the studies on this subject carried out by ECLA,[65] an estimate was made of consumption trends for the period 1948-59 (twelve years) by the method of least squares (see table 17 and figure VII). By this method the projections presented in table 18 were obtained. Instead of formulating one hypothesis for total consumption by countries, and another for each country for every product, as in the studies referred to, in the present study an over-all projection was made in the belief that any possible errors would cancel out if the problem were considered as a whole. In this way the figure of 2,080,000 tons was obtained for probable consumption for 1970. On the assumption that Central American output cannot meet more than 75 per cent of consumption, production in 1970 should be 1,560,000 tons. As the industry operates for only 85 per cent of the time available (311 days a year),[66] this implies a daily output of 5,000 tons of petroleum products. Inputs should be of the order of 5,500 tons, or approximately 38,000 barrels a day of crude petroleum.[67] (Tables 17 and 18 and figure VII.)

Table 17

CENTRAL AMERICA: CONSUMPTION OF PETROLEUM PRODUCTS, 1948-59

(Thousands of tons)

Year	*Volume*
1948	628
1949	624
1950	702
1951	687
1952	737
1953	854
1954	800
1955	818
1956	946
1957	1,039
1958	1,136
1959	1,119

SOURCE: Foreign trade statistics of the Central American countries.

Table 18

CENTRAL AMERICA: PROJECTED CONSUMPTION OF PETROLEUM PRODUCTS FOR 1965 AND 1970

(Thousands of tons)

Year	*ECLA*		*ILO*
	Hypothesis A	*Hypothesis B*	
1959	1,119	1,119	1,119
1965	1,640	1,902 [a]	1,555
1970	2,326	2,936 [a]	2,080

SOURCE: ECLA, *Central American economic integration: development and prospects*, op. cit.

[a] In a subsequent revision these figures were changed to 2,153,000 tons for 1966 and 3,053,000 tons for 1970. See Derivados del petróleo: *examen preliminar de posibilidades de desarrollo industrial integrado en Centroamérica*. Note by the Secretariat (E/CN.12/CCE/245).

(b) *Petroleum refining in Central America*

In order to be able to project a profitable level of production, it is not enough to establish a refining capacity for Central America, since a number of other factors must be taken into account. Firstly, the level will depend on the crude petroleum available, since petroleum is not a strictly homogeneous product; crude petroleum from adjoining oilfields, and even from the same wells, may

* Study prepared by Ramón Aguado Jou and G. R. Galla More, experts of the International Labour Office regional project on productivity and vocational training for Central America.

[65] See *Central American economic integration: development and prospects* (E/CN.12/422), and the study in the preceding pages on petroleum products.

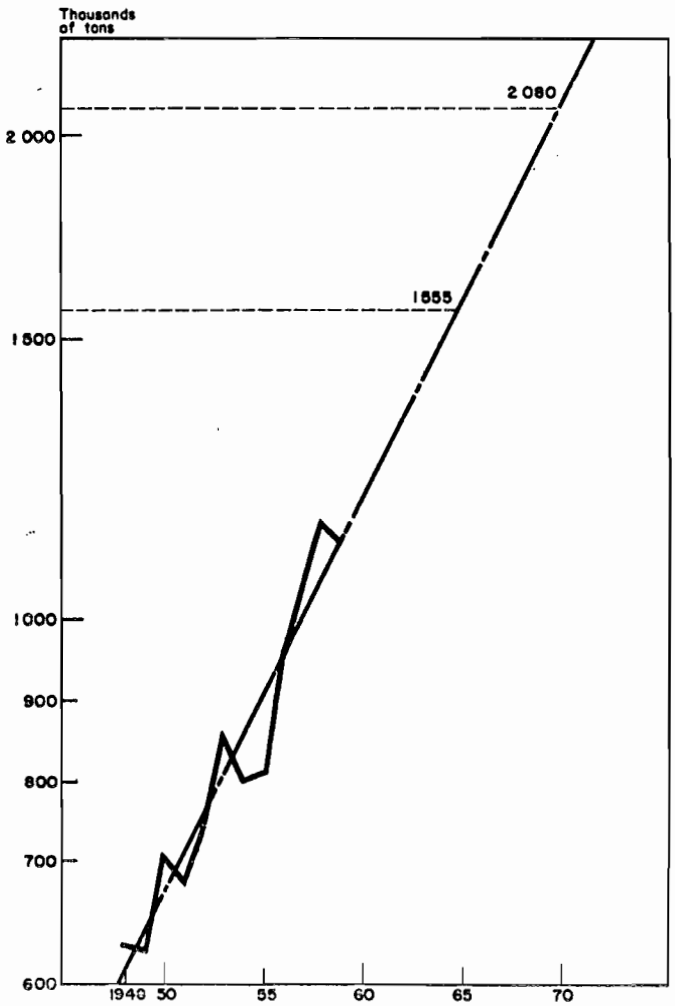
[66] Some experts stated that production time could rise to 350 working days a year, but the whole of the present study is based on the figure of 311 working days, and consequently the appropriate adjustments will have to be made if production time is assumed to be 350 days a year.

[67] An average of 7 barrels per ton, representing a specific gravity of 26 degrees API (American Petroleum Institute).

Figure VII

CENTRAL AMERICA: TREND OF THE CONSUMPTION OF PETROLEUM PRODUCTS, 1948-59, AND PROJECTION TO 1970

Semi-logarithmic scale



vary appreciably in composition, and this variation becomes greater when the petroleum is from different areas.

Secondly, the level of profitable production will depend on the composition of the demand for petroleum products; it may well be that in relation to the existing demand the output of some products will be insufficient, and of others excessive. Moreover the complexity of the equipment, and consequently its cost, will depend largely on the proportions of the various products that are obtained, and this factor also has a considerable effect on the cost of refining.

Consequently, in determining the total investment required the following factors have to be taken into account: (i) the type of crude petroleum available; (ii) the demand for the various products and the proportions in which they are used in Central America, and (iii) the technical processes selected.

(i) *Nature of the crude petroleum available.* It is very difficult to determine the type of crude petroleum that can be used most economically in Central America. As there is no production at present, refining must be based entirely on imports of crude petroleum. The main suppliers would probably be Peru and Bolivia, because of their ease of access to Central America by the Pacific route, or Venezuela, where at present some producing companies are not working to full capacity. The price of the crude petroleum from Venezuela might be advantageous, in the region of 2 dollars a barrel instead of the 3 dollars paid for petroleum from other sources.

It would probably be advisable to install units to mix the crude petroleum before refining it, in order to obtain an input calculated to yield the required proportions of products.

Reference will be made below to the possibility of using fuel oil as a raw material, either from other Latin American refineries or from the United States.

(ii) *Breakdown of the demand for petroleum derivatives in Central America.* One of the factors that may have the greatest effect on the cost of installing a refinery is the extent of the demand for the various products concerned. The following groups of products were established for the purpose of specifying the demand for each: (1) petrol; (2) kerosene; (3) Diesel and fuel oil; (4) lubricating oils and greases, and (5) petroleum asphalt, pitch, resins, etc. Imports of these products into Central America during the period 1947-59, with annual percentages, are shown in table 19.

Figure VIII

CENTRAL AMERICA: PERCENTAGE OF TOTAL CONSUMPTION OF PETROLEUM PRODUCTS REPRESENTED BY INDIVIDUAL PRODUCTS, 1947-59

Natural scale

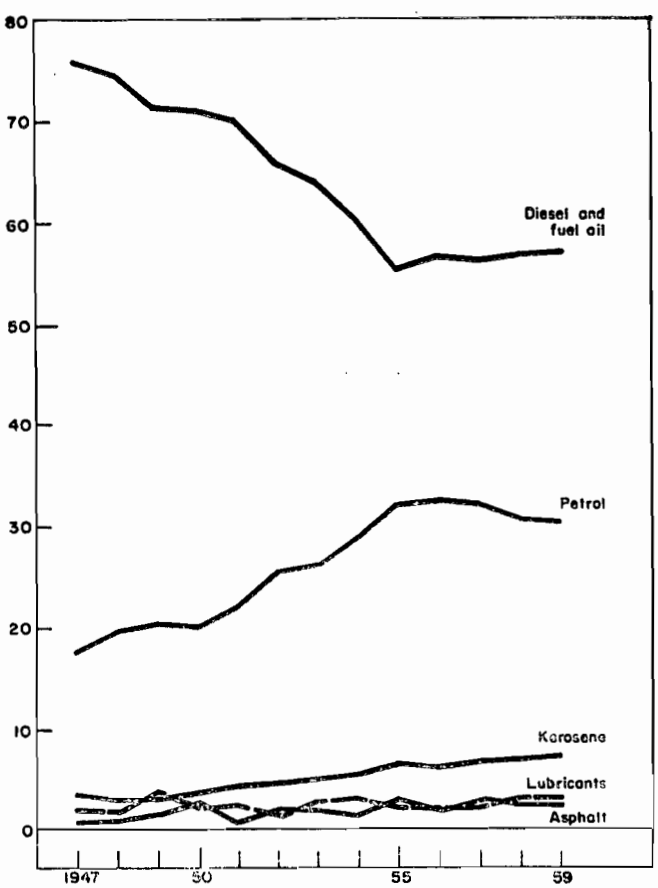


Table 19

CENTRAL AMERICA: IMPORTS OF PETROLEUM PRODUCTS, 1947-59

(Thousands of tons)

Year \ Product	Petrol	Kerosene	Diesel and fuel oil	Lubricants	Asphalt etc.	Total
1947						
Volume	87.3	15.1	376.1	9.8	4.6	492.9
Percentage	17.5	3.6	76.0	2.0	0.9	100.0
1948						
Volume	122.3	18.8	470.2	11.4	5.7	628.4
Percentage	19.5	3.0	74.8	1.8	0.9	100.0
1949						
Volume	127.4	18.8	446.9	23.9	7.3	624.3
Percentage	20.4	3.0	71.5	3.8	1.3	100.0
1950						
Volume	142.8	24.6	499.0	15.0	21.0	702.4
Percentage	20.3	3.5	71.2	2.1	2.9	100.0
1951						
Volume	152.7	29.2	481.1	17.3	6.5	686.8
Percentage	22.2	4.3	70.1	2.5	0.9	100.0
1952						
Volume	190.5	33.3	485.3	13.2	14.5	736.8
Percentage	25.8	4.5	66.0	1.8	1.9	100.0
1953						
Volume	225.8	41.7	546.8	22.1	17.1	853.5
Percentage	26.4	4.9	64.1	2.6	2.0	100.0
1954						
Volume	232.3	46.8	483.3	26.0	11.9	800.3
Percentage	29.0	5.8	60.4	3.3	1.5	100.0
1955						
Volume	264.2	54.8	456.8	19.0	23.7	818.5
Percentage	32.2	6.7	55.9	2.3	2.9	100.0
1956						
Volume	308.7	60.4	538.6	19.2	19.0	945.9
Percentage	32.6	6.4	56.9	2.1	2.0	100.0
1957						
Volume	334.8	72.3	586.2	20.8	24.6	1,038.7
Percentage	23.3	6.9	56.5	2.0	2.3	100.0
1958						
Volume	349.3	81.3	648.3	27.9	29.5	1,136.3
Percentage	30.7	7.2	57.1	2.4	2.6	100.0
1959						
Volume	340.5	83.4	639.6	24.0	31.3	1,118.8
Percentage	30.4	7.5	57.2	2.1	2.8	100.0

SOURCE: Foreign trade statistics of the Central American countries.

The evolution of consumption during those years is shown in figure VIII, which indicates how the composition of demand changed. In 1947 Diesel and fuel oil accounted for a high proportion of consumption (76 per cent), and petrol a relatively low proportion (17.5 per cent), whereas by 1955 petrol accounted for 32 per cent, and its consumption remained more or less stable at that level up to 1959, while there was a steady decline in the proportion of Diesel and fuel oil consumed up to 1955, after which year their consumption remained approximately at the level of 56 per cent.

Although absolute consumption continued to increase, the stabilization of the composition of consumption that occurred during the last five years is significant, and appears likely to be maintained in the future. On the basis of those five years the average shown in table 20 was calculated, and it is believed that this structure of consumption may remain unchanged up to 1970, since although the increase in petrol consumption is likely to be substantial, the introduction of more Diesel motors will result in a parallel increase in the consumption of Diesel oil.

In table 21 these percentages are compared with those for Mexico and the United States. The close parallel between the Mexican and Central American percentages is some indication that the proportions estimated for Central America are correct.

Table 20

CENTRAL AMERICA: AVERAGE PERCENTAGE DISTRIBUTION OF THE TOTAL VOLUME OF PETROLEUM PRODUCTS CONSUMED, 1955-59

Year	Petrol	Kerosene	Diesel and fuel oil	Lubricants	Asphalt etc.	Total
1955	32.2	6.7	55.9	2.3	2.9	100.0
1956	32.6	6.4	56.9	2.1	2.0	100.0
1957	32.3	6.9	56.5	2.0	2.3	100.0
1958	30.7	7.2	57.1	2.4	2.6	100.0
1959	30.4	7.5	57.2	2.1	2.8	100.0
TOTAL	*158.2*	*34.7*	*283.6*	*10.9*	*12.6*	*500.0*
Percentage for Central America	31.7	6.9	56.7	2.2	2.5	100.0

SOURCE: Foreign trade statistics of the Central American countries.

Table 21

MEXICO, UNITED STATES AND CENTRAL AMERICA: DISTRIBUTION OF CONSUMPTION OF PETROLEUM PRODUCTS

(Percentage)

Product	Mexico 1957	United States 1940	Average for Central America 1955-59
Petrol	29.5	43.8	31.7
Kerosene	11.5	5.7	6.9
Diesel and fuel oil	55.1	38.6	56.7
Lubricants	1.1	2.9	2.2
Asphalt	2.8	9.0	2.5
TOTAL	*100.0*	*100.0*	*100.0*

SOURCE: PEMEX; and ECLA, *Central American economic integration: development and prospects*, op. cit., table 4.

(iii) *Technological level.* In the calculations and estimates that follow, the basic assumption is that advanced techniques will be used, since with other methods it is not possible to obtain the products in the proportions required to meet the needs of the Central American market.

(c) *Distribution of consumption by country*

The distribution of total consumption of petroleum products between the five Central American countries must be analysed for the purpose of planning the best siting for installations and appropriate storage and distribution facilities. Table 22 shows the distribution of consumption by country for 1948-59, with annual percentages. Movable averages of the percentages have been determined, to give a clearer indication of the trend shown in table 23. A line joining the points representing each period (see figure IX) shows that Nicaragua's proportion of the whole nearly doubled over the period; the share of Honduras fell from 22 to 16 per cent, that of El Salvador increased from 13 to 17 per cent (where it remains stable), while the share of Costa Rica decreased and that of Guatemala increased (the gain of one country being at the expense of the other). As the future trend given by a projection of the above trends would be somewhat unlikely, the distribution percentages adopted were those for the last five-year period, as follows:

Guatemala	37.0
Honduras	16.3
El Salvador	17.2
Nicaragua	15.0
Costa Rica	14.5
	100.0

The order by size of consumption is shown in figure X.

Figure IX

CENTRAL AMERICA: PERCENTAGE DISTRIBUTION OF CONSUMPTION OF PETROLEUM PRODUCTS, BY COUNTRY, 1947-58

(MOVING AVERAGES)

Natural scale

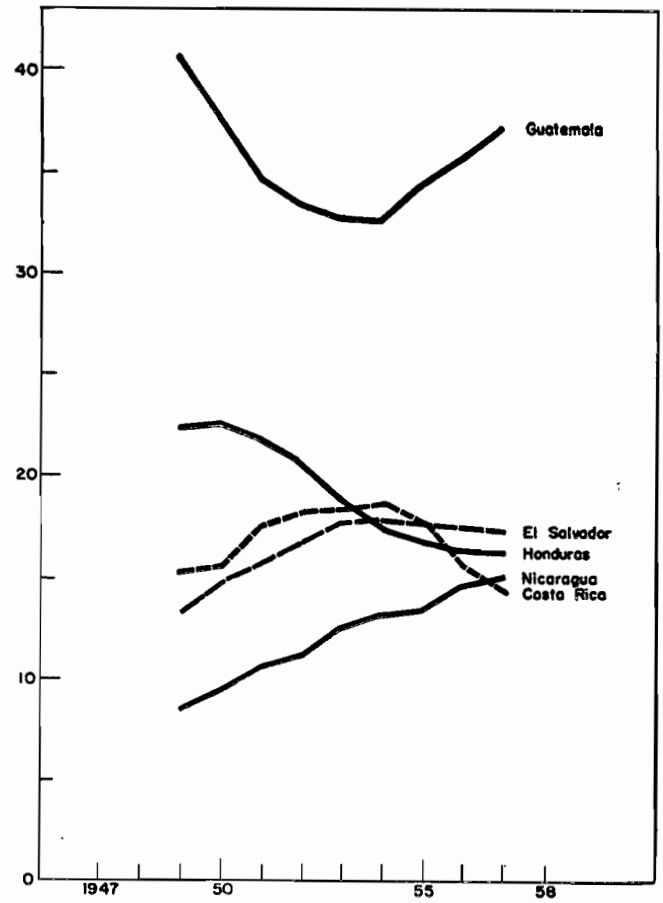


Figure X

CENTRAL AMERICA: PERCENTAGE OF TOTAL CONSUMPTION OF PETROLEUM PRODUCTS ACCOUNTED FOR BY EACH COUNTRY

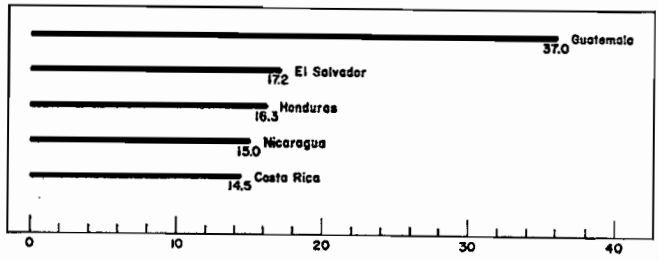


Table 22

CENTRAL AMERICA: DISTRIBUTION OF THE CONSUMPTION OF PETROLEUM PRODUCTS, 1948-59

(Thousands of tons)

Year	*Costa Rica*	*El Salvador*	*Guate-mala*	*Honduras*	*Nica-ragua*	*Total*
1947						
Volume	84	58	204	109	38	493
Percentage	17.0	11.8	41.4	22.1	7.7	100.0
1948						
Volume	97	75	271	142	43	628
Percentage	15.4	12.0	43.2	22.6	6.8	100.0
1949						
Volume	87	84	294	145	59	624
Percentage	13.9	13.4	40.0	23.3	9.4	100.0
1950						
Volume	98	93	291	153	67	702
Percentage	13.9	13.3	41.5	21.8	9.5	100.0
1951						
Volume	105	112	251	151	68	687
Percentage	15.3	16.3	36.5	22.0	9.9	100.0
1952						
Volume	137	134	204	170	92	737
Percentage	18.6	18.2	27.7	23.0	12.5	100.0
1953						
Volume	212	140	239	167	96	854
Percentage	24.8	16.4	28.0	19.6	11.2	100.0
1954						
Volume	142	151	258	144	105	800
Percentage	17.7	18.9	32.3	18.0	13.1	100.0
1955						
Volume	118	147	324	96	133	818
Percentage	14.4	18.0	39.6	11.7	16.3	100.0
1956						
Volume	162	168	339	152	125	946
Percentage	17.1	17.8	35.8	16.1	13.2	100.0
1957						
Volume	160	182	365	193	139	1,039
Percentage	15.4	17.5	35.1	18.6	13.4	100.0
1958						
Volume	157	181	401	198	199	1,136
Percentage	13.8	16.0	35.3	17.4	17.5	100.0
1959						
Volume	132	186	438	199	164	1,119
Percentage	11.8	16.6	39.2	17.8	14.6	100.0

SOURCE: Foreign trade statistics of the Central American countries.

Table 23

CENTRAL AMERICA: MOVABLE AVERAGES OF THE PERCENTAGE DISTRIBUTION OF CONSUMPTION OF PETROLEUM PRODUCTS, BY COUNTRY

Country	*1947-51*	*1948-52*	*1949-53*	*1950-54*	*1951-55*	*1952-56*	*1953-57*	*1954-58*	*1955-59*
Guatemala	40.52	37.78	34.74	33.20	32.82	32.68	34.16	35.62	37.00
El Salvador	13.36	14.64	15.52	16.62	17.56	17.86	17.72	17.64	17.18
Honduras	22.36	22.54	21.94	20.88	18.86	17.68	16.80	16.36	16.32
Nicaragua	8.66	9.62	10.50	11.24	12.60	13.26	13.44	14.70	15.00
Costa Rica	15.10	15.42	17.30	18.06	18.16	18.52	17.88	15.68	14.50
TOTAL	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*

SOURCE: Foreign trade statistics of the Central American countries.

2. A Central American petroleum refinery

(a) *Installation costs*

Market studies have indicated as suitable the installation of a refinery with a daily input capacity of 38,000 barrels by 1970. The proportions of products that could in principle be obtained from such a refinery are:

	Percentage
Petrol	31.7
Kerosene	6.9
Diesel and fuel oil	56.7
Lubricants	2.2
Asphalt	2.5
	100.0

On this basis, the cost of installing a refinery of the production capacity proposed would be 1,000 dollars per barrel, a figure that is entirely in line with the results of experience in Mexico. In 1959 investment per daily barrel (expressed in dollars) in Mexico was:

Production	1,209
Refinery	800
Oil tanker transport	52
Other transport	300
Distribution and sales	200
	2,561

The most recent figures, and the likelihood of a future increase, justify the assumption that the item "refinery" would increase to 1,000 dollars per barrel.

The fixed investment for 38,000 barrels a day would thus be about 38 million dollars, which would include all necessary fixed capital, that is, the cost of the equipment, installation, control systems, buildings, electrical and steam installation, land, contractor's fees, construction work, etc., and in addition the maintenance of a spare part inventory sufficient to guarantee uninterrupted operation. In this case the refinery plant would consist of a unit for catalytic cracking and input blending. The cost could be reduced to 600 dollars a barrel if continuous operation 24 hours a day were not guaranteed; moreover, part of the cost could be used for auxiliary installations for obtaining special lubricants, etc.

(i) *Verifying installation costs.* The above estimate is also supported by other data. In the first place, there is a refinery in Chile that represents a real investment of 34 million dollars, with a daily capacity of 44,000 barrels, giving a cost per barrel of approximately 800 dollars. Secondly, according to information available, the figures for various refineries that have been approved in Central America and Panama are as follows:

		Barrels per day	*Investment (millions of dollars)*	*Investment per barrel (dollars)*
Guatemala	A	6,000	8	1,333
	B	12,000	18	1,500
El Salvador	A	10,000	10	1,000
	B	10,000	10	1,000
Nicaragua		5,000	8	1,600
Panama	A	50,000	35	700
	B	55,000	—	

These figures confirm the estimated investment cost of 1,000 dollars per barrel. This cost would increase if the refinery's capacity were reduced.

(ii) *Calculation of the installation costs of a refinery with a daily capacity of 19,000 barrels.* As shown above, the cost of installing a refinery with a daily capacity of 38,000 barrels, based on the distribution of production required for the Central American market for the various products, would be 38 million dollars. However, to estimate costs and make the comparisons needed as a basis for deciding on the size of the refinery, it is necessary to determine the cost of a refinery with a lower output. If the capacity of an industry is increased, the installation costs do not increase in a linear form, but exponentially to a power less than unity. This has been demonstrated in a large number of industries, the exponent varying between 0.42 and 0.90. For a petroleum refinery the exponent is 0.5.[68] Consequently:

$$I_1 = I_2[C_1/C_2]^{0.5}$$

where:

I_1 = the investment for 38,000 barrels

C_1 = a capacity of 38,000 barrels

C_2 = a capacity of 19,000 barrels

I_2 = the investment needed for 19,000 barrels.

Substituting values for the other terms gives:

$$I_2 = \frac{38 \text{ million dollars}}{\sqrt{2}} = \frac{38}{1.42} = 27 \text{ million dollars.}$$

(b) *Operational costs*

(i) *Materials.* The cost of a barrel of crude petroleum can be estimated as in the region of 3 dollars, although in 1955 it was estimated as 2.48 dollars.[69] It might be possible to obtain a lower quotation from Venezuela or other areas.

(ii) *Labour.* Two types of workers are needed for petroleum refineries, corresponding to the two aspects of production and maintenance. Since the industry is based on an automatic process, production workers have little effect on total cost. Their function is one of control rather than of operation. Three daily shifts are needed to permit continuous operation.

It is difficult to obtain exact data as to the number of workers needed for the operation of a refinery, but for the purposes of calculation it can be assumed, in the light of experience in plants of similar capacity in other countries, that a Central American refinery of the kind described would need about 500 workers, of which 200 would be operational staff and 300 maintenance and administrative staff. The hourly wage is assumed to be an average of 0.50 dollars per worker; thus the average daily wage

[68] Indicated by PEMEX. In Mexico this exponent ranges from 0.5 to 0.6.

[69] See *Central American economic integration: development and prospects*, op. cit.

would be 4 dollars, giving a total daily wage bill of 2,000 dollars. Table 24 classifies petroleum refining establishments in the United States by number of workers, indicating the value added; this table and figure XI show that the value added per worker is highest in the group with an average of 123 workers.

Table 24

UNITED STATES: RELATION BETWEEN VALUE ADDED AND NUMBER OF WORKERS IN THE PETROLEUM REFINING INDUSTRY

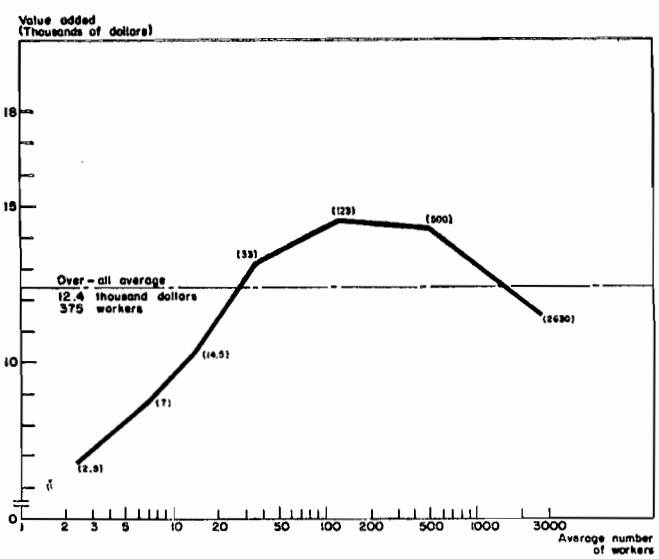
	All refineries	*Refineries employing the following number of workers:*						
		1-4	*5-9*	*10-19*	*20-49*	*50-249*	*250-999*	*1,000*
Number of refineries	409	30	22	41	69	133	78	36
Total workers employed	153,072	76	153	597	2,268	16,353	39,018	94,607
Average number of workers	375	2.5	7	14.5	33	123	500	2 630
Value added (thousands of dollars)	1,901,333	515	1,327	6,204	29,966	237,368	554,948	1,071,005
Value added per worker (thousands of dollars)	12.4	6.8	8.7	10.4	13.2	14.5	14.2	11.3

SOURCE: U.S. Department of Commerce, *1954 Census of Manufactures.*

Figure XI

UNITED STATES: VALUE ADDED PER WORKER IN THE PETROLEUM REFINING INDUSTRY

Semi-logarithmic scale



(iii) *Amortization.* Ten per cent annually was allowed for depreciation; this may seem rather high, but it takes account of the nature of petroleum technology, which is constantly developing.

(iv) *Maintenance.* The figure of 4 per cent a year obtained from PEMEX (Mexico) agrees with that obtained from other sources and other processing industries.

(v) *Insurance, taxes, etc.* The allowance made was 2 per cent of the investment.

(vi) *Remuneration of capital.* The amount allowed was 12 per cent, including taxes and other charges.

(vii) *Approximate operating cost.* The operating cost for a plant with a daily input of 38,000 barrels and a production of about 34,500 barrels of various products is about 4.34 dollars per barrel produced (see table 25), on the basis of the figures given in the foregoing paragraphs. The cost of refining amounts to about 0.62 dollars, which agrees with the cost calculated in the United States (0.60 dollars per barrel of crude petroleum). In Mexico the cost is somewhat lower, 5.90 pesos (0.48 dollars) per barrel, but conditions are very different.

Table 25

APPROXIMATE OPERATING COSTS OF A PETROLEUM REFINERY WITH A DAILY INPUT CAPACITY OF 38,000 BARRELS

(Dollars)

	Annual cost	*Cost per barrel produced*	
Materials	35,454,000	3.330	
Labour	622,000	0.058	
Amortization (10 per cent)	3,800,000	0.353	
Maintenance (4 per cent)	1,520,000	0.140	0.621
Insurance, taxes, etc. (2 per cent)	760,000	0.070	
Normal remuneration of capital (12 per cent)	4,560,000	0.424	
TOTAL	*46,716,000*	*4.345*	

(c) *Calculation of the minimum economic capacity of a petroleum refinery*

Although the economic size of a modern refinery ranges between 6,000 and 10,000 barrels a day, and many refineries (especially in the United States) operate economically at a level below 10,000 barrels a day, it is not now regarded as advisable to install very small plants, and the minimum economic size is estimated as about 30,000 barrels a day. As a check, the operating costs for a number of different sizes have been estimated, in accordance with the formula set forth in sub-paragraph (a) (ii) on page 43 (see also table 26).

In addition the sales price of each barrel produced was calculated, taking account of the proportions of the

Table 26

OPERATING COSTS OF A PETROLEUM REFINERY AT VARIOUS LEVELS OF CAPACITY

Level	Level of capacity					Operating costs							
	Input capacity		Annual output	Number of workers	Installation cost (millions of dollars)	Annual costs (thousands of dollars)							
	Daily	Annual				Materials	Labour	Amortization (10 per cent)	Maintenance (4 per cent)	Insurance and taxes (2 per cent)	Remuneration of capital (12 per cent)	Total	Cost per barrel (dollars)
	(Thousands of barrels)												
A	10	3,110	2,830	225	19.5	9,330	280	1,950	780	390	2,310	15,040	5.32
B	19	5,909	5,370	315	27	17,700	392	2,700	1,080	540	3,240	25,652	4.78
C	28.5	8,863	8,050	384	32.9	26,590	478	3,290	1,316	658	3,948	36,280	4.50
D	38	11,818	10,740	500	38	35,454	622	3,800	1,520	760	4,560	46,716	4.34
E	50	15,550	14,100	625	43.6	46,650	778	4,360	1,744	872	5,232	59,636	4.23
F	100	31,100	28,200	1,125	61.6	93,300	1,400	6,160	2,464	1,232	7,392	111,948	3.97

various products that it is hoped to produce, at the dollar prices obtained from the aforementioned ECLA study and from the United Nations Statistical Office, as follows:

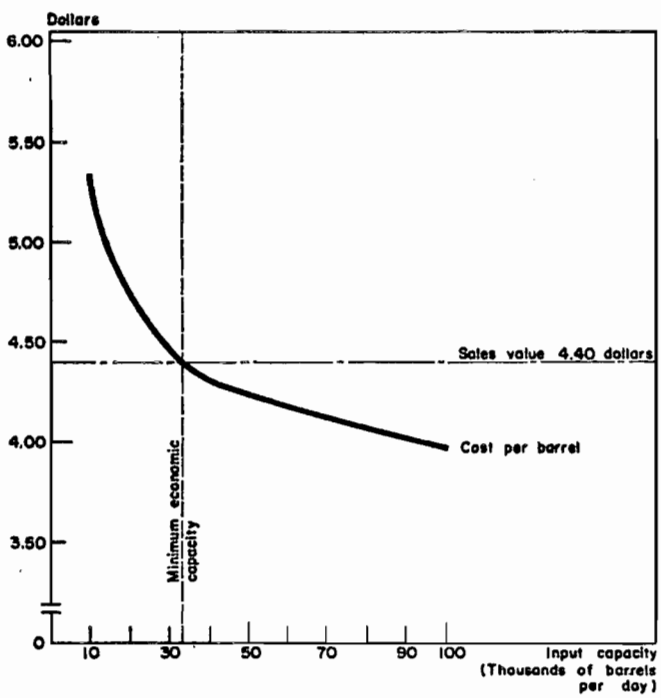
Product	*Percentage*	*Price per barrel (dollars)*	*Sales price per barrel (refined) (dollars)*
Petrol	31.7	4.95	1.57
Kerosene	6.9	4.50	0.31
Diesel and fuel oil	56.7	4.20	2.38
Lubricants, etc.	2.2	3.97	0.09
Asphalt, etc.	2.5	1.90	0.05
	100.0		4.40

Figure XII gives the curve for these costs and its intersection with the price axis indicates the minimum economic capacity: 33,000 barrels a day.

Figure XII

CALCULATION OF THE MINIMUM ECONOMIC SIZE OF A PETROLEUM REFINERY

Natural scale



(d) *Alternative method: use of fuel oil instead of crude petroleum as raw material*

The ECLA study on Central American integration (op. cit.) suggests the possibility of using fuel oil in the proposed Central American refinery, instead of crude petroleum. This alternative involves a less costly installation, which would consist only of a cracking unit. However, the drawback is that in periods of emergency it would be more difficult to obtain petroleum products than crude petroleum, and a refinery planned on these lines would have to include installation of a thermo-electric plant to use the residual coke. It might be preferable for the sake of convenience to decide on a refining plant that could handle either fuel oil or crude petroleum, in which case the installation costs would be similar to those indicated previously. This solution would provide great operating flexibility that would permit providing for possible market variations either in petroleum products or crude petroleum, and the use of whichever raw material was most advantageous.

3. SITE OF THE REFINERY

The siting of the Central American petroleum refinery should take account of a number of factors, some of which are fairly complex, such as geographical situation and centralization; size of the market; access to ports; costs of transport of crude petroleum, and costs of internal transport and distribution.

(a) *Geographical situation and centralization*

Generally speaking the geographical features of Central America are favourable to a supply of crude petroleum. As consumption is concentrated mainly on the Pacific coast, which is the area with the best communications, it seems preferable to locate the refinery or refineries in this area (see the map of the principal roads of Central America).

As regards the distribution of the products, it would be best to locate the refinery installations at some strategic point, although here the difficulty will always arise that distribution between the Central American countries is not uniform. This problem might be solved by installing distribution and storage plants that would redistribute the products.

Each country would have at least one distribution and storage centre on the Pacific coast, near a large port, and transfer from the oil-tankers to the storage units could be effected by means of relatively short oil pipelines. If such storage depots were decided upon, the marketing and distribution of the products would have a decisive influence on the siting of the refinery.

(b) *Cost of transporting the crude petroleum*

Transport would be mainly by sea, and the cost would be the same as or slightly higher than the corresponding costs for petroleum products; consequently it is not essential to carry out studies on the siting of the refinery and its impact on the transport costs. This conclusion would naturally have to be reviewed in the light of the studies of the industrial sector, an analysis which is outside the scope of the present study.

(c) *Cost of internal transport*

This item would tend to affect the eventual site of the industry. In Mexico transport costs per barrel in 1959 were:

	Dollars		*Percentage*	
Refinery	800		59.2	
Tanker transport	52	552	3.8	40.8
Other transport	300		22.2	
Distribution and sales	200		14.8	
	1,352		100.0	

The item "other transport" is very high because of the installation of numerous oil pipelines for the distribution and transport of crude petroleum. Nevertheless, the fact that about 40 per cent of the total investment is for transport (excluding investment for production) gives an idea of the magnitude of the problem; costs of transport and internal distribution are always very high. The refinery should be so sited that as many forms of transport as possible (sea, road, rail and oil pipelines) can be used.

Transport by oil pipeline involves high installation costs, but the operating cost is very low compared with the costs of road or rail transport; consequently pipelines are the best means of transport if the volume to be transported is over 300 barrels a day, when costs amount to about a third of what the rail costs would be. In the specific case of Mexico, installation of an oil pipeline over a distance of 445 kilometres gave the following operating costs:

	Cost per barrel and per kilometre (dollars)
Lorry transport	0.001,060
Pipeline transport	0.000,224
Difference	0.000,836
Percentage	79

4. General observations on productivity

The need to achieve maximum productivity in the petroleum and petroleum products industry — as regards both materials, machinery and labour — is beyond question. This industry is a processing industry in which direct labour is not one of the most important operating costs (as it is in tyre manufacture, for example, in which most of the operations are performed by machines controlled manually by the workers). Petroleum products for industrial use are produced from crude petroleum by refining; the necessary processes are carried out in bulk in distillation towers, cracking units, tanks, etc., and during these processes the petroleum travels from one stage to the next by means of pumps and other machinery. Labour is required mainly to control these operations, to handle the regulation and control instruments and to maintain the equipment and installations. In this situation the ratio labour/materials/general costs is of the order 7/84/9.

Distribution of petroleum, between the refinery and the storage depots, can be carried out by sea, pipelines, rail or road; it is in the last case that labour productivity is most significant. Thus in this industry the productivity function is determined by the existing technology, the maintenance of the refinery installations, transport (operation and maintenance), and control of production and distribution.

(a) *Maintenance of a refinery installation*

As production in a refinery is continuous throughout the twenty-four hours, maximum utilization of the plant and equipment requires a system of preventive maintenance that will reduce to the minimum the likelihood of unforeseen breakdowns. This requires: (1) a well established revision and periodic inspection, to check the condition of vital parts of the installations, and operating conditions, at predetermined intervals; (2) a sufficient stock of the spare parts and other items needed to permit the speedy execution of unexpected repairs; this stock should be maintained through a system of inventory control that establishes maximum and minimum inventory levels and replacement quantities; (3) a workshop with the machine-tools and other equipment required to manufacture or repair machinery and spare parts; (4) the building up and training of staff capable of operating at a high level of efficiency and in accordance with the control system established.

(b) *Transport: operation and maintenance*

For transporting petroleum products from the refinery to the storage depots and thence to the consumers (garages, factories, etc.) vehicles are required (road tankers), together with drivers and mechanics, and a system designed to obviate the loss of time in transport that is inevitable when the movement of vehicles is not properly organized and there is no system of control for this stage of the operation. Where transport is by oil pipeline, similar systems of inspection and maintenance can be installed to ensure maximum efficiency in maintaining in good condition both the pipelines themselves, and the pumping and heating equipment.

(c) *Control of production and distribution*

Office work and administration account for only a small part of operating costs, and consequently reorganization in that sphere can make no substantial reduction in costs; however, it can lead to greater efficiency in the enterprise's services, in the sense of the reports, data and statistics required for production and distribution.

(d) *Training*

Training courses in productivity techniques should include all the productive and commercial activities mentioned above, since such courses can be used by both high-level and less responsible staff. In conjunction with these courses there should be training and instruction for intermediate level staff and workers, aimed at providing a better trained labour force capable of operating the controls and systems established in the industry.

(e) *Use of petroleum products*

Petroleum products in their various forms are used in a vast range of industries, both in meeting the daily needs of the population and in producing energy, as well as supplying most forms of transport.

The development of an integrated petroleum industry in Central America can thus furnish a necessary service by supplying raw materials for essential manufactures, and products for direct use in the development of transport and of industrial energy. The resulting savings in foreign currency for the Central American countries could be devoted to improving the machinery inventory for existing and future industries. Later in this study a list is given of the main industries for which a supply of petroleum products is essential.

5. Conclusions and recommendations

(1) It is estimated that the total Central American market for petroleum products in 1970 will be about 2.1 million tons.

(2) The refining industry could absorb about 75 per cent of the total market.

(3) Consequently a refining industry should produce 1.6 million tons by 1970.

(4) On the basis of 311 working days a year and uninterrupted operation, the industry's input capacity would be about 38,000 barrels of crude petroleum a day.

(5) The structure of consumption of the various products in Central America, both for the present and the near future, is estimated in percentage terms as:

Petrol	31.7
Kerosene	6.9
Diesel and fuel oil	56.7
Lubricating oils and greases	2.2
Asphalt, pitch, resins, etc.	2.5
	100.0

(6) On the basis of the above percentages, the cost of installing a refinery with a capacity of 38,000 barrels a day would be approximately 38 million dollars.

(7) The minimum economic size of a refinery is 30,000 barrels a day.

(8) Storage and distribution depots would have to be established in each country, and the products would be transported from the refinery to those points by oil tankers.

(9) Consideration should be given to the possibility of installing plants that could use either fuel oil or crude petroleum as raw material.

(10) The type of raw material (crude petroleum or fuel oil) to be used at different times of the year should be programmed in advance, on the basis of a constant and careful analysis of market conditions and prices of crude petroleum on the world market.

(11) Although the incidence of labour productivity on costs in this type of industry is slight, there should be greater emphasis on training of personnel in control and management techniques, especially in relation to maintenance and distribution.

Annex

USES OF PETROLEUM AND PETROLEUM PRODUCTS

Industry	*Use*
Adhesives	Ingredients and softening agents
Building industry	Waterproofing agents
Chemical products	Ingredients, preservatives and catalysing agents Processing materials in the manufacture of benzene, ethylene, propane, toluene, etc. Purifying agent in the production of ammonia and anthracene Recovery agent for benzene Solvent for chlorohydrin and oil-soluble colouring agents Solvent in the process of polymerization of acrylic acid (plastic) Raw material for the production of chlorinated compounds Suspension medium for acetic acid
Cosmetics	Lotions, creams, dentifrices, hair tonics, lipsticks, shampoos and miscellaneous toilet articles
Dentistry	Agent used in the manufacture of material for taking mouth impressions
Disinfectants	Antiseptics
Dry cleaning	Absorbent, solvent and ingredient
Dyes	Processing materials
Electricity	Used in the manufacture of insulators, electric batteries, etc.
Explosives and matches	Used as an absorbent for explosives, inflammable compounds, fireworks, and wax matches
Fertilizers	Raw material
Fire prevention	Fire extinguisher component
Food	Preservative for eggs Ingredient in chewing gum Protective coverings Processing materials for butter substitutes
Glass	Processing material
Inks	Raw material
Insecticides and fungicides	Ingredient and base
Leather	Used in curing, softening and waterproofing
Lubricants	
Manufacture of: Carbon paper, Food containers, Softening agents, Colour solvents, Liquid ammonia, Waterproofing, Agents in general	Processing material
Metallurgy	Ingredient in compounds for tempering and treatment, moulds for magnesium
Metal-transforming	Recovery agent for aluminium, metallic paper and solder
Miscellaneous	Used in manufacturing polishes, padding, detergents, printing rollers, anti-rust compounds, templates, stencils, and waterproofing compounds
Oils and fats	Processing materials
Paper	Processing material in the manufacture of greaseproof and waterproof papers
Paints and varnishes	Paint bases

Industry	*Use*
Pharmaceuticals	Ingredients for prescriptions and proprietary remedies
Photography	Ingredient in film developing agents, film cartridges
Plastics	Used as absorbent, softening agents, and processing materials
Rubber	Recovery agent Regenerating agent Solvent
Soap	Ingredient in soaps and creams
Sugar	Purifying agent
Textiles	Steeping agents, raw materials, lubricants
Transport (air, sea and land)	Fuels and lubricants
Wood products	Ingredient in varnishes, polishes and preservative agents

IX. VISCOSE AND ACETATE RAYON

The present section analyses the possibility of establishing in Central America viscose or acetate rayon plant that could produce either continuous filament yarn or staple fibre for use in textile mills. At present no rayon or acetate yarn is produced in the area.

This is not the first study on this subject made in Central America; in 1956 and 1957 a United Nations expert studied the textile industry in these countries and came to the conclusion that a plant for the production of rayon filament and staple fibre would be a practical possibility by 1961.[70] In addition, in 1961 ICAITI prepared for the Instituto de Fomento Nacional a study entitled *Apreciación preliminar sobre la factibilidad de una planta de rayón en Nicaragua* (E/CN.12/CCE/GT.IND/2) which was submitted to the meeting of the *Ad hoc* Working Group on Industrial Development.

The present aim is to analyse the features and recent trends of the Central America market for rayon and rayon products, and to project its probable development during the present decade. It should also be considered whether the imports of continuous filament and staple fibre indicate a demand sufficient to justify the establishment of the industry in Central America, or whether it will also be necessary to encourage a process of substitution of imports of rayon fabrics, in which case it will be necessary to evaluate the capacity of the existing textile industry to absorb the output of a plant producing the raw materials.

In addition, production of viscose rayon and acetate rayon will have to be analysed from several standpoints — size of plant, total investment, raw material requirements, value added and degree of integration — with a view to comparative evaluation of the merits of the two industrial processes.

1. The Central American market

The Central American market for rayon fibre (staple or filament) is represented by imports of fabrics and of raw materials.[71] At present this fibre is not produced in any Central American country.

In 1959 apparent consumption of rayon products in Central America amounted to slightly over 4,700 tons,[72] with a c.i.f. value of 10.6 million dollars. Of this volume 4,000 tons represented imported fabrics and the rest imports of fibres and yarn for the manufacture of textiles (see table 27).

During the fifties consumption more than doubled, starting from an initial import volume of 2,200 tons. The annual cumulative growth rate for the period as a whole was 9.4 per cent.

Per capita consumption increased by about two-thirds (65 per cent), from 271 grammes in 1950 to 446 grammes in 1959. The increase was practically continuous, and was even sharper after 1957, when imports rose sharply and Japan took over the role of principal supplier of rayon fabrics to Central America. Per capita consumption levels were very similar in Guatemala, El Salvador, Honduras and Nicaragua, and amounted in 1959 to about 370 grammes. In Costa Rica the level was twice that in the other countries throughout the period, and in 1959 it was 861 grammes (see table 28).

It should be noted that there is a substantial unrecorded trade in imported rayon fabrics supplied from Honduras to Guatemala, El Salvador and Nicaragua. This is the

[70] See *Examen preliminar de las posibilidades de producción de filamento continuo y fibra corta de rayón en Centroamérica* (AC.2/I/DT/9), July 1956, and *Informe preliminar sobre la industria textil en Centroamérica* (TAA/LAT/8), April 1957, pp. 178-179 and annex I.

[71] These imports correspond to the following NAUCA items: 266-01-00 Artificial and synthetic fibres suitable for spinning, and waste of such fibres; 651-06-01 Rayon yarn and thread; 635-05-01 Velvet, plush, velveteen and triple-loop terry, of rayon or other synthetic fibres, pure or mixed with other textile fibres (except natural silk); 653-01-05-02 Fabrics n.e.s. of rayon, unmixed with other textile fibres; 654-03-03 Ribbons of rayon, pure or mixed; 654-04-03 Embroidery on fabrics, tulle, lace, ribbon, velvets, etc., of rayon pure or mixed; 656-03-03 Blankets, travelling rugs and coverlets of rayon and other man-made textile fibres, pure or mixed; 841-01-03 Stockings and socks of rayon, pure or mixed; 841-02-03 Undergarments and nightwear, knitted or crocheted, or made of knitted or crocheted fabrics, of rayon, pure or mixed; 841-03-03 Outer garments, knitted or crocheted, or made of knitted or crocheted fabrics, of rayon, pure or mixed; 841-04-03 Undergarments and nightwear, other than knitted or crocheted, of rayon, pure or mixed; 841-05-03 Outer garments, other than knitted or crocheted, of rayon, pure or mixed.

[72] In terms of rayon only. If this volume is adjusted to include the rayon content of products of rayon blended with other fibres, and assuming that the average rayon content of such articles is about 12.5 per cent, total consumption of rayon (both continuous filament and staple fibre) would be about 5,200 tons.

Table 27

CENTRAL AMERICA: APPARENT CONSUMPTION OF RAYON PRODUCTS, 1950-60

(Tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
TOTAL	*2,154*	*2,430*	*2,315*	*2,697*	*2,954*	*3,249*	*3,312*	*4,315*	*4,362*	*4,706*	*3,971*
Production [a]	208	182	231	307	684	330	570	709	652	731	909
Imports	1,946	2,248	2,084	2,390	2,270	2,919	2,742	3,606	3,710	3,974	3,062
Guatemala	*392*	*365*	*446*	*410*	*345*	*438*	*406*	*552*	*511*	*489*	*820*
Production [a]	86	78	124	99	191	146	195	372	361	369	625
Imports	306	287	322	311	154	292	211	180	150	120	195
El Salvador	*538*	*588*	*633*	*701*	*867*	*768*	*585*	*489*	*385*	*289*	*406*
Production [a]	—	—	—	43	216	66	102	45	21	8	15
Imports	538	588	633	658	651	702	483	444	364	281	391
Honduras	*356*	*511*	*467*	*491*	*459*	*618*	*1,305*	*1,897*	*1,940*	*2,553*	*1,452*
Production [a]	—	—	—	—	—	—	15	19	4	5	3
Imports	356	511	467	491	459	618	1,290	1,878	1,936	2,548	1,449
Nicaragua	*382*	*116*	*264*	*436*	*737*	*854*	*330*	*383*	*379*	*296*	*326*
Production [a]	46	34	50	80	172	46	58	59	27	68	46
Imports	336	82	214	356	565	808	272	324	352	228	280
Costa Rica	*486*	*495*	*505*	*659*	*546*	*571*	*686*	*994*	*1,147*	*1,079*	*967*
Production [a]	76	70	57	85	105	72	200	214	239	282	220
Imports	410	425	448	574	441	499	486	780	908	797	747

SOURCE: Foreign trade yearbooks.

[a] According to the records of imports of rayon fibre and yarn.

Table 28

CENTRAL AMERICA: APPARENT PER CAPITA CONSUMPTION OF RAYON PRODUCTS, 1950-59

(Grammes)

Year	Total for Central America	Costa Rica	Rest of Central America
1950	271	605	233
1951	253	600	214
1952	274	592	238
1953	309	749	260
1954	328	592	298
1955	349	600	320
1956	345	694	305
1957	434	962	373
1958	425	1,066	350
1959	446	861	369

Table 29

CENTRAL AMERICA: PRICES [a] OF IMPORTED RAYON AND COTTON FABRICS AND INDEX OF THE PRICE OF RAYON RELATIVE TO COTTON, [b] 1950-59

Year	Rayon	Cotton	Relative price of rayon (Index)
1950	3,500	2,184	151
1951	3,828	2,442	148
1952	3,555	2,407	139
1953	3,102	2,383	123
1954	3,230	2,351	130
1955	2,485	2,343	100
1956	2,447	2,324	99
1957	2,179	2,285	90
1958	2,014	2,209	86
1959	1,910	2,250	80

SOURCE: Official statistics.

[a] C.i.f. unit import prices in dollars per ton.

[b] 1955 = 100.

reason for the unexpectedly high level of per capita consumption in Honduras and for the variations found in the other three countries, and makes it necessary to base the analysis on the average consumption of the four countries as a whole. The difference between the rayon consumption in Costa Rica and in the remaining four countries is due to the much higher levels of per capita income in Costa Rica.

The rapid growth in the demand for rayon in Central America is not due solely to increases in population and income, but also to an almost continuous decline in the relative price of rayon fabrics. Between 1950 and 1959 the c.i.f. unit prices of rayon and cotton fabrics declined, but the decrease was sharper for rayon, and was reflected in a drop of 47 per cent during the period in the price of rayon fabrics relative to that of cotton fabrics; this resulted in a record growth rate in the consumption of rayon fabrics (see table 29). The consumption of cotton fabrics also increased, and continues to be by far the largest item in the textile sector. Nevertheless, according to preliminary estimates the share of rayon in the total

consumption of cotton and rayon rose from 8 per cent in 1948 to about 20 per cent in 1959.

At the same time there was a change in the source of supply, with the result that the proportion of raw materials in all imports of rayon and rayon fabric rose from 9 per cent per year in the three-year period 1950-52 to 16 per cent in the period 1957-59. It should be noted that this increase came about despite the fact that the unit import prices of raw materials fell less than the corresponding prices for finished products, and that all production was based on imported raw materials. Central American production is concentrated in Costa Rica and Guatemala, countries that have been contributing between 60 and 90 per cent of the total for the region.

Despite the rapid growth of rayon consumption in Central America during the last decade, per capita consumption in 1956-58 was still low compared with other areas. For Central America as a whole the level represented about 47 per cent of average world consumption (850 grammes), 57 per cent of the average consumption for Latin America (700 grammes), 19 per cent of that for western Europe (2,100 grammes), 14 per cent of that for the United States (2,900 grammes), and about 66 per cent of that for Africa (600 grammes).[73] If Costa Rica is excluded, these percentages would be even lower.

It appears useful to study more closely the effects on rayon consumption of an increase in per capita income and of a fall in the relative price, in order to make some estimate of the probable evolution of this consumption from 1959 to 1966 and 1970. The analyses made suggest that in Central America the sensitivity of per capita rayon consumption to increases in income is high at relatively low income levels (between 160 and 175 dollars per capita per annum), whereas sensitivity to decreases in the relative price of rayon is low. Between 1950 and 1959 the ratios, for Guatemala, El Salvador, Honduras and Nicaragua taken together, were 1 to 2 for income and 1 to 0.3 for relative price. Thus on an average increases of 1 per cent in per capita income, or decreases of 1 per cent in the relative price, resulted in increases of 2 and 0.3 per cent, respectively, in per capita consumption of rayon.

The analyses also suggest that when per capita income increases up to intermediate levels (between 300 and 350 dollars a year) there is a reduction in the sensitivity of the demand for rayon to increases in income, and an increase, on the other hand, in sensitivity to reductions in the relative price of rayon products. In Costa Rica, and countries with similar income levels, the income-consumption ratio is approximately 1 to 1, but the relative-price consumption ratio in Costa Rica seems to be greater than unity; that is, on an average the per capita consumption of rayon tends to increase proportionally with income and more than proportionally with a decrease in the relative price.

Clearly the future demand for rayon will continue to depend largely on how income level develops and on the price relative to that of other fibres, particularly cotton. The increase in the relative price of rayon cannot be expected to continue indefinitely at the same rate as in the fifties, in view of the fact that there has already been a substantial drop in the price of rayon textiles and that current prices are now lower than those of cotton goods. Consequently, the Central American demand for rayon is likely to increase less rapidly than in the past. The growth rate will thus depend mainly on the development of per capita income, and will tend to increase proportionally with the ability of the Central American countries to improve the slow economic growth of recent years and initiate a more rapid process of economic development.

In addition it should be noted that if the relative price situation remains unchanged, the demand both for rayon and for textiles in general will tend to increase on lines determined more directly by consumer preferences, and consequently an increase in the substitution of rayon for cotton textiles, either absolute or relative, cannot necessarily be expected. In these circumstances it seems likely that the rise in per capita income will result, in addition to a higher total consumption of textiles, in a transfer of demand from coarse to fine cotton goods, and not only to rayon goods. The proportions in which the additional income devoted to textiles will be divided between cotton and rayon will depend partly on relative sensitivity to the change in income, and partly on the improvement of production techniques in the cotton sector. Even if such improvements are hampered by problems that can only be solved on an intermediate or long term basis, the most recent demand trends in other countries indicate the existence of factors that are potentially more favourable to cotton in its competition with other textile fibres for the income of the Central American consumer.

On the basis of the foregoing considerations it has been assumed, in projecting the rayon market for Central America as a whole, that the relative price will remain at its present level throughout the sixties. The growth rate projected for per capita income is an annual cumulative rate of 2.5 per cent. This rate, which is undoubtedly higher than the rate for Central America in recent years, will not be easy to achieve, and is based on the assumption that a strict policy of integrated economic development will be pursued, and that the conditions of the traditional export markets will not deteriorate. Separate projections were made for Costa Rica and for the rest of Central America, because of the differences between the two as regards the relative sensitivity of demand to changes in income.

In the light of the demographic growth rate foreseen, the Central American market for rayon is estimated as 7,800 tons for 1966 and nearly 10,500 tons for 1970. This would involve doubling the size of the market within ten years, and an annual cumulative growth rate of 7.5 per cent, which would be lower by one-fifth than the rate for 1950-59.

2. Size of the market and minimum economic size of the plant

Expert opinion agrees that the minimum economic size of a viscose rayon plant, in the general conditions of costs and prices now existing, is about 3,000 tons a year.

[73] FAO, Commodity Series No. 31, *Per capita fibre consumption levels, 1948-1958* (Rome, 1960).

For an acetate rayon plant the minimum economic level would be only 1,400 tons. In the light of these requirements, it can be readily appreciated that it would be impossible to establish either type of plant in Central America in the near future for the sole purpose of substituting imports of rayon yarn, since, as already explained, these imports amounted to only 700 tons in 1959. There would have to be a simultaneous increase in the substitution of imported fabrics and other rayon products, in order to absorb the total volume that a Central American plant would have to produce.

Available information indicates that the textile industry in these countries does not yet have sufficient capacity to utilize the production of the proposed plant. It is estimated that to spin and weave 3,000 tons of rayon fibre requires between 30,000 and 35,000 spindles, operating 24 hours a day, and about 1,500 looms. At present Central America has about 4,000 looms, of which between 500 and 600 are used for rayon weaving. Unconfirmed data suggest that current spinning of rayon is of very small proportions.

Consideration might be given to achieving the rayon spinning and weaving capacity needed by using part of the spindles and looms now used to process cotton. This is feasible from the technical standpoint, and would require a smaller investment, estimated for spinning as about half a million dollars.

However, this might have an adverse effect on the production of cotton goods, and decrease the volume of cotton fibre now being processed in the region. As the textile industry has been operating with excess capacity, it may be that some capacity could be used as suggested above, although not on the scale proposed.

If the proposal is to establish additional installed capacity without in any way affecting existing capacity, new investments of between 11.7 and 13.1 million dollars would be needed. This amount would be distributed as follows: between 4.5 and 5.2 million dollars for spinning, between 6.2 and 6.9 for weaving and over a million dollars for equipment to generate thermal electric power.

In any case, large investments would have to be made in plants for the printing and finishing of rayon fabrics, amounting to some 5 or 6 million dollars.

To sum up, the above figures give a maximum of between 16.7 and 19.1 million dollars as the investment in the Central American textile industry required to increase the regional output of rayon goods sufficiently to absorb the output of a viscose rayon plant of minimum economic size.

In the circumstances envisaged the above estimates would be rather high, in that the plant would produce continuous filament that would not require spinning. Moreover the investment in the textile industry would be lower if an acetate rayon plant were established, since its minimum economic size would be smaller.

In comparing the foregoing totals with the estimates made by ICAITI (op. cit.) it should be noted that the two estimates are based on different hypotheses as regards prices of machinery and certain technical coefficients. In addition, the Institute's estimates, which are between 25 and 30 million dollars, relate to the possibility of absorbing 4,500 tons of viscose rayon. However, if these figures are adjusted in terms of the 3,000 tons envisaged in the examples given above, the results are practically the same, 16.7 and 19.9 million dollars.

It can apparently be concluded that even if the investment needed in the textile industry is reduced — through the use of part of the existing capacity in the manufacture of rayon products — the total would still be relatively high. This points to the need to approach the problem of the development of an integrated rayon industry as part of the programme of development and specialization of the textile industry of the Central American countries on a regional basis. It is to be hoped that the work now being done on these lines with the technical assistance of the United Nations will provide further useful information on this point.

3. Characteristics of a viscose rayon plant

(a) *Volume and composition of the investment*

The fixed investment required for a plant of minimum economic size (3,180 tons a year) is estimated as about 10 million dollars, of which 8.8 million represent equipment for producing filament, and one million the additional plant needed to produce staple fibre. The working capital required is estimated as 20 or 25 per cent of the fixed investment, or about 2.5 million dollars. In arriving at this estimate account has been taken of, *inter alia*, the manufacturing period (21 days) for this type of industrial process. The composition of the fixed investment would be as follows:

	Millions of dollars	*Percentage*
TOTAL	*9.8*	*100.0*
Land and buildings	1.8	19.0
Production machinery	4.9	50.0
Other equipment and services (including an electric power generator)	3.1	31.0

(b) *Labour requirements*

The labour employed in such a plant varies according to whether the spinning equipment is continuous or non-continuous; in the first case the total labour force would be about 300, and in the second about 500. Non-continuous equipment is difficult to keep in good condition, and consequently it has been assumed that the automatic process would be used. The labour force would consist of 200 production workers and 100 maintenance and management staff.

(c) *Raw materials*

Rayon is produced from a number of raw materials that are of great interest from the standpoint of integrated Central American development, and the proposed plant would provide a source of substantial demand for these materials. The main ingredients are cellulose, sulphuric acid and caustic soda; carbon bisulphide and other materials are also used, although in smaller quantities. The inputs of the three main ingredients, for an output of 3,180 tons, would be 3,243 tons of cellulose, 3,816 tons of sulphuric acid (76 per cent) and 2,544 tons of caustic soda. None of these raw materials are produced

in Central America at present. In this connexion it should be recalled that in 1958 the Central American Economic Co-operation Committee expressed interest in establishing production of rayon continuous filament and staple fibre from cotton waste.[74] In a study prepared for ICAITI by the Instituto de Fomento Nacional of Nicaragua an analysis was made of the possibility of installing a plant to produce 2,500 tons of cotton cellulose in connexion with the establishment of a rayon plant that at the first stage would have a capacity of 2,000 tons. The conclusions of this study indicate that the cellulose could be produced at prices competitive with, or even appreciably lower than, the prices of the imported product. Again, in the pulp and paper project in Honduras,[75] the possibility of producing wood pulp for export was studied. If the pulp were chemically and not mechanically produced, part of the output could be used in the production of viscose rayon. Lastly, there are projects at an advanced stage for the production in Central America of caustic soda and sulphuric acid, as part of industrial complexes, that could perhaps constitute a source of supply of these materials for a Central American viscose rayon industry.

(d) *Production costs*

The production costs given below have been calculated on the assumption that the manufacture of rayon fibre would be based, at least during the first stage, on imported raw materials. On the basis of a direct survey, an estimated percentage breakdown of the various cost components of a ton of 120 denier filament (the common type of rayon produced) was arrived at, mainly for purposes of illustration, as follows:

Costs	*Percentage*	*Dollars a*
TOTAL (ex-factory, excluding profit)	*100.0*	*1,700*
Cellulose	10.0	170
Sulphuric acid, caustic soda and carbon bisulphide	17.0	289
Other raw materials	10.0	170
Labour	33.0	561
Depreciation	15.0	255
Public services and other production costs	15.0	255

a At 1959 prices.

It should be noted that the 33 per cent for labour is the main cost item, and that the cellulose accounts for a comparatively low percentage of the total cost of raw materials. The high charges for depreciation are due to the high rates of obsolescence obtaining in the artificial fibre industry.

The production cost of 1,700 dollars per ton of rayon viscose filament is higher than the c.i.f. unit cost of imported yarns, which are estimated as about 1,400 dollars.

Since the above cost calculations do not include any allowance for profit, and assuming that the saving on transport and distribution cost would not be sufficient to offset the high manufacturing cost, it seems clear that the industry could not be established unless a certain margin of tariff protection were afforded.

4. CHARACTERISTICS OF AN ACETATE RAYON PLANT

It is not possible to determine exactly the size of the separate market in Central America for rayon and acetate yarns, and only the market for the two together can be estimated. These fibres are largely interchangeable, and consequently it can be assumed that the market can be supplied by a plant of either type. However, it should be noted that viscose rayon staple fibre is easier to use than acetate staple fibre, at least when it is blended with cotton. The data given below is based on experience with acetate plants in Latin American countries, notably Mexico, Peru and Venezuela.

(a) *Volume and composition of the investment*

The fixed investment needed for an acetate plant of minimum size is estimated as 3 million dollars, of which 250,000 dollars would represent the equipment for producing the staple fibre. The working capital would represent about 25 per cent of the fixed investment (as for the viscose rayon plant), or 750,000 dollars. The composition of the fixed investment would be:

	Millions of dollars	*Percentage*
TOTAL	*3.00*	*100.0*
Land and building	0.75	25.0
Production machinery	1.75	58.0
Other equipment and services	0.50	17.0

(b) *Labour requirements*

In all, the plant would employ 200 people, consisting of 175 production workers plus a small maintenance staff. The increase in the labour force called for by any subsequent expansion of spinning capacity would also be small.

(c) *Raw materials*

The main raw material used in the production of acetate rayon is cellulose acetate, a petrochemical industry product that would necessarily have to be imported. Small amounts of acetone and certain kinds of oil are also needed. The inputs required to produce 1,375 tons of acetate fibre are: 1,378 tons of cellulose acetate flakes, 137 tons of acetone, and 41 tons of oils.

(d) *Production costs*

The production costs have been estimated in the same way as for the viscose rayon plant. For a filament of between 150 and 170 deniers the figures are:

Costs	*Percentage*	*Dollars a*
TOTAL (ex-factory, excluding profit)	*100.0*	*1,250*
Cellulose acetate	56.0	700
Other raw materials	4.0	50
Labour	10.0	124
Depreciation	15.0	188
Public services and other production costs	15.0	188

a At 1959 prices.

[74] Resolution 60 (CCE) adopted at the Committee's fifth session: see the report of the session (E/CN.12/492), United Nations publication, Sales No.: 58.II.G.3), pp. 20-21.

[75] Op. cit, see footnote 58.

The total production cost of 1,250 dollars per ton of acetate filament is comparable with the c.i.f. price of the imported product (about 1,300 dollars). Although this ratio is more favourable than for viscose rayon, the margin is clearly too small to permit an economic operation that would cover profits and transport and distribution costs.

5. Conclusions

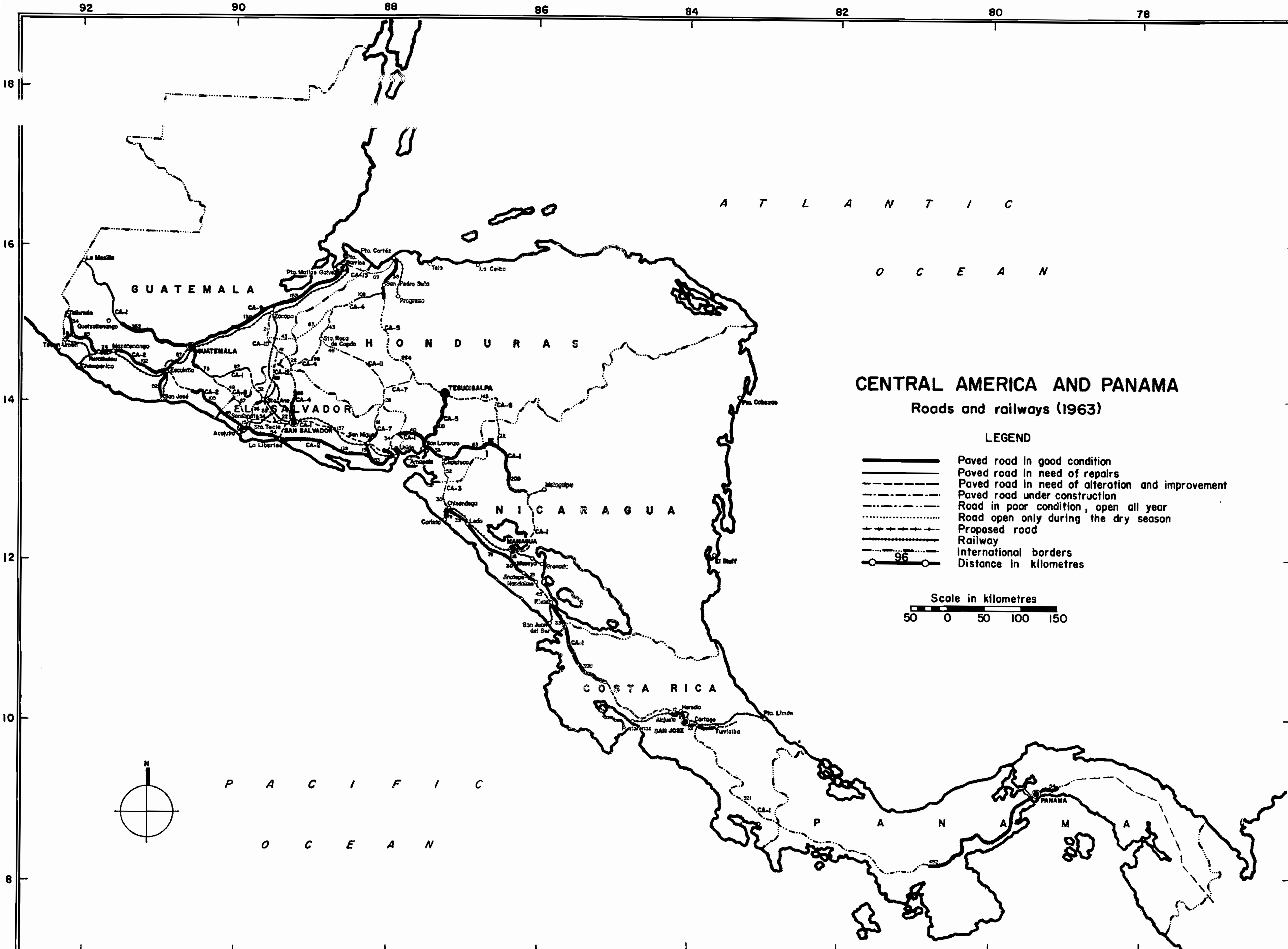
The establishment of a viscose or acetate rayon plant in the area, to supply the Central American market, should be considered in the light of an evaluation of the additional investments that would have to be made in the textile industry to enable it to absorb the volume of fibre produced in a plant of the minimum economic size, through a process of substitution of imports of rayon fabrics and other products. These investments would be high and might amount to between 16 and 20 million dollars.

Both the minimum economic size and the investment needed are higher for a viscose rayon plant than for an acetate plant. The relative manpower absorption per unit of output would be higher for the acetate plant, although it would tend to decrease at higher levels of capacity.

The manufacture of viscose rayon could give rise in the foreseeable future to an integrated operation through the use of raw materials and intermediate goods produced in Central America. In this sense it would encourage the establishment of other industrial branches of interest to the region. The manufacture of acetate would have to be based solely on the processing of imported intermediate products.

The unit cost of production would be relatively high for both types of plant, in comparison with the price of the imported item, but it would be lower for acetate.

The value added in the Central American production would be higher for the viscose rayon plant. The savings of foreign currency that such a plant would make possible would be nearly twice as much, per ton, as for acetate.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Distance in kilometres
Scale in kilometres
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