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UPGRADING OF THE ELECTRIC POWER EQUIPMENT INDUSTRY IN DEVELOPING COUNTRIES

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Main results of the study work on industrial sectors are presented in the Sectoral Studies Series. In addition a series of Sectoral Working Papers is issued.

This document presents major results of work under the element Capital Goods Industries in UNIDO's programme of Industrial Studies 1986/87.

This paper has been prepared in co-operation with the UNIDO consultant, Dr. T. Balabanov.

Preface

This study summarizes the internal and external conditions for upgrading the electric power equipment industries of developing countries to a higher technological level. It outlines the main characteristics and constraints of different country groups as well as possible general directions of UNIDO technical assistance activities are also given.

The study is based on earlier studies on the electric power equipment industry in selected developing countries undertaken by UNIDO's Sectoral Studies Branch, under the work programme on capital goods. This includes i.a. the second world-wide study on the capital goods industry, a special study on a typology and elements of strategy for electric power equipment production as well as 11 country case studies on this industry.

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EXPLANATORY NOTES

References to dollars ($) are to United States dollars, unless otherwise stated.

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

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

A slash between dates (e.g., 1980/81) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

Metric tons have been used throughout.

The following forms have been used in tables:

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

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

A blank indicates that the item is not applicable.

Totals may not add up precisely because of rounding.

Besides the common abbreviations, symbols and terms and those accepted by the International System of Units (SI), the following abbreviations and contractions have been used in this report:

Economic and technical abbreviations

AC	Alternating current
GNP	Gross national product
Gwh	Gigawatt hour
ISIS	International Standard Industry Classification
kW	Kilowatt
kWh	Kilowatt hour
KWU	Kraftwerk Union AG
MPU	Multipurpose unit
MWe	Megawatt electricity
R+D	Research and development
R, D+D	Research, development and demonstration

1. INTRODUCTION

Among the industrial sectors the electric power equipment industry is one that has matured after a long period of development. Most of its products absorb recent developments of automation and control, metallurgical and engineering practices and sciences. Thus, its production processes are based on numerous inputs from other industrial sectors, e.g. basic metal industries, manufactures of fabricated metal products, etc. In other words, the electric power equipment industry has strong linkages to the rest of the national economy.

The scope of its products ranges from very simple ones, e.g. wood pylons and poles to sophisticated installations e.g. steam boilers and co-generation turbines.

Previous studies have revealed that the complexity levels of the equipment and services needed for electric power equipment industry can be grouped into six plains or strata each one characterized by a relatively common set of requirements for technological capabilities and infrastructure, as well as by specific capital output ratios.

UNIDO's case studies on electric power equipment industry of 11 developing countries, belonging to different development levels, have shown that:

- As countries advance in their industrial capabilities they add more complex products to the existing pallet thus showing a gradual increase in the product's sophistication;

- There is hardly any evidence of a country jumping over some of the development plains.

The above as well as considerations of a plausible market for electric power equipment have resulted in the creation of a scoring system, or typology, that devises seven distinct groups of developing countries ranked in accordance with countries potential for setting up electric power equipment manufacture. The grouping makes it possible to devise strategies for the development of the electric power equipment industry which aim at upgrading production capabilities and technological complexity of the products whose manufacture is envisaged by:

- Taking into account the differences in the countries manufacturing capabilities;

- Taking into account the prospects of the electric power equipment industry at the world level and thus increasing the country's bargaining power for technology transfer;

- Applying systems approach to identify the external and internal conditions for upgrading of electric power equipment production capabilities.

In most of the developing countries the incentives to increase the production of electric power equipment are related to the:

(a) Indigenous production of imported capital goods that are characterized by a high value added component and thus are subject to international price increases;

(b) Reduction of the foreign currency component of planned power plants and of distribution networks;

(c) Improved capabilities for international co-operation including joint ventures, technology transfer, etc.

(d) Increased reliability and availability of power plants through improved maintenance and supply of spare parts.

Some of the salient topics in analyzing the paths for upgrading electric power equipment industries are:

- Extensive long-term planning and full governmental support for the development of the industry;
- Unpackaging of the projects and technologies;
- Rehabilitation of the existing power plants and capital goods production facilities;
- Extensive north-south and south-south co-operation in upgrading the industry.

In the case of the least developed countries issues are particularly the start-up problems in the local manufacturing of equipment for decentralized electricity supply in rural areas, e.g. medium to small hydro power and wind generators.

Based on information from country case studies, and other relevant publications, this report aims at summarizing the external and internal conditions for upgrading the electric power equipment industries in each group of developing countries to the higher technological frontier.

The conceptual framework for UNIDO's technical assistance programmes advisable for each group of countries will be discussed. This includes also an assessment of the needs for training and for development of the necessary infrastructure.

The report is structured as follows:

In section 2.1 an analysis of the existent typology and of the selection criteria for each group of countries is made.

In section 2.2 the technological sophistication of different product lines is discussed with an aim at establishing of staircase of the electric power equipment product sophistication.

In section 3.1 the demands and the timing of electric power equipment, exemplified by two regional electrification projects are presented.

In section 3.2 the supply lines linking electric power equipment production with the output, or services, of other industries are discussed.

In section 4 the conditions for upgrading electric power equipment production capabilities, as well as the common constraints and options based on the country case studies are presented. This includes conceptual framework

for UNIDO's technical assistance advisable for each group of countries, ranging from very small market with low production capacity up to the most advanced semi-industrialized developing countries.

Based on the general analysis, section 5 presents some main recommendations for increasing production capabilities of the electric power equipment.

2. EVALUATION OF THE EXISTING TYPOLOGIES

2.1 Typology of the developing countries and of the selection criteria

The multi-criteria scoring system presented in a UNIDO publication[1/] is the typology to be used in the present study. It is based on statistical data and covers 92 countries with population bigger than one million inhabitants.

The elaborated multi-criteria scoring takes into account the following factors:

- The size and development potential of the country's domestic market for electric power equipment;
- The potential industrial capacity for commencing the production of electric power equipment.

The indicators selected to evaluate the market potential for electric power equipment are:

- Total population
- Per capita electricity production
- The existing level of import of electric power equipment.

Industrial capacity and the potential for setting up the manufacture of electric power equipment are measured by the value added in all metal working mechanical and electrical engineering industries. The selection is justified by the similarity of the technologies used, of the skills needed and of the existing links between the mechanical and electrical engineering industries.

To sum up, the classification of the countries is based on four statistical indicators:

- Population;
- Per capita production of electricity;
- Import of electric power equipment; and
- Value added in the metalworking, mechanical and electrical engineering industries.

As can be seen from the above, the suggested typology is made in terms of potential capacity for developing production of electric power equipment and market potential for it and not in actual (effective) demand or markets.

A clear distinction must be made between effective demand and potential demand or market potential.

Effective demand for electric power equipment is that portion of the potential that is realized on the market under a certain set of determining factors, subject themselves to both controllable and uncontrollable events.

1/ Electric power equipment production in developing countries: a typology and elements of strategy, UNIDO/IS.509, Sectoral Working Paper Series No. 26, 1985.

Thus, the task of evaluating the effective demands requires consideration of those determining factors and assessment of opportunities to minimize the demand evaluation error under the existing uncertainties. The same distinction applies to production capacity.

Since the present study aims at establishing criteria for upgrading the electric power equipment industry to higher complexity levels the effective demand and production capacity will be considered hereafter.

Another methodological drawback that deserves mentioning here is the macro- micro-level dichotomy with respect to the information used for identification production capabilities. The latter is based on the available aggregated macro data on the level of three digits ISIC code, e.g. groups 711, 714, 716, etc. or even on the industry level, e.g. mechanical and electrical engineering industries (ISIC, Division 38).

The assessment of a country's capabilities definitely should be conducted at a much more disaggregated level, for example at products level.

Some additional disadvantages common to all formal scoring systems are:

(a) A bias towards more economic than political input. Statistical systems are inevitably geared to the availability of data. This tends to introduce a bias towards more economic input than political input. It also means that important intangibles, or factors for which data are sparse, may be left out.

(b) Inflexibility. If a system is based on statistical indicators it is difficult in practice to include all variables that may be relevant for each country.

However, in spite the above quoted drawbacks, the formal scoring system has the following advantages:

(a) It enables comparisons between countries on a direct statistical basis;

(b) It serves as a cross-check against subjective assessments;

(c) It provides a format for systematic investigation.

The classification of countries in accordance with the four chosen criteria is presented in table 1. All terms in it, with the exception of the potential production capacity, are self-explanatory.

The potential production capacity has been subdivided into five classes as follows:

(a) Low capacity for starting and of developing the manufacture of electric power equipment: countries with total present value of produced capital goods less than $US 20 million;

(b) Low to medium capacity for starting and of developing the manufacture of electric power equipment: countries with total present value of produced capital goods between $US 20 million and $US 60 million;

Table 1. Typology of developing countries

Population in million		
Less than 5	Between 5 and 20	Above 20
Group 1: Very small market/ low capacity		
1. Central African Republic		
2. Chad		
3. Congo		
4. Honduras		
5. Liberia		
6. Mauritania		
7. Nicaragua		
8. Paraguay		
9. Sierra Leone		
10. Somalia		
11. Togo		
Group 2: Medium sized market/ low to medium capacity		
1. Cost Rica		
2. Jamaica		
3. Jordan		
4. Kuwait		
5. Lebanon		
6. Libya		
7. Panama		
8. Trinidad and Tobago		
9. Uruguay		
	Group 3: Small market/low capacity	
	1. Afghanistan	11. Madagascar
	2. Angola	12. Malawi
	3. Bolivia	13. Mali
	4. Burkina Faso	14. Mozambique
	5. Cameroon	15. Nepal
	6. Dominican Republic	16. Senegal
	7. El Salvador	17. Sudan
	8. Guatemala	18. Tanzania
	9. Guinea	19. Uganda
	10. Haiti	20. Yemen Arab Republic
	Group 4: Medium-sized market/medium capacity	
	1. Cuba	8. Tunisia
	2. Ecuador	9. Saudi Arabia
	3. Ghana	10. Sri Lanka
	4. Iraq	11. Syria
	5. Ivory Coast	12. Zambia
	6. Kenya	13. Zimbabwe
	7. Korea, Dem. Rep.	
	Group 6: Large market/large capacity	
	1. Chile	
	2. Malaysia	
	3. Peru	
	4. Venezuela	
Group 7: Large market/large capacity		
1. Singapore		
		Group 5: Medium-sized market/ low capacity
		1. Bangladesh
		2. Burma
		3. Ethiopia
		4. Zaire
		Group 6: Large market/large capacity
		1. Algeria 7. Nigeria
		2. Colombia 8. Pakistan
		3. Egypt 9. Philippines
		4. Indonesia 10. Thailand
		5. Iran 11. Turkey
		6. Morocco
		Group 7: Very large market/ very large capacity
		1. Argentina 4. India
		2. Brazil 5. Korea, Rep.
		3. China 6. Mexico

(c) Medium level development capacity: countries with capital goods production between $US 60 and 300 million;

(d) Large development capacity: countries with value of capital goods production between $US 300 and 2,000 million;

(e) Very large development capacity: countries lacking merely a few elements of a complete electric power equipment industry and with value of capital goods production more than $US 2,000 million.

One additional indicator not included in table 1 would be the geographical distribution of the countries from the groups 1-7. This indicator can be useful when discussing the options for regional co-operation and their impact on the status and the trends of electric power equipment production.

Along the above lines, simple statistics show that the low capacity diagonal of table 1, namely groups 1, 3 and 5 includes 20 of the 26 sub-Saharan African countries considered in the typology. It is likely that the 17 sub-Saharan countries absent from the table 1 will fall within the same low capacity diagonal. The country listing is supportive to that claim: Benin, Botswana, Burundi, Cape Verde, Comoros, Equatorial Guinea, Gabon, Gambia, Guinea, Guinea Bissau, Lesotho, Mauritius, Namibia, Niger, Rwanda, Seychelles and Swaziland. All these countries have low per capita electricity consumption and their industries are at an embryonic development stage.

Therefore out of the new total of 52 low capacity countries 39 (75 per cent) belong to sub-Saharan Africa. This outstanding over-representation determines the special attention given to the problems of that group of countries later in this analysis.

The remaining 25 per cent from the low potential diagonal include 8 Latin American, 4 Asian countries and 1 Arab country.

2.2 Grouping of electric power equipment products and services and their complexity level

In the early stages of development of the capital goods sector there is very little differentiation between the metal processing and the machine producing sectors. It is claimed that there is at this stage a technological convergence between the two sectors in so far as the same technologies are used to produce both machinery and the end-products of the metal-processing sector. The specialization and the differentiation occurs at a later stage when the production of more sophisticated capital goods is attempted.

It has been recognized that in both developed and developing countries parts of the capital goods sector have evolved in essentially similar ways.

In the first stage some firms in the metal-processing sector, e.g. some companies in Ghana and Tanzania currently begin to specialize in manufacturing, repairing and producing spare parts for machinery. At this stage there are no barriers to entry since the necessary capabilities and equipment are the same or very similar to their previous metal-processing activities.

In the second stage some of the firms begin to produce relatively simple machinery. In this stage the barriers to entry are still low and firms may be assisted by a combination of a variety of factors, for example, abundant and cheap labor, local and inexpensive raw materials (use of scrap metals), relatively simple designs allowing easy imitations, etc.

In the third and subsequent stages technological capabilities are progressively upgraded leading in final stages to the ability to design internationally tradable efficient machinery.

The above general framework of the development of capital goods industry has been translated in the study "Electric power equipment production in developing countries: options and strategies"[2/] into the following groups of electric power equipment manufactured goods and services that form subsequent levels of development:

Level 1 - Basic goods and services

Electric power equipment products - items based on indigenous materials, e.g. wooden distribution poles, some isolators, etc.

Services - civil construction.

Main characteristics - uses almost unprocessed local materials, is labour intensive and needs a very low capital layout.

Level 2 - Low technology goods and services

Electric power equipment products - Fabricated metal products, simple electrical machinery, e.g. metal transmission towers, twisted wire, etc.

Services - in-country ability to develop plant design and detailed specification, the ability to assemble and install equipment, specifically thermal and small-scale hydro equipment, the ability to design and to develop rural distribution systems.

These products lay the ground for establishing the linkage between the electric power equipment sector and the rest of the economy at two levels:

(1) Skill level- by borrowing the needed similar skills from the other sectors; and
(2) Inter-industry level - by acquiring a flow of goods and services from the other industrial sectors.

Main characteristics - low level of technological sophistication, labour intensive, low level of required capital layout.

This group makes a substantial contribution to decreasing the imported component of the electric power systems.

2/ Electric power equipment production in developing countries: options and strategies. An analysis of eleven country case studies, UNIDO/IS.507, Sectoral Working Paper Series No. 25, 1985.

Level 3 - Medium technology goods and services

Electric power equipment products - distribution equipment, switchgear, small scale motors, insulators for high voltage suspension systems, etc.

Services - construction supervision is done by nationals (not by expatriate personnel). Construction of the substations and transmission systems is done by local firms.

The process of technological transfer starts to take place.

The capital intensity of the production processes increases and so does the requirement for specialized skills.

Level 4 - Moderately advanced goods and services

Sophisticated electric power equipment products - power and substation transformers, large AC motors, water turbines, etc.

Services - high level design capabilities, e.g. modeling of the performance, materials testing and R&D capabiiities.

This group needs a developed industrial structure, skill differentiation and substantial capital/output ratios of production.

Mastering of the production processes needs licensing and agreements on transfer of technology that are controled by few multinational corporations.

Level 5 - High technology goods

Electric power equipment products - high capacity boilers, steam turbines, electric generator sets, measuring and control instruments, equipment for nuclear power plants, etc.

This plain needs mature industrial structure, especially developed engineering and metallurgical industries, highly qualified labour and very high capital investment.

Level 6 - Very high technology items

Electric power equipment products - mostly goods not produced in developing countries, e.g. gas turbines, the higher range of measurement and control equipment, computers and computer based dispatching and control centers, complete nuclear power plants, etc.

There is evidence that the production of gas turbines and some of the lower range computers will start soon. The latter development is speeded up by the spreading of microelectronics indirectly affecting the electric power equipment, i.e. in instrumentation and control, computer aided design and manufacturing.

3. DEMAND FOR ELECTRIC POWER EQUIPMENT

3.1 Needs for electricity in the long run

The growth prospects for the electrical power equipment industry are closely linked to the evolution of electric power production and subsequently to the power plants investment programme that determines the size of the market for electric power equipment products.

Two regional examples will exemplify the scale of envisaged developments:

(a) The UN Economic Commission for Latin America (ECLAC) has estimated for the period 1980-2000 an increase in electric power production capacity of 140,000 MWe for the hydroelectric power plants and 43,000 MWe for the thermal power plants, implying the installation of about 1,000 hydro-turbines rated at 142 MWe and 250 thermal units rated at 172 MWe;

(b) The UN Economic Commission for Africa (ECA) claims that during the period 1978-2008 an increase of 133,000 MWe hydro capacity and of 24,000 MWe thermal capacity is needed for the continent's revival. That implies the installation of 940 hydro-turbines, rated at 142 MWe each, and 140 thermal units rated at 172 MWe.

The cost of the corresponding equipment, including the needed transportation and distribution networks, can be estimated at more than $US 250 billion for each of the above regions, not including the investment for rural electrification schemes.

Ambitious bright development prospects have been revealed in UNIDO's country case studies. The available country data or projections of installed electrical capacity for 1986, 1990 and 1995 given in MWe are:

	1986	1990	1995
Algeria	2,900	4,900	13,000
Bolivia	567	776	1,150
Colombia	8,090	9,650	13,980
Egypt	9,443	10,890	16,500
Indonesia	5,245	8,616	16,132
Rep. of Korea	16,570	20,464	
Mexico	22,600	29,063	41,600
Pakistan	6,414	10,900	20,632

Source: Electric power equipment production in developing countries: options and strategies. An analysis of eleven country case studies. Statistical data, UNIDO/IS.507/Add.1, Sectoral Working Paper Series No. 25, 1985.

This growth prospects constitute an enormous prospective market for electric power equipment products and the sheer size of it emphasizes the need for and the urgency of developing and upgrading of the industry. The

inevitable time lag of 5 to 10 years between the point of taking a decision for creating a higher level electric power equipment production line and the delivery of the final products should not be overlooked.

3.2 The electric power equipment and the capital goods industry

The electric power equipment industry is not a prime-mover of and/or an entry route into the capital goods sector. On the contrary, its development depends upon the existing level of the capital goods industry, engineering skills and supply of intermediate goods. This statement is supported by the structure of the construction cost of coal power plant, the two types of hydro power plants and of the transmission and distribution network presented in table 2.

The fabricated plate products (ISIC groups 3813, 3819) including manufacture of structural components, boiler shop products, sheet metal components of buildings and valves pipes and fittings constitute around 16 per cent of the cost of both types of hydro power plants, while they make 18 per cent of the cost of the transmission and the distribution lines up to 48 per cent for coal fired power plant.

These figures demonstrate the importance of simple metalworking operations in building power plants. These operations are very labour intensive and require relatively low skills level. The cost of physical inputs, e.g. angle iron, channel beam components, etc., is low compared to the cost of labour.

Another important result from table 2 is that the total cost of engines and turbines, electrical equipment, instrumentation and control equipment amounts to 25 per cent for the coal power plant and around 44 per cent for both types of hydro plants.

The importance of mastering civil engineering work for the hydro plants is underlined by the 32 per cent share that construction equipment and machineries have in the total construction cost.

For the construction cost of transmission and distribution lines, beyond the fabricated metal products that have been discussed above, the main items are non-ferrous materials (mainly cables and wires) with a share of 30 per cent and electrical equipment (mainly transformers and circuit breakers) with 32 per cent, but also instrumentation and control equipment demanding more than 8 per cent of the construction cost.

The design and engineering costs can be estimated as 10 per cent from total construction cost for all facilities.

The production of equipment necessitates also extensive links with the supporting manufacturing facilities, e.g. forging and casting, as well as for multitude of specific material inputs like the rolled silicon steel for distribution transformers or thermal insulation. This factor should be taken into account in considering the figures below.

Table 2. Structure of construction cost per unit of capacity (percentage)

Product - equipment	Coal power plant	High dam hydro power plant	Earth dam hydro power plant	Transmission and distribution
Primary iron and steel manufacturing	1.10	0.28	0.27	1.20
Fabricated metal products	48.80	16.00	15.65	18.10
Non-ferrous metals manufacturing	2.20	0.14	0.14	30.04
Chemical products	0.46	0.76	0.80	0.54
Petroleum products	1.71	1.00	1.00	1.11
Building materials - stone, clay and glass	2.91	1.40	3.92	5.33
Lumber and wood	1.81	1.30	1.30	1.78
Miscellaneous materials	4.00	2.00	...	...
Engines and turbines	18.01	34.70	34.30	...
Electrical equipment	4.53	8.30	7.88	31.81
Construction equipment and machineries	5.60	32.40	32.10	2.30
Material handling equipment	1.74	...	...	...
Instrumentation and control	2.66	0.77	0.68	8.06
General industry equipment	4.38	2.67	0.34	...
Capital cost assumptions ($US/kW el)	1,000	2,000	1,500	...

4. CONDITIONS FOR UPGRADING THE ELECTRIC POWER EQUIPMENT PRODUCTION CAPABILITIES IN DEVELOPING COUNTRIES

4.1 External conditions

4.1.1 Main constraints related to country grouping

Among the broad set of constraints checking the development prospects of electric power equipment industry in developing countries the following external and internal factors have been singled out in the previous UNIDO studies:

(a) Governmental action - lack of defined governmental policies and strategies, perceptual constraints in allocating offers, etc.

(b) Market size constraints with three components: indigenous and perceived export demands for electric power equipment products and their timing (production schedule);

(c) Lack of adequate consultancy capabilities that would support indigenous equipment production;

(d) Technological complexity of equipment, difficulties in the transfer and mastering of technology;

(e) Scarcity of external and internal capital for financing needed investment for both power sector and electric power equipment industry caused by:

- Lack of a stable cashable income of the utilities;
- Lack of negotiation skill and capabilities for financial engineering of project;
- Underdeveloped capital markets and general capital scarcity.

(f) Policies of the funding agencies for packaging power projects that effectively exclude participation of the indigenous infant industries;

(g) Lack of supporting industrial activities, e.g. casting, forging, heat treatment, etc.;

(h) Bottlenecks in supply of raw materials and intermediate goods;

(i) Lack of standardization and proper quality control.

The main characteristics and constraints of different country groups as related to electric power equipment industry are summarized in Table 3.

The constraints presented concern activities related to the indigenous production of electric power equipment as well as those needed for successfully putting into operation and maintaining the electricity generation, transportation and distribution facilities.

Table 3. Main characteristics and constraints of different country groups related to electric power equipment industry

Groups	Country groups characteristics	CONSTRAINTS: Governmental policies	Financing	Standardization quality control	Consultancy services	Assembly and maintenance	Manufacturing of el. power equip.
GROUP 1 Very small market, low production capacity 25 countries Africa - 22 Latin America - 3	El. production: - less than 100 kWh/capita - total less than 400 Gwh/year Predominantly rural population Very limited market Up to 1,000 workers in metalworking and engineering industries	Lack of reliable policies supportive to EPE industry, subsidized electricity prices, low negotiation power	Difficulties in securing both external and internal financing, low self-financing ratio of utilities, lack of financial engineering capabilities	Lack of national or regional standards, lack of laboratories for testing and quality control	Lack of capabilities for: medium to long term planning, feasibility studies, site selection, preparation of specifications, bidding, project engineering, procurement of equipment	Assembly under the supervision of equipment supplier, lack of spare parts, repair shop tools, skilled people resulting in low availability of instalations	Very limited production capabilities. The activities are related to: level 1: basic goods and services: low volt. poles, cables, consoles, switch boards Absence of supporting industrial sectors
GROUP 2 Small market, low capacity 9 countries Latin America - 5 Arabia - 4	El. production: - above 500 kWh/capita - total less than 4,000 Gwh/year Large urban population Limited but growing market Up to 3,000 workers in engineering industries	Lack of reliable policies supportive to EPE industry, subsidized electricity prices, low negotiation power	Low self-financing ratio of utilities, lack of financial engineering capabilities	Lack of national or regional standards, lack of equipped laboratories for independent quality control	Lack of capabilities for: medium to long term planning, feasibility studies, site selection, preparation of specifications, bidding, project engineering, procurement of equipment	Assembly under the supervision of equipment supplier, lack of skilled people resulting in relatively low availability of instalations	Limited production capabilities. The activities are related to: level 1: basic level 2: low technology goods and services Weak link with the supporting industrial sectors
GROUP 3 Medium-sized market, low production capacity 22 countries Africa - 14 Latin America - 5 Others - 3	El. production: - less than 500 kWh/capita - total less than 2,000 Gwh/year Limited present market, good prospects 3,000-5,000 workers in engineering industries Manufacturing V.A. 5% to 10% of GNP	Lack of reliable policies supportive to EPE industry, subsidized electricity prices, low negotiation power	Difficulties in securing both external and internal financing, low self-financing ratio of utilities, lack of financial engineering capabilities	Lack of national or regional standards, lack of laboratories for testing and quality control	Lack of capabilities for: medium to long term planning, feasibility studies, site selection, preparation of specifications, bidding, project engineering, procurement of equipment	Managerial problems resulting in low availability of instalations	The activities are related to: level 1: basic level 2: low technology services Entrance in level 3: medium technology goods and services Weak link with the supporting industrial sector

Table 3. Main characteristics and constraints of different country groups related to electric power equipment industry (cont'd)

Groups	Country groups characteristics	CONSTRAINTS: Governmental policies	Financing	Standardization quality control	Consultancy services	Assembly and maintenance	Manufacturing of el. power equip.
GROUP 4 Medium-sized market, low to medium production capacity 13 countries Africa - 5 Latin America - 2 Arabia - 4 Asia - 2	El. production: - up to 550 kWh/ capita - total 3,000 to 5,000 Gwh/year High urbanization rate Market close to economic limit Manufacturing V.A 10% to 27% of GNP	Weak support of regional co-operation for trade and production of electric power equipment, subsidized electricity prices	Low self-financing ratio of utilities, lack of financial engineering capabilities	Lack of regional lack of equipped laboratories for idependent quality control	Capabilities for: project engineering aimed at increasing negotiation power and at increased local content	Still low availability of power plants	Technology mastered up to the level 3: medium technology Partial entry into level 4: moderately advanced goods and services Still high production costs Quality control problems
GROUP 5 Medium-sized market, low capacity Bangladesh, Burma, Ethiopia, Zaire	El. production: - up to 150 kWh/ capita Limited present markets Manufacturing V.A. 5% to 10% of GNP	Lack of policy supportive to electric power equipment industry, subsidized electricity prices, low negotiation power	Low self-financing ratio of utilities, lack of financial engineering capabilities	Lack of national or regional standards, lack of laboratories for testing and quality control	Lack of capa-bilities for: medium to long term planning, feasibility studies, site selection, etc.	Assembly under the supervision of equipment supplier, lack of skilled people	Limited production capabilities. The activities are related to: level 1: basic Lack of supportive in-dustrial sectors
GROUP 6 Large market, high capacity 15 countries	El. production: - total 10,000 to 20,000 Gwh/year Manufacturing V.A. 15% to 25% of GNP	Need for integrated planning of capital goods sector linked to manpower development; lack of legis-lation for protection, technology un-packaging and transfer, etc.	High capital output ratios; needs developed capital markets	Scarcity of equipped laboratories for independent quality control, lack of regional standards	Scarcity of research, development and demon-stration services		Technology mastered up to the level 4: moderately advanced goods and services From level 5: high technology goods: negligible production of equipment for power stations Entry in an oli-gopolistic market
GROUP 7 Semi-industrialized countries	7 new industrialized countries	Need for structural changes away from the saturated market for heavy EPE; need advanced legislation	Very high capital/out-put rations; needs developed export financing facilities	Lack of national system for patents and licences	Lack of com-prehensive conceptual engineering capabilities for export oriented projects		Technology mastered up to the level 5: high technology goods, entry into the last level 6: very high tech-nology items

These activities can be subdivided into three phases, namely:

(a) Preparatory phase: Long-range demand-supply analysis; research, demonstration and development; project definition; feasibility studies; pre-design activities; project engineering; preparation of tender documents; procurement of equipment and materials;

(b) Implementation phase: activities in the suppliers factories, including:

(i) Design of the equipment and setting up of quality standards;
(ii) Production;
(iii) Quality control;
(iv) Timely delivery.

On site activities, including:

(i) Civil works of various kinds;
(ii) Supply and construction of ancillary facilities;
(iii) Installation of low to medium technology and auxiliary equipment, i.e. low pressure piping, electric installations, pumps, funs, etc.
(iv) Assembly of main equipment, e.g. high pressure pipes, boiler, turbogenerator, etc.

(c) Exploitation phase: operation, maintenance and repair.

4.1.2 Financing electric power equipment development

Within the developing countries virtually all of the larger projects for expansion of the electricity supply system are funded through international bilateral and multilateral agreements and by commercial banks. As a result of that the international financial community has acquired a tremendous influence upon the structuring of power projects and an impact upon the purchasing policies for electric power equipment.

The country case studies on one side have pointed out that the policies of international funding agencies can constrain the development of indigenous electric power equipment industry but, on the other side, they have shown that the lack of thorough understanding of facilities made available to developing countries by funding institutions can lead to misuse of funds for purchasing of only imported equipment or services.

The average annual investment requirements for electrical power development in the developing countries have been estimated by the World Bank at $US 60 billion, distributed as shown on figure 1. The biggest share of the pie goes to the hydro-electricity projects (36 per cent) followed by electricity transport and distribution networks (31 per cent).

The Bank's estimates are that foreign currency contribution amounts to $US 20 billion, leaving the rest of $US 40 billion per annum to be financed through countries internal sources. To the above must be added the financial requirements for the investment in the electric power equipment industry. They can amount to as much as 20 per cent of the power sector investment cost mainly because the electric power equipment industry is characterized by a capital intensity sharply increasing with a product's technical complexity.

Figure 1. Developing countries' requirements for power, production 1982-1992 ($US 60 Bio.)

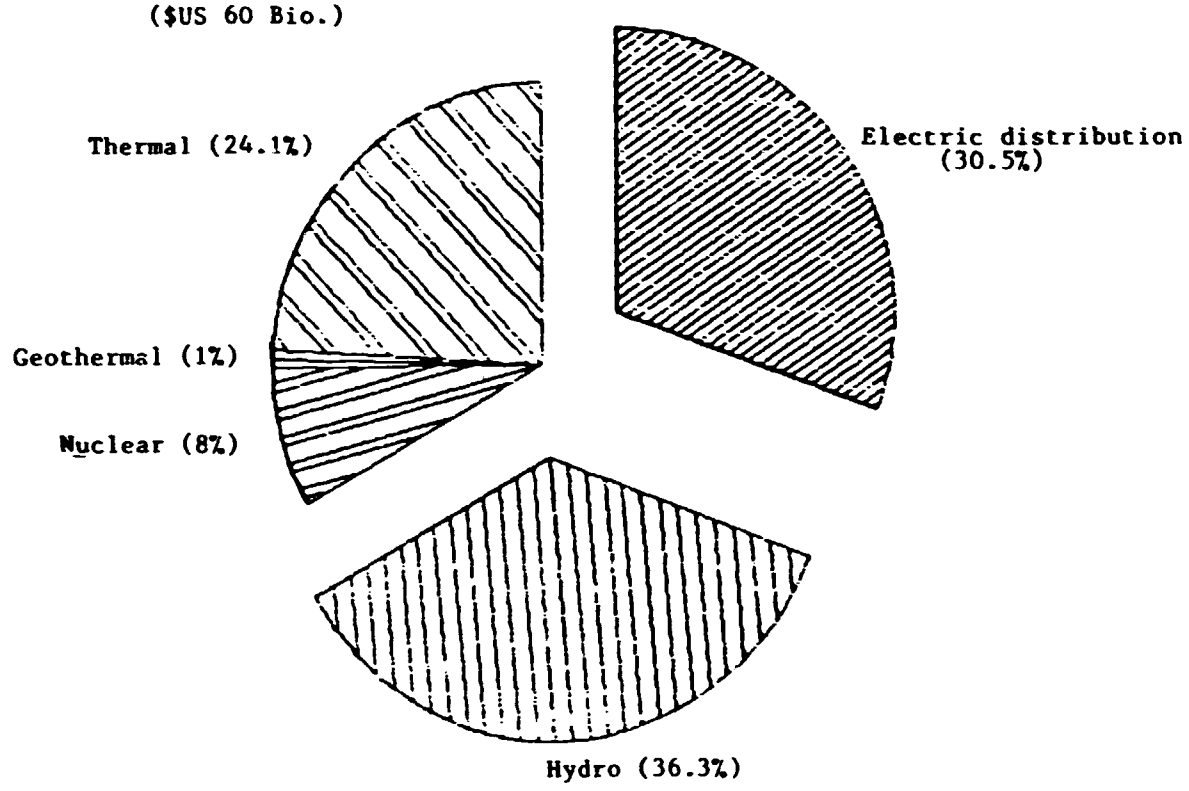
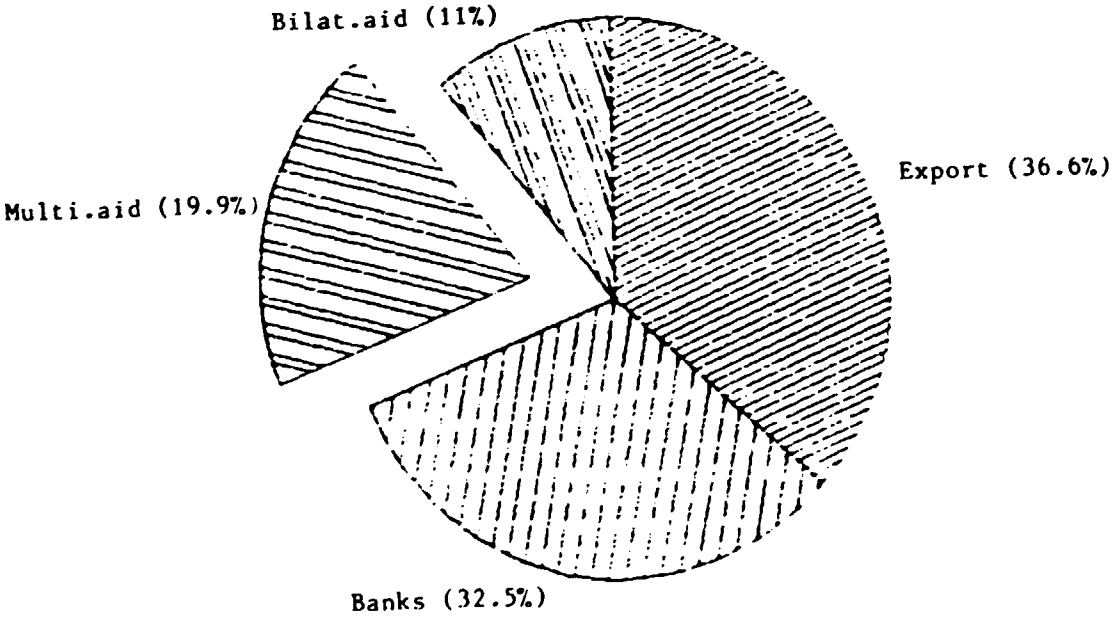


Figure 2. External lending for power sector, 1975-1980 ($US 70 Bio.)



Source: Trancard Guy, Development of the electric energy capital goods industry: financial aspects, UNIDO, 1985.

The principal sources of foreign financing in the 1980s (see also figure 2) were:

- "Multilateral aid": the World Bank together with the regional development banks have contributed on an average 20 per cent of the loans granted;

- "Export credits" of the industrialized countries represent about 36 per cent;

- Commercial banks participation has contributed 32 per cent; and

- "Bilateral aid" on preferential terms amounted to 11 per cent.

Every source of financing differs in respect of conditions and terms imposed to the borrower.

Some creditors like the World Bank have allowances for easing local participation in power projects by breaking down the projects into series of lots and by allowing the local tenders price margin up to 15 per cent compared to the foreign offers.

Others, like the export credit systems of some industrialized countries, provide the option for incorporating up to 30 per cent of the equipment produced within the borrowing country, when reciprocity agreement exists.

In the last years the debt burden on the economies of most developing countries increased enormously thus curtailing their future borrowing capabilities.

In this context it can be expected that an increasing part of the purchases of electric power equipment capital goods or equipment needed for the development of electric power equipment industry will be conducted within the framework of barter or compensation agreements. This form of trade, being common among the developing countries, if spread to more electric power equipment products, can be a strong boost to the South-South co-operation.

A substantial part of the demand for foreign capital should anyway be financed by borrowing through the international facilities.

The skill of financial engineering of electricity production and electricity power equipment projects acquires paramount importance given the variety of advantages and constraints of the various modalities corresponding to each financing source or barter agreement.

The bulk of the financing needed for power projects, estimated by the World Bank at $US 40 billion per annum, should come from the countries' own internal sources.

However, experience has shown that most national power companies in developing countries have not been able to consistently meet self-financing ratios of 20-30 per cent over time.

The reasons for this low performance are numerous and country-specific, but the main ones can be summed up, as:

(a) Low capital accumulation caused by inadequate tariff increases, coupled with rising unit investment and fuel costs;

(b) Slow collection of payments from the customers; particularly from municipalities and other government agencies;

(c) Low capacity utilization and high transmission losses;

In order to be able to finance the local cost component of investment programmes internally, utilities have been forced to borrow foreign exchange.

This and other shortfalls in utility financing capabilities have forced some governments to create new sources of medium- to long-term local financing, as well as to increase contributions from the public budget for project financing and direct equity injections to national companies. This has endangered utilities expansion plans by forcing them to compete for scarce public resources with other high priorities sectors of the national economy.

To soften the financing constraint and thus create conditions for upgrading their electric power equipment industry, developing countries will have to develop a policy framework for attracting the private and public capital needed, as well as for improving the mobilization of domestic public resources, particularly by the utilities.

Typical for this trend is the decision of the Indian "Committee on Power" to set a target, and to create conditions for its realization, so that 50 per cent of the investment would be covered through self-financing of the electric power production and distribution companies.

4.2 Internal conditions

4.2.1 The role of the government in upgrading the industry

Government policy has direct effects on the demand for capital goods and by influencing all the other demand-determining factors can also be expected to exert major indirect effects.

In many developing countries the emergence of industry and thus derived demand for capital goods has been, generally speaking, the outgrowth of a broad import substitution policy, with tariffs as the main instrument of protectionism.

However, these policies have not always been consistent or coherent in all countries, and have been to a large extent governed by tax revenue and other financial objectives of the governments involved.

The policy of import substitution has often resulted in high tariffs for consumer goods and respective derived demand for capital goods. At the same time, the low protection imposed on capital goods has caused much of this demand to be met through imported items.

The lack of continuity in industrial promotion measures has been an outstanding feature of many industrial promotion policies. Governments have provided varying levels of guidance, credit, direct investment and support by financial institutions. Technical advice, training and research has often been markedly inadequate.

In short, there is a long way to go before a consistent, co-ordinated and integrated industrial strategy emerges in many of the developing countries. Until this is achieved, industrial activity and the resulting demand for

capital goods will be at a suboptimal level; a large part of whatever demand exists will be met through imports and not through increased local capital goods production.

In those developing countries which have achieved progress in electric power equipment production the governments have played a decisive role emanating from the governmental control on the entire energy system and in particular on the generation, transmission and distribution of electricity.

Government action in most cases tends to be concentrated on:

(a) Planning of capital goods industry, setting up priorities and allocation of scarce resources;

(b) Education and training of industrial manpower;

(c) Establishing of financial and tariff policies;

(d) Pursuing purchasing policies supportive to indigenous electric power equipment;

(e) Establishment of engineering, technical support and research and development capabilities;

(f) Establishment of standards and quality control;

(g) Creation and development of production units;

(h) Negotiation of regional co-operation agreements.

4.2.2 Technological capabilities and policies

(a) Manufacturing capabilities

The evaluation of the status of electric power equipment production of the 11 countries surveyed by UNIDO, elaborated in an earlier UNIDO study and displayed in table 4, shows along some general country and energy characteristics, an approximation of countries manufacturing capabilities.

These capabilities are judged by ranking country production of electric power equipment into six plains of increasing technological complexity starting from basic materials and services (level 1) up to very high technology items (level 6).

From table 4 it can be seen that production capabilities even of the countries belonging to group 7 differ substantially. While India and the Republic of Korea have mastered almost the full pallet of good and services up to high technology level (level 5), in Mexico only selected specific items from the same cluster have been mastered. The spread is even more visible for surveyed countries from group 6: Algeria, Colombia, Egypt and Indonesia. While in mastering electric power equipment technology Algeria and partly Pakistan have approached the production capabilities of some group 7 countries, the rest - Egypt, Indonesia and Colombia lag behind.

These limited technological characteristics and, in some cases the lack of manufacturing capabilities, is much more visible in least developed countries, in our case those belonging to the low capacity diagonal of table 1 - groups 1, 3 and 5.

Table 4. Manufacturing capacities of case study countries

	India	Rep.Korea	Mexico	Algeria	Colombia	Egypt	Indonesia	Pakistan	Bolivia	Cameroon	Tanzania
Country Class	7	7	7	6	6	6	6	6	3	3	3
Population million	690	39	71	20	26	43	150	85	6	9	19
Income$/Yr/person	170	1030	904	310	790	430	47	200	250	144	37
kWh/yr/person	230	1490	1980	1940	1260	550	450	310	570	730	270
MVA/Year Nuclear	94	942	82	0	0	200	0	0	0		0
Thermal	3594	0	1597	213	42	901	1381	536	9		0
Hydro	1205	319	692	0	603	90	402	322	31		25
Other	0	0	63	0	0	0	50	0	0		0
Subs	0	5938			792	5447	2755		176		
Km/Yer Trans	14351	1092	2157		342	1667	1730		100		
Dist	44066	7002		7500	1650	2571	5744		301		
Plain 1: Basic Items											
Maint. and Oper	B1	B1	B1	B1	B1	B1		C/B		B	C1
Distr Poles	B1			B1	B1	A1	C	C1	B2	B2	B1
Civil Construction	B1	B1		C1	C1	B1	C	C1	B1		
Plain 2: Low Technology Items											
Distr Hardware	A1	B1	C1				B1	B1			B2
Trans Towers	A1	B1	A1	B1	B1	B1	B2	B1		C2	
Distr Transformers	A1	A2		B3	C1	C2	C2	B	B1		B2
Distr Cable	A1	B1	B2	B1		A2		B1	B2		B2
ACSR Wire	A1	B1	B3			B2	B1	B1	B2		B2
Copper Wire	A1	B1		B1		B2	B1	B1	B2		
Plant Des+spec	A1	B3		C1	C1	B1	B		C1		
Assembly+Install	B1	B1		C1	C1	B1	C	C1			
Rural Dist Constr	B.			B1	B1	B1	B	B1			C1
Plain 3: Medium Technology Items											
Distr Equipment	A1	B1	B1	B1		C2	B2	B1			
Distr Switchgear	A1	B1	B3	B1		C3	B2	C1			B2
Suspension Inculat	A1	B2	B1				C2	B1			
Med+Small Motors	A1	A1	B3	C1	B1,C1		B2	B1			B2
Supervision	B1	B3		C1	C1	B1	C		B1		
Substa Constr	B1			C1	C1	B1		C1			
Trans Constr	B1			B1	C1	B1	B	C1			
Plain 4: Moderately Advanced Technology Items											
Power Transformers	A1	A2	B2		C1		C2				
Subst Transformers	A1	A2	B2	B3	C1		C2	B			
Large AC Motors	A1	B3	B3	B3	C1,C3			B1			
Water Turbines	A1	B3	B3		C1,C3		B1				
Post Insulators	A1	B1					B1	B1			
Plain 5: High Technology											
Boilers	A1	C3	C3		A1						
Other Plant Equipt	A1	C3		C1							
Steam Turbines	A1	C3									
Electric Generator	A1	C3						B1			
Trans Switchgear	A1	B2	B3					C1			
Bushings	A1	B1									
Trans Cable	A1	B2					B	C1			
Meters	A1		B3	B2				B1			
Static Converters	A1		B3								
Inductors			B3		C1						
Capacitors	B1	B1									
Plain 6: Very high technology items											
Gas Turbines		C									
Dispaching and control											
Mainframe computers											

Notes: A - production for export and internal use
B - production for internal use only
C - Produces less than half of needs

1 - internal funding and technology
2 - License arrangement with DC's
3 - Joint ventures with DC's

The mastering of technology in these countries appears to be at the first and second development stages (as described in section 2.2) where companies have began to specialize in manufacturing/repairing of machinery and/or the production of relatively simple machinery. The case studies completed for three countries belonging to the group 3 underline the above statement. While most of the items included in level 1 have been mastered (see table 4), scattered activities exist in level 2, related mostly to the production of cables, wire and distribution transformers. Finally, the only medium to small electrical motors and some insulators are produced from the items belonging to level 3.

The above comments do not diminish, but rather underline, the validity of the findings from UNIDO's case studies on electric power equipment industry of 11 developing countries, namely that:

- As countries advance in their industrial capabilities they add more complex products to the existing pallet thus showing a gradual increase in the product's sophistication;

- That the countries which produce electric power equipment consistently progress from a simple, low numbered, manufacturing capacity group to a higher numbered group in a monotonous fashion and that it would be hard to expect a country to jump over any technological complexity level.

(b) Unpackaging of projects and technologies

Time sequence for power project implementation is the first factor to consider when discussing the unpackaging options of projects and technologies. In the case of building a conventional power plant this includes:

(i) Preparatory phase:
  (1) Long-range demand-supply analysis;
  (2) Project definition;
  (3) Feasibility study;
  (4) Pre-design activities:
    - Preparation of specifications
    - Bid preparation and evaluation
    - Contract negotiation
  (5) Project engineering;
  (6) Preparation of tender documents;
  (7) Procurement of equipment and materials.

(ii) Implementation phase:
  (8) Activities in the suppliers factories, including:
    - Design of the equipment and setting up of quality standards;
    - Production;
    - Quality control;
    - Timely delivery
  (9) On site activities, including:
    - Civil works of various kinds;
    - Supply and construction of ancillary facilities;
    - Installation of low to medium technology and auxiliary equipment, i.e. low pressure piping, electrical installations, pumps, fans, etc.
    - Assembly of main equipment,e.g. high pressure pipes, boiler, turbogenerator, etc.

(iii) Exploitation phase:
(10) Operation of the power system;
(11) Maintenance and repair

The above list shows a broad scope for unpackaging during each of the phases and for local participation subject to the availability of indigenous consultancy capabilities, production and test facilities.

But even the low technology part of the list can substantially reduce foreign currency costs also serving as a vehicle for entry into the production of some of the equipment.

Thus, the unpackaging of the power project will have considerable effect on the distribution of necessary consultancy among the partners according to their particular functions and responsibilities. This is a function of the accepted type of contractual relations.

The three main types of contracts that are commonly used in power projects are:

(1) The turn-key contract. A single main contractor or consortium takes overall responsibility for the design, construction and commissioning of the project. Technology transfer is very limited, unless it is explicitly mentioned in the general supply agreements.

(2) The split package (lots) contract. The overall for design and construction is shared between a relatively small number of contractors who manage, design, construct and/or manufacture the bulk of the plant: whole systems, buildings, etc. One of these contractors is usually responsible for system integration and performance studies as well as for the co-ordination of the project and contracts. Separate contracts may be awarded, for example, to:

- The boiler and attached equipment;
- The turbo-generator set;
- The remainder of the plant;
- The services of an industrial architect.

(3) The multiple package (lots) contract. Within the framework of its own organization or through its industrial architect, the electricity company takes the direct responsibility for the management of the design and construction work and prepares a large number of contracts, typically around 100.

On the example of a nuclear power plant, table 5 shows the breakdown of the main responsibilities which is normally applied to each of these main contract categories.

It can be seen from table 5 that the existence as well as the appropriate qualification of national consultants is a prerequisite for splitting power projects into lots and thus for creating a market for local product and services.

The existence of a stable and profitable market is the main condition for indigenous production of electric power equipment and for upgrading of this industry.

Table 5. Normal distribution of responsibilities according to the type of contract

Activity	Main responsibility		
	Turnkey contract	Split package contract	Multiple package contract
Pre-project activities	EC	EC	EC
Project management	MC	IA or EC	EC + IA
Engineering design	MC	IA + SS	EC or IA
Quality assurance/ quality control	MC + EC	IA + SS + EC	EC + IA
Supplies	MC	IA + SS	EC or IA
Licensing requests	EC	EC	EC
Issue of licences	RB	RB	RB
Manufacture	MC	SS + EM	EM
Preparation of the site	EC or MC	EC or IA	EC or IA
Construction	MC	IA + SS	EC or IA
Installation of the equipment	MC	IA + SS	EC or IA
Commissioning trials	MC	IA + SS	EC or IA
Operation and maintenance of plant	EC	EC	EC

Note: IA: Industrial architect
EC: Electricity company
MC: Main contractor
EM: Equipment manufacturer
SS: System supplier
RB: Regulatory body

Source: IAEA, Energy and nuclear power planning study for Algeria, IAEA, Vienna, 1985.

In the Republic of Korea, technology unpackaging is mainly done by using the purchasing power of the utility. The country drew up clear indigenization policies and strategies and obtained technology through licenses bought by the national enterprises wholly or partly owned by the utility. The private firms in the sector are also active, but a direct involvement of foreign capital does not exist. The required inputs of production are imported freely at the beginning and indigenized progressively as they become available within the country. The utility in this country plays the central role and is involved in every aspect of the development of the sector.

In India, the heavy electrical industry has been established through state enterprises and with the aim to attain complete self-sufficiency. In line with this target, basic engineering capabilities have been created and technology transfer has been made through a limited number of licences. The domestic market is protected and every effort is made to indigenize the inputs required for production.

It could be argued that the cost of development of the electric power sector could greatly vary in both alternative routes mentioned above. As a future activity, the analysis of costs and risks involved in each case could be carried out to assist the decision makers in developing countries in their efforts to upgrade the industry.

In addition there is a conflict between the short-term goal of obtaining the electric power plants rapidly and the long-term objective of increasing self-reliance. A balance between the two can be achieved with far-sighted policies. The slow process of training which requires to bear the costs of "learning by doing" and to put faith in the national talents and capabilities is the kind of approach required for building up technological self-reliance.

(c) Rehabilitation of the production units

A characteristic common to the countries belonging to groups 1, 3 and 5 is the low level of production capacity utilization. This in turn contributes to abnormally high capital/output ratios.

Data shows that the rates of capacity utilization in several least developed countries have been going down for some years, especially in the larger plants.

The plants producing electric power equipment, where they exist, have been confronted with particularly severe problems as electrification plans slow down and new orders decline. Average capacity utilization rates in some of these plants have gone down to bellow 60 per cent.

Another factor that has contributed to the low capacity utilization is the lack of foreign exchange needed to import spare parts and other essential inputs. Sometimes this situation is further complicated by restrictive import licensing laws.

The above considerations have lead to the increase of the international assistance in rehabilitation of existing production facilities.

An example for such assistance is the recent joint Egypt/Federal Republic of Germany project on rehabilitation of the Egyptian industry. A major component is the updating of the manufacture of transformers, transmission towers and other capital goods related to electric power equipment production.

(d) Multipurpose units approach in least developed countries

A multipurpose approach in industry means the use of the same production equipment and manpower to manufacture several products in relatively small batches aimed at the maximization of the production capacity utilization.

The integration of the multipurpose units (MPU) with the capital goods sector in general and with the electric power equipment production in particular widens the scope of the multipurpose approach.

Main characteristics of this approach are:

- Flexibility between the product and the technological process of production;
- Production process based on universal machinery designed to perform a set of basic operations, e.g. cutting, welding, machining, etc., in which labour plays a determining role;
- Production of relatively small quantities of the variety of products having low to medium technological complexity;
- Suitable for horizontal integration with the domestic technological infrastructure.

It is equally important for multipurpose units to be designed and operated in a way which would make it possible for developing countries to accumulate the technological knowledge needed for mastering the electric power equipment technology.

Three main types of multipurpose units (MPUs) can be of relevance to the electric power equipment production, especially during the start-up stage:

(1) Multipurpose machine shops;
(2) Multipurpose repair and assembly shops;
(3) Multipurpose mobile assembly units.

The profitable existence of MPUs depends heavily on the availability of suitable designs and appropriate technical assistance.

In order to enjoy in full the benefits of the MPUs approach it is necessary to reduce as far as possible the number of technical standards as well as the variety of indigenous and especially imported inputs used for electric power equipment production. The choice of licences should also be guided by this consideration.

4.2.3 National development policies

(a) Least developed countries

An industrial characteristic that is common to most least developed countries is the tendency for industrial branches to feature one large, relatively capital-intensive plant with a number of small, under-capitalized, satellite enterprises. Very often, the large plant uses imported, capital-intensive equipment to produce goods that have high content of imported intermediate inputs and thus limited in country applicability. For

example, the import content of the distribution transformers in Tanzania is 50 per cent and of the aluminum conductors 80 per cent.

On the other extreme, the small enterprises tend to use second-hand equipment, containing little imported content, to produce goods for consumption by the lower income domestic market. Examples of this formal/informal sector dichotomy are numerous.

Any changes in the industrial structure of the least developed countries during the remainder of the present decade will be strongly influenced by the policy stance of the governments concerned and by the status of the capital goods sector. Although data on these matters are difficult to gather, and to interpret, it would appear that a growing number of least developed countries realize the need to:

(i) Reform the micro-economic framework within which their firms operate,
(ii) Allow factor prices - notably wages and interest rates - to reflect more fully their true resource endowments, and
(iii) Simplify current laws and systems relating to subsidies and taxes.

The adoption of such measures, apart from contributing to improved efficiency from existing investment, might encourage more subcontracting work - perhaps more labour-intensive work - from plants in more advanced developing countries.

The fact that capital goods in general and electric power equipment in particular account for an increasing percentage of the total visible imports implies growing ties with suppliers of machine tools and other capital goods manufacturers, most of whom will be located in developed countries. Second hand capital goods may, however, account for a portion of these imports, and some of these may come from developing countries.

One conclusion that does emerge from this analysis, however, is the essentially micro-economic character of the industry in the least developed countries and the positive economic implications of policy reforms and related efforts aimed at establishing a broader base for development and international co-operation.

(b) Country case: Algeria

Based on the Algerian experience in building thermal power plants, the impact that national development policies has on upgrading electric power equipment industry, the role which the public utility can play in national integration and its effect on the promotion of the electric power equipment industry will be illustrated.

In order to achieve more than 50 per cent local content in the construction of thermal plants, the Algerian utility company have started the following activities:

(i) Planning, to control electricity demand and anticipate it by a long-term equipment plan prepared sufficiently well ahead and periodically up-dated;

(ii) Standardization of equipment, to reduce the items to be produced;
(iii) Engineering as the human basis of any industrial development and integration.

In such a way these activities establish the preferred framework for discussions and negotiations between foreign manufacturers and the national industry for the transfer of technology.

Three basic principles are constantly applied in thermal station construction:

(1) Ensuring that the control function remains in all circumstances with the public utility. This job cannot be delegated to a foreign consultant, whatever his skill and whatever his goodwill, for the success of any project depends to a great extent on the capacity and determination of the engineering team to establish a dialogue with or to confront the constructor's experts. This dialogue or, if needed, confrontation is what encourages the accumulation of knowledge and the transfer of technology.

(2) Refusal of turn-key contracts and systematic use of the separate contractors formula. For instance, the client makes a number of contracts for a single station and is responsible for the follow-up, management and co-ordination in implementation.

(3) Systematic use of national industry. On this point it is worth noting the attitude of some international bodies which fail to understand the preference given to the national industry and suggest that national the industry should participate in international bidding on an equal footing with foreign firms.

Obviously, the application of these principles, by avoiding the easy solution, increases the scope of utility's responsibilities and compels it to improve its technological capabilities and its negotiating abilities in order to gain credibility.

In practice, the break down of the projects into lots is carried out by the utility jointly with the national firms concerned which negotiate with the foreign manufacturers the limits of their prerogatives and commitments.

However, it is important to note that the utility's attitude towards sub-contracted national companies is not strictly that of a client but rather of an adviser and assistant in particular when trying to achieve the required quality standards.

The result of this long term (more than 20 years) persistent policy is that Algeria has mastered the process of building thermal stations by ever-increasing participation in engineering, in the manufacture of particular items of equipment, particularly metal work and boiler work, and the assembly of imported equipment.

4.3 Conceptual framework for technical assistance projects in each level of the technology upgrading scale

The conceptual framework for technical assistance projects in each country group aimes at assisting the decision-makers in developing countries in the formulation of policies as well as of requests for external assistance for upgrading of electric power equipment production capabilities. The framework is elaborated by applying systems approach to identify and remove the external and internal constraints to industry's upgrading at national, regional and interregional level.

4.3.1 Very small market, low production capacity

This group includes 25 countries with the following geographical distribution:

- Twenty-two countries from sub-Saharan Africa: Burundi, Benin, Botswana, Cape Verde, Central African Republic, Chad, Congo, Comoros, Equatorial Guinea, Gabon, Gambia, Guinea, Guinea Bissau, Lesotho, Liberia, Mauritania, Mauritius, Namibia, Sierra Leone, Somalia, Seychelles, Swaziland and Togo.

- Three countries from Latin America: Honduras, Nicaragua and Paraguay.

The status and prospects of electric power equipment industry of these countries have not been the subject of earlier UNIDO studies.

Most of the above 25 countries belong to the group of least developed countries and their capital goods sector deals mainly with metalworking operations rather than with machine building.

The goal here would be to upgrade electric power equipment production from almost zero indigenous activities to an entry into goods and services included into level 1 of the technology upgrading scale.

For mastering the transition to machine building stage and for overcoming related start up problems multitude of activities will need assistance from the international agencies.

In this respect the framework for technical assistance aimed at upgrading of electric power equipment production can consist in:

(a) Strengthening governmental policies for:

(i) Development of policy framework for attracting the private and public capital needed, as well as for improving the mobilization of domestic public resources, particularly by utilities. Timely adjustment of the electricity prices and setting targets for self-financing ratios for the utilities.

(ii) Definition of legislation and policies supportive to the active participation of local firms in the rural electrification programmes.

(iii) Exploring the external and the internal opportunities for training both for the creation of production skills, e.g. welding, forging, etc., and for operation and maintenance of installations. Specialized technical assistance needed for:
- training in the operation and maintenance of installations;
- training in production skills.

(iv) Support to:
- technical co-operation agreements;
- regional co-operation arrangements; and
- the creation of preferential trade areas.

(b) Financial and managerial help in the creation of small to medium multipurpose units, namely:

(i) Multipurpose engineering maintenance workshops that can be used also by other sectors, e.g. for joint production and maintenance of electric power equipment and agricultural machinery;

(ii) Multipurpose sheet metal and general metal working shops for the production of metal cabinets and boxes as well as metal furniture and equipment for renewable energy sources.

(c) Upgrading of a country's negotiation power vis-à-vis the external financing agencies through better financial engineering of the project and by mastering national planning activities, engineering consultancy services and project management. The main recipients of assistance should be the utilities as well as the national bodies for planning and project studies. Specialized technical assistance needed for the development of national consultancy services.

On all above activities UNIDO's technical assistance can have a positive impact and in fact the countries have been insistent in requesting it.

Examples can be found in "Initial integrated industrial promotion programme at the subregional level" where among the long list of prospective energy related manufacturing projects Guinea, jointly with Ghana, demands help for starting up manufacture of aluminum conductors and cables and Togo is looking for technical assistance and donor's financial commitments in establishing manufacture of power transformers for its rural electrification programmes.

A common feature of all requests for technical assistance is their "piecemeal" approach to the country's industrialization and energy development prospects.

What is lacking is a coherent industrialization policy, based on medium to long terms indigenously developed plans.

An example of this kind of assistance would be the recently initiated UNIDO study on integrated energy/industry planning for some African countries. The study envisages the following main activities:

(a) Review and adaptation of existing methodologies and tools for energy/industry planning in accordance with the specific situation of the least industrialized African countries, in particular related to:

- Small scale industrial development in rural areas;
- Substitution and/or improved efficiency of non-commercial energy, mainly fuelwood;
- Local production of equipment needed for rural electrification, e.g. mini-hydro installations, distribution networks, wind engines, etc.

(b) Implementation of the adapted methodologies on a compatible personal computer and development of a databank for selected methodologies and techniques.

(c) Compilation, review and presentation of data about the socio-economic, industrial and energy-related status in selected African countries representing different sub-regions and development stages. This activity should include the following main steps:

(i) Collection of the socio-economic, industry and related energy data, in particular:
- Population;
- Economic information from national accounts;
- Energy balance data;
- Energy resource;
- Industry related information:
  - Basic data;
  - Output of energy intensive products of major industrial sub-sectors;
  - Production of energy related equipment;
  - Sectorial consumption of final energy forms.
- Additional indicators, e.g.:
  - Energy intensity of produced commodities;
  - Types of technologies used;
  - Plans for new industrial capacities;
  - Structure of production of small-scale industries in rural areas.

(ii) Direct collection of data jointly with African national and regional organizations and authorities responsible for energy and industrial development.

(iii) Review of data and evaluation of the collected information and its subsequent organization in an appropriate form corresponding to the chosen methodology, e.g. normative energy balances, industrial and socio-economic determinants of energy demand, etc.

(iv) Elaboration of a flexible methodology for projecting demands of energy related equipment and related to them demands for general purpose machines and infrastructure facilities such as casting and forging.

(d) Conducting of several case studies aimed at translating of the methodologies elaborated, training of national teams and definition of workable technical assistance programmes for respective countries.

4.3.2 Medium sized market, low to medium cap /

The group includes 9 countries with the following geographical distribution:

- Five Latin American countries: Costa Rica, Jamaica, Panama, Trinidad and Tobago, Uruguay.

- Four Arab countries: Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya.

The status and prospects of electric power equipment industry of these countries have not been the subject of earlier UNIDO studies.

The nine countries in the group constitute a medium market for electric power equipment products and have some traditions in capital goods production. For this set of countries, in their efforts to upgrade the electric power equipment production, it is still not necessary to be attentive to the development of basic metal industries but rather to the creation of:

- Industrial infrastructure, e.g. foundry, forging and machining;
- Specialized subcontracting, e.g. heat treatment, surface coating, etc.

The upgrading will aim at acquiring manufacturing capacities for entry into level 2 and 3. In that respect the framework for technical assistance aimed at upgrading of electric power equipment production can be in terms of:

(a) Strengthening governmental policies in:

(i) Programming public purchases of electric power equipment supportive to the active participation of local firms in the electrification programmes;

(ii) Creation of legislation for temporary protection of infant industries;

(iii) Definition of policies supportive to the technology transfer;

(iv) Setting targets for self-financing ratios for the utilities, as well as for achieving up to 50 per cent local content for certain lots of the electric power projects;

(v) Support to regional co-operation arrangements and to the creation of preferential trade areas.

(b) Development of negotiation capacity of the national engineering companies and of the utilities through:

(i) Better financial engineering of the projects;

(ii) Technological unpackaging;

(iii) Using the comparative advantages of the existing "buyers' market" for the main electric power equipment components;

(iv) Mastering national planning activities, engineering consultancy services and the project management.

(c) Acquisition from abroad of technology for the development of national electric power equipment industry, e.g. from the companies in the newly industrialized countries.

(d) Development of unified national and regional standards and establishment of quality control and testing facilities that are independent from the production units.

In all the above activities a well formulated technical assistance programme on the part of UNIDO will have a substantial contribution to the upgrading of the countries production capabilities.

4.3.3 Small market, low capacity

The group includes 22 countries with the following geographical distribution:

- Fourteen from sub-Saharan Africa: Angola, Burkina Faso, Cameroon, Guinea, Madagaskar, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Sudan, Tanzania and Uganda.

- Five from Latin America: Bolivia, Dominican Republic, El Salvador, Guatemala and Haiti.

- Three others: Afganistan, Nepal and Yemen Arab Republic.

The status and prospects of electric power equipment industry for three countries from the group, namely of Bolivia, Cameroon and Tanzania, have been subject of earlier UNIDO studies. The accumulated empirical evidence from them will be used throughout the discussion that follows.

As can be seen from table 4 the three countries in this group have overcome their first hurdles in the development of the electric power equipment sector.

In Bolivia and Tanzania most of the goods and services included in level 1 and level 2 have been mastered mainly through license arrangements with developed countries. There are even some entries into the production of medium technology items (level 3).

A general weakness of the industrial structure is reflected in the extremely low utilization levels of the existing capacities.

This is a result mainly of lopsided planning and development of product lines that have a high import content of the produced equipment. For example the import content of the distribution transformers in Tanzania is 50 per cent and of the aluminum conductors 80 per cent.

In this connection an industrial sector programme should give priority to:

- Rehabilitation of the existing financially viable production facilities, maybe by their reorientation towards multipurpose production of both agricultural equipment and electric power equipment;

- Mastering the goods and services from levels 1 and 2;

- Entry into production of medium technology items (level 3).

A genuine start-up of the production of electric power equipment for these countries necessitates technology unpackaging and consequently the development of national engineering capability.

Certain countries belonging to higher development levels, e.g. Brazil, Egypt, the Republic of Korea and Indonesia have established legislation for the purpose, firstly to promote national engineering companies and secondly to ensure that the turnkey approach is not considered the only means for power plants construction. In this context, it should be pointed out that also some group 4 countries (for example Tunisia) are setting up a strategy for technology unpackaging so that they can entrust to the national industry the manufacture of sub-assemblies of low to medium complexity (levels 2 and 3), e.g. metal structures, atmospheric pressure tanks, etc.

In the studies of both Tanzania and Cameroon there is a reference to the need for assistance in negotiating financial packages that allow unpackaging, thus creating a market for local products and services. In this respect learning from the experience of the more developed countries belonging to the higher groups may be of assistance.

The framework for technical assistance aimed at upgrading of electric power equipment production consists in:

(a) Strengthening governmental policies for:

(i) Timely adjustment of the electricity prices and setting targets for self-financing ratios for the utilities.

(ii) Definition of legislation and policies supportive to the active participation of local firms in the:
- Lots of power projects with subsequently increasing complexity;
- Assembly operations and production of spare parts;
- Rural electrification programmes.

(iii) Support to regional co-operation arrangements and to creation of preferential trade areas, e.g. creation of joint production facilities for distribution transformers, electric motors and miscellaneous medium voltage apparatus, etc., situated in different countries and aimed at satisfying the regional demand for that equipment.

(iv) Exploring the external and the internal opportunities for training both for the creation of production skills, e.g. welding, forging, etc., and for operation and maintenance of installations. Specialized technical assistance needed for:
- Training in the operation and maintenance of installations;
- Training in production skills.

(b) Financial and managerial help in the creation of small to medium multipurpose unit, namely:

(i) Multipurpose metal structure and boiler making workshops for production of pylons, tanks, etc.;

(ii) Multipurpose sheet metal and general metal working shops for the production of metal cabinets and boxes as well as metal furniture and equipment for renewable energy sources.

(c) Establishing production facilities for distributed electricity generating systems, e.g. mini-hydro, wind mills, etc.

(d) Upgrading of a country's negotiation power vis-à-vis the external financing agencies through better financial engineering of the project and by mastering national planning activities, engineering consultancy services and project management. The main recipients of assistance should be the state company for the generation, transmission and distribution of electric power as well as the national bodies for planning and project studies. Specialized technical assistance needed for the development of national consultancy services.

4.3.4 Medium sized market, medium capacity

The group includes 13 countries with the following geographical distribution:

- Five from sub-Saharan Africa: Ghana, Côte d'Ivoire, Kenya, Zambia and Zimbabwe.

- Two from Latin America: Cuba and Equador.

- Four Arab countries: Iraq, Tunisia, Saudi Arabia and Syria.

- Two Asian countries: Democratic Republic of Korea and Sri Lanka.

The status and prospects for electric power equipment industry of these countries have not been the subject of earlier UNIDO studies.

The manufacturing capacity of the countries in the group is very heterogeneous ranging from level 2 - low technology items in Kenya and Tunisia up to level 4 - moderately advanced technology items in Zimbabwe (see table 4 for definitions).

In upgrading production capabilities for electric power equipment the following constraints should be relaxed (see also table 3):

(a) Slow development of engineering companies capable of taking part in management and production activities involved in the lots of the unpackaged power projects. International technical assistance projects have been helpful in upgrading the capabilities in the few countries, e.g. Kenya and Côte d'Ivoire, but for the rest of the group this process is still ahead;

(b) The local content of detail engineering is still low, the goal should be to upgrade it to 80 per cent in the civil engineering and the assembly. Training and selective foreign technical assistance can help closing the gap;

(c) Technical assistance can speed up production in sufficient quantities of the full set of products and services included in levels 2 and 3 and in certain cases, as the examples of Zimbabwe and Tunisia show, also of some high voltage equipment (belonging to level 4).

Important implementation stages of the upgrading strategy, suitable for international assistance, would be:

(d) Negotiation of selective financing aimed at encouraging the production of needed electric power equipment;

(e) Elaboration of governmental technological policy supportive to local electric power equipment manufacturing, including the choice and control of imported technology, avoidance of turnkey contracts coupled with the establishment of rules for technological unpackaging, establishment of testing facilities and finally efforts to expand the market through regional co-operation;

(f) Enhancing the role of the government in feasibility studies and in the promotion of new projects, in scheduling public purchasing programmes, adopting protection measures for the local industry, etc.

The activities aimed at enhancing of national planning and project engineering capabilities can in this group also be singled out as an area in which UNIDO should have a substantial role to play.

4.3.5 Medium sized market, low capacity

This group consists of four least developed countries: Bangladesh, Burma, Ethiopia and Zaire, singled out because of their large population.

The status and prospects for electric power equipment industry of these countries have not been the subject of earlier UNIDO studies.

The main element that influences the strategy for upgrading the electric power equipment industry is the substantial potential market. Till now the development of the electricity sector is almost totally dependent on external financing. In this respect the framework for technical assistance in upgrading of electric power equipment production is similar to that of the group 3 countries and oriented towards:

(a) Strenghtening the governmental policies in the:

(i) Timely adjustment of the electricity prices and setting targets for self-financing ratios for the utilities.

(ii) Definition of legislation and policies supportive to the active participation of local firms in the:
- Lots of power projects with subsequently increasing complexity;
- Assembly operations and production of spare parts;
- Rural electrification programmes.

(iii) Exploring the external and the internal opportunities for training both for the creation of production skills, e.g. welding, forging, etc.,and for operation and maintenance of installations. Specialized technical assistance needed for:

- Training in the operation and maintenance of installations;
- Training in production skills.

(b) Financial and managerial help in the creation of production units, namely:

(i) Multipurpose metal structure and boiler making workshops for production of pylons, tanks, etc.

(ii) Multipurpose sheet metal and general metal working shops for the production of metal cabinets and boxes as well as metal furniture and equipment for renewable energy sources.
- Electric cable and wires factories;
- Shops producing distribution transformers;
- Establishing production facilities for distributed electricity generating systems, e.g. mini-hydro, wind mills, etc.

(c) Upgrading of a country's negotiation power vis-à-vis the external financing agencies through better financial engineering of the project and by mastering national planning activities, engineering consultancy services and project management. The main recipients of assistance should be the state company for the generation, transmission and distribution of electric power as well as the national bodies for planning and project studies. Specialized technical assistance needed for the development of national consultancy services.

The activities aimed at developing and enhancing national planning and project engineering capabilities can be singled out as areas in which UNIDO can strengthen its role.

An example of this kind of assistance would be the study on integrated energy/industry planning for the African countries presented in section 4.3.1.

4.3.6 Large market, large capacity

The group includes 15 countries with the following geographical distribution:

- Four from Africa: Algeria, Egypt, Morocco and Nigeria.
- Five from Latin America: Colombia, Chile, Peru and Venezuela.
- Six from Asia: Indonesia, Iran, Pakistan, Philippines, Thailand, and Turkey.

The status and prospects of electric power equipment industry for 5 countries from the group namely: Algeria, Colombia, Egypt, Indonesia and Pakistan, have been subject of earlier UNIDO studies. That distinguishes this group as the most studied one among the 11 country case studies conducted by UNIDO. The accumulated empirical evidence will be used throughout the discussion that follows.

As a common characteristic of the countries in this group, industry accounts for 15 to 20 per cent of the GDP, with some countries experiencing a relatively long industrial history.

The countries have already developed the nucleus of electric power equipment industry, including most of the moderately advanced technology items (level 3) and for some countries, e.g. Algeria, Colombia and Pakistan, entry into the level 5 - high technology items (see also table 4).

The main efforts in upgrading electric power equipment industry would be linked to the development of the main fairly capital intensive industrial supporting branches, namely iron and steel metallurgy, non-ferrous metals industry, production of electronic measurement devices, etc. To the above should be added the extension of countries heavy infrastructure: forging, heat treatment, etc., needed for full-fledged electric power equipment production.

Also a lot remains to be done for improving the products quality, increasing the utilization of production capacity needed in order to achieve a step wise increase of production volumes.

An example of assistance aimed at improvement capacity utilization rates is the recent joint Egypt/Federal Republic of Germany project on rehabilitation of the Egyptian industry. A major component is the updating of the manufacture of transformers, transmission towers and other capital goods related to electric power equipment production. The transfer of technology from the German company KWU to the respective Egyptian authorities is an important part of this project.

For the countries of this group in general it can be claimed that the country energy strategies are based on the continuation of their electrification programmes, particularly rural electrification, and the implementation of this strategies should bring about substantial demand for electric power equipment.

External assistance in upgrading the industry can be oriented towards relaxation of some of the following constraints (see also tables 3 and 6):

(a) Elaboration of governmental policy supportive to the:

- Promotion of national engineering capability;
- The choice and control of imported technology;
- Establishment of rules for technological unpackaging;
- Establishment of research centers and testing facilities;
- Efforts to expand the market through regional co-operation.

(b) Enhancing the role of the government in:

- Feasibility studies;
- The promotion of new projects;
- Scheduling public purchasing programmes;
- Adopting protection measure for the local industry, etc.

(c) Development of a policy framework for:

- Attracting the private and public capital needed;
- Improving the mobilization of domestic public resources, particularly by the utilities;
- Timely adjustment of the electricity prices;
- Setting targets for self-financing ratios for the utilities.

(d) Organization of a subcontracting network to inv ive the small- and medium-scale enterprises into the longer-term plans for electrification.

(e) Promotion of the joint ventures aimed at technology transfer and opening up of re-export opportunities.

4.3.7 Very large market, very large capacity

The group includes: Argentina, Brazil, People's Republic of China, India, Republic of Korea, Mexico and Singapore.

The status and prospects of electric power equipment industry for 3 countries from the group namely: India, Republic of Korea and Mexico, have been subject of earlier UNIDO studies.

Driven by various development strategies, the electric power equipment industry in the countries of the group have reached a mature level, including most of the manufacturing capacities needed for level 5 - high technology.

Recent developments suggest that the last barriers of entry into the higher level 6, very high technology items, namely the production of complete standardized nuclear power plants, are soon going to be overcome.

It is being reported[3/] that the bid for two 900 MW nuclear units in the Republic of Korea contains an unusual clause - "In order to facilitate the transfer of technology, the reactor will be designed jointly by the foreign contractor and the South Korean counterpart. Yet the foreign company must assume full liability for any design flaws - a large responsibility in the case of nuclear reactors."

This condition can be considered as full exploration of the capabilities of the existent "buyer's" market aimed at forced technology transfer.

The above example illustrates that each of the countries from the group is able to formulate its own strategy for the development of electric power equipment industry.

In formulating the possible areas for technical assistance basically two sub-groups of countries should be considered:

- Countries with a huge and unsaturated market, e.g. India, Mexico and the People's Republic of China;

- Countries that have a limited internal market and are pursuing aggressive export oriented policies, e.g. Republic of Korea and Singapore.

For strengthening the country's technological and organizational capabilities in the first group, international assistance could be sought, while in the second, the attention may be devoted to questions of industrial restructuring and to international division of labour.

3/ Financial Times, 4 June 1986.

5. MAIN RECOMMENDATIONS FOR INCREASING PRODUCTION CAPABILITIES OF ELECTRIC POWER EQUIPMENT IN DEVELOPING COUNTRIES

5.1 General framework

The UNIDO concepts "energy for industry" and "industry for energy" exemplify the strong linkages existing between the electric power equipment industry and almost all other sectors of the national economy. These characteristics, in turn, make it necessary to plan electric power equipment development together with the other sectors which it links, which constitutes an integrated planning approach.

The integrated energy industry planning should be developed around some basic questions:

(a) What are the national economic, social, political, and other development objectives?

(b) What are the capabilities already existing in the country and what are the possibilities for their consolidation and improvement?

(c) What is the total future demand for capital goods including the intermediate demand and the industry's requirement for reproduction?

(d) Can the output of existing capital goods industry meet the total future demand and if not what will be the cost of imports?

(e) If an import substitution policy is adopted, what will be the additional production facilities required?

(f) What will be the additional financial, technological, human, etc. inputs required by the capital goods industry to meet anticipated demand?

(g) What will be the options for utilization of the country's resource endowment as a substitute for imported inputs?

(h) What will be the policies and strategies to be adopted in order to achieve planned targets?

The answer to these basic questions can be reached through an iterative procedure for assessment of options and constraints till the feasible path is found. This process represents, for a medium-size developing country with some level of industrialization, a huge but necessary task. For the least developed countries an additional complication is the selection of entry routes into production.

The specific problem of the higher levels of electric power equipment industries is that they require long periods of gestation, heavy initial capital outlays (a substantial proportion of which may be in terms of foreign exchange for imported machinery), low profits, transfer of technology from developed or other developing countries and high degree of skills for managers, engineers and artisans.

On account of those factors it is essential to take a policy decision as to which areas should be covered by the public sector so that the overall industrial progress does not suffer from the typical for private sector

attitude: shifts of priority sectors and subsequent avoidance to take up difficult, complex or low profit items.

The policy decision can be facilitated by the establishment of a flexible system of micro planning activities. The micro level activities for planning and development of capital goods industry should cover the following:

(a) To design a flexible methodology suitable to the country for projecting sectoral demands of capital goods based on international codes for special purpose machinery, for priority process industries, service industries (e.g. electric power equipment), for general purpose machines and infrastructure facilities such as casting and forging.

(b) Classification and codification of all capital goods relevant to selected sectors to suit technological parameters anticipated to be used in industry in future.

(c) Computation of demand for capital goods as codified, for selected priority sectors.

(d) Aggregation of the above sectoral demand with the help of a computer programme from the point of view of manufacturing facilities.

(e) Analysis of the present and proposed capacity for selected capital goods in public and private sector establishments in the context of anticipated national demand and recommendations for priority determinations.

(f) Recommendations for optimum utilization of installed capacity for capital goods in public and private sectors.

(g) Establishment of investment programmes in public and private sectors.

(h) Study of policy considerations for the development of capital goods industry and definition of instruments for policy needed to stimulate and promote it.

(i) Carrying out feasibility studies based on the above and making recommendations to attract the needed investment and technology.

The creation of an experienced and efficient planning team and a mechanism of policy implementation is a long-term undertaking that has a substantial accelerating effect on the industry's upgrading and as such deserves the standing attention of governments and of concerned international organizations.

5.2 Conceptual framework

The conceptual framework for required technical assistance, given in section 4.3 could be best understood in the context of the two basic typologies elaborated in chapter 2, namely the typology of the developing countries and the grouping of electric power equipment products and services into 6 levels of increasing technological sophistication (see also table 1 and 4). In this context the case studies have identified a positive correlation of the two variables, thus revieling a relationship between the accumulation of countries industrial capabilities and the increased sophistication of produced electric power equipment.

This relationship has been used for elaboration of general framework for policy formation and formulation of needs for technical assistance that aim at upgrading of electric power equipment industry in different country groups through removing the existent constraints to its development.

The summary of the constraints in regard to governmental policies, financing, quality control, consultancy services and assembly and maintenance of electric power equipment for each country group is presented in table 3. Short evaluation of the production capabilities is also presented there.

From the elaborated framework, presented in details for each group of developing countries in section 4.3 above, can be concluded that the main factors influencing the upgrading of electric power equipment industry are: policies adopted by the principal national agents, the existence of linkages with the country's capital goods industry, the existence of long term commitment to technological and manpower development and finally the availability of external assistance and international co-operation. The implementation strategies for upgrading electric power equipment industry related to country groups for some of the factors mentioned above is presented in table 6.

Table 6. Implementation of strategies for upgrading electric power equipment industry

	The principal agents	Linkage with the capital goods industry	Technological policy and training	Needs for assistance and co-operation
Very small market/low capacity Group 1	(1) The government to: - Implement financing - Negotiate technical assistance (2) State company for the generation, transmission and distribution of electric power (3) National bodies for planning and project studies (4) Assembly and civil engineering enterprises	(1) Multipurpose engineering maintenance workshops that can be used for other sectors (2) Multipurpose sheetmetal and general metalworking shops for the production of metal cabinets and boxes as well as metal furniture and equipment for renewable energy sources	- Specialized training in maintenance - Training for energy planning studies, financial engineering of power projects	- Specialized technical assistance for training in the operation and maintenance of the installations - Specialized technical assistance for the development of national consultancy services
Small to medium market/low capacity Group 3 Group 5	(1) The government to: - Implement financing - Promote specific training - Negotiate technical assistance (2) Assembly and civil engineering enterprises (3) Electric cables and transformers enterprises	(1) Multipurpose metal structure and boilermaking workshops (pylons, tanks) (2) Multipurpose sheetmetal and general metalworking shops	- Specialized training in electrical trades - Specialized training for planning and for project studies, etc. - Policy for the search for partners for technical assistance and regional co-operation	- Specialized technical assistance for training in electrical trades - Specialized technical assistance for the development of national consultancy services
Medium-sized markets/low to mdeium capacity Group 2 Group 4	(1) The government to: - Programme public purchases - Temporary protect the infant industry - Define technological policy (2) National engineering companies (3) National industrial enterprises (4) Enterprises in industrialized countries and NICs	(1) Development of the infrastructure (foundry, forging, machining) (2) Development of specialized subcontracting (heat treatment surface coatings)	- To develop negotiation capacity - To select the technologies to be imported - Technological unpackaging	- Acquisition of technology abroad for the development of a national electric power equipment industry Partners: - Enterprises in the NICs
Large markets/ large capacity Group 6	(1) The government to: - Promote national engineering capability - Promote a capital goods industry - Programme public purchases (2) National engineering companies (3) Industrial enterprises (4) Transnational corporations	- Iron and steel - metallurgy - Heavy infrastructure - Subcontracting	- R, D+D centres - Plan for the development of a capital goods industry - Policy for the acquisition of technology	Partners: - Small and medium-scale enterprises in the industrialized countries - Transnational corporations

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Upgrading of the electric power equipment industry in developing countries

		(please check appropriate box) yes	no
(1)	Were the data contained in the study useful?	/_/	/_/
(2)	Was the analysis sound?	/_/	/_/
(3)	Was the information provided new?	/_/	/_/
(4)	Did you agree with the conclusion?	/_/	/_/
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