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ECUADOR

POWER SECTOR MEMORANDUM

May 12, 1981

Projects Department  
Latin America and the Caribbean Regional Office

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## CURRENCY EQUIVALENTS

|                         |   |                              |
|-------------------------|---|------------------------------|
| Currency unit           | = | Sucre (S/)                   |
| S/. 1.00 = 100 centavos | = | US\$0.04                     |
| S/. 1,000,000           | = | US\$40,000                   |
| US\$1.00                | = | S/. 25.00 <sup>1/</sup>      |
| US\$1,000,000           | = | S/. 25,000,000 <sup>1/</sup> |
| US\$ mill 1             | = | S/. 0.0250                   |

## ACRONYMS

|         |   |  |
|---------|---|--|
| CENAFE  | = | Centro Nacional Franco-Ecuatoriano             |
| CEPE    | = | Corporacion Estatal Petrolera Ecuatoriana      |
| CONADE  | = | Consejo Nacional de Desarrollo                 |
| EEO     | = | Empresa Electrica de Quito S.A.                |
| EMELEC  | = | Empresa Electrica del Ecuador Inc.             |
| FONAPRE | = | Fondo Nacional de Preinversion                 |
| IDB     | = | Inter-American Development Bank                |
| IECO    | = | International Engineering Co. - U.S.A.         |
| INE     | = | Instituto Nacional de Energia                  |
| INECEL  | = | Instituto Ecuatoriano de Electrificacion       |
| MPNE    | = | Ministerio de Recursos Naturales y Energeticos |
| OLADE   | = | Latin-American Energy Organization             |
| SNI     | = | National Interconnected System                 |

## ABBREVIATIONS, UNITS AND MEASURES

|                 |   |  |
|-----------------|---|--|
| kcal            | = | kilocalorie (1,000 calories = 1.163 kWh)     |
| kW              | = | kilowatt                                     |
| Mw              | = | megawatt (1,000 kW)                          |
| kWh             | = | kilowatt hour                                |
| GWh             | = | gigawatt hour (1,000,000 kWh)                |
| kV              | = | kilovolt (1,000 volts)                       |
| MVA             | = | megavolt-ampere (1,000 kVA)                  |
| km              | = | kilometer (0.6214 mile)                      |
| km <sup>2</sup> | = | square kilometer (0.386 sq. mi)              |
| ha              | = | hectare (0.01 km <sup>2</sup> = 2.471 acres) |
| TOE             | = | ton of oil equivalent (10 <sup>7</sup> kcal) |

## FISCAL YEAR

INECEL's fiscal year ends December 31

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<sup>1/</sup> Exchange rate as of March 31, 1981, which was used to compute currency equivalents in this report.

ECUADOR

POWER SECTOR MEMORANDUM

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This report is based on the findings of a sector mission which visited Ecuador in July 1980. The mission comprised Ms. Ursula Weimper and Messrs. Jorge Larrieu and Ricardo Halperin. The report was updated to incorporate the findings of the INECEL transmission project appraisal mission, which took place in November 1980.

PART II

THE POWER SECTOR

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## FUEL PRICES: AN UPDATE

1. On February 18, 1981 the Government of Ecuador approved across-the-board increases in the domestic prices of petroleum derivatives 1/. The following table summarizes the old and new prices:

| <u>Product</u>        | <u>Proportion<br/>of total<br/>Consumption (%)</u> | <u>Old Price</u><br>(US\$ cents per gallon) | <u>New Price</u> | <u>Percentage<br/>Increase</u> |
|-----------------------|--|---|------------------|--------------------------------|
| 92 octane<br>gasoline | 4  | 72.8  | 80.0             | 9.9                            |
| 80 octane<br>gasoline | 34   | 18.6  | 60.0             | 222.6                          |
| 63 octane<br>gasoline | 2  | 16.4  | 40.0             | 143.9                          |
| diesel                | 24   | 14.4  | 44.0             | 205.6                          |
| kerosene              | 11   | 13.4  | 24.0             | 79.1                           |
| jet fuel              | 4  | 44.8  | 88.0             | 96.4                           |
| bunker                | 21   | 10.4  | 28.0             | 169.2                          |

2. These increases represent a major breakthrough and show that the Government is willing to implement the policy changes required to address the issues facing the sector. It is estimated that, ceteris paribus, the increases will reduce the implicit subsidy to consumers (as given by the difference between the domestic price and the international price), from about 8% of GDP in 1980 to 4% in 1981.

3. Despite the above measures, domestic prices still average less than 50% of world market levels. Thus the need for further price adjustments in the future remains.

4. Another important issue still outstanding is the inconsistency of the structure of petroleum price derivatives with either cost of production or world market values. For example, the new price of kerosene, widely used by lower-income groups, is about half that of diesel. This, and other similar differences in the cases of other products, are likely to induce undesirable substitutions, with the resulting distortions in the allocation of resources. Thus, the Bank should continue to convey its concern that the Government address the need for a more rational price structure.

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1/ The price revision did not include specialty products and LPG, which approximately represent 7% of consumption.

## SUMMARY, ISSUES AND RECOMMENDATIONS 1/

1. Ecuador has abundant renewable and non-renewable energy resources. The hydroelectric generation potential is very significant and yet largely untapped. Since 1972, the country has become a major oil producer and there are good prospects to increase reserves, both of conventional and of heavy crude oils. The use of associated gas is being developed, and in the Guayaquil Gulf important natural gas deposits have been detected. In addition, a preliminary inventory of geothermal resources is now being completed by the Organizacion Latinoamericana de Energia (OLADE). Wood and bagasse provide a substantial portion of non-commercial energy and the Instituto Nacional de Energia (INE) is currently evaluating the efficiency of its use, together with solar and biogas possibilities.
2. The oil price increase that has taken place in world markets since 1973 caused an economic bonanza with, however, some negative side effects which are now becoming increasingly evident and which the Government is trying to correct. Due to failure to adjust internal fuel prices, consumption has been high, and, also, fuel destined for the internal market has been smuggled to neighboring countries. Inadequate pricing policy has created an inconsistency between the structure of primary energy consumption and that of available resources, in particular favoring thermal electricity generation over the development of the large hydropower potential; similarly, the oil consumption pattern and refinery yields have become increasingly unbalanced. Furthermore, exploration activities have been low, and proven reserves have been declining. Under pessimistic assumptions of production and growing demand, this could imply that, as early as 1988, Ecuador would cease to be an oil exporting country.
3. Ecuador's major objectives for the energy sector are the following:
  - (a) increase petroleum exploration and optimize petroleum production;
  - (b) cause changes in the structure of petroleum consumption, to rationalize its use and to prevent smuggling and waste;
  - (c) cause changes in the domestic prices for petroleum derivatives, to enhance the sector's financial capability;
  - (d) develop the hydroelectric potential, improve the use of wood charcoal in the rural sectors and develop other energy sources (geothermal, solar and biogas);
  - (e) integrate isolated electric generating systems, develop rural electrification, and assure the supply of electricity both in urban and in rural areas.

The power sector also has important social objectives to be implemented by connecting lower income consumers to the grid and by reducing, in relative terms, the tariffs paid by the less affluent.

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1/ For a fuller discussion of economic issues, see "Ecuador, Development Problems and Prospects". IBRD, July 1979.

4. The power sector goals for the short and medium term are ambitious. Commissioning of the first stage of the Paute hydroelectric project is scheduled for 1982 (200 MW) and 1983 (300 MW); it will triple existing hydro capacity. By 1984 other important hydro projects, Agoyan (150 MW), Paute "C" (500 MW) and Daule-Peripa (130 MW), will be under construction, and by 1986 two other large hydroprojects will be starting: Paute-Mazar (140 MW) and Toachi (300 MW). Investment in transmission will be substantial; while currently there is only one major transmission line in operation (between Quito and Guayaquil), by 1985 most of the regional systems will have been interconnected to the national grid. Finally, in distribution the goal for 1985 is to increase the electrification rate 1/ from about 40% to 50% and to reduce overall distribution losses from 15% to 12% by upgrading the various networks.

5. The achievement of these goals will require a major mobilization of financial and human resources. Sector investments between 1980 and 1985 are expected to amount to over US\$1,600 million (at 1980 price levels), while at present, the sector's revalued gross fixed assets in operation amount to little over US\$800 million equivalent. Employment within the electric utilities is forecasted to grow from about 7,300 people in 1980 to nearly 11,000 in 1984.

6. Thus, the Government authorities face a formidable challenge, which will put to a severe test their ability to implement the actions required. The Bank's review of the sector has identified several issues which will have to be adequately addressed if the sector objectives are to be satisfactorily met. The main issues and recommendations on how they may be handled are presented below.

#### Issue No. 1

7. Fuel Prices. The prices of petroleum products in Ecuador are among the lowest in the world. In 1978 these prices constituted an implicit subsidy 2/ amounting to about 6% of GDP. Due to subsequent world oil price increases, in 1980 the subsidy is likely to have been as high as 8%. The problems and the distortions caused by the low internal prices are significant and, unless substantially reduced, will act as a brake to the country's economic growth.

8. Fuel price subsidies are specially important in the transport sector and also within the power sector, where they encourage auto-production and thermal generation, and distort electricity costs inducing excessive consumption and waste.

9. Recommendations. Implementation of a policy of price increases to bring the internal levels in line with international values should be a prerequisite of further Bank financing to Ecuador's productive sectors.

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1/ Population with electricity service/total population ratio.

2/ The subsidy has been calculated as the difference between domestic prices and the price of petroleum derivatives posted in Caribbean refineries.

10. The sector financial projections developed by the Bank mission assume that the prices of fuels used for electricity generation (Bunker C, diesel and kerosene) will be progressively increased to the following proportion of international levels: 25% in 1981, 37.5% in 1982 and 50% in 1983. Such policy, if accompanied by regulatory measures to induce optimal generation schemes, would allow Bank support for the Instituto Ecuatoriano de Electrificación transmission project now under consideration and for future projects in the power sector.

Issue No. 2

11. Electricity Tariffs. At present the provisions of the electricity tariff regime (which requires that tariffs be set so as to yield a rate of return on revalued assets of 8.5% per year) are not being complied with. As a result, electricity tariffs are low and the power sector's consolidated rate of return is negligible, while net internal cash generation is negative.

12. Recommendations. Retail tariffs should be progressively increased so as to allow reaching an 8.5% rate of return in 1984. The Bank mission has forecast that rates of return of 2% in 1981, 4% in 1982, and 8% in 1983 would be achieved. This would result in a self-financing ratio for 1982-85 of about 20%, which is a modest target, especially in view of the very large sector investment program. By 1985 retail tariffs would have tripled; however, after adjusting for domestic inflation, the increase would only be about 50%, which should be a feasible target.

Issue No. 3

13. Management and Organization. Both the management of INECEL and of its subsidiaries leave room for considerable improvement. Areas deserving specific attention are:

- (a) INECEL's coordination and control over the operations of its subsidiaries;
- (b) overstaffing, both within certain areas in INECEL and in its subsidiaries; and
- (c) information systems, especially accounting, budgetary, financial and statistical information) 1/.

14. Recommendations. Qualified consultants should be engaged soon to assist INECEL in the above matters 2/. Until such consultants' recommendations become available, INECEL should take such immediate measures as may be feasible to improve its performance.

---

1/ The mission found that the quality of technical and financial information developed by INECEL or gathered from its subsidiaries is extremely poor. Lack of consistency is frequent. Financial statements do not follow accepted accounting practices.

2/ These consulting services would be part of the proposed INECEL Transmission Project.

15. Independent external auditors, both for INECEL and for its subsidiaries should be engaged at the earliest to assist in the upgrading of the accounting system, revision of accounting criteria and adjustments to the historic financial statements, asset revaluation, and preparation of consolidated financial statements.

Issue No. 4:

16. Financing. The implementation of the proposed 1980-84 investment program will require a massive financial effort.

17. Recommendations. The tariff actions discussed in paragraph 12 will have to be complemented by Government financing and by substantial borrowings in international financial markets. With regard to the Government contributions, an early definition would be required so that, based on it, alternative financing strategies may be devised.

18. In view of the magnitude of the financial issues, the Bank should include a major projects clause in the Guarantee Agreement for the proposed INECEL Transmission Project, which clause would be designed to ensure that any major projects undertaken within the sector are economically justified and are adequately financed.

Issue No. 5

19. Training. The planned sector expansion will result in a significant increase in workforce requirements. The successful implementation of the expansion program and the achievement of more satisfactory efficiency levels, will, to a large degree, be contingent upon the adequacy of the sector's training program. INECEL is conscious of this need and - in consultation with the Bank - has already taken steps to engage consultants to assist in the identification of training requirements and formulation and implementation of programs.

20. Recommendations. The proposed INECEL Transmission Project would include a substantial training component, which would address this issue.

Issue No. 6:

21. System Losses. The statistical information available shows that some of INECEL's subsidiaries have unacceptably high levels of losses. While in some cases this may be partly attributed to deficiencies in the information itself, it is quite clear that many distribution systems exhibit flaws which require remedial action.

22. Recommendations. To address this issue, INECEL should develop a program for the study of losses within its subsidiaries and for system upgrading and administrative improvements to reduce losses to acceptable levels. Such a program is to be implemented as early as feasible.

**PART I**

**THE ENERGY SECTOR**

## 1. ENERGY RESOURCES

1.01 Ecuador has a large and diversified energy base which has not yet been fully assessed. In the following paragraphs, known reserves and potential resources of fossil fuels, as well as renewable sources of energy, are discussed.

### Hydrocarbons

1.02 Total sedimentary basins extend over an area of 17 million ha. of which less than 20% has been explored. The most important oil reserves were discovered in 1969 by the Texaco-Gulf consortium in the Eastern region. During the 1970s exploration activities were limited, and proven reserves decreased from 1.6 billion barrels in 1972 to 1.2 billion barrels in 1979. Actual proven reserves might be higher and are to be assessed by a reserve audit study. Currently, the reserves-to-production ratio averages 15 years. The prospects for increasing the resource base are favorable; both for conventional and for heavy crude oils and the Government objectives for the next five years are to add 730 million barrels of crude oil to proven reserves through enhanced recovery, development of known fields and new exploration, and to maintain an average production volume of 225,000 barrels per day.

1.03 The economic future of Ecuador depends to a significant degree on the success of achieving the above objectives. Major responsibility for this is assigned to the national oil corporation: Corporacion Estatal Petrolera Ecuatoriana (CEPE) <sup>1/</sup>. As a means of overcoming CEPE's technical and financial limitations, the Government has also announced its interest in attracting foreign contractors to join in the exploratory effort. The terms of the hydrocarbon operations contracts under which new companies are to operate have not yet been adequately defined. Also, agreement with already established companies over future operating conditions must be reached if foreign participation is to increase.

1.04 Natural gas is expected to become an important energy source in the future. At present, only the LPG (propane and butane) fraction of associated gas produced at the Santa Elena oil fields is being recovered, but in 1981 a new LPG plant and a pipeline will enable the economic recovery of part of the associated gas produced in the Eastern region. In addition, preliminary exploratory work shows important free gas resources in the Gulf of Guayaquil. These are to be developed during the next five years and will be used to promote industrial development in the area.

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<sup>1/</sup> CEPE and its currently associated operators are to evaluate 90% of sedimentary basins and drill 350 wells, which will require an investment of some US\$470 million. CEPE's share in this program is US\$370 millions, which represents one-third of its total investment budget for the five-year period 1980-84.

### Hydroelectric Resources

1.05 The Andean mountain range separates the eastern from the western watersheds, which have drops of more than 3,000 meters. Twenty-two hydrographic basins have been identified, covering 85% of the country's surface. The usable hydroelectric potential is currently estimated at 22,000 MW, mainly contained in the Pastaza, Santiago and Napo basins. Fully developed, these basins could generate 90,000 GWh/year of firm energy (which if thermally generated would require about 150 million barrels of oil per year). It is presently estimated that about 12,000 MW could be economically developed, but at present only about 2% of this potential has been tapped. In 1983, however, this ratio will increase to about 6% with the commissioning of the 500 MW Paute hydroelectric development. The 1980-84 development plan has set as an objective the rapid development of hydroelectric capacity and by 1985 it is estimated that 72% of electricity requirements will be provided by this source. This is a significant change in the generation structure if compared with the present hydro generation ratio of about 25%.

### Alternative Energy Resources

1.06 One of the major problems for effective energy planning is the lack of reliable data on alternative energy resources. The 1980-84 Development Plan includes both studies and in-the-field measurements of these resources; a brief summary of the present state of knowledge is given in the following paragraphs.

### Geothermal Resources

1.07 Ecuador's localization offers favorable prospects for geothermal development. Superficial showings have been detected in Tungurahua, Pichincha and Azuay (see Map). The Instituto Ecuatoriano de Electrificación (INECEL) has the responsibility for evaluating the geothermal potential and in the first stage has received assistance from OLADE.

### Fuelwood

1.08 Fuelwood is an important source of energy in the rural areas. The country has important forestry resources, mainly in the Amazonas region and in the province of Esmeraldas. However, the lack of a reforestation policy and the indiscriminate use of wood for industrial and energy purposes, has reduced considerably the forest area and the rural regions are facing shortages of fuelwood. The Instituto Nacional de Energía (INE) is attempting to address the problem by developing improved stoves for cooking with fuelwood.

### Uranium Fuel

1.09 The Ministerio de Recursos Naturales y Energeticos (MRNE) and the Atomic Energy Authority have undertaken to explore for uranium. Although no proven deposits have been determined, it is thought that the mineral exists in the Oriente region.

Other Non-conventional Energy Sources

1.10 Currently, the possible use of solar energy, minihydropower, and other sources is being studied by INE. In addition, OLADE is promoting the construction of biodigestors, in which animal and vegetables waste is converted into methane. A demonstration plant has been built in cooperation with the Provincial Council of Pichincha and OLADE is also providing technical assistance to other provinces.

## 2. ENERGY BALANCE - CONSUMPTION 1/

### The Present Energy Market -

2.01 Despite the fact that petroleum represents less than half of Ecuador's known energy resources, the national economy has become increasingly dependent on this source. Oil exports amount to approximately 65% of total primary energy production, which can be estimated at 10.8 million tons of oil equivalent (mtoe) in 1978, and over 95% of domestic commercial energy needs are supplied by oil. The basic objective of long-term energy policy is to make energy consumption more consistent with available resources. The thrust of the present Development Plan is on the supply side, mainly accelerated development of the hydropower potential and expansion of the productive capacity of the oil industry. The Plan is less specific with respect to energy consumption, although the consequences of postponing measures to rationalize domestic petroleum demand are discussed.

2.02 Between 1973 and 1978, final consumption of commercial energy increased on the average by 14% per year, which is high when compared with its prior evolution and with the more recent performance of the economy. 2/ The breakdown by fuel type (Annex 1, Attachment 1.1) shows that gasoline is by far the most important product in the market. Although the price of LPG is considerably higher than that of competing fuels, its market penetration has been limited only by available supplies. Electricity still has a rather small participation; furnishing only about 14% of industrial energy requirements and servicing mainly urban areas. The structure of final energy consumption by type of fuel is shown below.

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1/ INE has initiated work on energy balances and up to now has produced balances for 1969-78, based on commercial energy demand at the final consumer level (which means that conversion losses are not accounted for). In Annex 1, Attachment 1.1, an attempt is made to construct the global energy balance for 1978, which reveals the degree of under-estimation implicit in the first approach. Information on the structure and trend of consumption over time is taken from INE's work.

2/ During the period 1969-73, final energy consumption rose by 7.2% per year. Between 1973 and 1978, GDP at constant prices, excluding the energy sector, increased by 6.8% per year.

|                     | <u>1978 Relative<br/>Market Share (%)</u> | <u>Average Annual Growth<br/>Rate during 1973-1978 (%)</u> |
|---------------------|---|--|
| LPG                 | 3.2                                       | 35.1   |
| Gasolines <u>1/</u> | 39.4 (43.2)                               | 11.3 (15.4)  |
| Jet Fuel            | 5.0                                       | 28.5   |
| Kerosene            | 10.7                                      | 12.2   |
| Diesel Oil          | 16.8                                      | 12.6   |
| Residual Fuel Oil   | 16.5                                      | 18.2   |
| Electricity         | <u>8.4</u>                                | <u>16.7</u>  |
| Total               | <u>100.0</u>                              | <u>14.1</u>  |

2.03 The high proportion of light and middle distillates in total petroleum consumption is not in balance with the yields obtained from domestic refineries. As a result, refinery operations are not optimal, deficit products have to be imported and refining capacity has to be expanded at an accelerated pace. 2/

2.04 Fuel consumption for public electric generation purposes represents 17% of petroleum sales. It is important to note that presently about 75% of the electric generating capacity is thermal, distributed as follows: internal combustion generating units, about 60%, and steam-driven turbine generating units, about 15%. The reduced share of steam generators is due to the existence of numerous small isolated systems which consume important volumes of diesel oil and, if available, kerosene. Information on fuel input to auto-generators is not available.

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1/ The figures between brackets reflect actual sales of the product, whereas those lined up in the columns, refer to estimated effective domestic consumption. The difference is attributable to smuggling and indicates the results that can be expected from drastic measures to control this traffic.

2/ In 1979, the refineries had to process 26% more crude oil than warranted by straight volumetric requirements and produced a 52% surplus of residual fuel oil which had to be exported. In addition, 2.7 million barrels of gasoline and other clean products had to be imported to supply domestic requirements, at a cost equivalent to the export of 4.9 million barrels of crude oil. Annex 2 discusses at length the oil industry's difficulties in supplying the domestic market.

2.05 The table below presents the demand structure by economic sectors. 1/

|                            | <u>1978 Relative<br/>Market Share (%)</u> | <u>Average Annual<br/>Growth Rate 1973-78 (%)</u> |
|----------------------------|---|---|
| Agriculture and Fishing    | 7.1                                       | 8.2   |
| Mining and Industry        | 17.8                                      | 10.5  |
| Transport                  | 52.8                                      | 17.4  |
| of which:                  |   |   |
| Private Car Fleet          | 22.6                                      | 18.4  |
| Air and Maritime Shipping  | 11.4                                      | 36.1  |
| Residential and Commercial | 20.7                                      | 12.9  |
| Others                     | <u>1.6</u>                                | <u>8.7</u>  |
| <b>Total</b>               | <b><u>100.0</u></b>                       | <b><u>14.1</u></b>                                |

The figures shown confirm that transport takes over one-half of final energy consumption and provides further evidence that substitution of traditional fuels has taken place, mainly in the residential sector, and that efficiency in energy use has been declining.

#### Future Demand

2.06 Future demand for liquid fuels and for electricity is expected to increase at rates of 12% and 11.5% per year respectively. These seem reasonable, and perhaps on the high side for petroleum products, since the market for these fuels is already showing a certain level of saturation, as evidenced by the slower growth in 1980 (9% over 1979); in addition the expansion of hydroelectric generation and the interconnection of the power system will reduce fuel requirements for thermal generation.

#### Rural Energy Survey

2.07 INE is currently carrying out a survey of non-commercial energy use by rural households and cottage industries. Preliminary information gathered indicates that the use of wood and charcoal are much less important than previously thought, and that their weight in total primary energy consumption probably is in the range of 17 to 23%. The use of bagasse in sugar refineries has not yet been studied.

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1/ Aggregated from tables in "Balance Energetico, la parte: Analisis del Consumo Final", INE, May 1980.

### 3. DOMESTIC OIL PRICES

#### Current Level and Structure

3.01 The Government recognizes the need to adjust energy prices, but the necessary decisions to correct the absolute and relative price levels have not yet been taken. Laws have been passed to adjust electric tariffs but they have not been enforced (para. 8.10) and changes in petroleum product prices have not affected major fuels. As a result, direct and cross-sector subsidization practices pervade. These practices not only reduce the self-financing capability of CEPE and of INECEL, but also lead to inter-institutional conflicts that reduce efficiency and induce poor allocation of productive resources. Thus, to achieve Ecuador's long-run economic objectives, a coherent pricing policy should be implemented.

3.02 Prices for liquid fuels have not changed substantially since 1973. Compared with the domestic inflation rate, the consumer is actually paying 120% less in 1980 than he did in 1973. Moreover, the current average retail price of US\$7.033 per barrel is less than 20% of world market prices (compared with mid-1980 levels).

3.03 Price changes of individual products distort the relative price structure and lead to undesirable substitutions. As shown in the following table, LPG and asphalt are priced close to international levels. In 1980, prices for international bunkers were increased by about 65% for volumes above a basic quota, and a new grade gasoline (92 octanes) was introduced in the domestic market at a price equivalent to US\$30.58 per barrel (US\$0.73/gal.) The Government expects to gradually substitute the lower priced product by this new fuel in the more affluent areas and to achieve within one year a 10% market penetration, representing a 36% increase in CEPE's revenues from total gasoline sales.

|                     | <u>US\$/Gallon</u> | <u>US\$/bbl</u> |
|---------------------|--------------------|-----------------|
| LPG                 | 0.522              | 21.91           |
| Gasoline 92 octanes | 0.728              | 30.58           |
| Gasoline 83 octanes | 0.186              | 7.81            |
| Gasoline low grade  | 0.164              | 6.89            |
| Kerosene            | 0.134              | 5.62            |
| Diesel              | 0.144              | 6.05            |
| Residual Fuel       | 0.104              | 4.37            |
| Asphalt             | 0.578              | 24.27           |

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1/ Mid-1980 price for the Guayaquil area. Due to transportation costs prices in other parts of the country are generally slightly higher.

### Price Subsidies

3.04 - The subsidy to the domestic consumer should be measured by comparing prices to marginal long-run supply costs or to world market prices (opportunity cost). However, even if measured in terms of current technical production costs, the subsidy is still substantial.

3.05 The bulk price for crude oil delivered by the oil companies for the domestic market is negotiated by the Government on the basis of presumptive production costs. All producing companies share market requirements in proportion to their relative production. The current average price is US\$1.55/bbl, but the range is from US\$1.40/bbl. for the older production ventures to over US\$6.0/bbl. for the more recent ones. The latter is indicative of the long-run marginal cost for crude. It is estimated that by 1985 about one-third of crude production will have to come from higher cost sources. If, in addition, consideration is given to the new investments that have to be made in refining, transport and marketing facilities, it is evident that the average cost of supplying the Ecuadorean market will increase significantly in the coming years.

3.06 Based on average technical supply costs, the net subsidy to the domestic consumer of petroleum products can be estimated at US\$1.56/bbl. for 1980 <sup>1/</sup>. However, the subsidy paid by CEPE is considerably larger (US\$3.64/bbl), as the company's revenue from sales (US\$4.96/bbl) is the average retail price (US\$7.03/bbl), less consumption taxes (US\$2.08). The current supply cost is estimated at US\$8.59/bbl including the cost of importing deficit products, while the technical production cost of products derived from domestic crude oil is about US\$5 per barrel (this figure, however, assumes a zero value for the crude oil itself). Thus, the real amount of the subsidy is far larger than indicated, given the opportunity cost value of oil in international markets and its replacement cost, as measured by the long-run marginal production cost.

3.07 Cross-sector subsidization transfers resources from the petroleum to the power sector. To finance the expansion of the power sector, 47% of the state royalties are directly allocated to INECEL and additional funds are made available through an Electrification Fund and transfers to Provincial Councils. In 1980, limits were set to these automatic allocations <sup>2/</sup>.

### Criteria for Future Pricing Policy

3.08 In adjusting the price structure, the Government should avoid the danger of a fragmented policy and of further distortions of the demand structure. The following factors should be taken into account in the determination of relative prices for petroleum products:

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<sup>1/</sup> See Annex 2, Table 2.6.

<sup>2/</sup> Regulation No. 57 of February 11, 1980 establishes the following ceilings for automatic participation: (a) price of crude oil exported at US\$23.50/bbl; (b) price of heavy fuel oil exported at US\$17.50/bbl; and (c) income from the domestic market is frozen both in volume and prices.

- (a) LPG is priced close to world market levels. This product is going to be in ample supply after mid-1981 when the pipeline from Shushufindi enters into operation. In order to create an incentive to use this new supply, the prices for kerosene and for low grade gasoline would have to be increased above that of LPG;
- (b) the fact that kerosene is priced below diesel oil creates an industrial demand for this fuel. This has been controlled in the past by limiting the supply of kerosene to the market, thus reducing its availability to low income consumers, which runs contrary to the social objectives of the Government's policies;
- (c) the current price differential between diesel and fuel oil is insufficient to induce the use of heavy fuel oil in industry and in power generation. As a consequence, Government has had to impose quantitative restrictions which distort resource allocation; and
- (d) current fuel oil prices do not provide an adequate incentive for hydroelectric development, and have also discouraged the development of the country's natural gas resources.

3.09 A realistic pricing policy should take into account the political feasibility of implementing the changes required. This is an extremely sensitive matter, and any evaluation is tainted with subjectivity. However, in view of the problems presently caused by subsidized prices, and the likelihood that they have not had any positive distributional effects, the argument is strong for implementing the required changes at a reasonably fast pace. The Bank should therefore insist on significant initial steps prior to making any new loans to Ecuador's productive sectors and should discuss the pace of programmed future increases to ensure that expected targets will be achieved in a reasonable time.

#### 4. ORGANIZATION OF THE ENERGY SECTOR

4.01 The Constitution of Ecuador and specific sector legislation establish that the Executive is to exploit the nation's fossil energy resources directly or in association with private enterprise and that the Government holds a monopoly on electricity generation, transmission and distribution, but that it can authorize private operations. Decisions are taken at the following levels: general energy policy is decided by the President of the Republic; MRNE defines and coordinates sectorial policies; and CEPE and INECEL are in charge of the administration and implementation of the policies. A brief description of the main institutions of the sector follows.

##### Consejo Nacional de Desarrollo (CONADE)

4.02 CONADE, chaired by the Vice-President of the Republic, is responsible for overall economic planning, and in March 1980 it completed the preparation of a development plan for 1980-84, which is mandatory for public sector institutions and which sets investment targets for both the oil and the power sectors. In order to insure that the objectives of the plan are achieved, annual programs are to be drawn up and performance is to be measured against milestone goals.

##### Ministerio de Recursos Naturales y Energeticos (MRNE)

4.03 MRNE is the central authority for energy matters, responsible for policy formulation and for overall organization and administration of the sector. Three undersecretaries, respectively responsible for Natural and Energy Resources, for Administration and for Fisheries, are under the direct authority of the Minister (Annex 4, chart 4.1).

4.04 The Undersecretary for Natural and Energy Resources supervises the departments of Hydrocarbons (Direccion General de Hidrocarburos - DGH) and of Geology and Mines. DGH is the policymaking and supervisory body for oil and gas, foreign investors' participation in the oil sector, approval of investment plans, revision of petroleum laws and pricing of petroleum products.

4.05 The scope of the activities of DGH calls for highly experienced personnel but because of the public salary structure and political changes personnel turnover has been very high. Since 1976 about 150 professional staff have left and most of the present staff are relatively new.

4.06 There are two energy-related advisory bodies to the Minister. The first is the National Energy Council, composed of the heads of the Ministries of Finance and Industry, CONADE, and the Joint Command of the Armed Forces, and chaired by the Minister of Natural and Energy Resources. The second is the Committee on Petroleum Policy, which brings together CEPE's General Manager and experts on the petroleum industry.

4.07 Also under the jurisdiction of MRNE are three autonomous institutions: CEPE, INECEL and INE, all of which are discussed below.

Corporacion Estatal Petrolera Ecuatoriana (CEPE)

4.08 CEPE, a public sector corporation established by Decree No. 522 of June 23, 1972, was set up as an instrument for government participation in all phases of the petroleum industry. CEPE is involved in the following activities:

(a) Exploration and Production. In addition to direct operations, CEPE has a 62.5% share in the CEPE-Texaco consortium, which produces 98% of Ecuador's oil and owns 50% of the trans-Andean pipeline and the associated export terminal facilities. CEPE supervises the activities of foreign contractors: Texaco, Cities Service and Yacimientos Petroliferos Fiscales (Argentina).

(b) Refining. CEPE owns and operates Ecuador's largest refinery at Esmeraldas and holds, respectively, a 24.2% and 12.3% participation in the Anglo and Gulf refineries. It plans substantial expansion of throughput and conversion capacity and proposes full reversion of privately held shares.

(c) Natural Gas. It manages the Shushufindi LPG plant and pipeline project and plans the development and utilization of gas resources in the Guayaquil Gulf.

(d) Marketing. It sells in international markets, not only its own share in crude oil production and its surplus of refined products, but also the Government's royalty crude. It imports deficit products and has a monopoly for local distribution and marketing.

4.09 CEPE's organization is composed of (a) a Board of Directors, whose functions include the appointment of management staff, approval of the budget and of major investment decisions, and policy formulation regarding private contractors; (b) a General Manager, who is the chief executive; and (c) operating and administrative units, which are being reorganized into major area divisions.

4.10 In the past, CEPE's efficiency has been hampered by a weak internal structure and by poor relations with MRNE and with other Government agencies. To deal with the first of the above, a foreign consultant <sup>1/</sup> was engaged to carry out an organizational study. This study has now been completed and its recommendations are being implemented. Regarding the second aspect, CEPE has argued that it lacks autonomy in decision making, being subject to the Ministry's approval in matters related to personnel, procurement and management. To solve these problems, CEPE has proposed increasing the decision-making power of its Board, which would be fully responsible for policy implementation

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<sup>1/</sup> SNC (a Canadian consulting firm) proposed the reorganization of CEPE in order to improve coordination of activities, delegation of authority, and project supervision. As a result, an Assistant General Manager was appointed and operational divisions were established. Also, a new system of accounting and management information and new procedures are being implemented.

within guidelines given by the Energy Council 1/. It is evident that the Ministry's supervisory role is compatible with managerial autonomy, if adequate long-term efficiency criteria are clearly established. Thus, the Bank should support CEPE's position. It is open to question, however, whether CEPE will be able to overcome its present organizational, financial and technical limitations and accomplish within the five-year period the proposed objectives. The Government has recently appointed a new Minister of Natural and Energy Resources and a new General Manager of CEPE, and, as a result, it is expected that project priorities will be redefined and coordinated in the context of a realistic policy.

4.11 The 1980-84 Development Plan includes an investment program for hydrocarbons in an amount equivalent to US\$1,300 million in 1979 constant dollars, of which 86% would be financed by CEPE. However, revised estimates are being prepared, and it is expected that investments will be increased above the company's present financing ability. If this is considered in conjunction with CEPE technical limitations, it becomes evident that priorities will have to be redefined or human and financial resources will be spread too thin to be productive.

4.12 A final, but not less important factor for the success of the proposed oil development plan is the Government's policy towards foreign companies, whose expertise is especially important in exploration activities. This policy has to define the incentives for potential newcomers, as well as solve the problems with present operations, and in particular with Texaco. The Government is currently proposing to establish a jointly operated company, Petroamazonas, staffed by personnel from both CEPE and of Texaco in proportion to their respective capital shares and which would become totally integrated to CEPE after a five-year transition period. As a result, Texaco is reluctant to invest in new projects (of which supplementary recovery is of high priority), unless adequate incentives are provided by the Government. Bank participation in the sector should be contingent upon a clarification of the Government's policy in these matters.

#### Instituto Ecuatoriano de Electrificación (INECEL)

4.13 Decree No. 1042 of September 1973 established INECEL as the public utility in charge of electric generation, transmission, distribution and marketing. Its organizational structure as well as the issues related to the power subsector are discussed in the second part of this memorandum.

#### Instituto Nacional de Energía (INE)

4.14 INE was created in 1978 as a technical-scientific body for the purpose of analyzing alternative energy strategies in the context of the changing international energy situation. It is a small institute with limited financial resources and staff and under the 1980-84 Development Plan, it has been assigned two main objectives:

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1/ CEPE's Board of Directors and the Energy Council are composed of the same Government authorities (para. 4.06).

- (a) to develop national energy balances and to inventory Ecuador's energy resources;
- (b) to analyze existing technologies on production and use of renewable sources of energy and promote the implementation of those best suited to Ecuador's resource endowments 1/.

4.15 INE has prepared historic commercial energy balances at the final consumer level for 1969-78 and is carrying out a survey on the use of renewable energy sources in Ecuador's rural areas. This has been done with the technical and financial assistance of the European Economic Community, which provided an energy planner and is making a second one available for 1981. INE is also introducing a more efficient stove for cooking with wood and charcoal and is trying to promote the installation of solar water heaters in new constructions.

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1/ This comprises solar, eolic, geothermal energy, biodigestors, micro- and minihydraulic generation and forestry, as well as more efficient use of fuelwood, through the introduction of better designed cooking stoves.

PART II

THE POWER SECTOR

## 5. SECTOR ORGANIZATION, INSTITUTIONS AND HUMAN RESOURCES

### Legal Framework

5.01 The most important legal provisions governing Ecuador's power sector are contained in the Electricity Law, passed in 1973 and subsequently amended on several occasions. The law, as it currently stands, establishes that the Government (through INECEL) has the monopoly on electricity generation, transmission and distribution; it is empowered, however, to authorize private operations. The Executive power defines sector policies through the Ministry of Natural Resources and Energy, the Ministry of Defense (when national security matters are at issue), and INECEL.

5.02 The provisions of the Electricity Law are generally sound, basically, tending toward the unification of power systems in INECEL. INECEL is provided with a sufficient degree of autonomy to enable it to carry out its operations efficiently.

### A. Instituto Ecuatoriano de Electrificación

#### Role in Sector

5.03 INECEL was created in 1961 as an autonomous entity. It operates the National Interconnected System and is the majority stockholder in 15 of the 16 utilities which operate in the sector. <sup>1/</sup> INECEL's participation in the capital stock of these companies ranges from 54% to nearly 99%, thus giving it full legal control (see Annex 5, Table 5.1). The 16th company, Empresa Electrica del Ecuador (EMELEC), is 100% privately owned and operates in the city of Guayaquil under a concession contract (para. 5.28).

5.04 INECEL's functions are defined in the Electricity Law; the main ones are:

- (a) to program, coordinate, execute and supervise the development of electrification in all its phases;
- (b) to take an inventory of national electricity generation resources;
- (c) to plan, finance, purchase and operate generation, transmission and distribution facilities;
- (d) to obtain the internal and external financing required to fund its investment programs; and
- (e) to promote the development of regional electric companies through the merger of existing utilities.

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<sup>1/</sup> There are also small electric power installations which operate in isolated systems and are owned by local municipalities, as well as a significant number of private autoproducers.

### Organization and Management

5.05 INECEL's Organization Chart is shown in Annex 5, Chart 5.1. Policy decisions are taken by the Board of Directors and day-to-day administration is entrusted to a General Manager.

5.06 INECEL's Board is composed of the Minister of Natural Resources and Energy, who presides over it; the Minister of Finance, the Minister of Industry and Commerce; the President of the Planning Board 1/, the Chief of Staff of the Armed Forces; and one representative from each of the following: the electric power companies, the National Association of Power Engineers and the electric sector workers 2/. Reporting to the General Manager are six operating units: Industrial Relations, Engineering and Construction, System Operations, Marketing and Distribution, Finance, and Rural Distribution. The latter is now being set up, as a condition of IDB's lending for rural distribution. Several staff groups also report directly to the General Manager: Planning, Systems Analysis, Legal Department, Procurement Committee, and Public Relations. The functions of these units are the standard ones associated with the respective names, except for marketing and distribution, discussed below.

### Supervision of Electric Power Companies

5.07 The Marketing and Distribution unit encompasses two main functions:

- (a) standards and supervision, which involves setting up standards for works and supervising operations and maintenance in INECEL's subsidiaries; and
- (b) supervision of managerial performance, which involves looking into the operations of the subsidiaries, seeing that norms instituted by INECEL are properly applied, and coordinating the work of INECEL's representatives at the Boards of Directors of its subsidiaries.

5.08 Until now, INECEL has seldom made its presence felt in the management of its subsidiaries. Though in all INECEL holds the voting power majority (para. 5.03), the other Board members represent the municipality in which the subsidiary operates and carry heavy political weight. Also, in some cases INECEL has appointed to Boards staff who lacked the adequate skills or personalities for the tasks, which may be one reason why INECEL's success in improving the quality of management within its subsidiaries has been limited. Currently, INECEL's management is trying to shape up its supervisory role. New staff have been appointed and further changes are being considered. It is too soon to evaluate these efforts, but they represent steps in the right direction and deserve the support of the Bank.

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1/ This provision is likely to be amended as the Planning Board has now been replaced by CONADE, which is presided over by the Vice-President of the Republic.

2/ The Government Directors may be represented by alternates.

5.09 INECEL also faces the additional problem that the subsidiaries are frequently unable to provide adequate information in a timely fashion. This is particularly true with regard to financial information. Even though INECEL appoints "comisarios," with--on paper--some of the functions of an external auditor, in general these people, performing such roles on a part-time basis and without supporting staff assistance, tend to rubber-stamp whatever information the subsidiaries provide. This results in a very noticeable lack of external control over the subsidiaries' operations. For the proposed INECEL transmission project, the Bank has requested that independent external auditors be appointed to all the subsidiaries 1/. This should result in an improvement of the subsidiaries' financial statements (which now generally are of poor quality) and provide some measure of external control. INECEL is also considering, albeit with some internal resistance from other areas, bolstering up its internal auditing group, presently understaffed, so as to exercise additional controls over the subsidiaries. Recent Bank missions have encouraged this approach.

### Sector Planning

5.10 INECEL is responsible for sector planning, which has to be consistent with the macroeconomic guidelines developed by CONADE. With the assistance of consultants (Lahmayer-Germany and Hidroservice-Brazil), INECEL is currently preparing the National Electrification Master plan (with Bank financing through Loan S-006-EC). The main objectives of the Plan are to: (a) study Ecuador's future power market; (b) select the least-cost program for power generation considering hydroelectric, geothermal and conventional thermal alternatives; and (c) define optimum transmission and distribution investment programs.

5.11 The Master Plan studies are being developed in three stages: short term (1978-85), medium term (1985-92) and long term (1992-2000). The following studies are also included under the Master Plan: (a) inventory of hydroelectric 2/ and geothermal 3/ resources, which will recollect existing information and create new information banks containing cartographic, hydrological and geological data, as well as information regarding the development stages of hydroelectric sites (identification, evaluation, pre-feasibility, feasibility and detail design studies); and (b) development of an Integrated Planning System (SIP) which will optimize the hydro/geothermal power plants (identified in the inventory of hydro/geothermal resources) and their installation sequence.

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1/ Only one of these subsidiaries, Empresa Electrica de Quito, currently engages external auditors. In EEO's case, this stems from a covenant under IDA Credit 286-EC, approved in 1972.

2/ The inventory is expected to cover about 225,000 km<sup>2</sup> or about 70% of Ecuador's area and about 80% of Ecuador's estimated hydroelectric potential.

3/ The inventory of geothermal resources, originally to be financed by the Bank, is now being financed through a grant from the Organizacion Latinoamericana de Energia (OLADE).

5.12 The short-term Master Plan (1978-85) studies have already been completed and the draft reports were found to be satisfactory by the Bank. The Master Plan medium/long-term studies are currently progressing satisfactorily and draft reports are expected to be available in February 1982.

#### Accounting

5.13 The quality of INECEL's financial statements is extremely poor, possibly because of the lack of importance hitherto attached to such information, department head changes, old fashioned recording systems, and absence of competent staff in the area. Contributing factors, too, have been the insufficient staff engaged in internal auditing tasks and the delays in the Contraloria General's external auditing interventions, which have limited their usefulness.

5.14 The main problems detected by the Bank missions are the following:

- (a) despite the fact that INECEL's share in the capital stock of its subsidiaries ranges between 54% and 99%, INECEL shows this participation as an investment (at historic cost; profits, or losses, earned by the subsidiaries, but not distributed, are not shown) and does not prepare financial statements which consolidate the data of its subsidiaries 1/; and
- (b) fixed assets are shown at cost, despite legal provisions which require their annual revaluation.

5.15 Other problems stem from the poor quality of some of the figures and from the excessive time taken to produce reports. For example, accounts receivable include items which are highly unlikely to be collected and an offsetting reserve for bad debts has not been set up; inventory figures are not supported by physical checks (not even on a sample basis); and studies undertaken in the past for projects which were discarded are shown within deferred charges, amortized over five year periods, instead of being written-off. As to the time taken to prepare reports, the Accounting Department emphasizes the delays it experiences in receiving information and the poor quality of data sent by warehouse managers 2/.

#### Auditing

5.16 By law, INECEL's financial statements are audited by the Contraloria General de la Nacion and this has resulted in major delays in the issuance of

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1/ The power companies follow a uniform system of accounts (originally prepared in 1966 with the assistance of Middle West Service and updated in 1977), which is reasonable.

2/ Managers have to provide data in a manner which allows allocating costs to each project under construction or to maintenance, and what they send is frequently incomplete, or inaccurately coded.

the audited statements due to the Contraloria's lack of staff. The Contraloria issues "long" reports which include a professional opinion as per the standard format; and, when necessary, has appropriately qualified its opinion or has explicitly stated that in its opinion the financial statements did not fairly present the financial position of the company.

5.17 In connection with the proposed transmission project currently under consideration, INECEL has agreed to request the authorization of the Contraloria to engage a private firm of external auditors. It is expected that this should reduce the delays in the completion of audits and, too, that the auditors would provide advice in solving the deficiencies in the accounting system noted in paragraphs 5.13 to 5.15.

#### Procurement

5.18 Government agencies' procurement procedures are governed by a national procurement law. In 1977, a Bank mission visited the country to study the law and to examine whether it could cause conflicts with the Bank's procurement procedures. The main conclusions then reached were that the provisions of the law itself are basically reasonable and do not generally collide with Bank guidelines.

5.19 The problems identified by the 1977 mission may be summarized as follows:

- (a) bidding committees tend to adopt restrictive interpretations of the law, thus drawing complaints from bidders;
- (b) the most serious deficiency in the legislation is that which limits the use of price adjustment clauses. Price adjustment is subject to various decrees (that lie outside the procurement law) which are broadly worded and confusing;
- (c) the Ecuadorean practice has been to require bank guarantees, since they do not have experience with performance bonds. Thus, in Bank financed projects, it becomes necessary to ensure that the option of furnishing a performance bond is provided and, too, to review the relevant provisions of the bidding documents;
- (d) the law appears to exclude the use of international commercial arbitration, which may work to the detriment of the executing agency; and
- (e) the law requires that contracts be awarded within 60 days of the receipt of the technical committee report. Often, this does not allow a reasonable time for the Bank to study the report.

#### Management Problems

5.20 INECEL currently faces important organizational and managerial difficulties, which, if no remedial action is taken, are likely to increase in the coming years due to the strains imposed by corporate growth and a very ambitious investment program. INECEL's top management is conscious of this,

and, in the proposed transmission project which the Bank is currently considering, it has included consulting services for institutional development. This project component is of substantial importance as, through it, the Bank would be able to provide an important input to INECEL's institutional development.

5.21 INECEL's current difficulties, discussed above, are mainly in the following areas:

- (a) accounting and financial information systems, due to the poor quality of the information and the excessive time taken to produce reports;
- (b) information systems in general, because of lack of coordination, absence of checks and duplication of efforts;
- (c) long-term financial planning, which (partly due to the factors mentioned above and, also, to lack of competent staff) is inadequate. Presently, efforts are being undertaken to improve this situation;
- (d) lack of adequate coordination between various departments which tend to operate as autonomous entities. Tackling this problem will require an in-depth analysis of the organizational structure and division of responsibilities and it is likely to be one of the major difficulties faced by the consultants;
- (e) unclear or, in some cases, non-existent policies with regard to the management of its subsidiaries (para. 5.08) and inadequate staff to supervise them; and
- (f) a weak internal auditing department, which is performing only a fraction of the functions it should undertake.

5.22 A sensitive issue has been the frequency of changes in the position of General Manager, as well as in other high management posts. Though the law establishes that the General Manager is appointed for a four year term, and may be reappointed, changes have been more frequent because the position has been considered to be of a political nature. This is bound to have affected policy continuity and, consequently, company efficiency. Furthermore, the expectation of short tenures would lead to emphasizing short-term goals over long-term objectives. Since the problem stems from political practices in Ecuador, it is doubtful that it could be solved through legal provisions.

5.23 It has been preliminarily agreed with INECEL that the first phase of the consultants' study will be a diagnosis of the present situation, which would provide a more comprehensive analysis than outlined above.

### B. Empresa Electrica de Quito

5.24 EEQ is organized as a private corporation. Its main shareholders are INECEL and the Municipality of Quito (other private sector shareholders account for about 2% of EEQ's capital). The organizational structure calls for a Board of Directors, a General Manager, and five operating units: engineering and construction, operations, commercial, administration, and finance. The organization is reasonable, though in the past the company has had management problems.

5.25 EEQ provides electric service to a substantial part of the province of Pichincha, including the city of Quito. At present, EEQ has over 160,000 customers and a customer/employee ratio of 131/1, above the national average as may be expected in view of the characteristics of the area it serves. EEQ now has a generating capacity of about 136 MW and an additional 34.2 MW are to be commissioned in early 1981.

5.26 EEQ has been the main recipient of Bank Group funds within Ecuador's power sector <sup>1/</sup>. The first two Bank operations (in 1956 and 1957) helped to finance the 40 MW Cumbaya hydroelectric project, several diesel plants and extension of the distribution systems (these works were completed by the end of 1961 and have been operating satisfactorily).

5.27 IDA Credit 286-EC for US\$6.8 million was approved in 1972 and covered part of the foreign exchange costs of the Nayon hydropower plant, a diesel engine generating unit, transmission lines and a rural electrification component. A PPAR on this operation was issued on May 30, 1980 (PPAR No. 3003). Its main conclusions were that:

- (a) the physical objectives of the project were met, albeit with delays and cost overruns;
- (b) progress toward the institutional objectives of the project was disappointing;
- (c) most of the covenants related to the financial aspects at the institution were not met; and
- (d) lack of cooperation affected the efficiency of IDA supervision efforts, which, however, also required more frequent field supervision than actually took place;

These lessons should be kept in mind for the proposed transmission project currently being considered with INECEL.

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<sup>1/</sup> The only other financing provided by the Bank to the sector has been through Loan S-006-EC to FONAPRE for the Master Plan studies and feasibility of Paute-Mazar hydro-development, currently under way (para. 5.10).

### C. Empresa Electrica del Ecuador

5.28 Like EEQ, EMELEC is organized as a corporation. It is, however, privately owned. EMELEC's concession was granted by the municipality of Guayaquil in 1925 and was ratified by the National Government by a decree-law passed in 1966. The concession expires in 1985 after which time (but subject to a three-year advance notification), the Municipality may acquire all the company facilities at a "fair price."

5.29 The Government has, through the 1980-84 National Development Plan, expressed its concern at the negative effects associated with the private ownership of EMELEC and has indicated that eventually EMELEC should be nationalized. No date has, however, been set and, in some quarters, there seems to be some uncertainty at the position taken. It would be desirable if action is taken soon, as nationalization would reflect itself on the sector's financing requirements. Uncertainty over the Government's position on this matter could hypothetically result in a slower pace of investment by EMELEC's present ownership, eventually affecting the quality of the service it provides.

5.30 EMELEC serves the city of Guayaquil and some neighboring areas, totaling about 172,000 customers. EMELEC's generating plants are all thermal; with an installed capacity of about 183 MW. The company employs about 850 persons.

### D. Other Electric Power Companies

5.31 Besides EEQ and EMELEC, there are 14 other electric power companies of fairly small size operating in Ecuador. Additionally, 42 municipalities operate small local power facilities. The Government has set as one of its objectives in the sector the consolidation--through merger--of these companies. The medium-term target (for which no date has been set) is to reduce the total number of power companies from 16 to 9, a sensible effort that the Bank should support.

5.32 The income statements of the power companies (shown in Annex 8, Table 8.2) do not present a breakdown of O&M expenses, since the corresponding information is not available. The cost data which is available is summarized in Annex 5, Table 5.2. Particularly striking is the difference in absolute costs and in cost structure between EEQ and EMELEC, on the one hand, and the smaller power companies on the other. One of the factors causing higher O&M costs in these smaller companies is the high incidence of system losses (para. 7.04, and Annex 5, Table 5.3). Another reason is system size, since the small companies face diseconomies of scale, which are reflected in higher labor costs. However, it would seem that EMELEC manages to operate with a relatively much lower labor force than EEQ or the other INECEL subsidiaries. The available data roughly indicates that kWh sold per employee for EEQ come to about half that for EMELEC, while for the other INECEL subsidiaries they were again about half as much as in EEQ (in some cases they were as low as one-fourth or one-third). These factors, the management weaknesses, and shortage of professional staff detected in some of the smaller INECEL subsidiaries, lack of policy directives from INECEL, and casual style of control exercised over the subsidiaries together are reflected in performance inefficiencies and constitute an issue which ought to be addressed promptly.

E. Human Resources

Present Human Resources Availability

5.33 The following table illustrates the current human resources situation within the power supply industry:

|   | <u>Employees</u> | <u>%</u>   | <u>Customer/<br/>Employees</u> | <u>GWh Sold/<br/>Employees</u> |
|---|------------------|------------|--------------------------------|--------------------------------|
| INECEL                                    | 1,657            | 25         | - a/                           | - a/                           |
| EMELEC                                    | 860              | 13         | 182                            | 1.0                            |
| EEO                                       | 1,342            | 20         | 131                            | 0.44                           |
| INECEL subsidiaries<br>and municipalities | <u>2,714</u>     | <u>42</u>  | <u>106</u>                     | <u>0.21</u>                    |
| Total Power Sector                        | <u>6,573</u>     | <u>100</u> | <u>90 b/</u>                   | <u>0.31 b/</u>                 |

a/ INECFL is a bulk supplier.

b/ Includes INECFL's employees.

The above figures and ratios were considered within acceptable limits when compared with other Latin American countries which had similar sector infrastructure and level of development. 1/ However, once again notice should be taken of the disparities within the various public supplier organizations, which are shown above and discussed in paragraph 5.32. About 5,532 persons were also engaged by consultant and contractor firms working in activities directly related to the power sector. Annex 5, Table 5.4 provides additional statistical data on human resources.

Future Manpower Requirements

5.34 By the year 1985, INECFL expects that the power supply industry will require about 11,200 employees, nearly 2,800 of whom are to be engaged by INECFL and 8,400 by INECFL's subsidiaries, municipalities and EMELEC. The sector GWh sold/employee ratio is expected to improve from 0.31 in 1979 to 0.44 in 1985, while the connected customer/employee ratio is expected to increase from 90 in 1979 to 92.6 in 1985. It is also expected that in 1985 nearly 10,000 people will be working with consultant and contractor firms.

5.35 The different Bank missions that visited Ecuador recently reviewed the sector's human resources requirement projections and found them reasonable. Nevertheless, it appears that some areas of the sector (especially within

1/ Customer/employees and GWh sold/employees ratios were respectively 68 and 0.4 for Panama, 77 and 0.24 for Uruguay, 94 and 0.67 for Costa Rica, 233 and 1.08 for Peru.

INECEL and its subsidiaries) may be overstaffed. This issue is to be properly addressed and assessed in the proposed consulting studies for institutional development. Furthermore, INECEL is expected to agree with the Bank during the forthcoming negotiations for the proposed transmission project on targets for improving efficiency in this respect.

### Training Activities

5.36 INECEL has established an important and active Training Department which has, over the past seven years, developed a good, if somewhat centralized, training system. Training services are available to, and are widely used by, the staff of INECEL and its subsidiaries. The training system is based upon sound training principles and benefits from executive management commitment and support. The following features of the existing training scheme are indicative of the systematic manner in which training services have been developed and are now being routinely provided:

- (a) an annual policy statement on human resources and training is updated and circulated each year;
- (b) regular human resources planning and forecasting for the complete sector is undertaken as a corporate management exercise;
- (c) an annual training program is issued to all regional utilities, detailing the training programs to be offered at INECEL's training center and a variety of approved programs of education and training available in Ecuador and externally for which training grants are available; and
- (d) INECEL operates a well established residential training center (Centro Nacional Franco-Ecuatoriano-CENAFE-present capacity 100 trainees) with a highly trained staff and a good mix of well equipped practical training and classroom facilities.

Since the successful implementation of the 1980-85 development program will require a major mobilization of human resources, as well as improvements in management practices, the INECEL transmission project, currently under Bank consideration, would include a substantial training component.

## 6. SECTOR FACILITIES

### Generation

6.01 As of December 1979 installed power generating capacity was about 924 MW, of which 700 MW, or 75% of the total, was thermal and the balance hydroelectric. A summary description of these installations is given in the table below (see also Annex 6, Table 6.1).

|                | <u>Internal<br/>Combustion</u> | <u>Oil-fired<br/>Steam Plant</u> | <u>Hydro</u> | <u>Total</u> |
|----------------|--------------------------------|----------------------------------|--------------|--------------|
| Public Service | 423.2                          | 136.0                            | 212.5        | 771.7        |
| Self-Producers | <u>140.6</u>                   | -                                | <u>12.1</u>  | <u>152.7</u> |
| Total          | <u>563.8</u>                   | <u>136.0</u>                     | <u>224.6</u> | <u>924.4</u> |

About 520 MW, or 56% of the total installed capacity, are currently interconnected through the 230 kV Quito-Guayaquil transmission line and the 69/34.5/22 kV Quito-Latacunga-Riobamba-Ambato subtransmission network.

6.02 Present electricity public supply (through INECEL, its subsidiaries, EMELEC and municipalities) accounts for about 84% of total power supply. Private generation (self-producers - mostly industrial and agricultural undertakings), accounts for the remaining 16% (about 153 MW capacity, of which 141 MW are diesel generators and 12 MW are hydroelectric plants). It is expected that the share of self-producers' in electric generation (mainly thermal generation) will be reduced in the future when:

- (a) the National Interconnected System becomes operational (the 230 kV Quito-Guayaquil transmission line was commissioned in August 1980 and different interconnecting transmission lines will be commissioned during 1981-84);
- (b) the Paute hydroelectric development is commissioned (500 MW during 1983 and 500 MW during 1987); and
- (c) petroleum price subsidies for electricity generation are reduced.

6.03 The table below shows the power plant additions already committed to be installed and commissioned during the period 1980-82.

|    | <u>Internal<br/>Combustion</u> | <u>Oil-fired<br/>Steam Plant</u> | <u>Hydro</u> | <u>Total</u> |
|----|--------------------------------|----------------------------------|--------------|--------------|
| MW | <u>180.0</u>                   | <u>198.0</u>                     | <u>33.2</u>  | <u>411.2</u> |

INECEL is also installing 5 x 100 MW hydroelectric units at Paute, to be commissioned in 1982/83.

6.04 To meet 1986-90 forecasted energy requirements, INECEL, based on the results of the short-term Master Plan studies, developed a least-cost expansion program which involves the installation and commissioning of the following hydroelectric power plants (see also Annex 6, Attachments 6.1, 6.2 and 6.3):

| <u>Power Plant</u> | <u>Capacity (MW)</u> | <u>Tentative Commissioning Date</u> |
|--------------------|----------------------|-------------------------------------|
| Agoyan             | 150                  | 1986                                |
| Paute C            | 500                  | 1987                                |
| Daule-Peripa       | 130                  | 1988                                |
| Paute-Mazar        | 140                  | 1989                                |

#### Transmission

6.05 The existing transmission system is reduced to short transmission links between major consumption centers and the nearby power generating stations. The first SNI major interconnecting link was commissioned during August 1980 and ties the two biggest consumption centers, Guayaquil and Quito, through a 327 km - 230 kV, double circuit transmission line. The following transmission lines are currently under construction and are expected to be commissioned before the end of 1982 (See Annex 6, Attachment 6.3): (a) 183 km - 230 kV, double circuit Guayaquil-Paute; (b) 80 km - 138 kV single circuit, Quito-Ibarra; (c) 154 km - 138 kV, double circuit, Santo Domingo-Esmeraldas; and (d) 107 km - 138 kV, single circuit, Quevedo-Puertoviejo.

6.06 During the period 1982-85, INECEL intends to install and commission about 538 km of 230 kV transmission lines, 427 km of 138 kV transmission lines and about 280 MVA step-up/down transformation capacity at different substations. This will allow INECEL to: (a) incorporate the different isolated systems to the SNI network; and (b) deliver the hydro-electricity to be produced by the existing and proposed hydro-power plants (see Annex 6, Attachment 6.3).

#### Subtransmission

6.07 Some of the isolated systems (all of them INECEL subsidiaries) will be integrated into the main SNI network through subtransmission lines (69 kV and 34.5 kV). Therefore, about 1,300 km of 69 kV and 34.5 kV subtransmission lines and about 450 MVA step-up/down transformation capacity at different substations are to be installed and commissioned during the period 1982-85.

#### Distribution

6.09 From 1982 to 1985, INECEL aims to provide electricity to about 1,500,000 additional inhabitants in different areas (which represents about 250,000 new electricity consumer services). This would increase Ecuador's electrification rate from 38% in 1978 to 50% in 1985. For this purpose, INECEL and its subsidiaries plan to: (a) construct new low voltage distribution circuits; (b) extend and improve existing distribution systems; and (c) implement a two-stage rural electrification program, part of which is being financed by IDB.

## 7. THE POWER MARKET AND THE SECTOR DEVELOPMENT PROGRAM

### The Present Power Market

7.01 Ecuador's per capita installed capacity, energy consumption and population access to electricity are among the lowest in South America. <sup>1/</sup> Nevertheless, from 1970 to 1978, Ecuador substantially improved its electrification level as shown by the indicators in the following table:

| <u>Year</u> | <u>Capacity Installed/<br/>Inhabitant</u> | <u>Consumption/<br/>Inhabitant</u> | <u>Electrification<br/>Rate (%)</u> |
|-------------|---|------------------------------------|-------------------------------------|
| 1970        | 51 watts                                  | 155 kWh/year                       | 28                                  |
| 1975        | 74 watts                                  | 266 kWh/year                       | 32                                  |
| 1978        | 122 watts                                 | 333 kWh/year                       | 38                                  |

About 63% of the total electricity produced in the country (estimated at 2,600 GWh in 1978) is consumed in the Guayaquil (970 GWh or 37%) and Quito (680 GWh or 26%) areas.

7.02 Ecuador's electric public utilities (INECEL, its subsidiaries, EMELEC and municipalities) currently supply energy to about 622,000 customers, of whom about 162,000 (26% of the total) are customers of EEQ and about 172,000 are customers (28% of the total) of EMELEC. About 73% of the population in Quito and about 71% of the population in Guayaquil are currently connected to the public supply distribution system.

7.03 In 1978, total electricity generation amounted to 2,573.5 GWh (of which 2,181.8 GWh were sales and 391.7 GWh were losses and power station use). Industrial customers consumed about 863.3 GWh, while residential and commercial customers used 792.4 GWh and 299.9 GWh, respectively. Public lighting and municipal use amounted to 226.2 GWh. Total electricity sales in Ecuador have steadily increased at an average annual rate of about 13%, from 791.0 GWh in 1970 to 2,181.8 GWh in 1978 (see Annex 7, Table 7.1). Simultaneously, maximum demand has increased from 224.0 MW in 1970 to 564.5 MW in 1978 (see Annex 7, Table 7.2) at an average rate of about 12%.

7.04 In 1978, INECEL's subsidiaries' and EMELEC's system losses (see Annex 5, Table 5.3), including transformation and distribution losses, power station use, thefts and unaccounted, amounted to 293.6 GWh, or 13% of the utilities' gross generation/ purchases (estimated at 2,277.6 GWh). Some of INECEL's subsidiaries have reached an unacceptable level of losses and/or unaccounted for consumption (up to 35% of gross generation/purchases), mainly due to inadequacies of the distribution systems (overloaded distribution

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<sup>1/</sup> Consumption per capita and electrification rates of some other South-American countries are, respectively: Argentina 1,236 kWh and 80%; Brazil 912 kWh and 62%, Chile 927 kWh and 87%; Colombia, 691 kWh and 62%; and Peru 532 kWh and 35%.

transformers and lines, lack of compensating/regulating equipment - capacitors and voltage regulators, lack of adequate metering devices and registration methods). A program designed to address this issue is, therefore, urgently required.

The Future Power Market

7.05 The Master Plan load forecast was developed after considering the results obtained from alternative projection methodologies: extrapolation of historical and actual electricity consumption trends, correlation with macro-economic indicators, and regional and national forecasts by sectors. Total electricity requirements are expected to increase from 2,912 GWh in 1979 to 6163 GWh in 1986 at an average annual rate of about 11.5% 1/ Maximum demand is expected to increase from 658.3 MW in 1979 to 1,355.6 MW in 1986 at an average annual growth rate of about 11%. The generation plant load factor is expected to improve from 50.5% in 1979 to 51.8% in 1986. Details of the energy and demand forecasts are given in Annex 7, Tables 7.1 and 7.2.

7.06 Between 1978 and 1986 the industrial consumption is expected to increase from 34% to 38% of total electricity consumption, while losses and power station use are expected to decrease from 15% to 12%. 2/ Otherwise, the structure of electricity consumption is expected to remain basically unchanged, as shown below:

| <u>Category</u>              | <u>% of Total Generation</u> |              |
|------------------------------|------------------------------|--------------|
|                              | <u>1978</u>                  | <u>1986</u>  |
| Residential                  | 30.8                         | 31.0         |
| Commercial                   | 11.7                         | 12.2         |
| Industrial                   | 33.5                         | 37.7         |
| Public Lighting and Others   | 8.8                          | 7.1          |
| Losses and Power Station Use | <u>15.2</u>                  | <u>12.0</u>  |
| Total                        | <u>100.0</u>                 | <u>100.0</u> |

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1/ This growth is in line with Ecuador's economic projections as outlined in a Bank country study of July 1979 (Ecuador: Development Problems and Prospects) and with the macroeconomic forecasts contained in the 1980-84 development plan.

2/ It is reasonable to expect such reduction in energy losses and power station use because: (a) the bulk of the energy will be transferred through high voltage lines (230 kV and 138 kV); (b) existing subtransmission and distribution systems are expected to be improved; (c) INECEL and its subsidiaries are expected to improve the existing methods of energy monitoring and theft control; (d) power station use at thermal plants (which accounts for the bulk of this item) is expected to be reduced substantially, as the SNI thermal generation requirements will decrease when the Paute hydroelectric development becomes operational in 1983.

### Construction Program and Investment Requirements

7.07 In order to meet energy and power capacity requirements during the period 1980-90, INECEL and its subsidiaries have prepared generation, transmission, and distribution construction programs based on: (a) detailed analysis of the capability of existing generation and transmission facilities and of facilities being added to the existing system; and (b) the results of the short-term Master Plan optimization studies. The construction program includes the following major works: (a) about 945 MW and 1,220 MW of new generating capacity to be installed during 1980-85 and 1986-90, respectively; (b) about 860 and 980 circuit-kilometers of 230 kV and 138 kV transmission lines to be commissioned during 1980-82 and 1983-86, respectively; and (c) expansion of subtransmission and distribution systems. Details of capacity and commissioning dates for the different construction program works are given in Annex 6, Attachments 6.1 and 6.2.

7.08 The investment requirements for 1980-85 (see Annex 7, Table 7.3) are estimated at US\$1,640 million (at 1980 price levels). About US\$1,372 million are to be invested by INECEL in: (a) SNI generation plants (US\$829 million); (b) 138 kV and 230 kV SNI transmission lines (US\$308 million); (c) 69 kV and 34.5 SNI subtransmission lines and rural electrification (US\$169 million); and (d) studies and general investments (US\$66 million). In addition, EMELEC and INECEL's subsidiaries are expected to invest about US\$264 million in their distribution systems.

7.09 INECEL also has estimated the 1986-90 generation program investments at about US\$1,200 million. The 1986-90 transmission, subtransmission and distribution investment requirements would be only defined by February 1982, when the results of the medium-term master plan studies become available. A summary of the sector 1980-90 investment program (not including the 1986-90 transmission, subtransmission and distribution programs) is given below:

#### Sector Investment Program

| <u>(a) 1980 - 1985</u>                                    | <u>US\$ million (1980 price level)</u> |
|---|--|
| SNI generation program                                    | 829                                    |
| SNI transmission program                                  | 308                                    |
| SNI subtransmission and<br>Rural electrification programs | 169                                    |
| INECEL studies and general investments                    | 66                                     |
| INECEL's subsidiaries and EMELEC<br>distribution programs | <u>264</u>                             |
| Total   | <u>1,636</u>                           |
| <br>  |  |
| <u>(b) 1986-90</u>  |  |
| SNI generation program                                    | <u>1,200</u>                           |
| 1980-90 total investment                                  | <u>2,836</u>                           |

## 8. SECTOR FINANCES

### Current Financial Situation

8.01 In 1979 total sector investments in power facilities amounted to nearly US\$250 million equivalent, of which a substantial part corresponds to the Paute hydro project, currently under construction. By historic standards, this figure is very high, as the sector's revalued gross fixed assets in operation now amount to little over US\$800 million equivalent. Current plans call for an even greater investment effort in the coming years.

8.02 Presently, the sector's net internal cash generation is negative. Equity funds are derived mainly from INECEL's participation in oil royalties (over US\$160 million in 1979). INECEL, EEQ and EMELEC are fairly active borrowers in international financial markets. However, INECEL has lacked long-term financial planning and borrowing strategies and, as a consequence, it has relied too much on suppliers' credits with fairly short amortization periods, which is resulting in heavy debt service burdens. IDB has made several loans to the sector, and so has the Bank Group (to EEQ, see paras. 5.26-5.27). INECEL's subsidiaries tend to rely on INECEL for equity funds and for loans, complementing this mainly with supplier credits. Their borrowing in international markets is very low, and, to a large extent, this is due to the limited ability of local financial managers, to the red tape involved in obtaining approval from the Government, and to the high cost associated with obtaining the required guarantees.

8.03 Annex 8, Tables 8.1 and 8.2, respectively show the consolidated power sector balance sheets and income statements for 1978 and 1979 as estimated by the Bank mission. As of December 31, 1979, the sector had a low debt-equity ratio (38:62 with fully revalued assets 1/ and 46:54 without asset revaluation) which would indicate that, provided revenues are increased so as to yield an adequate debt coverage ratio 2/, the sector ought to be able to finance a substantial proportion of its investment program through borrowings.

### Investment and Financing Plan

8.04 The consolidated investment and financing plan for INECEL and its subsidiaries is summarized below: 3/

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- 1/ The highest debt equity ratio corresponds to INECEL (40:60). EEQ and EMELEC have figures of 35:65 and 33:67 respectively, while the average for INECEL's subsidiaries (excluding EEQ) is only 8:92.
  - 2/ The Bank mission forecasts are that in 1980 the debt service coverage ratio will be about 0.5. The tariff issue is discussed in paragraphs 8.10 to 8.23.
  - 3/ EMELEC's forecast investments in the same period amount to less than US\$50 million (and no financing problems are foreseen), thus the table is representative of the evolution projected for the sector as a whole.

**CONSOLIDATED INVESTMENT AND FINANCING PLAN\*, 1982-1985**  
(In millions of current dollars)

|                                      | <u>Amount</u>      | <u>%</u>         |
|--------------------------------------|--------------------|------------------|
| <b><u>Requirements for Funds</u></b> |                    |                  |
| Investments in:                      |                    |                  |
| Hydro generation                     | 693.1              | 38.2             |
| Transmission                         | 209.3              | 11.5             |
| Other, operational                   | 241.8              | 13.3             |
| Other, non operational               | 119.6              | 6.6              |
| Studies                              | 73.6               | 4.1              |
| Subtotal                             | <u>1,337.4</u>     | <u>73.7</u>      |
| Interest during construction         | 354.1              | 19.5             |
| Subtotal                             | <u>1,691.5</u>     | <u>93.2</u>      |
| Net working capital                  | <u>123.2</u>       | <u>6.8</u>       |
| <br>Total requirements               | <br><u>1,814.7</u> | <br><u>100.0</u> |
| <b><u>Sources of Funds</u></b>       |                    |                  |
| Net operating income                 | 541.5              | 29.8             |
| Other income (net)                   | (99.9)             | (5.5)            |
| Depreciation                         | <u>272.6</u>       | <u>15.0</u>      |
| Total gross cash generation          | 714.2              | 39.3             |
| Less: Debt service                   | <u>(357.4)</u>     | <u>(19.7)</u>    |
| Net internal cash generation         | 356.8              | 19.7             |
| Equity contributions:                |                    |                  |
| Oil royalties                        | 517.6              | 28.5             |
| Miscellaneous taxes                  | 10.5               | 0.6              |
| Other Government contributions       | <u>230.8</u>       | <u>12.7</u>      |
| Subtotal                             | <u>1,115.7</u>     | <u>61.5</u>      |
| Borrowing (gross)                    | <u>699.0</u>       | <u>38.5</u>      |
| <br>Total sources                    | <br><u>1,814.7</u> | <br><u>100.0</u> |

\*Figures may not add up because they have been rounded off.

8.05 The Bank has worked closely with INECEL and with the Government in developing a suitable program financing scheme. The Government is expected to assign over US\$1 billion equivalent (more than 60% of which from INECEL's participation in oil royalties) towards equity contributions, and between 1981 and 1985 new loans amounting to about US\$800 million are also to be raised from international lending agencies, suppliers and commercial banks.

#### Future Finances

8.06 The consolidated financial projections for INECEL and its subsidiaries are based on the assumption that retail tariffs will be progressively increased, so as to achieve rates of return (on a rate base composed by average net revalued fixed assets and a provision for working capital of 4% in 1982, 8% in 1983 and 8.5% in 1984 and after. This calls for nominal increases in the average price (inclusive of fuel clause) paid by consumers of 30% in 1981 1/, 34% in 1982, 9% in 1983, and 36% in 1984.

8.07 The rates of return indicated above would enable INECEL to make a contribution of about 20% to its 1982-85 investment program, which is reasonable in view of the magnitude of the works involved. Furthermore, by 1985 INECEL's contribution is expected to have increased to 35%.

8.08 The debt-equity ratio is expected to fall in the period considered, mainly because of the large amount of Government equity contributions forecasted. This suggests that, once tariffs reach reasonable levels, it may be feasible to finance a larger proportion of INECEL's investment needs through long-term borrowings, simultaneously reducing the sector's dependence on Government funds.

8.09 Several steps would be required to increase borrowing capacity and access to international markets under favorable conditions. One of these is the full revaluation of assets in the manner prescribed by Ecuador's tariff legislation (presumably this would confirm the mission estimate shown in Annex 8, Table 8.1, thus providing additional evidence of the sector's borrowing capacity). Another important measure would be the engagement of independent external auditors, since the quality of the financial statements of INECEL and of its subsidiaries is now very poor. INECEL should also proceed to prepare consolidated financial statements (this would have the additional effect of lowering INECEL's debt equity ratio). Financial management should also be improved: INECEL should set up a long term borrowing strategy (including possible refinancing of short term maturities), both for itself and for its subsidiaries, should devise mechanisms to limit the subsidiaries' traditional reliance on INECEL as lender of first resort and should also provide the subsidiaries with assistance in obtaining long term financing. This would imply a substantial broadening of the scope of INECEL's financial management, and would require the corresponding internal changes. Steps recently taken by INECEL management suggest that they are moving in this direction. External assistance will, however, be required and it is expected that this would be provided by the institutional development and training components of the Bank loan which is currently under consideration.

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1/ Over the December 1980 level.

Tariffs

8.10 Ecuador's tariff regime provides for an 8.5% annual rate of return on a satisfactorily revalued rate base, which is adequate. This legislation has not, however, been implemented. Recently enacted measures have, furthermore, created some confusion over what tariff adjustment criteria will be applied in the future. Thus, substantive policy changes are required if tariffs are to become adequate means for efficient resource allocation, and to allow a reasonable internal contribution to investment within the sector.

8.11 Over the past 10 years, the average tariff level for all electric power companies in Ecuador has not increased at the same pace as internal inflation (as measured by an index of consumer prices). In constant dollar terms, there has also been a small deterioration. These results are shown in the following table:

ECUADOR - Average Electricity Tariffs

|      | <u>Current</u><br><u>Sucres</u> <u>1/</u> | <u>Constant 1970</u><br><u>Sucres</u> <u>2/</u> | <u>Constant 1970</u><br><u>US\$ mills</u> <u>3/</u> |
|------|---|---|---|
| 1970 | 0.56                                      | 0.56  | 27.2  |
| 1971 | 0.66                                      | 0.60  | 25.3  |
| 1972 | 0.74                                      | 0.63  | 27.5  |
| 1973 | 0.75                                      | 0.57  | 26.2  |
| 1974 | 0.74                                      | 0.46  | 23.0  |
| 1975 | 0.78                                      | 0.42  | 22.5  |
| 1976 | 0.86                                      | 0.42  | 23.5  |
| 1977 | 0.96                                      | 0.42  | 24.6  |
| 1978 | 1.02                                      | 0.39  | 24.3  |
| 1979 | 1.09                                      | 0.38  | 23.3  |
| 1980 | 1.28 <u>4/</u>                            | 0.39  | 24.0  |

1/ Total sales revenues/sales in kWh.

2/ The deflator used in the index of consumer prices given in IBRD, Ecuador: Development Problems and Prospects, page 643, updated to 1979 by the index of consumer prices given in IMF's International Financial Statistics. For 1980 the annual average was estimated as 15% higher than the 1979 corresponding figure.

3/ For calculating the constant US dollar series, an exchange rate of S/20.9 per dollar in 1970 and of S/25 thereafter was used. As the deflator, the US consumer price index was used (sources, IBRD, World Tables, 2nd ed., 1980 and IMF Financial Statistics; for 1980 the annual average was estimated as 14% higher than the 1979 corresponding figure.

4/ Estimated by INECEL on the basis of the new tariff structure approved for 1980.

8.12 If, however, one takes into account that electricity generation in Ecuador is still predominantly (about 75%) from thermal sources, it is quite clear that - given the increases in relative oil prices that took place in world markets since 1973 - tariffs have not kept pace with costs if these are appropriately measured. Due, however, to the significant subsidy which oil derivatives sold in the internal market have (para. 3.05), the electricity companies cost figures significantly underestimate opportunity costs and, therefore, the low tariff levels have not affected the financial integrity of the sector to the degree that could have been expected.

8.13 Annex 8, Table 8.3 shows that, for the power sector as a whole, the financial rate of return in 1978 and 1979 was marginally positive (2.1% and 0.5%, respectively). Excluding EMELEC (which is the only private company in the sector with a rate of return of 9.5% guaranteed through its concession contract), in 1979 the consolidated sector rate of return fell from 1% to a marginally negative figure. Furthermore, the sector's cash flow had by 1979 dropped to about US\$15 million, an insignificant amount in relation to the sector's financing requirements. (If EMELEC is excluded, the figure drops further to about US\$12 million equivalent.)

8.14 The sector's profitability (or, more appropriately, lack of it) worsens dramatically if one attempts to recast costs to reflect international fuel prices. In 1978 the prices of Bunker C and diesel were at approximately one-fourth the international level, which implies a subsidy equivalent to more than US\$30 million. Had fuel prices been set at their international level, the average cost per kWh sold would have increased from S/0.90 to about S/1.32. This figure may be compared to an average tariff of about S/1.02kWh. Since 1979 the distortion caused by the fuel pricing policy has increased as world oil prices have risen significantly. We estimate now that the fuel price subsidy during 1980 will amount to about US\$120 million.

8.15 On a comparative basis, Ecuador's tariffs (which as of mid 1980 averaged about US\$0.05 per kWh) are well below the levels of all Latin American Bank borrowers with a high proportion of thermal generation which are meeting their rate of return or contribution to investment covenants.

8.16 The tariff levels and tariff structures of the 16 companies which constitute the sector vary considerably. In 1979 the average tariff was US\$44 mills. However, four systems (including the large EMELEC system and the Latacunga system, directly operated by INECEL) had average tariffs below US\$40 mills and in one of these (Riobamba), the average tariff was US\$28 mills. In contrast, six systems had average tariffs exceeding US\$56 mills/kWh. The national development plan for 1980-1984 sets as a policy goal the attainment of a national tariff structure, and the recently approved tariff changes are a modest step in this direction.

8.17 It should be noted that, with the present sector organization, the achievement of a national tariff structure will be a difficult goal to reach. This is because the cost structures of the various power companies differ considerably. While some companies like EEO and EMELEC operate in predominantly urban areas, where the population is heavily concentrated and industry has a

significant weight, others operate over larger territorial spans, where population is dispersed, average income is low, and industrial demand is not significant. Thus, a mechanism would be required to transfer funds between companies so as to allow them all to meet financing requirements and rate of return targets. The problem will, however, be partly reduced as the process of regionalization through merger of existing companies, to which INECEL and the Government are committed, continues. 1/

### Tariff Structures

8.18 The tariff structure prevailing through 1979 encouraged electricity use by establishing an inverse relationship between demand level and unit prices. For example, EEO's residential rate structure 2/ was as follows:

|              | <u>Cost (per kWh)</u> |
|--------------|-----------------------|
| Up to 30 kWh | S/. 1.22              |
| 31 - 60 kWh  | S/. 1.12              |
| 61 - 100 kWh | S/. 1.07              |
| 101 - ...    | S/. 1.02              |

8.19 This has now been changed and, for the residential sector, there are lower rates for demands below 70 kWh per month and higher (constant) rates when consumption exceeds this figure. For commercial and industrial users, the rate structure still favors the larger consumers. The variance in treatment between companies, however, still remains significant.

### Tariff Issues

8.20 The above analysis and the financing problems faced by the power sector discussed in the preceding section indicate that strong action in the tariff field is required. Such action involves: (a) significantly increasing average tariff levels, (b) further changing tariff structures so as to bring them in line with true economic costs, and (c) reducing the present tariff disparities between the various electric power companies.

8.21 The degree to which average tariff levels yet need to be adjusted is mentioned in paragraph 8.6, based on forecast financing requirements. Tariff structure adjustments would require a marginal cost study. A preliminary study of the marginal cost of electricity generation will be prepared by INECEL's consultants, Lahmeyer. GmbH, under the Master Plan studies they are currently carrying out (para. 5.10). It is expected that the draft report will be completed by February 1982.

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1/ The medium-term goal is to reduce the number of companies from 16 to 9.

2/ Other rates were available for high consumption residential consumers which, subject to a minimum monthly payment, brought the incremental rate per kWh as low as S/. 0.77.

8.22 INECEL should review the tariff structures of the power companies on the basis of the study mentioned above and should formulate a strategy to reduce geographical tariff disparities. This would require devising alternative mechanisms for the transfer of funds from the power companies which would have higher-than-required tariffs to those in the opposite situation.

8.23 The analysis of the above issues should also look into the social objectives of electric tariff policies. At present residential consumers with a monthly demand of 70 kWh or less are given a preferential rate, which, under the Government's wage and price guidelines, is to remain unchanged during the next two years or so. On theoretical grounds, social (or "lifeline") tariffs may be justified <sup>1/</sup>; however, efforts should be undertaken to ensure the rationale of the levels so determined and of the "cut-off" demand point up to which the social tariffs are applied.

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<sup>1/</sup> On this matter, see Electric Power Pricing Policy, World Bank Staff Working Paper No. 340, July 1979, page 37 and ss.

ECUADOR

POWER SECTOR MEMORANDUM

ENERGY BALANCE 1978

1.- NOMINAL ENERGY DEMAND:

|                                       | <u>10<sup>3</sup> Barrels</u> | <u>10<sup>3</sup> TEP 6/</u> |
|---------------------------------------|-------------------------------|------------------------------|
| Sales of Petroleum Products <u>1/</u> | <u>21,925.4</u>               | <u>2,799.9</u>               |
| Gasoline                              | 8,439.9                       | 995.9                        |
| Kerosene                              | 2,834.2                       | 365.6                        |
| Diesel                                | 4,682.7                       | 641.5                        |
| Residual                              | 4,234.2                       | 605.5                        |
| Turbo Fuel                            | 935.6                         | 121.6                        |
| Aviation Gasoline                     | 42.8                          | 4.8                          |
| LPG <u>2/</u>                         | 756.0                         | 65.0                         |
| Refinery Fuel <u>3/</u>               | 1,489.0                       | 212.9                        |
| Hydropower (GWH) <u>4/</u>            | <u>781.5</u>                  | <u>64.0</u>                  |
| NOMINAL COMMERCIAL DEMAND             | 3,076.8                       | 3,076.8                      |
| Non-Commercial Energy <u>5/</u>       |                               | <u>725.0</u>                 |
| NOMINAL TOTAL ENERGY DEMAND           |                               | <u>3,800.0</u>               |

General Note: This table was prepared in order to be able to roughly assess the underestimations of the Energy Balances at the Final Consumer level prepared by INE.

1/ Excluded are non-energy petroleum product sales, such as asphalt, solvents, and other oils. Sales include products bought by international shipping and smuggling. Also included are imports of refined products.

2/ LPG is obtained from the Peninsula oil fields and from refineries.

3/ Estimated at 5% of refineries' throughput.

4/ Estimated at 860 kcal/kWh and  $10,500 \times 10^6$  kcal/10<sup>3</sup> TOE.

5/ Estimated at 19% of total energy consumption

6/ Conversion factors used are indicated on Page 5. Tons of oil equivalent.

ECUADOR

POWER SECTOR MEMORANDUM

ENERGY BALANCE 1978

2.- EFFECTIVE ENERGY CONSUMPTION - PRODUCTION

|   | <u>10<sup>3</sup> TOE</u> |
|---|---------------------------|
| Commercial Energy Consumption by Final<br>/Domestic Consumer (Line 46)      | 2,248.5                   |
| Petroleum Products (Line 36 )   | 2,038.0 (90.6%)           |
| Natural Gas (LPG ) (Line 45)  | 31.6 ( 1.4%)              |
| Electricity (Line 35)   | 178.9 ( 8.0%)             |
| of which Hydro  | 54.4 ( 2.4%)              |
| Non-Commercial Energy Final Consumption<br>/(Line 4 minus 0.5xLine 21)      | 693.9                     |
| <u>Total Energy Consumption by Final Domestic Consumer:</u>                 | <u>2,942.4</u>            |
| Losses in the Energy System<br>/(Lines 14+19+23+34)                         | 647.2                     |
| Variation in Stocks and Statistical Adjustments<br>/(Decrease) (Lines 7,44) | ( 199.4 )                 |
| Net registered exports (Lines 6+40-43)                                      | 7,071.7                   |
| Unaccounted for exports (Lines 41+42)                                       | 290.4                     |
| <u>Total Energy Production</u>  | <u>10,752.3</u>           |
| Non-Energy Petroleum Products (Line 13)                                     | 81.4                      |
| <u>TOTAL PRIMARY ENERGY PRODUCTION</u>                                      | <u>10,833.7</u>           |

ECUADOR

POWER SECTOR MEMORANDUM

ENERGY BALANCE 1978

10<sup>3</sup> TOE

PRIMARY ENERGY AVAILABLE TO DOMESTIC SYSTEM:

Production:

|   |  |                 |
|---|--|-----------------|
| 1 | Crude Oil Production   | 10,013.1        |
| 2 | Public and Private Hydropower generation   | 64.0            |
| 3 | Natural Gas (LPG from oilfields <u>a/</u> )  | 31.6            |
| 4 | Non-commercial Energy (Wood & Bagasse)   | 725.0           |
| 5 | <u>Total Production Primary Energy:</u>  | <u>10.833.7</u> |
| 6 | Crude oil exports  | 6,092.7         |
| 7 | Variation in stocks and statistical adjustment<br>/(refers to crude oil only) (Decrease) | ( 225.1)        |
| 8 | <u>Primary Energy Available to Domestic System</u>                                       | <u>4,966.1</u>  |

9 ENERGY CONVERSION

10 Refining:

|    |                              |         |
|----|------------------------------|---------|
| 11 | Crude oil input              | 4,145.5 |
| 12 | Yield of Energy Products     | 3,851.2 |
| 13 | Yield of Non-Energy Products | 81.4    |
| 14 | Refinery Fuel                | 212.9   |

15 Thermal Electricity Generation:

|    |                             |             |
|----|-----------------------------|-------------|
| 16 | Public Sector               |             |
| 17 | Petroleum Products Input    | 487.0       |
| 18 | Gross Generation (1586 GWh) | 129.9       |
| 19 | Inefficiency in Generation  | 357.1 (...) |

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a/ It has been assumed that half of LPG production stems from natural gas and that the other is produced in the refinery process.

ECUADOR

POWER SECTOR MEMORANDUM

ENERGY BALANCE 1978

10<sup>3</sup> TOE

Thermal Electricity Generation (Cont...)

|    |   |             |                |
|----|---|-------------|----------------|
| 20 | Auto-Producers (Private)                        |             |                |
| 21 | Energy Input (50% assumed to be bagasse)        |             | 62.2           |
| 22 | Gross Generation (90% of 225 GWh)               |             | 16.6           |
| 23 | Inefficiency in Generation                      |             | 45.6           |
| 24 | <u>Net Energy from Conversion Processes</u>     |             | <u>3,997.7</u> |
| 25 | Losses due to Inefficiency in Conversion        |             | 615.6          |
| 26 | Non-Energy Products (derived from Refining)     |             | 81.4           |
| 27 | <b>ENERGY AVAILABLE TO FINAL CONSUMER:</b>      |             |                |
| 28 | <u>Commercial Energy:</u>                       |             |                |
| 29 | Gross Electricity Generation                    | 210.5       |                |
| 30 | Public: Hydro                                   | 62.2        |                |
| 31 | Thermal   | 129.9       |                |
| 32 | Private: Hydro                                  | 1.8         |                |
| 33 | Thermal   | <u>16.6</u> |                |
| 34 | Losses in Transmission & Distribution <u>a/</u> | <u>31.6</u> |                |
| 35 | Net Electricity Sales                           |             | 178.9          |
| 36 | Petroleum                                       |             | 2,038.0        |
| 37 | Production in Refinery                          | 3,851.2     |                |
| 38 | Used for Power Generation                       | 518.1       |                |
| 39 | Petroleum Products Available                    | 3,333.1     |                |
| 40 | Export of Residual Fuel Oil                     | 1,131.7     |                |
| 41 | Sales to International Transport                | 116.5       | (...)          |

a/ Losses estimated at 15% of gross generation.

ECUADOR

POWER SECTOR MEMORANDUM

ENERGY BALANCE 1978

10<sup>3</sup> TOE

Petroleum (Cont...)

|    |  |             |                |
|----|--|-------------|----------------|
| 42 | Smuggling  | 173.9       |                |
| 43 | Imports of Refined Products                                  | 152.7       |                |
| 44 | Variations in Stock - Increase                               | <u>25.7</u> |                |
| 45 | LPG (from Natural Gas)                                       |             | 31.6           |
| 46 | <u>Total Commercial Energy Consumption by Final Consumer</u> |             | <u>2,248.5</u> |
| 47 | <u>Non-Commercial Energy</u>                                 |             | 693.9          |
| 48 | Wood & Bagasse   | 725.0       |                |
| 49 | Less Bagasse used for Electric<br>/Generation                | <u>31.1</u> |                |
| 50 | <u>TOTAL ENERGY CONSUMPTION BY FINAL CONSUMER</u>            |             | <u>2,942.4</u> |

General Note:

Energy Conversion Factors used in the foregoing tables are those published by U.S. National Energy Information Center - Energy Interrelationships, FEA/R-77/166. Page 44, and read as follows:

|                      |                |              |                |
|----------------------|----------------|--------------|----------------|
| LPG                  | 0.086 TOE/bbl. | Kerosene     | 0.129 TOE/bbl. |
| Motor Gasoline       | 0.118 "        | Diesel oil   | 0.137 "        |
| Aviation Gasol.      | 0.113 "        | Residual FO. | 0.143 "        |
| Naphta               | 0.118 "        | Asphalt      | 0.167 "        |
| Jet Fuel (Kero type) | 0.130 TOE/bbl. |              |                |

THE OIL INDUSTRY

I. SUPPLY OF HYDROCARBONS

Reserves

1.01 Total sedimentary basins extend over an area of 17 million hectares (Mha). Of these, 3.2 Mha have been assigned or contracted with the following firms or consortia: Corporacion Estatal Petrolera Ecuatoriana (CEPE) 2.4 Mha; CEPE-Texaco 0.491 Mha; CEPE-City 0.04 Mha; and CEPE-YPF 0.06 Mha <sup>1/</sup>. The undistributed area is divided into 24 blocks in the eastern area and 46 blocks in the coastal on- and off-shore region. Over the decade 1970-80, only limited new reserves were found, and the level of proved reserves decreased from 1.6 billion barrels in 1972 to 1.2 billion barrels in 1979.

1.02 A detailed analysis of reserves is of high priority and currently an audit is being contracted. New areas will be opened for exploration under the hydrocarbons operations formula (para. 4.12) and secondary recovery projects will be implemented in the main producing fields: Sacha and Shushufindi-Aguarico. The potential areas offer prospects for conventional resources as well as for heavy crudes. The national development plan estimates additions to reserves in the amount of 730 million barrels over the period 1980-84, 570 million from secondary recovery and 160 million from new fields.

Coastal Area

1.03 On-shore. Little detailed information is available on this region. The Santa Elena Peninsula contains the old oil fields of Ancon, Carpet and Cautivo, whose accumulated production amounts to 100 million barrels; annual decline is at 13-14%, and production was 1.5 Mb/d in 1979. <sup>2/</sup> No estimates on remaining reserves are available, although it is thought that 88% of the original reserves are still unexploited. Work is being done to rehabilitate these fields which produce a 38° API crude with 0.2% sulfur. In addition, geochemical research in the provinces of Esmeraldas and Manabi indicates possible accumulations of hydrocarbons.

1.04 Off-shore. In 1977, the Western Geophysical Co. of America initiated seismic research in the areas of Esmeraldas, Manabi and Guayas; results show some prospects in Blocks 3 and 7. Studies indicated that the geology of the Gulf of Guayaquil is different from that in the Santa Elena Peninsula. In the Gulf of Guayaquil, ADA and Northwest have done exploratory work, and important shows of gas have been found. Reserves of free gas are estimated in the range of 180 to 260 billion cubic feet in the Amistad structure,

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<sup>1/</sup> 200,000 ha assigned to Northwest are under discussion (para. 1.3). Detailed reserve estimates are given in Annex 2, Table 2.1.

<sup>2/</sup> Mb/d expresses thousand barrels per day.

and additional reserves could be incorporated from other not yet evaluated structures in Block No. 11. 1/

Eastern Area

1.05 This region contains the most important actual and potential oil resources. Geological and geophysical studies of the northeastern region are well advanced:

- (a) the area assigned to the CEPE-Texaco consortium has been explored, although some work remains to be done in the south. Seismic interpretation of pre-cretaceous structures has been initiated and favorable prospects have been detected;
- (b) the small CEPE-CEPCO area has been covered. Only field Joan remains to be developed;
- (c) CEPE has carried out an important seismic program on its assigned area, by contract with Compagnie Generale Geophysique from July 1976 to March 1979. The results show the existence of stratigraphic traps, which might contain small hydrocarbon accumulations;
- (d) YPF of Argentina has carried out seismic explorations with no positive showings; and
- (e) in the southern jungle regions, there seem to be some favorable prospects, but no significant seismic studies were made after Amoco abandoned the research.

1.06 The most important reserves were discovered in 1969 by the Texaco-Gulf consortium. The four main fields contain 75% of total original proven and probable reserves (see Annex 2, Table 2.1). In comparison with these, all the other fields are marginal.

1.07 Total remaining proven, probable and supplementary reserves amount to 2,025 million barrels of which 83.5% are located in the area assigned to the CEPE-Texaco group, and CEPE by itself holds 15% of total reserves. In order to develop the smaller fields, important investments in infrastructure - roads and pipelines - must be made.

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1/ There is a legal problem associated with this gas. ADA, a joint venture of several companies (Philips Petroleum Co., Bell Oil & Gas Co., Equity Funding Corp., General Exploration Co., and American Ultramar Ltd.), which between 1970 and 1972 drilled nine wells and invested about US\$25 million, filed suit before US courts against Northwestern, the company that entered an association contract with the Ecuador Government in 1975. This latter contract was also declared extinct in 1979, and at present CEPE proposes to develop the Amistad Field by itself.

Production

1.08 The Oriente region has supplied 98% of the country's accumulated production over the period 1972-78 which was 437.2 million barrels. Indeed, in 1979, 99.4% of the 78 (see Annex 2, Table 2.2) million barrels produced originated in only eight fields of this area. The producers were the CEPE-  
Texaco consortium (98%); CEPE-City (1.6%); and CEPE (0.4%).

1.9 For the period 1980-84 the development plan estimates an increase in production to an average of 225 Mb/d, conditioned to the following works:

(a) artificial lifting, well reconditioning and secondary recovery in fields Sacha and Shushufindi. It is estimated that, through supplementary recovery, reserves will increase by 570 million barrels and production could increase by 20 Mb/d.

(b) incorporation of the following fields:

|                              |           |
|------------------------------|-----------|
| Yuca, Charapa, Dureno, Joan  | 15.6 Mb/d |
| Bermejo, Coca, Cononaco      | 14.3 "    |
| Tignino, Shiripuno, Tivacuno | 12.7 "    |
| Cuyabeno, Pucuna             | 6.0 "     |
| Primavera, Yuturi, Tiputini  | 6.8 "     |

1.10 CEPE is revising the daily production forecasts upward (to about 250 to 300 Mb/d), but the Ministry of National Resources and Energy argues that during the transition period significant delays may arise and that maintaining present production rates will demand significant technical and financial efforts. The pace of future activity will also depend on Ecuador's success in attracting foreign interest for further exploration.

II. Consumption and Exports

2.01 Annex 2, tables 2.3, 2.4, and 2.5 present basic data on oil consumption and refinery processing, which show the following structure for 1979:

|                         | <u>Product Structure (%) 1/</u>     |                        |
|-------------------------|-------------------------------------|------------------------|
|                         | <u>Domestic Market Requirements</u> | <u>Refinery Yields</u> |
| Gasolines               | 38.2                                | 25.4                   |
| Kerosene and Turbo Fuel | 15.1                                | 11.3                   |
| Diesel                  | 22.1                                | 15.9                   |
| Residual                | 20.4                                | 43.0                   |

1/ Only the most important products have been included. The total excludes asphalt.

2.02 The qualitative imbalance enhances the already substantial volumetric problem that the domestic market poses for the oil industry. Total demand for petroleum products rose by an average of 15% per year, from 29.2 thousand barrels per day (Mb/d) in 1973 to 69.2 Mb/d in 1979, and its share in the country's crude oil production increased from 14% to 32% over this period. Qualitatively, the demand for light and middle distillates grew at a higher than average rate, thus increasing the imbalance between refinery yields and the structure of consumption. As a result, refinery operations are not optimal.

2.03 The domestic market requirements are supplied by all oil producing companies according to their relative share in production. The volume is calculated as that amount of crude oil processed in domestic refineries plus the value of crude oil that has to be exported in order to pay for imports of supplementary products. This latter portion is called "compensatory crude".

#### Product Demand

2.04 Motor gasoline is the single most important product consumed in the market (38% of total sales). Two grades were traditionally marketed, of which the low octane (80) product has been gradually replaced by medium (83) octane gasoline (special). The special grade gasoline priced at the equivalent of 19 US cents/gallon gained increasing drivers' acceptance for better performance, but its use was also stimulated by quantitative restrictions on the supply of the lower octane gasoline. In July 1980 CEPE introduced a new higher octane gasoline (92 octane), priced at the equivalent of 73 US cents/gallon (almost four times the price of special gasoline), and the Government has indicated that it expects it to drive out the lower priced product in the more affluent areas, thus forcing the higher price on the market. Gasoline sales increased 14.4% per year during the period 1972-79; demand accelerated substantially and reached a peak growth of more than 20% in 1975; the rate seems to have slowed down since. It should be noted that because of the price differential for gasoline between Ecuador and its neighboring countries, an unaccounted outflow of gasoline is taking place. It is estimated that these illegal exports amount to 10 to 15% of domestic demand. If the consumption figures shown in Attachment 3 are corrected for this illegal traffic, the average rate of growth of domestic demand for the period 1973-78 falls to 11.6% per year 1/.

2.05 Kerosene demand represents about 10 to 12% of total sales. It has experienced a 16.3% yearly growth since 1973, due to its wider use in marginal urban and rural areas, substitution of more traditional fuels, and its utilization in industrial installations; Ecuador's price structure favors such use and only restricted availability of this fuel has avoided a more irrational use.

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1/ In the Energy Balances, the following statistical differences due to illegal gasoline exports were estimated: 1975, 550,000 barrels; 1976, 753,000 barrels; 1977, 687,000 barrels; 1978, 1,283,000 barrels.

2.06 LPG has been the fastest growing fuel, especially in urban areas, where it has substituted for gasoline and kerosene in household use. The present policy is to promote its use in other sectors, as supply comes forward from the Shushufindi plant. Research should be directed towards its use in transportation.

2.07 Aviation fuel sales, particularly turbo-fuels, have increased at high rates. Recent price increases (limited to international sales) should reduce this growth in the future.

2.08 Diesel oil had an average growth rate of about 15% over the period 1972-79 and its participation has remained at approximately 22% of total oil requirements. A significant part (18%) of consumption is due to electric use for electricity generation.

2.09 Similarly, residual fuel demand is to a large extent caused by electricity generation requirements (approximately 60% of total domestic sales). Its relatively low participation in total domestic consumption (20%) reflects the structure of the country's economy and the absence of heavy industry. In the long run, it is likely that the share of heavy fuels will not grow significantly, because of hydroelectric development and the introduction of natural gas into the fuel market.

#### Oil Consumption for Electricity Generation

2.10 At present, electricity generation capacity amounts to about 924 MW; about 700 MW or 76% of the total capacity, corresponds to thermoelectric generators which are distributed as follows: diesel engine generators 51%, gas turbines 26%, and steam driven generators 23%. The reduced share of steam generators is due to the existence of numerous small isolated systems which use up important volumes of diesel oil and, if available, kerosene. Annex 2, tables 2.6 and 2.7 provide information on the pattern of fuel requirements used for electricity generation. Diesel oil supplies more than one-fourth of oil requirements of the sector (on a volumetric basis) and residual fuel oil the balance. The precise distribution is not known since some utilities report their fuel inputs as mixtures of diesel and Bunker C without stating their composition.

#### Projection of Future Domestic Demand

2.11 It is important to appraise domestic consumption in the framework of the country's production level. In 1972, domestic demand of 28.4 Mb/d represented 33% of production. In 1973, the sharp increase of production to 208 Mb/d reduced the share of the domestic market to 14%. Since then, production has stagnated while internal demand has soared to 69 Mb/d in 1979, reducing the exportable surplus to 67.6% of production. If such conditions were to remain unchanged in the future, by 1988 all production would be consumed domestically and long before that time the cost of imports of supplementary products would have exceeded revenues from surplus exports.

2.12 The growth rate of domestic demand has declined from an average of 16.1% per year for the period 1973-78 to 12% for 1979, which could mean that a certain level of saturation has been reached. Also measures are being taken to reduce smuggling to neighboring countries. In addition, in the long run the

expansion of hydroelectric generation and the interconnection of the electric system, will directly reduce the intake of petroleum products for generation purposes and indirectly substitute electricity for formerly used household fuels such as kerosene and gasoline. Upon these facts, the national oil company assumes that the estimated growth rate of 12% per year contained in the development plan may be reduced to approximately 9%.

Refining

2.13 Refining operations were started in 1926 and were directed toward the domestic market. Except for short periods of time, domestic production had to be supplemented by imports of such products as gasoline, kerosene, diesel, jet fuel and asphalt. In the early 1970s, the Government decided to participate more actively in the refining activities which were carried out by private companies. It then contracted the construction of a new refinery, Esmeraldas, of which CEPE is the sole owner. Also in 1974, the Government took over a 12.5% participation in the Gulf refinery and a 24.3553% participation in the production of the Anglo-Ecuadorean plant.

2.14 Capacity. There are four refineries in Ecuador with the following capacity:

|             | <u>Designed Capacity 1/</u><br>(b/cd) | <u>Volume Processed 2/</u><br>1979<br>(b/cd) | <u>Capacity Utilization</u><br>(%) |
|-------------|---------------------------------------|--|------------------------------------|
| Esmeraldas  | 55,615                                | 50,259                                       | 90.4                               |
| Anglo       | 31,000                                | 28,976                                       | 93.5                               |
| Gulf        | 7,000                                 | 6,757  | 96.5                               |
| CEPE-Texaco | <u>1,000</u>                          | <u>1,003</u>                                 | <u>100.0</u>                       |
|             | <u>94,615</u>                         | <u>86,995</u>                                | <u>91.9</u>                        |

Source: 1/ "Balance de la Situacion Petrolera del Ecuador"  
Cuestiones Economicas - Banco Central de Ecuador - 1980.

2/ Boletín de Hidrocarburos - Ministerio de Recursos Naturales y Energeticos - December 1979.

The above table shows that in 1979 the average rate of utilization of installed capacity was 92%, which is a worldwide efficient level of operation. Figures for the first five months of 1980 indicate that capacity utilization is at 97%.

2.15 Refining Structure. Table 8 refers to refined products processed in domestic refineries over 1972-79. The simplified product slate has changed over time in the following manner:

|                         | <u>1975</u> | <u>1978</u> | <u>1979</u> |
|-------------------------|-------------|-------------|-------------|
| Gasolines               | 39.7%       | 25.6%       | 25.4%       |
| Kerosene and Turbo Fuel | 13.3%       | 13.0%       | 11.3%       |
| Diesel                  | 22.0%       | 15.8%       | 15.9%       |
| Residual                | 25.0%       | 45.6%       | 43.0%       |

Source: From data in Annex 2, table 2.8.

The information for 1975 refers to production by the Anglo-Ecuadorean, Gulf, and CEPE-Texaco refineries. The first two, located on the Santa Elena Peninsula, were built to process light crudes. When domestic supply of these declined, feedstock was imported in the form of Bolivian crude and Venezuelan reconstituted oil. Today, these atmospheric distillation plants are fed 96% with Oriente crude and the balance comes from adjacent domestic production. By September 1977, the more modern Esmeraldas refinery had entered into operation. It is 100% supplied with Oriente crude via the trans-Ecuadorean pipeline. It yields 28% gasoline, 9% kerosene, 16.1% diesel, 31.5% residual, and 11.6% asphalt.

2.16 CEPE's present expansion plans consider the further optimization of the Esmeraldas refinery and the increase of its capacity to 70 Mb/d in 1982 and to 90 Mb/d in 1987. In addition, the two refineries of the Santa Elena Peninsula will be integrated into one production system with a global capacity of 45 Mb/d (a 7 Mb/d increase from present level) and united to an olefin based petrochemical complex. The date for this development has not yet been defined. Also a new grass-root refinery with an initial capacity of 75 Mb/d is planned to start operations in 1984. The localization of this facility has not yet been determined. Projected installed capacity is as follows:

|      |                                     |
|------|-------------------------------------|
| 1980 | 90,300 barrels per day of operation |
| 1981 | 90,300 " " " "                      |
| 1982 | 105,300 " " " "                     |
| 1983 | 105,300 " " " "                     |
| 1984 | 180,300 " " " "                     |

Balance of Refined Products on the Domestic Market

2.17 Although present refining capacity greatly exceeds the volumetric requirements of the domestic market (94 Mb/d vs 69 Mb/d), an important imbalance exists due to the qualitative difference in the product slate. Table 9 lists the imports of products that were necessary over the period 1972-79 to satisfy the domestic market. For 1979, they represent 10.8% of all fuel sales and 14.2% of gasoline requirements. The volume decreased substantially when the Esmeraldas refinery entered into operation, but significant volumes of gasoline, kerosene, diesel oil and LPG continue to be imported.

2.18 Once the LPG pipeline enters into operation in 1981, that product will be available in excess to domestic requirements. Gasoline supply, however, will continue to be in short supply over the next few years until new conversion facilities are constructed in existing refineries. However, in the longer run, consumption of middle distillates will increase due to wider use in transport and industry. For this reason, CEPE foresees a deficit of this product in the second half of the decade, and the second expansion phase of the Esmeraldas refinery is to include conversion facilities of residual oil into middle distillates, thus reducing the surplus of heavy ends.

2.19 Price differentials between clean products and residual fuel oil are likely to become larger. CEPE has attempted to reduce the present deficit of light products by contracting refining capacity in the Caribbean; shipping these back and selling the surplus products in the market. However, due to the high shipping costs and reduced storing facilities in Ecuadorean ports, this operation has not been completely successful.

2.20 The five-year development plan gives the following provisional figures for the product balance, in million barrels per year:

|              | <u>Refining</u> | <u>Consumption</u> | <u>Exports</u> | <u>Imports</u> |
|--------------|-----------------|--------------------|----------------|----------------|
| 1980         | 33.2            | 26.3               | 8.8            | 1.9            |
| 1981         | 33.7            | 29.4               | 8.2            | 3.8            |
| 1982         | 38.6            | 32.8               | 9.6            | 3.8            |
| 1983         | 49.1            | 36.7               | 13.4           | 1.1            |
| 1984         | <u>63.7</u>     | <u>41.3</u>        | <u>23.0</u>    | <u>0.7</u>     |
| <b>TOTAL</b> | <u>218.3</u>    | <u>166.5</u>       | <u>63.0</u>    | <u>11.3</u>    |

Source: CONADE, 1980-84 Development Plan.

### Exports

2.21 Crude oil exports in 1979 were as follows:

| <u>Exporter</u> | <u>Direct Exports</u> | <u>Compensatory Exports</u><br>(Thousands of barrels) | <u>Export of Royalty</u> | <u>Total Exports</u> |
|-----------------|-----------------------|---|--------------------------|----------------------|
| CEPE            | 28,144.3              | 2,991.5   | 3,093.0                  | 34,228.8             |
| TEXACO          | 8,301.2               | 1,794.8   | -                        | 10,096.0             |
| CITY            | 344.2                 | 54.4  | -                        | 398.6                |
| CEPE-CEPCO      |                       | <u>18.2</u>   | -                        | <u>18.2</u>          |
| <b>TOTAL</b>    | <u>36,789.7</u>       | <u>4,858.9</u>  | <u>3,093.0</u>           | <u>44,741.6</u>      |

Source: Boletín de Hidrocarburos - Ministerio de Recursos Naturales y Energeticos - December 1979.

The main markets for Ecuador's crudes in 1979 were the Netherland Antilles (48%), Panama (21%), USA (16%), and Chile (11%). This distribution has changed substantially from former years, when a higher volume was sold to final markets. Table 10 gives export figures for 1972-79.

2.22 In 1979 7 million barrels of fuel oil were exported, 91% to the USA and 8% to Mexico. Additional exports of diesel and fuel oil in the form of bunkers are included in domestic sales' statistics.

#### Transport and Storage Facilities

2.23 There is a need to improve and expand domestic facilities to handle petroleum products. The development plan establishes the following targets:  
Pipelines: La Libertad-Guayaquil: extension 243 km with a capacity of

|                |  |
|----------------|--|
|                | 42 Mb/d  |
| Alausi-Cuenca: | extension 120 km with a capacity of<br>10 Mb/d |

Maritime terminals: Esmeralda and La Libertad.

Storage capacity at refineries and distribution centers:

|           |                 |
|-----------|-----------------|
| Gasoline: | 559,643 barrels |
| Kerosene: | 202,173 "       |
| Diesel:   | 471,117 "       |
| LPG:      | 1,433 tons      |

### III. Financial Aspects of the Oil Industry

#### Fiscal Policy

3.01 The oil industry is subject to the Hydrocarbons Law and to various decrees and regulations. The most significant provisions affecting the sector's finances refer to royalties, unified income tax, distribution of oil revenue and industry profits. They are discussed below.

#### Royalties 1/

3.02 Royalty payment is levied on gross crude production and, since February 20, 1979, is paid in kind. The rate varies from 12.5% for a production level of less than 30 Mb/d to 18.5% when production exceeds 60 Mb/d. The average rate in 1979 was 17.4%.

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1/ Article 49 of the Hydrocarbons Law of 1978.

Unified Income Tax 1/

3.03 In 1975, a unified income tax was established for private operations. This tax is equal to 87.31% of net income, including revenue from exports and domestic sales, less royalty payments and authorized costs.

3.04 The national oil company (CEPE) retains 28% of net income, once royalty payments and other non-industry related charges are deducted. 2/

Distribution of Oil Revenue

3.05 Until recently, all fiscal revenues were earmarked. Royalties were distributed in the following manner: 47% for the Instituto Ecuatoriano de Electrificación (INECEL), 3% for Provincial Councils and 50% for National Defense. The proceeds from income taxes were allocated automatically to 16 different organizations; the National Development Fund (FONADE) received the largest share (43.6% of income tax on private operations and 47.7% of CEPE's remaining distributable income), followed by the National Budget (33.3% and 36.5%, respectively). Other destinations included diverse funds, for purposes such as electrification, housing, health, education and military agencies.

3.06 In February 1980, it was established that earmarked participations would be calculated based on a value of US\$23.50 per barrel of exported crude oil, a value of US\$17.50 per barrel of heavy fuel oil, and on current revenues from domestic sales.

3.07 The income received above these established limits is to be directly allocated to the Treasury, exception is made of a US\$80.2 million allocation in 1980 and US\$120 million in future years for Provincial Councils and Municipalities. This income should increase the central government's capacity to improve the use of petroleum revenues for development purposes.

Profits of the Oil Industry

3.08 It is estimated that the main private operator, Texaco, earns about US\$1.45/bbl of crude oil produced, which represents an internal financial return over assets, at book values, of 34.3%.

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1/ For private companies, according to Decree No. 982 of November 21, 1975 and modified by Decree No. 2059 of December 15, 1977. For CEPE, Decree No. 1678 of July 27, 1977, modified by Decrees Nos. 218 and 337.

2/ These refer to a 8% deduction for National Defense and a US\$3/bbl reduction, which is to pay debt service incurred for the purchase of military equipment.

3.09 Although the annual report for 1979 was not yet published when the mission visited Ecuador, it is possible to estimate CEPE's net revenue on oil production at US\$1.57 per barrel. This preliminary figure must be corrected for a US\$0.20/bbl allowance which CEPE receives for each barrel of crude oil exported by private operators, and which is used for financing the company's participation in exploration and exploitation activities. Furthermore, in July 1980 the Government agreed to transfer to CEPE an amount equal to US\$0.20 per barrel from its own oil receipts, to improve CEPE's short-term financial situation, which is considerably impaired by the cost of supplying the domestic market.

#### Financial Requirements

3.10 The development plan proposed a US\$1,300 million investment program for hydrocarbons of which 86% would be financed by CEPE. Approximately 57% of these resources are to be allocated to exploration and development, 31% to refining, 6% to transport and storage facilities, and the remainder to gas development.

3.11 When the mission visited Ecuador, CEPE was revising its investment requirements to a total outlay of approximately US\$4 billion for the period 1981-85. Under present pricing conditions, CEPE's annual net income would vary from US\$285 million in 1981 to approximately US\$323 million in 1985. These figures suggest that the company's own financial resources would probably be adequate to finance the original investment figures proposed in the development plan. However, if the stepped-up program is to be executed, a large financing gap would ensue.

### IV. Policies and Issues

4.01 The economy of Ecuador depends to a large extent on its oil industry. In 1979, it generated 15.5% of the nation's GDP, contributed 18.3% to public revenues, and earned 55% of total export receipts. However, these contributions have been declining since 1976, because of the stagnation of production, the impressive growth of domestic consumption, and the internal pricing policy that is subsidizing the other sectors of the economy at the expense of the oil industry.

4.02 The Development Plan for 1980-84 seeks to increase foreign exchange and public sector revenues by revitalizing, among others, the energy sector. The objective of the plan is to achieve an average annual growth rate of 6.5% for the economy as a whole and of 13.5% for the energy sector. To this end, total investments in the economy were estimated, in constant 1979 terms, at about US\$5 billion, of which 31% would be in energy.

4.03 The strategy for the development of the hydrocarbon sector encompasses demand management and pricing policies, revitalization of production capacity and other facilities related to supplying the market, and, finally, institution building to improve planning, operational and managerial capabilities.

A. Domestic Pricing - Subsidies

4.04 Although somewhat understated in the development plan because of the sensitive nature of the subject, the pivotal element of the energy policy is demand management, through progressive adjustment of domestic petroleum prices to their opportunity cost values. The present pricing policy stimulates indiscriminate growth of consumption and jeopardizes the development, not only of the energy sector, but of the economy as a whole.

4.05 In 1973 the prices of petroleum products were set above international levels. Since then, they have remained mostly unchanged and thus, in real terms, the cost of fuels to the consumer has decreased by more than 120% relative to the general price level. In relation to mid-1980 levels, domestic fuels are priced at less than 20% of world market values.

4.06 Crude oil is supplied to the domestic market at an average price of US\$1.55 per barrel; this covers production expenses, pipeline fees and a 20% profit margin for the producing companies. If compared to the mid-1980 price for Ecuadorean crude oil in international markets of US\$35.50 per barrel, the domestic level represents 4.4% of the opportunity cost.

4.07 For 1979, the weighted average price for the barrel of products sold on the domestic market was US\$7.033; consumption tax was US\$2.076 and sales revenue for the national oil company CEPE was US\$4.957 (or US\$0.118/gallon). Assuming a zero value for crude oil and no product imports, the technical cost of supplying a barrel of products for the market was US\$5.103; thus, CEPE incurred a net loss of US\$0.146 per barrel. In addition, imports of clean products amounted to 10.8% of total domestic sales; assuming an import cost of US\$40/bbl, the subsidy for this concept alone was US\$4.32 per barrel. <sup>1/</sup> As a result, domestic prices would have to be increased by 90% only to compensate CEPE for the current technical costs incurred in supplying the domestic market. For 1979, the annual subsidy on this basis may be estimated at US\$113 million.

4.08 Petroleum is a non-renewable and limited resource. Its depletion must be compensated by an equivalent expansion of the nation's economic capacity and the long-term pricing policy should attempt to reach the opportunity cost value, i.e., must reflect international market levels and serve as an instrument of economic development. In order to achieve this objective, current domestic prices would have to be increased by more than 500%. On this basis, it can be estimated that the subsidy level is in the order of US\$900 million per year, which represents 8% of the GDP for 1980. Although it is recognized that such a gap cannot be bridged in the short term without considerable economic and social disruptions, over the longer period such a policy would contribute to a more equitable distribution of the nation's income, promote the development of a wider energy base and, finally, orient the consumption of petroleum products towards higher value end-uses.

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<sup>1/</sup> "Compensatory crude oil exports" allow CEPE to recover the loss. For technical cost estimates, see Table 6.

4.09 In order to assess the effective impact of higher fuel prices on the economic and social structure of Ecuador, a thorough analysis is required. Preliminary data shows that the economy should be able to absorb increased costs. It is estimated that energy represents less than 5% of total inputs in industrial and basic food products; exports of manufactured goods are less than 8% of total exports; a 100% increase in gasoline prices would increase the operating costs of a bus by 5%; only 10% of the population is served by the private car fleet that consumes a large part of the more than 8 million barrels of gasoline that the market demands.

4.10 The Government has stated its commitment to increase domestic prices in a gradual and progressive manner. In January 1980, bunker prices were increased: above a certain quota, turbo fuel was increased by 65% to US\$1.39/gallon and aviation gasoline to US\$1.70/gallon; also, prices for diesel and fuel oil for maritime use were increased twice during 1980 to about 45% of international levels.

#### B. Supply Strategy

4.11 The targets for increased crude oil production and addition to proven reserves are subject to a reassessment of reserves. Present state of knowledge on discovered hydrocarbon fields is not accurate enough to allow the definition of technically optimum production levels, to appraise supplementary recovery projects and to establish priorities in the development of already discovered fields.

4.12 Renewed exploratory efforts are required to define long-term policies for the petroleum sector. The plan proposes to assess 90% of the sedimentary basins during 1980-84. For this purpose, the Government has announced that it will invite qualified private operators to join efforts with the national oil company under the hydrocarbons operation contract formula. As indicated, the operator is to carry out exploration and exploitation activities at his own risk and, if sources for commercial production are found, he will be allowed to recover his investment, with an adequate profit margin. The definition of what may be considered an "adequate" margin is likely to be an important issue in the negotiations and, therefore, some time is to elapse before effective private participation in exploration can be attracted.

4.13 On the other hand, in the past the national oil company has not been very active in exploration. This activity requires highly experienced personnel, and such a group can be formed only over the long term. Therefore, it is considered that even if CEPE's budget constraints are lifted, there is likely to be a gap between the supply objectives of the development plan and the actual performance of the industry.

#### Development of Alternative Energy Resources and Conservation

4.14 The development of alternative energy resources is linked to the oil sector, for the following reasons: (a) substantial investments are required to bring them forward and the oil industry is the only likely source to generate

the funds required; (b) the economic feasibility for incorporating these resources into production requires that prices for liquid fuels be increased; and (c) hydroelectric power and natural gas will affect the demand structure for petroleum products and, therefore, the oil industry must introduce the appropriate provisions in its long-term investment policy.

4.15 Moreover, the economy currently makes inefficient use of energy. In order to enhance conservation in all sectors, adequate incentives have to be given. The development plan lists the following measures that are to be implemented in order to reduce the growth rate of demand for gasoline: (a) elimination of smuggling to neighboring countries through rigorous controls 1/; (b) substitution for diesel in trucks; (c) prohibition on the import of large cylinder cars; (d) tax on vehicles according to cylinder capacity; and (e) improvement of public transportation in urban and inter-urban areas.

#### Institutional Strengthening

4.16 The objective of a balanced energy policy should be to adjust energy production to the long-term requirements of economic growth and to the resource base of the country. The Government is cautiously developing a strategy toward this end and is attempting to strengthen its institutional structure.

4.17 In the first place, the Executive is promoting a better understanding of the energy issues by Congress and the public in general in order to obtain its backing for a revision of the domestic pricing policy. As indicated in the previous paragraphs, this is fundamental for increasing the financial surplus generated by the oil industry and required to promote economic development.

4.18 Second, the Executive is striving for a unification of oil revenues in the National Treasury. To a large extent, these revenues are earmarked and automatically allocated to autonomous institutions, with the consequent inefficient use of financial resources.

4.19 The development plan recognizes the need to promote energy production, not only of petroleum but of hydroelectric power, natural gas, and other resources. There is, however, no thorough analysis of the interaction of these developments. This shows that there is a lack of coordination among CEPE, INECEL, the Instituto Nacional de Energia (INE) and the MRNE. Energy conservation has not been properly addressed and there seems to be a limited interest in fostering overall energy CEPE, INECEL, INE and the MRNE. Energy conservation has not been properly addressed and there seems to be a limited interest in fostering overall energy planning, although in principle, these issues are under the responsibility of the INE. 2/ There is also a need to

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1/ Gasoline prices for regular grade are US\$0.75/gallon in Colombia and US\$0.80/gallon. in Peru. This compares with less than US\$0.20 for Ecuadorean gasoline at the border.

2/ INE's budget is estimated at approximately US\$1.6 million per year.

work out an understanding between the MRNE and CEPE, by which the Ministry retains its policy-making and supervisory functions, but leaves CEPE with the necessary authority to operate as an autonomous corporation.

ECUADOR  
POWER SECTOR MEMORANDUM  
OIL RESERVES  
(Thousand barrels)

|                      | <u>Proved Original<br/>Volumes</u> | <u>Accumulated<br/>Production</u> | <u>Remaining<br/>Proved</u> | <u>Additional<br/>Probable</u> | <u>Supplemental<br/>Recovery</u> |
|----------------------|------------------------------------|-----------------------------------|-----------------------------|--------------------------------|----------------------------------|
| <u>CEPE-TEXACO:</u>  | <u>1,513,059</u>                   | <u>429,884</u>                    | <u>1,083,175</u>            | <u>236,105</u>                 | + <u>372,600</u>                 |
| Auca                 | 95,482                             | 14,135                            | 81,347                      | 84,804                         | -                                |
| Lago Agrio           | 191,178                            | 67,785                            | 123,393                     | -                              | -                                |
| Sacha                | 633,784                            | 147,849                           | 485,935                     | -                              | Evaluation                       |
| Shushufindi-Aguarico | 559,651                            | 199,905                           | 359,656                     | -                              | 372,600                          |
| Atacapi              | 8,572                              | -                                 | 8,572                       | -                              | -                                |
| Parahuaco            | 12,403                             | 120                               | 12,283                      | -                              | -                                |
| Coca                 | 700                                | -                                 | 700                         | 904                            | -                                |
| Cononaco             | 5,000                              | -                                 | 5,000                       | 35,000                         | -                                |
| Dureno               | 1,858                              | -                                 | 1,858                       | 7,350                          | -                                |
| Yuca                 | 4,431                              | -                                 | 4,431                       | 108,047                        | -                                |
| <u>CEPE-CEPCO</u>    | <u>27,440</u>                      | <u>839</u>                        | <u>26,601</u>               | <u>-</u>                       | <u>-</u>                         |
| Fanny                | 7,058                              | ( -                               | ( -                         | -                              | -                                |
| Mariann              | 19,123                             | ( 839                             | (25,342                     | -                              | -                                |
| Joan                 | 1,259                              | -                                 | 1,259                       | -                              | -                                |
| <u>CEPE:</u>         | <u>63,831</u>                      | <u>-</u>                          | <u>63,831</u>               | <u>242,824</u>                 | <u>-</u>                         |
| 18 - B.              | 3,502                              | 1/                                | 3,502                       | -                              | -                                |
| Charapa              | 3,693                              | -                                 | 3,693                       | -                              | -                                |
| Capiron              | 23,000                             | -                                 | 23,000                      | -                              | -                                |
| Other fields         | 33,636                             | -                                 | 33,636                      | 43,870                         | -                                |
| Bernedo              | -                                  | -                                 | -                           | 29,800                         | -                                |
| Cuyabeno             | -                                  | -                                 | -                           | 62,504                         | -                                |
| Pucuma               | -                                  | -                                 | -                           | 57,527                         | -                                |
| Tiputini             | -                                  | -                                 | -                           | 49,123                         | -                                |
| <u>TOTAL ORIENTE</u> | <u>1,604,330</u>                   | <u>430,723</u>                    | <u>1,173,607</u>            | <u>478,929</u>                 | <u>570,000</u>                   |

1/ Started production early 1979.

Source: Article: Situación Petrolera en el Ecuador, by Abelardo Pachano.  
Published in Cuestiones Económicas - Banco Central de Ecuador - January 1980  
Author quotes as source: Dirección de Producción de CEPE - 1979.

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**NATIONAL PRODUCTION OF CRUDE OIL**  
**(barrels)**

|                  | 1972              | 1973              | 1974              | 1975              | 1976              | 1977              | 1978              | 1979              |
|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| January          | 98,686            | 61478,096         | 71472,698         | 41390,783         | 51381,960         | 61716,907         | 51421,042         | 61763,558         |
| February         | 94,039            | 51955,155         | 61840,268         | 41837,542         | 51328,402         | 51788,639         | 41680,261         | 61128,982         |
| March            | 96,765            | 61927,111         | 71397,878         | 835,946           | 61560,820         | 41880,152         | 51887,443         | 71059,548         |
| April            | 90,717            | 51636,878         | 71251,573         | 61313,591         | 51997,234         | 51270,155         | 61231,199         | 61584,836         |
| May              | 423,162           | 41782,260         | 61984,765         | 41414,038         | 61297,122         | 51393,261         | 61221,934         | 61625,202         |
| June             | 1142,698          | 51848,125         | 61065,443         | 41185,607         | 31408,936         | 51895,937         | 61653,813         | 61304,675         |
| July             | 11377,966         | 61545,940         | 31462,986         | 41475,632         | 31512,129         | 41727,104         | 61419,028         | 61563,107         |
| August           | 11885,637         | 61222,330         | 41482,326         | 61014,312         | 61242,804         | 51780,739         | 61257,419         | 61606,917         |
| September        | 41260,174         | 61916,993         | 41467,229         | 51594,812         | 61506,012         | 41277,433         | 61207,191         | 61329,362         |
| October          | 51682,418         | 71074,834         | 31864,866         | 51616,853         | 61200,875         | 51400,877         | 61450,060         | 61624,702         |
| November         | 61701,670         | 61750,859         | 21188,382         | 61135,082         | 61409,306         | 61320,731         | 61589,544         | 61380,350         |
| December         | 61681,638         | 71011,001         | 41153,591         | 51967,429         | 61420,528         | 61145,790         | 61607,209         | 61093,088         |
| <b>TOTAL :</b>   | <b>281535,570</b> | <b>761149,582</b> | <b>641632,005</b> | <b>581783,627</b> | <b>681266,098</b> | <b>661597,725</b> | <b>731626,143</b> | <b>781064,367</b> |
| Rate of growth % |                   | 166,9             | - 15,1            | - 9,0             | 16,1              | - 2,4             | 10,6              | 6,0               |

Source: CEPE

ECUADOR  
POWER SECTOR MEMORANDUM  
NATIONAL PRODUCTION OF OIL DERIVATIVES  
(barrels)

|                    | 1972              | 1973              | 1974              | 1975              | 1976              | 1977              | 1978              | 1979              | Change %<br>1978 - 1979 |
|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------------|
| GASOLINE (63 OCT.) | 1'302,594         | 1'311,572         | 1'285,311         | 1'399,939         | 1'246,034         | 846,883           | 687,001           | 712,372           | 3.7                     |
| GASOLINE (80 OCT.) | 2'301,064         | 2'790,785         | 3'544,225         | 4'280,476         | 4'833,450         | 5'297,134         | 6'605,543         | 7'448,353         | 12.8                    |
| <b>TOTAL :</b>     | <b>3'604,558</b>  | <b>4'102,357</b>  | <b>4'829,536</b>  | <b>5'680,415</b>  | <b>6'079,484</b>  | <b>6'144,017</b>  | <b>7'292,544</b>  | <b>8'160,725</b>  | <b>11.9</b>             |
| KEREX              | 416,952           | 399,511           | 593,375           | 1'429,010         | 1'914,583         | 2'381,257         | 2'716,252         | 2'497,557         | - 8.1                   |
| TURBO FUEL         | 811,899           | 920,264           | 3'113,021         | 466,259           | 466,905           | 537,367           | 985,059           | 1'154,713         | 17.2                    |
| DIESEL OIL         | 2'313,717         | 2'720,321         | 960,456           | 3'154,606         | 2'885,821         | 3'214,321         | 4'517,915         | 5'075,844         | 12.3                    |
| RESIDUAL           | 3'002,397         | 3'161,023         | 3'277,842         | 3'582,004         | 3'775,653         | 6'602,227         | 13'018,093        | 13'653,546        | 4.9                     |
| RUBBER SOLVENT     | 4,025             | 8,044             | 3,454             | 6,957             | 10,925            | 14,526            | 15,631            | 17,520            | 12.1                    |
| MINERAL TURPENTINE | 7,378             | 8,390             | 9,425             | 7,998             | 9,015             | 13,554            | 22,167            | 15,968            | - 28.0                  |
| SPRAY OIL          | 159,326           | 169,586           | 97,453            | 127,254           | 131,626           | 104,049           | 64,077            | 74,938            | 17.0                    |
| SOLVENT N° 1       | -                 | -                 | -                 | -                 | -                 | 353               | -----             | 6,247             | 100.0                   |
| ASPHALT            | -                 | -                 | -                 | -                 | -                 | 208,006           | 415,255           | 482,197           | 16.1                    |
| LIQUID GAS         | 50,406            | 49,992            | 63,187            | 52,768            | 40,087            | 227,920           | 734,929           | 814,560           | 10.8                    |
| <b>TOTAL :</b>     | <b>10'370,658</b> | <b>11'539,488</b> | <b>12'947,749</b> | <b>14'507,271</b> | <b>15'314,099</b> | <b>19'447,597</b> | <b>29'781,522</b> | <b>31'953,825</b> | <b>7.3</b>              |

SOURCE: CEPE

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**SALES OF PETROLEUM DERIVATIVES, 1972-1979**  
**(barrels)**

|                    | 1972             | 1973              | 1974              | 1975              | 1976              | 1977              | 1978              | 1979              | TOTAL              | Change %<br>1978-1979 |
|--------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-----------------------|
| GASOLINE (63 OCT.) | 1'307.578        | 1'289.783         | 1'234.727         | 1'275.775         | 1'286.720         | 927.303           | 664.465           | 664.476           | 8'650.827          | (0)                   |
| GASOLINE (80 OCT.) | 2'397.684        | 2'835.629         | 3'498.562         | 4'447.713         | 5'323.916         | 6'569.347         | 7'775.465         | 8'862.608         | 41'705.924         | 14.0                  |
| TOTAL:             | 3'705.262        | 4'125.412         | 4'733.289         | 5'718.488         | 6'610.636         | 7'496.650         | 8'439.930         | 9'527.084         | 50'356.751         | 12.9                  |
| KEREX (M)          | 936.966          | 1'078.427         | 1'198.748         | 1'465.316         | 2'030.761         | 2'484.537         | 2'834.210         | 2'692.658         | 14'721.623         | - 5.0                 |
| DIESEL OIL         | 2'115.459        | 2'513.249         | 2'843.913         | 3'209.202         | 3'617.356         | 4'355.229         | 4'682.667         | 5'514.066         | 26'851.141         | 17.8                  |
| RESIDUAL           | 2'149.727        | 2'225.775         | 2'480.742         | 3'046.372         | 3'162.513         | 3'343.389         | 4'234.205         | 5'095.089         | 25'731.812         | 20.3                  |
| LIQUID GAS         | 117.820          | 242.594           | 228.685           | 304.628           | 405.446           | 570.825           | 755.984           | 946.752           | 3'572.734          | 25.2                  |
| TURBO FUEL         | 238.437          | 239.856           | 312.079           | 437.605           | 379.123           | 638.343           | 935.648           | 1'071.918         | 4'247.049          | 14.6                  |
| AVIATION GASOLINE  | 127.512          | 94.440            | 76.682            | 56.248            | 40.113            | 46.657            | 42.779            | 36.305            | 520.736            | - 15.1                |
| SPRAY OIL          | 163.502          | 138.375           | 117.012           | 117.869           | 121.337           | 116.590           | 43.580            | 72.611            | 890.876            | 66.2                  |
| MINERAL TURPENTINE | 3.034            | 4.853             | 5.648             | 7.641             | 7.666             | 11.657            | 17.038            | 16.579            | 74.116             | - 2.7                 |
| SOLVENT No. 1      | 2.603            | 3.323             | 3.773             | 4.404             | 4.437             | 6.302             | 6.716             | 6.742             | 38.300             | 0.5                   |
| RUBBER SOLVENT     | 5.888            | 7.055             | 4.501             | 6.561             | 9.410             | 11.181            | 11.760            | 17.796            | 74.452             | 51.3                  |
| ASPHALT            | (0)              | (0)               | (0)               | (0)               | (0)               | 479.170           | 550.098           | 263.468           | 1'292.736          | - 52.1                |
| <b>TOTAL</b>       | <b>9'566.210</b> | <b>10'673.359</b> | <b>12'005.072</b> | <b>14'361.334</b> | <b>16'388.798</b> | <b>19'560.530</b> | <b>22'554.615</b> | <b>25'261.068</b> | <b>130'372.026</b> | <b>12.0</b>           |

SOURCE: CEPE

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**Structure of Petroleum Consumption**  
**(%)**

|                   | <u>1972</u>  | <u>1973</u>  | <u>1974</u>  | <u>1975</u>  | <u>1976</u>  | <u>1977</u>  | <u>1978</u>  | <u>1979</u>  |
|-------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Motor Gasoline    | 38.7         | 38.7         | 39.4         | 39.8         | 40.3         | 39.3         | 38.4         | 38.1         |
| Kerosene          | 9.8          | 10.1         | 10.0         | 10.2         | 12.4         | 13.0         | 12.9         | 10.8         |
| Diesel Oil        | 22.1         | 23.5         | 23.7         | 22.3         | 22.1         | 22.8         | 21.3         | 22.1         |
| Residual Fuel     | 22.5         | 20.9         | 20.7         | 21.2         | 19.3         | 17.5         | 19.2         | 20.4         |
| LPG               | 1.2          | 2.3          | 1.9          | 2.1          | 2.5          | 3.0          | 3.4          | 3.8          |
| Turbo Fuel        | 2.5          | 2.2          | 2.6          | 3.0          | 2.3          | 3.3          | 4.3          | 4.3          |
| Aviation Gasoline | 1.3          | 0.9          | 0.6          | 0.4          | 0.2          | 0.2          | 0.2          | 0.1          |
| Others <u>1/</u>  | 1.9          | 1.4          | 1.1          | 1.0          | 0.9          | 0.9          | 0.3          | 0.4          |
| <b>TOTAL:</b>     | <u>100.0</u> |

1/ Does not include asphalt.

SOURCE: Based on data from Attachment No. 3.

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**Petroleum Consumption of Power Sector**  
**(Barrels and Percentages)**

|                     | 1972             |              | 1973             |              | 1974             |              | 1975             |              | 1976             |              | 1977             |              | 1978             |              | 1978/72 |
|---------------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|---------|
|                     | Volume           | %            | %       |
| Kerosene            | 71,687           | 5.9          | 71,904           | 5.1          | 109,203          | 7.0          | 140              | -            | 1,925            | -            | 131,720          | 4.3          | 42,753           | 1.2          | (40.4)  |
| Diesel              | 240,819          | 19.9         | 369,751          | 26.4         | 404,585          | 25.9         | 354,981          | 19.6         | 629,794          | 26.4         | 826,597          | 26.9         | 839,100          | 24.4         | 248.4   |
| Residual            | 900,608          | 74.2         | 957,958          | 68.5         | 1,047,690        | 67.1         | 1,099,178        | 60.8         | 1,194,558        | 50.0         | 1,319,033        | 42.9         | 1,562,862        | 45.4         | 73.5    |
| Mixture 1/          | -                | -            | -                | -            | -                | -            | 355,006          | 19.6         | 562,020          | 23.6         | 796,141          | 25.9         | 999,781          | 29.0         | -       |
| <b>TOTALs</b>       | <b>1,213,114</b> | <b>100.0</b> | <b>1,399,613</b> | <b>100.0</b> | <b>1,561,478</b> | <b>100.0</b> | <b>1,809,305</b> | <b>100.0</b> | <b>2,388,297</b> | <b>100.0</b> | <b>3,073,551</b> | <b>100.0</b> | <b>3,444,496</b> | <b>100.0</b> |         |
| Annual Increase (%) |                  | 15.4         |                  | 11.6         |                  | 15.9         |                  | 32.0         |                  | 28.7         |                  | 12.1         |                  |              | 19.0    |

1/ Mixture of Diesel and Residual. Relative composition not known.

SOURCE: Based on Informe Anual de Actividades INECEL, 1978.

ECUADOR  
POWER SECTOR MEMORANDUM  
Power Sector Consumption of Fuels (as Percentage  
of Total Domestic Demand for Specific Fuels 1/

|      | <u>Kerosene</u> | <u>Diesel</u> | <u>Residual</u> | <u>Residual + Mixture 2/</u> |
|------|-----------------|---------------|-----------------|------------------------------|
| 1972 | 7.7             | 11.4          | 41.9            | -                            |
| 1973 | 6.7             | 14.7          | 43.0            | -                            |
| 1974 | 9.1             | 14.2          | 42.2            | -                            |
| 1975 | -               | 11.1          | 36.2            | 47.8                         |
| 1976 | 0.1             | 17.4          | 37.8            | 55.5                         |
| 1977 | 5.3             | 19.0          | 39.5            | 63.3                         |
| 1978 | 1.5             | 17.9          | 36.9            | 60.5                         |

1/ Calculated for each product as:  $(\text{Electric Consumption} / \text{Total Domestic Sales}) \times 100$ .

2/ Composition of mixture unknown. However, it is safe to assume that a large percentage is heavy fuel oil.

SOURCE: Data from Attachments Nos. 6 and 3.

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**IMPORTS OF PETROLEUM DERIVATIVES AND OF BLENDS 1972-1979.**  
**(Barrels)**

|                    | 1972             | 1973             | 1974             | 1975             | 1976             | 1977             | 1978             | 1979             |
|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| GASOLINE           | --               | --               | --               | --               | 258.846          | 1'679.279        | 1'294.378        | 1'356.054        |
| AVIATION GASOLINE  | 117.644          | 84.657           | 76.131           | 63.855           | 47.263           | 49.048           | 28.122           | 50.936           |
| TURBO FUEL         | --               | --               | --               | --               | 58.864           | 265.949          | 93.181           | --               |
| KEREX              | --               | --               | --               | --               | 17.895           | 177.057          | 199.427          | 391.856          |
| DIESEL OIL         | --               | --               | --               | 203.305          | 828.561          | 1'119.592        | 405.866          | 840.707          |
| LIQUID GAS         | 55.068           | 94.949           | 163.843          | 250.436          | 393.023          | 371.450          | 93.318           | 91.656           |
| ASPHALT            | --               | --               | --               | --               | 226.486          | 254.041          | --               | --               |
| BLENDS             | 8'529.558        | 6'868.068        | 9'424.876        | 8'264.762        | 8'004.832        | 5'173.276        | --               | --               |
| <b>T O T A L :</b> | <b>8'702.270</b> | <b>7'047.674</b> | <b>9'664.850</b> | <b>8'782.358</b> | <b>9'835.770</b> | <b>9'089.692</b> | <b>2'114.092</b> | <b>2'731.209</b> |

SOURCE: CRPE

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**EXPORTS OF ORIENTE CRUDE, 1972-1979**  
**(barrels)**

|                | 1972              | 1973              | 1974              | 1975              | 1976              | 1977              | 1978              | 1979              | TOTAL              | Change %<br>1978-1979 |
|----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|-----------------------|
| JANUARY        | -.-               | 5'440,795         | 6'480,056         | 4'445,782         | 4'474,989         | 6'070,815         | 3'114,889         | 3'081,279         | 33'108,665         | - 1.1                 |
| FEBRUARY       | -.-               | 5'231,365         | 7'077,331         | 4'482,061         | 4'568,854         | 4'315,454         | 2'922,651         | 2'599,605         | 31'597,321         | 2.6                   |
| MARCH          | -.-               | 6'818,101         | 6'773,574         | -.-               | 6'233,188         | 3'627,001         | 3'932,665         | 4'993,995         | 32'378,524         | 27.0                  |
| APRIL          | -.-               | 5'393,425         | 7'042,281         | 5'739,317         | 5'408,364         | 4'525,486         | 4'170,621         | 3'740,845         | 36'020,339         | - 10.3                |
| MAY            | -.-               | 3'914,704         | 6'768,995         | 3'563,060         | 6'576,575         | 5'245,431         | 3'922,981         | 3'790,085         | 33'781,831         | - 3.4                 |
| JUNE           | -.-               | 5'335,047         | 5'966,063         | 3'650,586         | 2'830,314         | 4'877,732         | 4'158,242         | 4'004,091         | 30'322,075         | - 3.7                 |
| JULY           | -.-               | 7'053,292         | 2'204,657         | 3'579,711         | 2'743,647         | 3'441,429         | 3'473,984         | 3'662,914         | 26'159,634         | 5.4                   |
| AUGUST         | 1'649,465         | 5'207,716         | 4'161,339         | 6'082,759         | 5'161,172         | 3'569,345         | 3'687,882         | 3'678,255         | 33'397,933         | 5.1                   |
| SEPTEMBER      | 4'480,609         | 6'471,722         | 4'111,633         | 4'569,205         | 5'430,789         | 2'902,726         | 3'721,304         | 4'437,747         | 36'125,735         | 19.2                  |
| OCTOBER        | 5'488,978         | 7'203,214         | 3'179,123         | 5'444,952         | 5'768,435         | 3'134,600         | 3'024,617         | 4'423,677         | 37'667,596         | 46.3                  |
| NOVEMBER       | 6'696,510         | 5'928,058         | 1'662,398         | 4'773,936         | 6'925,574         | 4'740,712         | 3'996,227         | 2'562,761         | 37'286,176         | - 36.0                |
| DECEMBER       | 6'646,028         | 7'128,112         | 3'805,631         | 5'763,568         | 5'387,965         | 4'002,375         | 4'673,077         | 3'196,666         | 40'603,422         | - 31.6                |
| <b>TOTAL :</b> | <b>24'961,590</b> | <b>71'125,551</b> | <b>59'233,081</b> | <b>52'094,937</b> | <b>61'509,866</b> | <b>50'453,106</b> | <b>44'799,140</b> | <b>44'771,920</b> | <b>408'949,191</b> | <b>- 0.06</b>         |

SOURCE: CEPE

ECUADOR  
POWER SECTOR MEMORANDUM  
ESTIMATION OF SUBSIDY TO DOMESTIC MARKET a/

|                                      | <u>US\$/gallon</u> | <u>US\$/Barrel</u> |
|--------------------------------------|--------------------|--------------------|
| Weighted average retail price        | 0.167              | 7.033              |
| Excise tax                           | 0.049              | 2.076              |
| Sales revenue to CEPE                | 0.118              | 4.957              |
| Technical production cost <u>1/</u>  | 0.109              | 4.593              |
| Import of refined products <u>2/</u> | 0.095              | 4.000              |
| State Cost Subsidy                   | 0.037              | 1.560              |
| Direct Subsidy paid by CEPE          | 0.086              | 3.636              |

a/ Calculated on the basis of actual costs.

1/ Includes crude production costs, refining, transport and distribution costs as indicated in Attachment 6, page 2. This figure does not value the crude oil itself. In this calculation, the barrel cost has been weighted by 0.9, in order to incorporate the 10% of imports.

2/ The imbalance between the structure of consumption and of refining creates the need to import increasing volumes of white products (gasoline, diesel and others of less significant). It is estimated that imports represent 10% of demand and have a landed value of US\$ 40.0 per barrel.

ECUADOR  
POWER SECTOR MEMORANDUM  
TECHNICAL COSTS

|  | <u>US\$ per barrel</u> |
|--|------------------------|
| (a) Crude production cost  | 0.917 <u>1/</u>        |
| Pipeline transport   | 0.226 <u>2/</u>        |
| Maritime shipment  | 0.154 <u>3/</u>        |
| Refining   | <u>1.800 <u>4/</u></u> |
| Ex-Refinery cost   | US\$ 3.097             |
|  |                        |
| (b) Handling cost of products at<br>Esmeraldas Refinery Terminal | 0.379                  |
| Transport of products  | 0.758                  |
| Storage of products  | 0.148                  |
| Marketing costs  | 0.165                  |
| Distribution cost  | <u>0.556</u>           |
| Post-Refinery Costs <u>5/</u>                                    | US\$ 2.006             |

1/ Average weighted exploitation cost estimated by CEPE.

2/ Fixed by Decree No. 1056 of December 1975.

3/ Transport for portion of crude refined at Santa Elena.  
Unit shipment cost from Balao to La Libertad is estimated  
at US\$0.385/bbl.

4/ Estimated by CEPE as average of all three refineries;  
Esmeraldas US\$2.42 vs. US\$0.87 for Anglo and Gulf.

5/ CEPE-Commercial Department.

ECUADOR  
POWER SECTOR MEMORANDUM  
RETAIL PRICES OF PETROLEUM DERIVATIVES (1980)  
(Sucres per gallon)

|                         | <u>GASOLINE EXTRA</u> | <u>GASOLINE REGUL.</u> | <u>KEROCEPE</u> | <u>DIESEL</u> | <u>LPG (S/ kg)</u> |
|-------------------------|-----------------------|------------------------|-----------------|---------------|--------------------|
| CARCHI (Tulcán)         | 4.80                  | 4.30                   | 4.00            | 4.30          | 6.30               |
| IMBABURA (Ibarra)       | 4.80                  | 4.30                   | 3.60            | 3.75          | 6.30               |
| PICHINCHA (Quito)       | 4.65                  | 4.10                   | 3.35            | 3.55          | 6.30               |
| COTOPAXI (Latacunga)    | 4.65                  | 4.10                   | 3.40            | 3.75          | 6.30               |
| TUNGURAHUA (Ambato)     | 4.65                  | 4.10                   | 3.40            | 3.75          | 6.30               |
| CHINBORAZO (Riobamba)   | 4.65                  | 4.10                   | 3.40            | 3.70          | 6.30               |
| BOLIVAR (Guaranda)      | 4.65                  | 4.10                   | 3.50            | 3.75          | 6.30               |
| CAÑAR (Azogues)         | 5.05                  | -                      | 3.35            | 3.55          | 6.30               |
| AZUAY (Cuenca)          | 5.05                  | 4.40                   | 3.35            | 3.55          | 6.30               |
| LOJA (Loja)             | 5.05                  | -                      | 3.00            | 3.45          | 6.30               |
| ESMERALDAS (Esmeraldas) | 5.20                  | 4.80                   | 3.60            | 3.90          | 6.30               |
| MANABI (Portoviejo)     | 4.80                  | 4.40                   | 3.00            | 3.80          | 6.30               |
| GUAYAS (Guayaquil)      | 4.65                  | 4.10                   | 2.65            | 3.15          | 6.30               |
| EL ORO (Machala)        | 4.85                  | -                      | 2.80            | 3.40          | 6.30               |
| LOS RIOS (Babahoyo)     | 5.20                  | 4.70                   | 3.50            | 3.75          | 6.30               |
| NAPO (Tena)             | 5.80                  | 4.70                   | 4.00            | 4.40          | 6.30               |
| PASTAZA (Puyo)          | 5.30                  | 4.80                   | 4.00            | 4.60          | 6.30               |
| MORONA (Macas)          | 5.50                  | 4.50                   | 4.00            | 4.50          | 6.30               |
| ZAMORA (Zamora)         | 5.90                  | -                      | 4.30            | 4.50          | 6.30               |

SOURCE: CEPE

*J. L. ...*

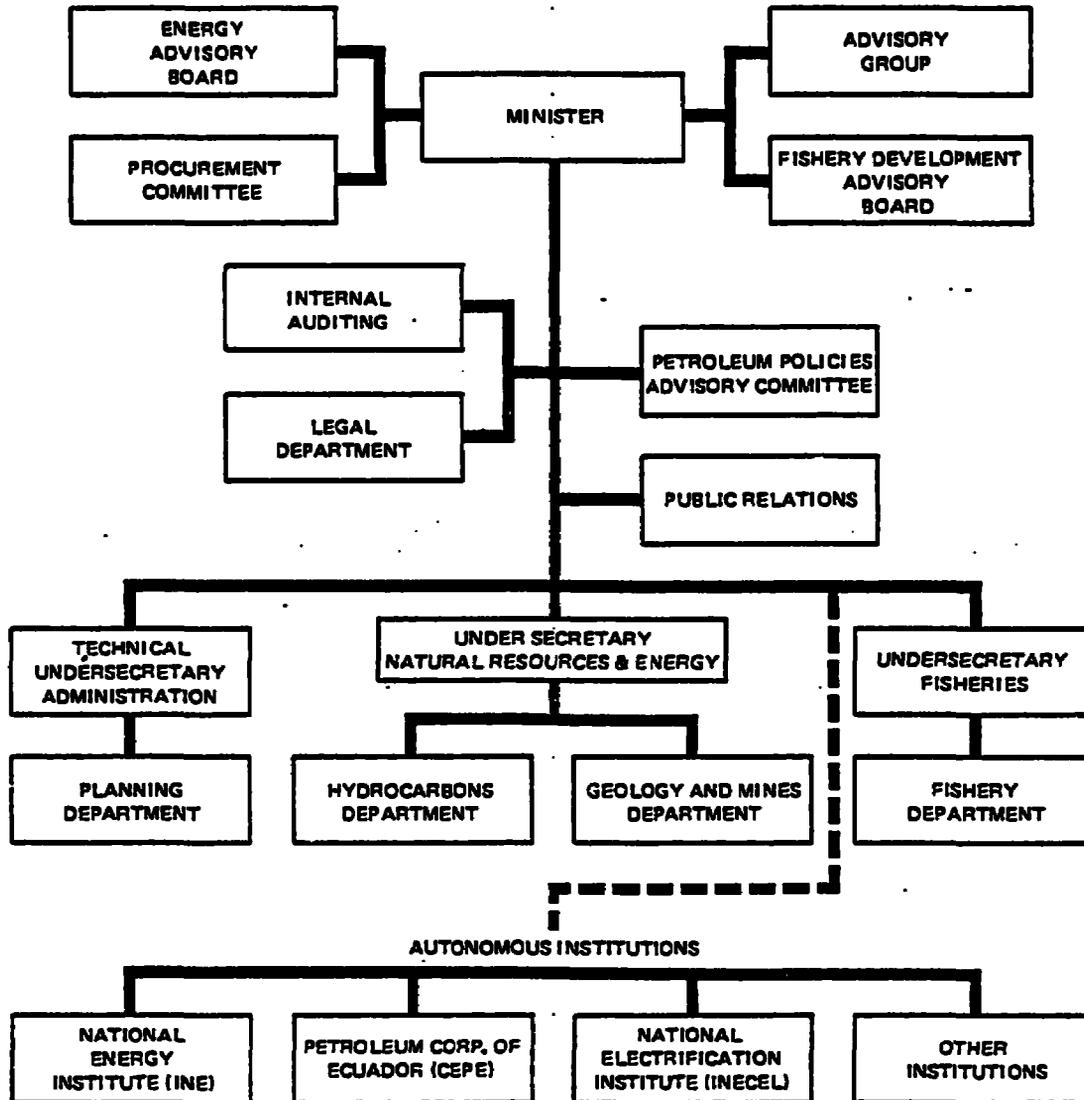
Table 2.8

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**CRUDE OIL EXPORT REVENUE DISTRIBUTION, 1979**  
**(in sucres)**

| REVENUES<br>DISTRIBUTION                | C E P E           | T E X A C O      | C I T Y        | T O T A L         |
|---|-------------------|------------------|----------------|-------------------|
|   | 11.828'899.765.00 | 4.278'103.965.75 | 211'757.610.50 | 16.318'761.341.25 |
| <b>Royalties</b>                        | 475'945.057.54    | 267'521.417.75   | 6'195.045.50   | 749'661.529.79    |
| H.J.D.N.                                |                   |                  | 53'042.673.73  | 53'042.673.73     |
| H.J.D.N. RA DICTO. No. 214              | 914'759.030.50    | 341'995.976.00   |                | 1.256'755.006.50  |
| PROVISTOS DICTO. No. 137                | 506'851.700.00    | 520'957.400.00   |                | 1.027'809.100.00  |
| CEPE PARTICIPACION US \$ 0.20           |                   | 45'714.495.00    |                | 45'714.495.00     |
| TASA DE SERVICIO SOBRE US \$ 0.20       |                   | 457.099.97       |                | 457.099.97        |
| FONDO NACIONAL DE ELECTRIFICACION       | 8'014.181.95      | 71'442.672.70    |                | 79'456.854.55     |
| PROGRAMA DESARROLLO DE ESPERALDAS       | 543.745.94        | 4'571.677.47     |                | 5'115.423.45      |
| MINISTERIO DE SALUD PUBLICA             | 123'023.474.63    | 42'363.877.07    |                | 165'387.351.70    |
| MINISTERIO DE TRABAJO                   | 184'542.196.09    | 63'561.007.68    |                | 248'103.203.77    |
| PATRONATO NACIONAL DEL NIÑO             | 61'464.451.24     | 21'164.245.25    |                | 82'628.696.49     |
| B.E.V.                                  | 246'053.647.33    | 84'727.854.13    |                | 330'781.501.46    |
| CUENTA UNICA TESORO NACIONAL            | 2.445'669.513.60  | 442'167.846.95   |                | 3.297'836.360.55  |
| FONDO NACIONAL DE PARTICIPACIONES       | 229'666.218.71    | 153'560.945.73   |                | 382'227.164.44    |
| UNIVERSIDADES ESTATALES                 | 171'642.910.23    | 57'353.325.30    |                | 228'996.235.53    |
| UNIVERSIDADES PARTICULARES              | 16'713.647.62     | 5'739.933.66     |                | 22'453.581.28     |
| FONADE                                  | 3.507'041.362.74  | 612'835.307.75   |                | 4.119'876.670.49  |
| CEPE                                    | 8'470.227.18      | 2'919.034.30     |                | 11'389.261.48     |
| BANCO CENTRAL                           | 1'908.682.14      | 627.133.34       |                | 2'535.815.48      |
| I.E.C.E.                                | 5'602.620.62      | 3'522.523.44     |                | 9'125.144.06      |
| H.J.D.N. IMPUESTO RENTA PETROLERA       |                   | 43'843.537.42    |                | 43'843.537.42     |
| F.A.E. IMPUESTO RENTA PETROLERA         |                   | 29'227.960.39    |                | 29'227.960.39     |
| BANCO DE DESARROLLO DEL ECUADOR         |                   | 489'159.800.00   |                | 489'159.800.00    |
| CUENTA UNICA TESORO NACIONAL 90% LASTRE | 22'720.931.25     | 3'122.920.50     |                | 25'843.851.75     |
| TASA DE SERVICIO LASTRE                 | 226.670.94        |                  |                | 226.670.94        |
| TASA DE SERVICIO                        | 70'217.657.73     | 47'556.100.82    | 3'604.346.88   | 121'378.105.43    |
| INTERESES                               |                   |                  | 217.067.39     | 217.067.39        |
| <b>I TOTAL NATIONAL PARTICIPATION</b>   | 9.004'117.304.72  | 3.755'910.138.59 | 63'059.133.50  | 12.823'086.576.81 |
| <b>II TOTAL COMPANY PARTICIPATION</b>   | 2.824'742.061.24  | 522'193.827.16   | 148'694.477.00 | 3.495'630.365.40  |
| <b>III ALLOCATED</b>                    | 400.00            |                  |                | 400.00            |
| <b>GRAND TOTAL</b>                      | 11.828'899.765.00 | 4.278'103.965.75 | 211'757.610.50 | 16.318'761.341.25 |

SOURCE: CEPE

ECUADOR  
MINISTRY OF NATURAL RESOURCES AND ENERGY  
ORGANIZATION CHART



POWER SECTOR MEMORANDUM

INECEL's Participation in the Capital  
of the Electric Power Companies <sup>1/</sup>

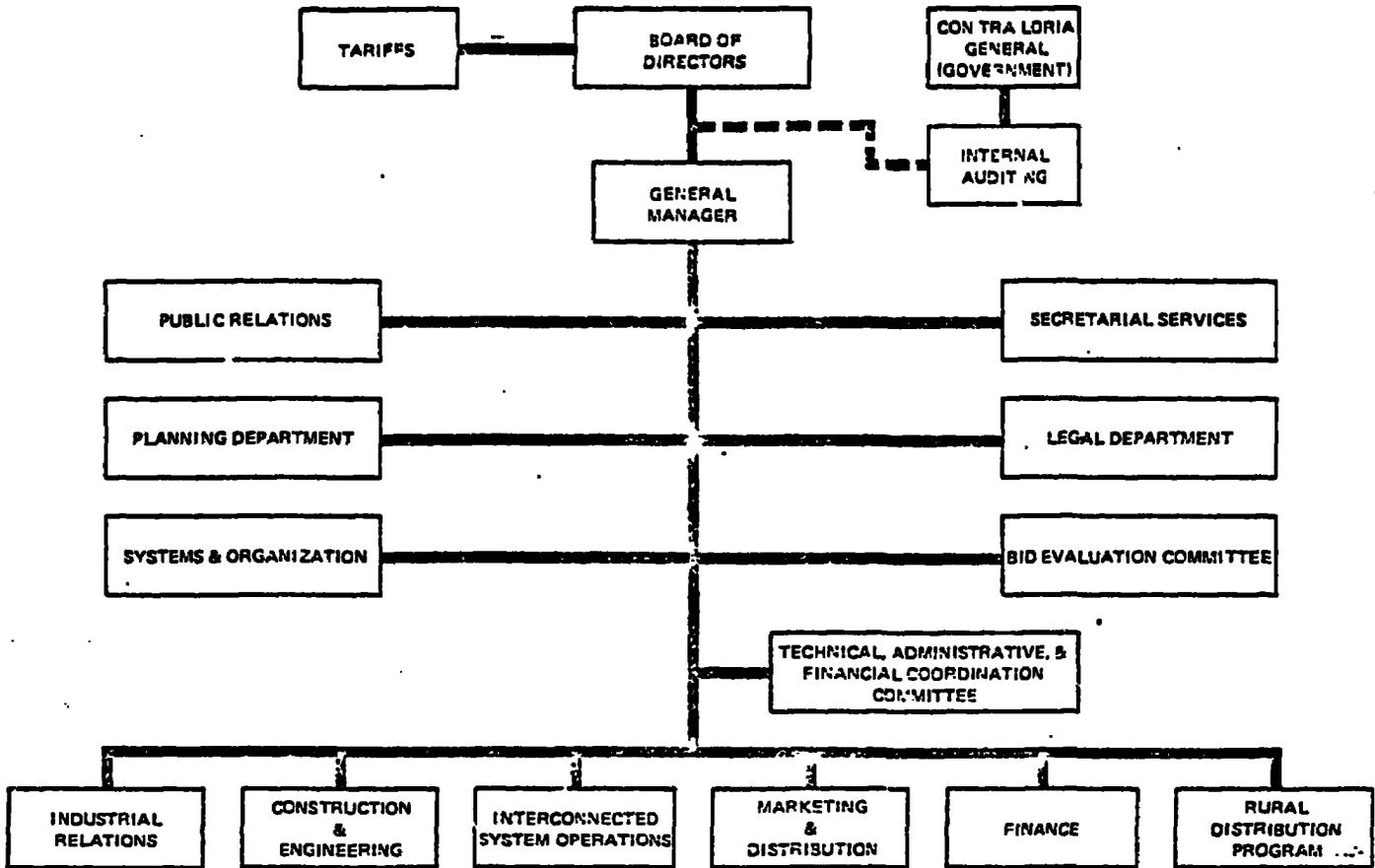
| <u>Power Company Name</u> | <u>% of Capital Stock</u> <sup>2/</sup><br><u>Owned by INECEL</u> |
|---------------------------|---|
| Regional Norte            | 90.1  |
| Quito                     | 55.8  |
| Santo Domingo             | 100.0   |
| Ambato                    | 54.5  |
| Riobamba                  | 67.4  |
| Bolivar                   | 93.2 <sup>3/</sup>  |
| Azoques                   | 76.2  |
| Cuenca                    | 88.4  |
| Regional Sur              | 93.4  |
| Esmeraldas                | 92.8  |
| Manabí                    | 86.9  |
| Santa Elena               | 98.4  |
| Milagro                   | 94.9  |
| Los Rios                  | 98.8  |
| El Oro                    | <u>92.2</u>   |
| Weighted average          | <u>85.2</u>   |

<sup>1/</sup> Data as of December 31, 1979 (based on unaudited financial statements).

<sup>2/</sup> Percentages are based on issued capital, which in some cases differs from paid in capital.

<sup>3/</sup> As of June 30, 1979.

**ECUADOR - INECEL  
ORGANIZATION CHART**



ECUADOR - POWER SECTOR MEMORANDUM

1978 Operation and Maintenance Costs Breakdown  
(sucres per kWh sold)

|                                   | <u>EEQ</u> | <u>EMELEC</u> | <u>Selected INECEL<br/>Subsidiaries</u> <sup>1/</sup> |
|-----------------------------------|------------|---------------|---|
| Personnel <sup>2/</sup>           | .31        | .20           | .36   |
| Fuel <sup>3/ 4/</sup>             | .05        | .23           | .23   |
| Energy purchases                  | .28        | .06           | .04   |
| Materials                         | .07        | .03           | .10   |
| Other costs <sup>2/</sup>         | .08        | .22           | .14   |
| <b>Total O&amp;M<sup>4/</sup></b> | <b>.78</b> | <b>.75</b>    | <b>.88</b>  |

1/ E.E. Cuenca, E.E. Ambato, S.E.R. Manabi, E.E. Riobamba, E.E. Santa Elena, E.E.R. del Sur, E.E. El Oro, E.E. Milagio, E.E.R. del Norte, Coop. Santa Domingo, and E.E. Bolivar.

2/ Some labor costs are classified as "other costs" (however treatment differs between the various companies, so that direct comparison is not legitimate).

3/ EMELEC's facilities have a relatively low fuel efficiency (gallons/kWh generated) which would reflect itself in higher fuel costs.

4/ In 1978, the structure of electricity supply and incidence of system losses (including own consumption) was estimated by the mission to be the following:

|                                 | <u>Own Generation</u> |                | <u>Energy Purchases</u> | <u>Total</u> | <u>Own Consumption</u> | <u>Losses</u> | <u>Sales</u> |
|---------------------------------|-----------------------|----------------|-------------------------|--------------|------------------------|---------------|--------------|
|                                 | <u>Hydro</u>          | <u>Thermal</u> |                         |              |                        |               |              |
| EEQ                             | 47                    | 12             | 41                      | 100          | 1                      | 12            | 87           |
| EMELEC                          | -                     | 87             | 13                      | 100          | 3                      | 10            | 87           |
| Selected INECEL<br>Subsidiaries | 37                    | 56             | 7                       | 100          | 2                      | 18            | 80           |

ECUADORANNEX 5Table 5.3POWER SECTOR MEMORANDUM1978 Gross Generation/Purchases, Sales, Local Use and Losses (GWh)

|                               | <u>Gross<br/>Generation &amp;<br/>Purchases</u> | <u>Sales</u>   | <u>Power<br/>Station Use</u> | <u>Losses</u> | <u>Losses ÷<br/>Gross<br/>Generation %</u> |
|-------------------------------|---|----------------|------------------------------|---------------|--|
| Cuenca                        | 90.3  | 71.0           | 0.5                          | 18.8          | 20.8                                       |
| Bolivar                       | 6.9   | 5.9            | 0.2                          | 0.8           | 11.6                                       |
| Azogues                       | 6.8   | 4.3            | 0.1                          | 2.4           | 35.2                                       |
| Norte                         | 49.0  | 38.6           | 0.2                          | 10.2          | 20.8                                       |
| Latacunga                     | 25.1  | 17.3           | 0.1                          | 7.7           | 30.7                                       |
| Riobamba                      | 52.0  | 46.2           | 0.3                          | 5.5           | 10.6                                       |
| Sur                           | 26.8  | 21.4           | 0.5                          | 4.9           | 18.3                                       |
| Quito                         | 673.2   | 583.6          | 4.5                          | 85.1          | 12.6                                       |
| Ambato                        | 57.6  | 45.6           | 0.3                          | 11.7          | 20.3                                       |
| El Oro                        | 48.1  | 38.4           | 0.3                          | 9.4           | 19.5                                       |
| Esmeraldas                    | 32.2  | 28.8           | 0.2                          | 3.2           | 10.0                                       |
| Milagro                       | 50.9  | 41.6           | 1.8                          | 7.5           | 14.7                                       |
| Sta. Elena                    | 26.3  | 22.1           | 0.9                          | 3.3           | 12.5                                       |
| Los Rios                      | 24.1  | 19.5           | 0.8                          | 3.8           | 15.8                                       |
| Manabi                        | <u>114.0</u>                                    | <u>84.9</u>    | <u>7.5</u>                   | <u>21.6</u>   | <u>18.9</u>                                |
| TOTAL INECEL<br>SUBSIDIARIES  | 1,283.3   | 1,069.2        | 18.2                         | 195.9         | 15.3                                       |
| EMELEC                        | 994.3   | 869.0          | 27.6                         | 97.7          | 9.8  |
| <u>TOTAL POWER<br/>SECTOR</u> | <u>2,277.6</u>                                  | <u>1,938.2</u> | <u>45.8</u>                  | <u>293.6</u>  | <u>12.9</u>                                |

ECUADOR

POWER SECTOR MEMORANDUM

MANPOWER RESOURCES

a) EXISTING MANPOWER (1979)

|                                | INECEL     | INECEL Sub-<br>sidiaries,<br>Municipal-<br>ities &<br>EMELEC | Consultants<br>& Contractors | Total Power<br>Supply<br>Industry |
|--------------------------------|------------|--|------------------------------|-----------------------------------|
| MANAGERIAL                     | 70         | 98   | 27                           | 195                               |
| PROFESSIONAL                   | 437        | 311  | 260                          | 1,008                             |
| TECHNICAL                      | 127        | 200  | 207                          | 534                               |
| CLERICAL AND<br>OTHER SERVICES | 451        | 1,468  | 305                          | 2,224                             |
| WORKERS                        | <u>572</u> | <u>2,839</u>   | <u>4,733</u>                 | <u>8,144</u>                      |
| TOTAL                          | 1,657      | 4,916  | 5,532                        | 12,105                            |

b) MANPOWER REQUIREMENT PROJECTIONS<sup>1/</sup>

| YEAR | INECEL | INECEL, Sub-<br>sidiaries,<br>Municipal-<br>ities &<br>EMELEC | Consultants &<br>Contractors | Total Power<br>Supply<br>Industry<br>Requirements |
|------|--------|---|------------------------------|---|
| 1980 | 1,841  | 5,462   | 6,147                        | 13,450  |
| 1981 | 2,040  | 6,051   | 6,809                        | 14,900  |
| 1982 | 2,196  | 6,514   | 7,330                        | 16,040  |
| 1983 | 2,477  | 7,346   | 8,267                        | 18,090  |
| 1984 | 2,720  | 8,069   | 9,081                        | 19,870  |
| 1985 | 2,835  | 8,410   | 9,465                        | 20,710  |

<sup>1/</sup> Source: INECEL

ECUADOR  
POWER SECTOR MEMORANDUM

Ecuador's Installed Capacity (KW)

| <u>Provinces</u> | <u>ENELCO,<br/>INCEL AND SUBSIDIARIES</u> |                |                | <u>MUNICIPAL</u> |                |               | <u>SELF-PRODUCERS</u> |                |                | <u>TOTAL</u>   |                |                |
|------------------|---|----------------|----------------|------------------|----------------|---------------|-----------------------|----------------|----------------|----------------|----------------|----------------|
|                  | <u>Hydro</u>                              | <u>Thermal</u> | <u>Total</u>   | <u>Hydro</u>     | <u>Thermal</u> | <u>Total</u>  | <u>Hydro</u>          | <u>Thermal</u> | <u>Total</u>   | <u>Hydro</u>   | <u>Thermal</u> | <u>Total</u>   |
| Azuay            | 15.725                                    | 14.185         | 29.910         | 226              | 111            | 337           | --                    | 2.666          | 2.666          | 15.951         | 16.962         | 32.913         |
| Bolivar          | 840                                       | 5.033          | 5.873          | 80               | 15             | 95            | --                    | --             | --             | 920            | 5.048          | 5.968          |
| Cañar            | 840                                       | 1.380          | 2.220          | 80               | --             | 80            | --                    | 9.075          | 9.075          | 920            | 10.455         | 11.375         |
| Carchi           | 1.620                                     | 766            | 2.386          | 501              | --             | 501           | --                    | --             | --             | 2.201          | 966            | 2.967          |
| Cotacachi        | 4.200                                     | 3.388          | 7.588          | 405              | 492            | 897           | --                    | 4.551          | 4.551          | 4.605          | 8.431          | 13.036         |
| Chimborazo       | 9.117                                     | 5.364          | 14.481         | 245              | 202            | 447           | 1.900                 | 711            | 2.611          | 11.262         | 6.277          | 17.539         |
| El Oro           | --  | 10.576         | 10.576         | 2,366            | 275            | 2,641         | --                    | 578            | 578            | 2,366          | 19,429         | 21,795         |
| Esmeraldas       | --  | 7.192          | 7.192          | --               | 164            | 164           | --                    | 25.603         | 25.603         | --             | 32.959         | 32.959         |
| Galapagos        | --  | --             | --             | --               | 689            | 689           | --                    | 285            | 285            | --             | 974            | 974            |
| Guayas           | --  | 319.783        | 319.783        | --               | 676            | 676           | --                    | 39.551         | 39.551         | --             | 360.010        | 360.010        |
| Imbabura         | 9.622                                     | 6.514          | 16.136         | 440              | --             | 440           | 871                   | 3.041          | 3.912          | 10.933         | 9.575          | 20.508         |
| Loja             | 2.560                                     | 9.259          | 11.819         | --               | 127            | 127           | 206                   | 1.096          | 1.302          | 2.766          | 10.482         | 13.248         |
| Los Rios         | --  | 21.112         | 21.112         | --               | 216            | 216           | --                    | 7.433          | 7.433          | --             | 28.761         | 28.761         |
| Manabí           | --  | 33.600         | 33.600         | --               | 991            | 991           | --                    | 4.284          | 4.284          | --             | 38.875         | 38.875         |
| Morona Santiago  | --  | --             | --             | 153              | 1.066          | 1,219         | 256                   | --             | 256            | 409            | 1,066          | 1,475          |
| Napo             | --  | --             | --             | 71               | 1,171          | 1,242         | 1,800                 | 10,382         | 12,182         | 1,871          | 11,553         | 13,424         |
| Pastaza          | 110                                       | 945            | 1,055          | --               | --             | --            | --                    | 570            | 570            | 110            | 1,515          | 1,625          |
| Pichincha        | 85.360                                    | 94.816         | 180.176        | 2,804            | --             | 2,804         | 7,050                 | 30,677         | 37,727         | 95,214         | 125,493        | 220,707        |
| Tungurahua       | 74.961                                    | 10.980         | 85.941         | --               | --             | --            | --                    | 98             | 98             | 74,961         | 11,078         | 86,039         |
| Zamora Chinchipe | --  | --             | --             | --               | 154            | 154           | --                    | --             | --             | --             | 154            | 154            |
| <b>TOTAL</b>     | <b>204.955</b>                            | <b>552.913</b> | <b>757.868</b> | <b>7.451</b>     | <b>6.349</b>   | <b>13.800</b> | <b>12.083</b>         | <b>140.601</b> | <b>152.684</b> | <b>224,489</b> | <b>699.863</b> | <b>924.352</b> |

ECUADOR

POWER SECTOR MEMORANDUM

ONGOING AND FUTURE DEVELOPMENT PROJECTS

(a) Ongoing Projects

| <u>Project</u>                                 | <u>Capacity</u> | <u>Commissioning Dates</u> |
|--|-----------------|----------------------------|
| - Paute hydroelectric plant.<br>(Phase A & B)  | 500 MW          | 1982/1983                  |
| - Guayaquil No.3 (steam)                       | 73 MW           | 1980                       |
| - Esmeraldas No.1 (steam)                      | 125 MW          | 1981                       |
| - Quito (gas turbines)                         | 60 MW           | 1980                       |
| - Regional Systems' generation                 | 186 MW          | 1980/1982                  |
| - SNI transmission system<br>(138 kV & 230 kV) | -               | 1980/1982                  |
| Total  |                 |                            |

(b) Future Projects

|  |        |           |
|--|--------|-----------|
| - Agoyan   | 150 MW | 1986      |
| - Daule-Peripa <sup>1/</sup>   | 130 MW | 1988      |
| - Paute - Phase C  | 500 MW | 1987      |
| - Paute-Mazar  | 140 MW | 1989      |
| - Toachi   | 300 MW | 1990      |
| - SNI transmission system<br>(230 kV & 138 kV)                       | -      | 1982/1985 |
| - Regional systems' transmission<br>system (69 kV & 345 kV)          | -      | 1982/1985 |
| - Distribution & Rural<br>electrification                            | -      | 1982/1985 |
| - Studies, small generation<br>stations and general invest-<br>ments | -      | 1982/1988 |
| Total  |        |           |

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<sup>1/</sup> Corporacion de Desarrollo de Guayas (CEDEGE) is carrying out the development of this multipurpose project. INECEL is not participating in its financing. The power facilities of project are to be leased by CEDEGE in a multi-year agreement with INECEL.

Main Characteristics of Future Power Plants

(A) HYDROELECTRIC DEVELOPMENTS

1. Paute - Phases "A" and "B"

- Dam and Reservoir
  - Type: Arch Dam (concrete)
  - Height: 170 m
  - Length: 400 m
  - Volume: Gross:  $120 \times 10^6 \text{ m}^3$
  - Net :  $100 \times 10^6 \text{ m}^3$
  
- Powerhouse
  - Turbines: Pelton (net head: 615 m)
  - Installed Capacity:  $5 \times 100 \text{ MW}$
  - Firm Capacity : 437 MW
  - Firm Energy : 2355 GWh/year
  - Average Energy : 4017 GWh/year

2. Agoyan

- Dam and Reservoir
  - Type: Gravity (concrete)
  - Height: 36 m
  - Length: 270 m
  - Volume: Gross:  $1.87 \times 10^6 \text{ m}^3$
  - Net :  $0.88 \times 10^6 \text{ m}^3$
  
- Powerhouse
  - Turbines: Francis (net head: 155 m)
  - Installed Capacity:  $2 \times 75 \text{ MW}$
  - Firm Capacity : 138 MW
  - Firm Energy : 569 GWh/year
  - Average Energy : 1031 GWh/year

3. Paute - Phase "C"

- This development is an extension of Paute "A" and "B" described in (1). The additional capacity added to Paute is:
  - Installed Capacity:  $5 \times 100 \text{ MW}$
  - Firm Capacity : 437 MW
  - Firm Energy : 0
  - Average Energy : 1710 GWh/year

4. Daule-Peripa

- Dam and Reservoir (multi-purpose: power, irrigation and water supply).

Type: Earthfill  
Height: 78 m  
Length: 230 m  
Volume: Gross:  $6 \times 10^9 \text{ m}^3$   
Net :  $4.3 \times 10^9 \text{ m}^3$

- Powerhouse  
Turbines: Francis (net head: 55.7 m)  
Installed Capacity: 2 x 65 MW  
Firm Capacity : 77 MW  
Firm Energy : 521 GWh/year  
Average Energy : 710 GWh/year

5. Toachi

- Dam and Reservoir  
Type: Rockfill with impermeable core  
Height: 154 m  
Length: 370 m  
Volume: Gross:  $139 \times 10^6 \text{ m}^3$   
Net :  $94 \times 10^6 \text{ m}^3$

- Powerhouse  
Turbines: Pelton (nethead: 292 m)  
Installed Capacity: 4 x 75 MW  
Firm Capacity : 253 MW  
Firm Energy : 767 GWh/year  
Average Energy : 1587 GWh/year

6. Paute-Mazar

- To be constructed upstream of Paute hydro-development. Paute-Mazar dam will control sedimentation of Paute dam and also will increase Paute firm energy by about 1950 GWh/year. Its main features are described below:

- Dam and Reservoir:  
Type: Gravity (concrete)  
Height: 170 m  
Length: 420 m  
Volume: Gross:  $500 \times 10^6 \text{ m}^3$   
Net :  $460 \times 10^6 \text{ m}^3$

- Powerhouse  
Turbines: Francis (net head 200 m)  
Installed Capacity: 2 x 70 MW  
Firm Capacity : 77 MW  
Firm Energy : 680 GWh/year  
Average Energy : 1047 GWh/year

In addition Paute-Mazar will increase Paute (Phases "A", "B" and "C") firm capacity and firm energy by 100 MW and 1950 GWh/year respectively.

(B) THERMOELECTRIC DEVELOPMENTS

1. Salitral Thermal Station (Steam)

- Installed Capacity: 73 MW
- Steam Production Capacity: 295 tons/hour (continuous)
- Fuel: Bunker "C" (also natural gas)
- Steam Pressure: 105 kg/cm<sup>2</sup> at 513°C
- Speed: 3600 r.p.m.

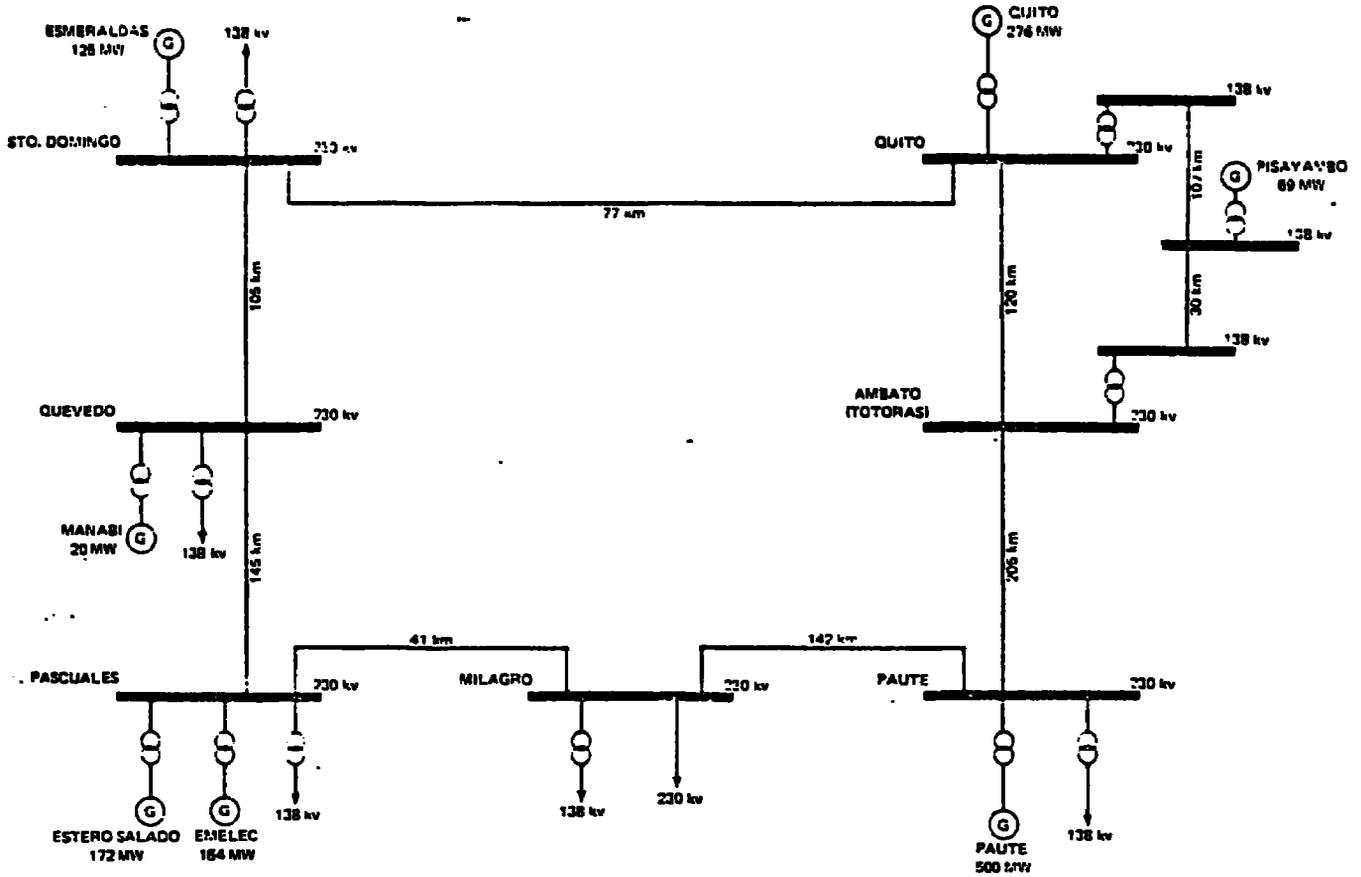
2. Esmeraldas Thermal Station (Steam)

- Installed Capacity: 125 MW
- Steam Production Capacity: 428 tons/hour (continuous)
- Fuel: Bunker "C"
- Steam Pressure: 139 kg/cm<sup>2</sup> at 538°C
- Speed: 3600 r.p.m.

3. Quito Thermal Station (Gas Turbine)

- Installed Capacity: 3 x 20 MW

**ECUADOR**  
**POWER SECTOR MEMORANDUM**  
**NATIONAL INTERCONNECTED SYSTEM**  
**SIMPLIFIED SINGLE-LINE DIAGRAM**



POWER SECTOR MEMORANDUM

ANNEX 7  
Table 7.1

National and SNI Energy Forecast (CWh) 1/

|          | Year   | National Forecast |            |            |                 |             |        | SNI Forecast     |        |
|----------|--------|-------------------|------------|------------|-----------------|-------------|--------|------------------|--------|
|          |        | Residential       | Commercial | Industrial | Public Lighting | Total Sales | Losses | Total Generation | Total  |
| ACTUAL   | ( 1970 | 279.7             | 103.4      | 320.8      | 87.1            | 791.0       | 157.8  | 948.8            | -      |
|          | ( 1971 | 306.9             | 116.5      | 353.9      | 97.7            | 875.0       | 174.6  | 1049.6           | -      |
|          | ( 1972 | 341.6             | 135.4      | 375.2      | 103.5           | 955.7       | 161.4  | 1117.1           | -      |
|          | ( 1973 | 359.0             | 147.0      | 414.7      | 123.2           | 1,043.9     | 220.6  | 1264.5           | -      |
|          | ( 1974 | 405.9             | 177.4      | 464.5      | 159.0           | 1,206.8     | 223.1  | 1429.9           | -      |
|          | ( 1975 | 487.2             | 191.6      | 528.2      | 132.9           | 1,339.9     | 254.9  | 1594.8           | -      |
|          | ( 1976 | 587.7             | 234.5      | 590.1      | 163.9           | 1,576.2     | 254.6  | 1830.8           | -      |
|          | ( 1977 | 668.4             | 263.7      | 693.1      | 189.7           | 1,814.9     | 312.3  | 2127.2           | -      |
|          | ( 1978 | 792.4             | 299.9      | 863.3      | 226.2           | 2,181.8     | 391.7  | 2573.5           | -      |
|          | ( 1979 | 903.6             | 354.2      | 989.5      | 245.5           | 2,492.8     | 419.3  | 2912.1           | -      |
| FORECAST | ( 1980 | 1131.9            | 405.5      | 1125.9     | 266.7           | 2,930.0     | 476.9  | 3406.9           | 2421.8 |
|          | ( 1981 | 1158.7            | 455.4      | 1277.7     | 289.1           | 3,180.9     | 500.7  | 3681.6           | 2891.0 |
|          | ( 1982 | 1295.9            | 509.3      | 1447.1     | 313.6           | 3,565.9     | 547.0  | 4112.9           | 3644.0 |
|          | ( 1983 | 1443.1            | 567.1      | 1634.5     | 341.3           | 3,986.0     | 574.6  | 4560.6           | 4320.5 |
|          | ( 1984 | 1582.5            | 621.9      | 1842.4     | 370.7           | 4,417.5     | 602.1  | 5025.6           | 4771.2 |
|          | ( 1985 | 1756.9            | 690.5      | 2071.2     | 402.7           | 4,921.3     | 677.4  | 5598.7           | 5598.7 |
|          | ( 1986 | 1915.6            | 752.8      | 2323.7     | 437.5           | 5,429.6     | 733.4  | 6163.0           | 6163.0 |

1/ The SNI became operational in August 1980. The different isolated systems would be gradually integrated to the SNI during the 1980-1984 period. By end of 1984 it is forecasted that all isolated systems would be integrated to the SNI.

Source: 1980-1985 INECEL's short-term Masterplan Studies.

## POWER SECTOR MEMORANDUM

National and SNI Demand Forecast (MW)

|          | <u>Year</u> | <u>National Demand (MW)</u> | <u>SNI Demand (MW)</u> | <u>National Load Factor (%)</u> | <u>SNI Load Factor (%)</u> |
|----------|-------------|-----------------------------|------------------------|---------------------------------|----------------------------|
| ACTUAL   | ( 1970      | 224.0                       | -                      | 48.8                            | -                          |
|          | ( 1971      | 250.5                       | -                      | 47.8                            | -                          |
|          | ( 1972      | 262.2                       | -                      | 48.6                            | -                          |
|          | ( 1973      | 281.5                       | -                      | 51.3                            | -                          |
|          | ( 1974      | 318.5                       | -                      | 51.2                            | -                          |
|          | ( 1975      | 358.5                       | -                      | 50.8                            | -                          |
|          | ( 1976      | 413.9                       | -                      | 50.5                            | -                          |
|          | ( 1977      | 479.8                       | -                      | 50.6                            | -                          |
|          | ( 1978      | 564.5                       | -                      | 52.0                            | -                          |
|          | ( 1979      | 658.3                       | -                      | 50.5                            | -                          |
| FORECAST | ( 1980      | 767.1                       | 523.5                  | 50.7                            | 52.8 <u>1/</u>             |
|          | ( 1981      | 827.3                       | 696.5                  | 50.8                            | 47.4 <u>2/</u>             |
|          | ( 1982      | 922.4                       | 834.2                  | 50.9                            | 49.9                       |
|          | ( 1983      | 1,047.5                     | 966.3                  | 49.7                            | 51.0                       |
|          | ( 1984      | 1,107.5                     | 1,107.5                | 51.8                            | 49.2 <u>3/</u>             |
|          | ( 1985      | 1,231.5                     | 1,231.5                | 51.9                            | 51.9                       |
|          | ( 1986      | 1,355.6                     | 1,355.6                | 51.8                            | 51.9                       |

1/ Guayaquil and Quito, Ecuador's main industrial centers, were interconnected during August 1980.

2/ The SNI load factor decreases as the loads of the isolated systems which will be interconnected to the SNI are mainly domestic, commercial and rural.

3/ The SNI load factor decreases as the bulk of transmission works become operational (transmission works included in Bank financial project), thus interconnecting mainly domestic and rural loads.

Source: 1980-1985 INECEL short-term Masterplan Studies.



MISSION - POWER SECTOR RECONSTRUCTION  
**POWER SECTOR INTEGRATED BALANCE SHEETS 1978-1979**  
(current \$/millions)

ANNEX B  
Table B-1

|  | 1978           |               |               |                 | 1979           |                |               |               |                 |                |
|--|----------------|---------------|---------------|-----------------|----------------|----------------|---------------|---------------|-----------------|----------------|
|  | INECEL         | EEQ           | EMELEC        | OTHER COMPANIES | TOTAL          | INECEL         | EEQ           | EMELEC        | OTHER COMPANIES | TOTAL          |
| <b>ASSETS</b>                            |                |               |               |                 |                |                |               |               |                 |                |
| <u>Fixed Assets</u>                      |                |               |               |                 |                |                |               |               |                 |                |
| Ground plant in service                  | 4410.3         | 2261.3        | 1524.3        |                 |                | 4391.7         | 2882.7        | 1846.5        |                 |                |
| Less: Accumulated depreciation           | (1152.1)       | (872.9)       | (307.2)       |                 |                | (330.6)        | (1044.8)      | (574.9)       |                 |                |
| Net plant in service (at cost)           | 4215.2         | 1690.4        | 1382.1        | 2000.9          | 8299.6         | 3951.1         | 1795.9        | 1471.6        | 3511.1          | 8299.6         |
| Asset revaluation estimate b/            | 714.0          | 900.0         | 754.0         | 2300.0          | 3668.0         | 1291.2         | 1100.0        | 982.4         | 3164.6          | 3668.0         |
| Work in progress c/                      | 3171.1         | 70.4          | 11.5          |                 | 3253.0         | 772.6          | 382.4         | 7.7           |                 | 1162.7         |
| Other (net) c/                           | 138.3          | 0.7           |               |                 | 139.0          | 188.9          | 0.7           |               |                 | 190.3          |
| <b>Total fixed assets (net)</b>          | <b>8198.6</b>  | <b>2661.5</b> | <b>2147.6</b> | <b>5186.9</b>   | <b>18194.6</b> | <b>12580.6</b> | <b>3279.0</b> | <b>2461.7</b> | <b>6675.7</b>   | <b>24997.0</b> |
| <u>Investments</u>                       |                |               |               |                 |                |                |               |               |                 |                |
| Shareholdings in power companies d/      | 2824.8         |               |               |                 | 2824.8         | 3620.5         |               |               |                 | 3620.5         |
| Other d/                                 | 541.1          | 0.1           | 26.7          |                 | 567.9          | 154.4          | 0.1           | 7.5           |                 | 161.0          |
| Long term loans d/                       |                | 3.3           |               |                 | 3.3            | 319.1          |               |               |                 | 319.1          |
| <b>Total investments</b>                 | <b>3365.9</b>  | <b>3.4</b>    | <b>26.7</b>   | <b></b>         | <b>3396.0</b>  | <b>3994.0</b>  | <b>0.1</b>    | <b>7.5</b>    | <b></b>         | <b>3996.1</b>  |
| <u>Current Assets</u>                    |                |               |               |                 |                |                |               |               |                 |                |
| Cash                                     | 287.8          | 41.0          | 35.0          | 113.3           | 477.1          | 216.4          | 30.2          | 43.8          | 122.5           | 412.9          |
| Accounts receivable (net) g/             | 1059.7         | 127.6         | 154.1         | 231.9           | 1573.3         | 927.7          | 131.1         | 185.6         | 268.2           | 1512.6         |
| Inventories                              | 563.6          | 554.2         | 96.0          | 1070.5          | 2284.3         | 1071.6         | 752.0         | 98.8          | 932.4           | 2854.8         |
| <b>Total current assets</b>              | <b>1511.1</b>  | <b>722.8</b>  | <b>285.1</b>  | <b>1415.7</b>   | <b>4334.7</b>  | <b>2215.7</b>  | <b>913.3</b>  | <b>324.2</b>  | <b>1323.1</b>   | <b>4710.3</b>  |
| <u>Other Assets</u>                      |                |               |               |                 |                |                |               |               |                 |                |
| Deferred charges on studies f/           | 665.2          |               |               |                 | 665.2          | 802.7          |               |               |                 | 802.7          |
| Other f/                                 | 1241.0         | 52.7          | 18.8          | 697.1           | 2099.6         | 1258.2         | 245.7         | 27.3          | 1143.9          | 2675.1         |
| <b>Total Assets</b>                      | <b>15381.8</b> | <b>3440.6</b> | <b>2478.2</b> | <b>7299.7</b>   | <b>25775.5</b> | <b>21151.2</b> | <b>4438.1</b> | <b>2824.7</b> | <b>9142.7</b>   | <b>33936.2</b> |
| <b>LIABILITIES AND NET WORTH</b>         |                |               |               |                 |                |                |               |               |                 |                |
| <u>Net Worth</u>                         |                |               |               |                 |                |                |               |               |                 |                |
| Initial balance                          | 7473.3         | 1476.3        | 571.1         | 3539.1          | 13069.8        | 10671.4        | 1551.8        | 632.3         | 4187.1          | 13069.8        |
| Revaluation reserve                      | 714.0          | 900.0         | 754.0         | 230.0           | 2698.0         | 1291.2         | 1100.0        | 982.4         | 3164.6          | 2698.0         |
| Annual profit (or loss)                  | (16.7)         | 48.7          | 95.5          | 13.7            | 141.2          | (160.3)        | (38.4)        | 30.3          | (34.9)          | 141.2          |
| <b>Total Net Worth</b>                   | <b>8170.6</b>  | <b>2425.0</b> | <b>1420.6</b> | <b>5852.8</b>   | <b>15044.2</b> | <b>11802.3</b> | <b>2613.4</b> | <b>1645.0</b> | <b>7316.8</b>   | <b>19757.0</b> |
| Long term debts                          | 6128.9         | 676.2         | 653.6         | 1010.7          | 8469.4         | 8135.1         | 1397.7        | 820.6         | 1279.7          | 11633.1        |
| Short term debts                         | 1082.3         | 339.4         | 404.0         | 436.2           | 2261.9         | 1213.7         | 427.0         | 359.0         | 546.2           | 2545.9         |
| <b>Total debts</b>                       | <b>7211.2</b>  | <b>1015.6</b> | <b>1057.6</b> | <b>1446.9</b>   | <b>10731.3</b> | <b>9348.8</b>  | <b>1824.7</b> | <b>1179.6</b> | <b>1825.9</b>   | <b>14179.0</b> |
| <b>Total Liabilities &amp; Net Worth</b> | <b>15381.8</b> | <b>3440.6</b> | <b>2478.2</b> | <b>7299.7</b>   | <b>25775.5</b> | <b>21151.1</b> | <b>4438.1</b> | <b>2824.6</b> | <b>9142.7</b>   | <b>33936.0</b> |

\* Figures may not add up because they have been rounded off.

a/ Except for EEQ and EMELEC's, the 1978 financial statements have not been audited. The 1979 financial statements are preliminary, and in the case of several electric companies have not yet been approved by their upper management; only EMELEC's 1979 financial statements have been audited. Depreciation and asset revaluation figures are mission estimates.

b/ Asset revaluation estimates were developed by the mission on the basis of information provided by INECEL. EEQ revalued its assets in 1976 but has not done so again since. EMELEC revalued its assets to May 1975 price levels (using the replacement cost criterion) but this revaluation has not been approved by the Government nor is it shown in EMELEC's financial statements. The revaluation estimate for EMELEC shown in the table was developed by using inflation indices and is likely to be significantly lower than EMELEC's estimate on the basis of replacement costs.

c/ For "other companies", work in progress and other assets are included in the net plant in service figure, as an appropriate breakdown is not currently available.

d/ Figures shown have not been checked for consistency. In the past, INECEL's records and those of its subsidiaries have not matched. Consolidated totals may still include some double counting as reciprocal debts between companies have not been netted out.

e/ May include inter-company debts (which would cancel out on a consolidated basis), may also be inflated due to insufficient reserve for bad debts.

f/ A substantial part of deferred charges is likely to include losses which should have been charged against income.

EQUADOR - POWER SECTOR MEMORANDUM

POWER SECTOR ESTIMATED INCOME STATEMENTS 1978-1979 \*  
(current \$/ millions)

|                                  | 1978          |              |              |                      |                     | 1979           |               |              |                      |                     |
|----------------------------------|---------------|--------------|--------------|----------------------|---------------------|----------------|---------------|--------------|----------------------|---------------------|
|                                  | INCECEL       | EEQ          | EWELEC       | Other Companies      | Total <sup>1/</sup> | INCECEL        | EEQ           | EWELEC       | Other Companies      | Total <sup>1/</sup> |
| Sales revenues                   | 296.1         | 615.3        |              | 531.9                |                     | 505.5          | 657.2         | 956.8        | 675.2                | 2294.7              |
| Other operating revenues         | 6.1           | 41.4         |              | 28.6                 |                     | 4.0            | 43.7          | 16.5         | 32.3                 | 96.5                |
| Total operating revenues         | <u>302.2</u>  | <u>656.7</u> |              | <u>560.5</u>         | <u>2010.6</u>       | <u>509.5</u>   | <u>700.9</u>  | <u>973.3</u> | <u>707.5</u>         | <u>2391.2</u>       |
| Operating expenses               |               |              |              |                      |                     |                |               |              |                      |                     |
| Operation and maintenance        | 144.0         | 453.6        | 580.1        | 432.5                | 1308.0              | 291.5          | 558.7         | 815.4        | 542.9                | 1608.5              |
| Depreciation <sup>2/</sup>       | 94.1          | 121.6        | 47.2         | 136.6                | 399.5               | 164.4          | 162.5         | 63.0         | 200.0                | 590.9               |
| Amortization                     | 29.1          |              |              | 29.1                 | 29.1                | 20.3           |               |              |                      | 20.3                |
| Total operating expenses         | <u>267.2</u>  | <u>575.2</u> | <u>627.3</u> | <u>598.2</u>         | <u>1732.7</u>       | <u>476.2</u>   | <u>721.2</u>  | <u>878.4</u> | <u>742.9</u>         | <u>2378.7</u>       |
| Net operating income             | 35.0          | 81.5         | 166.1        | (8.6)                | 274.0               | 33.3           | (20.3)        | 94.1         | (35.4)               | 72.7                |
| Other income                     | 3.7           | 9.2          | 11.9         | 57.6                 | 82.4                | 0.9            | 4.7           | 5.1          | 52.3                 | 63.0                |
| Other expenses                   |               |              |              |                      |                     |                |               |              |                      |                     |
| Financial charges                | (54.7)        | (24.4)       | (67.1)       |                      | (146.2)             | (192.7)        | (20.9)        | (84.1)       |                      | (397.8)             |
| Other                            | (0.7)         |              |              | (35.3) <sup>4/</sup> | (182.2)             | (1.8)          |               |              | (57.8) <sup>4/</sup> | (372.3)             |
| Net income before taxes          | <u>(16.7)</u> | <u>66.3</u>  | <u>110.9</u> | <u>13.7</u>          | <u>174.2</u>        | <u>(160.3)</u> | <u>(36.5)</u> | <u>15.1</u>  | <u>(34.9)</u>        | <u>(216.6)</u>      |
| Income taxes (net) <sup>3/</sup> | -             | -            | (15.4)       |                      | (15.4)              | -              | -             | 15.2         |                      | 15.2                |
| Net income after taxes           | <u>(16.7)</u> | <u>66.3</u>  | <u>95.5</u>  | <u>13.7</u>          | <u>158.8</u>        | <u>(160.3)</u> | <u>(36.5)</u> | <u>30.3</u>  | <u>(34.9)</u>        | <u>(201.4)</u>      |
| Workers participation            |               | (14.1)       |              |                      | (14.1)              |                | (1.5)         |              |                      | (1.5)               |
| Contribution to CERAPE           |               | (3.5)        |              |                      | (3.5)               |                | (0.4)         |              |                      | (0.4)               |
| Retained earnings                | <u>(16.7)</u> | <u>48.7</u>  | <u>95.5</u>  | <u>13.7</u>          | <u>148.2</u>        | <u>(160.3)</u> | <u>(35.4)</u> | <u>30.3</u>  | <u>(34.9)</u>        | <u>(201.3)</u>      |

\* Figures may not add up because they have been rounded off.

<sup>1/</sup> Sector totals have been calculated assuming that all of INCECEL's operating revenues originate from the other electric power companies, which show the amounts billed as an O & M cost. This is not totally accurate, as a small proportion of INCECEL's sales is to final consumers.

<sup>2/</sup> Depreciation figures have been adjusted in rough proportion to the increase in gross fixed assets values caused by asset revaluation.

<sup>3/</sup> EWELEC is subject to income taxes (other taxes are included in O & M expenses). In 1979, EWELEC had a net tax credit.

<sup>4/</sup> Breakdowns not available.

**ANNEX 8**  
**Table 8.3**

**ECUADOR - POWER SECTOR MEMORANDUM**

**POWER COMPANIES' FINANCIAL RATES OF RETURN**

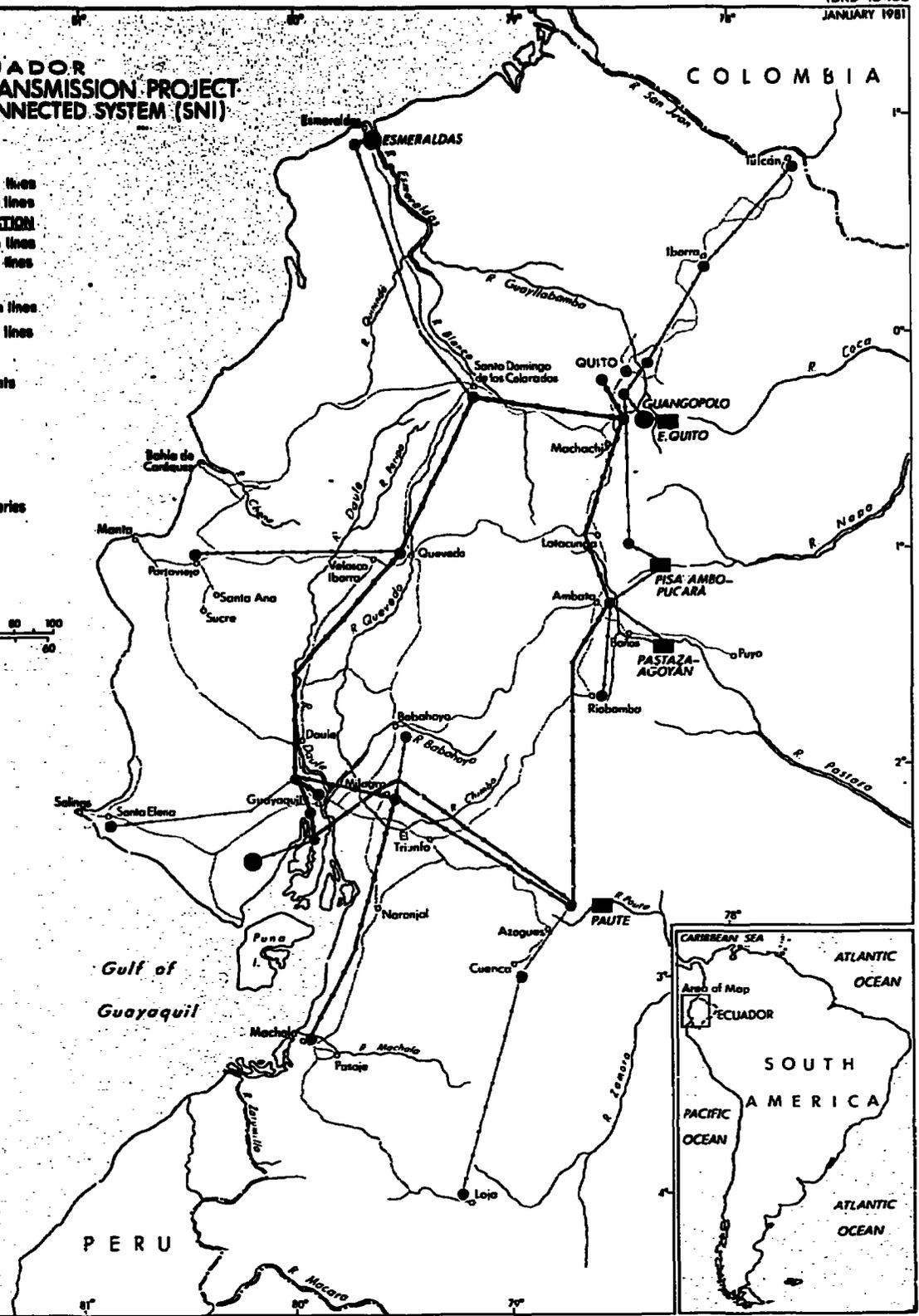
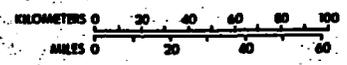
| Power Company                | 1978                                       |   |                                     | 1979                                       |   |                                     |
|------------------------------|--|---|-------------------------------------|--|---|-------------------------------------|
|                              | Average Tariff <sup>1/</sup><br>(S/. /kWh) | Rate Base <sup>2/</sup><br>(S/. millions) | Rate of Return <sup>3/</sup><br>(%) | Average Tariff <sup>1/</sup><br>(S/. /kWh) | Rate Base <sup>2/</sup><br>(S/. millions) | Rate of Return <sup>3/</sup><br>(%) |
| INECEL                       | <sup>8/</sup>                              | 3,818.0 <sup>4/</sup>                     | 0.9                                 | <sup>8/</sup>                              | 5,202.0                                   | 0.6                                 |
| EEQ                          | 1.07                                       | 2,499.0                                   | 3.3                                 | 1.14                                       | 2,905.0                                   | (0.7)                               |
| EMFLEC                       | 0.91                                       | 2,140.0                                   | 7.8                                 | 0.96                                       | 2,483.0                                   | 3.8                                 |
| All other electric companies | N.A.                                       | 4,500.0 <sup>5/</sup>                     | (...)                               | N.A. <sup>7/</sup>                         | 5,600.0 <sup>8/</sup>                     | (0.7)                               |
| Average <sup>6/</sup>        | 1.02                                       | 12,957.0                                  | 2.1                                 | 1.09                                       | 15,590.0                                  | 0.5                                 |

... : not significant (less than 0.1%)

- <sup>1/</sup> Ratio of sales revenues to kWh sold.
- <sup>2/</sup> Sum of net fixed assets in operations (less consumer contributions) plus working capital (estimated as three months of O & M expenses). Figure shown is average of beginning and end-of-year. Mission estimates incorporate the effects of asset revaluation (as required by existing legislation).
- <sup>3/</sup> Ratio of net operating income (adjusted only to reflect higher depreciation charges due to asset revaluation) to the rate base (x 100).
- <sup>4/</sup> Mission estimate. For December 1977, fixed assets in operation were calculated so as to include assets shown in the financial statements as work in progress but which, as per the Contraloria's audit report, actually were in operation.
- <sup>5/</sup> Rough estimates, as an accurate breakdown to distinguish between work in progress and fixed assets in operation was not available.
- <sup>6/</sup> Average tariff excludes INECEL's bulk rates from the computation; total rate base and average rate of return do include INECEL.
- <sup>7/</sup> Figures range between S/. 070/kWh in Riobamba to S/ 1.54/kWh in Manabi, Santa Elena and Santo Domingo.
- <sup>8/</sup> INECEL has contracts with EEQ and EMFLEC defining the conditions for the sale of electricity, which distinguish between sales to enable the electricity company to meet a final demand in excess of its generating capacity and sales destined to substitute one form of generation by another (more economical) source.

# ECUADOR INCEL POWER TRANSMISSION PROJECT NATIONAL INTERCONNECTED SYSTEM (SNI)

- PROJECT**
- 230 kv transmission lines
  - 130 kv transmission lines
- UNDER CONSTRUCTION**
- 230 kv transmission lines
  - 130 kv transmission lines
- EXISTING**
- 230 kv transmission lines
  - 130 kv transmission lines
- Hydro power plants
  - Thermal power plants
  - Substations
- Main roads
  - Rivers
  - International boundaries



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