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RMA/ROM-IP-01

COMPONENT #1: INDUSTRY PROFILE REPORT - ROMANIA

DECEMBER 1991

U.S. EMERGENCY ENERGY PROGRAM FOR EASTERN AND CENTRAL EUROPE

(USAID Project #: 180-0015)
(USAID Contract #: EUR-0015-C-00-1006-00)

Resource Management Associates of Madison, Inc.
Madison, Wisconsin, U.S.A.

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PREFACE

This is a working document published informally by Resource Management Associates of Madison, Inc. (RMA). To present the results of the project with the least possible delay, this trip report has not been prepared in accordance with the procedures appropriate to our formally printed documents. The report has received only light review, in the interest of timeliness.

This work is being carried out within the framework of the U.S. Emergency Energy Program for Eastern and Central Europe under an RMA contract with the U.S. Agency for International Development.

Table of Contents

i. Program Description 1

ii. Executive Summary 3

1.0 Introduction 6

2.0 Industrial Energy Efficiency in Romania 7

3.0 Decision Making Practices for Capital Investment 13

4.0 Management Practices 15

5.0 Program Structure 17

List of Tables

Table 1
Plant Energy Efficiency Opportunities 8

List of Appendices

Appendix A
Recommendations for a Long-Term Energy Efficiency Program

Appendix B
Supporting Data

Appendix C
Penalties for Exceeding Energy Allotment

Appendix D
Letter of Intention - Bucharest Polytechnic

Appendix E
List of Abbreviations

i. Program Description

The Industrial Energy Efficiency Component of the Eastern Europe Emergency Energy Program was designed to address the problems of industrial energy efficiency with a short term program aimed at the immediate needs of Romanian industry. The program addresses three main areas:

1. To identify and implement cost-effective low-cost\no-cost energy improvements with emphasis on oil savings.

2. To conduct energy audits and transfer energy auditing and management techniques, including financial and economic analysis.

3. To provide energy auditing and/or energy efficiency equipment to implement the program objectives, improve energy management, and identify additional energy efficiency opportunities.

The program deliverables consist of plant audit reports, a policy and institutional analysis report, this industry profile report, and the in-country audits, training, and equipment delivery and installations. The tasks are being carried out by a team of energy specialists and policy analysis experts in four distinct phases:

- Phase One Screening - During this phase the plants to be audited were identified, the host country counterpart agency identified, and a specific plan to implement the following phases was developed and put in place.

- Phase Two Industrial Plant Energy Audit/Training - A team of energy specialists performed a detailed energy audit at eight selected industrial sites. They identified short term energy efficiency measures, developed recommendations to implement these measures, demonstrated and trained plant personnel on auditing techniques, and demonstrated financial and economic methodologies to justify energy improvement projects. Energy auditing equipment was used to measure energy consumption and to help ascertain cost effective energy improvements.

- Phase Three Implementation - The energy conservation recommendations for each of the eight plants that were identified in Phase Two will be implemented and evaluated. Additional plant staff training will be provided and the final energy efficiency equipment turned over to the host country.

Phase Four Analysis of Factors - This phase will analyze the factors that make up energy efficiency management and investment decision making. Recommendations for policy reform and options for enhanced energy management will be identified and a program of implementation described.

The Industrial Energy Efficiency Component will complete project objectives to supply energy monitoring and testing equipment to the Romania Industrial Sector and GOR; and to provide the GOR with analysis and recommendations for further energy efficiency measures.

ii. Executive Summary

This Industrial Profile Report illustrates the current energy environment in Romania by examining industrial energy efficiency, decision making practices for capital investment, and management practice. In addition, recommendations for a long-term energy efficiency program are presented in Appendix A. The key findings are summarized and follow below.

Industrial Energy Efficiency - The Romanian technical community is well educated and very capable of maintaining production levels with outdated industrial facilities. They are eager and ready to accept new technology and to progress toward privatization. The industrial facilities audited can be categorized as large, centrally planned and energy inefficient. It is apparent that energy inefficiency has been accepted as a condition for maintaining production quotas. Four main areas of deficiencies are the root cause:

1. Incentives - Adequate incentives are not in place for all sectors: industrial consumers, energy suppliers and the Government of Romania (GOR).

2. Capital - There is a severe lack of capital available for investment in energy projects.

3. Technology - Romanian industry has been cut off from access to modern technology since 1975. Technological improvements are needed at every industrial site.

4. Sponsorship - There does not exist a capable and proactive sponsor for industrial energy efficiency.

5. Organizational Structure - Most enterprises have a strict "top-down" structure that inhibits implementation of energy efficiency opportunities.

The Romanians are aware of the problem areas and are moving to correct these deficiencies primarily through the investigation and limited adoption of foreign methods. Underlying these actions is a fundamental awareness that energy efficiency is the right direction, they are just unsure how to proceed. In order to accelerate this process, foreign expertise will be required for the next two to five years.

Decision Making Practices for Capital Investment

Romania is emerging from a firmly controlled, centrally planned economy. Most plant managers are not adequately prepared to make investment decisions which will modernize the industrial base and bring about improvement in energy efficiency. In fact, the majority of plants do not even have a capital improvement budget. There is still a strong tendency for plant managers to rely on central ministries for direction and guidance. Basic concepts,

such as retained earnings for capital improvement, are not well accepted. There is a strong tendency to look only at major process or manufacturing improvements as a way to reduce costs and become more competitive. Many plants do not have a thorough understanding of the costs of production, and of potential areas of improvement. This is particularly true of energy utilization and potential efficiency improvement. Therefore, the decision making process needs to be streamlined and concentrated more at the plant level. Plant managers need training in the capital investment decision making process and in project evaluation techniques.

Management Practices

The findings regarding energy management practices parallel the decision making practices. Plant management tends to concentrate authority and responsibility at the very top levels. Romanian enterprise is managed by a heavily bureaucratic system of Ministries, Enterprise Board of Directors and Plant Directors. The decision making process is unclear and often unresponsive, with responsible individuals unsure of their authority and accountability. This makes it difficult for plant managers to set priorities and to make effective decisions. Decisions regarding immediate production needs take precedence over long range planning, and lower priority needs do not receive the proper amount of attention. Energy efficiency usually falls in this latter category. It is sometimes difficult for knowledgeable technical staff to gain the attention of plant management regarding potentially sound energy investment projects. The plant managers interviewed recognize their limitations, but are not comfortable with sharing authority and information as of yet. This will come about, but slowly and only with considerable training.

Program Structure

The Industrial Energy Efficiency Program was well designed to meet the immediate needs of the industrial sector for improved energy efficiency. Primary strengths were the following:

1. The program was designed to be a fast track program which was able to bring expertise, advanced equipment, and modern concepts of energy efficiency directly to the users (industrial facilities) who need it most.

2. The program was concentrated on problems (low-cost\no-cost) which could be remedied with expertise and equipment at hand. Significant potential for improvement was demonstrated while the teams were on-site.

3. Clear and identifiable immediate benefits were realized by the host country. The energy efficiency equipment was turned over quickly and training was provided on site.

4. A clear commitment and program structure was established for the next phase (implementation and training).

The only significant weakness in the program was simply the enormity of the task at hand, with limited resources. The needs of the country far outweighed the ability to cover it adequately.

USAID Long-Term Energy Efficiency Program

It is strongly recommended that USAID consider sponsorship and funding of a long-term energy program. RMA envisions the program would address three main areas: 1) technology transfer; 2) capital for demonstration energy projects; and 3) institutional strengthening. The program is further defined in Appendix A. We believe that USAID has a unique opportunity to develop a comprehensive program of technical assistance which would give Romania a much needed boost toward energy efficiency, and the resulting push toward privatization and economic self sufficiency.

1.0 Introduction

Romania is emerging from a fifteen year period of virtual isolation from access to modern technology. This isolation is evident in all manufacturing and operational processes, and particularly in the area of energy management. This report will illustrate a general profile of energy utilization, energy technology, energy management, and decision making processes.

The data, both quantitative and qualitative, was gathered after approximately eight weeks in-country. The principal sectors which were visited to accumulate this data are the following:

- Governmental - The Ministry of Resources and Industry, Romanian Agency for Energy Conservation, RENEL (National Power Company), Metallurgical Research Institute, and the Institute for Food Chemistry Research.

- Academic - The Romania Polytechnic Institute, Department of Energetics.

- Private - Eight industrial sites:

  - Two power/thermal plants
  - One heavy steel products manufacturing
  - Two agricultural (soybeans and fertilizer)
  - One food products (milk products)
  - One pulp and paper plant
  - Two heavy industries (iron & steel and cement)

- Other - U.S. Embassy, Economics Section

In all cases, the representatives and officials were open and forthright with respect to their problems and goals for more efficient energy utilization. While the classic parameters of demand side management are not well known, most officials had a good understanding of efficient versus wasteful energy practices. They were also extremely cognizant of their lack of knowledge concerning modern techniques for energy management, and anxious to learn about new methodologies and technologies. The atmosphere was very receptive and open to our mission.

Assembling quantitative information for this report was complicated by the lack of verifiable historical data. Past records were artificially maintained to demonstrate suitable performance against production and energy allocation quotas. Much of the data appears unsubstantiated, yet there is no other source. Most officials would verify this problem, but could offer no suitable alternative. Therefore, this report contains analysis based primarily on a relatively short in-country exposure, and observations from numerous officials in a wide range of sectors.

2.0 Industrial Energy Efficiency in Romania

The environment for industrial energy efficiency in Romania is outdated and only marginally effective. While the basic concepts are understood and accepted, efficiency of energy utilization is not actively pursued or practiced. The following factors have influenced the present situation:

1. Lack of Incentive - Few incentives are in place to encourage or support energy efficiency. Even penalties are only marginally effective.

2. Lack of Capital - Most Romanian plants operate without an established capital improvement budget, and management does not practice conventional project economic analysis. Foreign equipment and technology is beyond the reach of most industries to acquire.

3. Lack of Technology - The country has been closed off to outside technology since about 1975. Modern methods of energy efficiency and energy efficient process equipment are not well known. The necessary import mechanisms are not established to acquire foreign equipment and technology.

4. Lack of Sponsorship - No organization within the country actively promotes energy efficiency.

These four areas are described in further detail. *Table 1* illustrates the plants that were audited, potential energy savings, and the primary technological areas in need of improvement.

Incentives

This is probably the major contributing factor to the present energy environment in Romania. There are virtually no incentives in place to promote energy efficiency, and even penalties are only marginally effective. A brief description of how energy has historically been produced, distributed and utilized follows.

Production/Distribution - Electrical energy is produced and distributed through a conventional system of block power facilities and transmission lines. Combined cycle plants (cogeneration) are widely used at industrial sites/towns to provide district thermal heating for flats and domestic hot water. Gas pipelines distribute gas for industrial and domestic use throughout the country. Oil pipelines and rail tankers distribute fuel oil primarily for industrial use. Appendix B profiles energy production. No incentives are in place for producers and distributors to encourage conservation of energy. In fact, most energy production is not even monitored accurately. Oil and gas rates are strictly based on

Table 1. Plant Energy Efficiency Opportunities

FACILITY	Combustion Controls	Steam Systems	Electrical	Waste Heat Recovery	Automated Controls	Energy Eff. Equip	Energy Mgmt. Program	Improve Turndown Capablility
Urzicheni	O	O	O	#	X	O	O	#
Bucharest	#	X	O	O	O	O	#	#
Galatz	X	X	O	X	X	X	X	X
Brailia	X	X	X	X	X	X	X	X
GRIRO	O	O	O	O	O	#	O	#
South Bucharest	O	O	#	O	#	O	O	#
Cimpulung	X	X	X	X	X	X	X	X
Craiova	X	X	X	X	X	X	X	X

Notes:

X - Denotes energy efficiency improvement greater than 10%

O - Denotes energy efficieny improvement of 5 - 10%

- Denotes energy efficiency improvement less than 5%

consumption and distribution costs. No fuel multipliers are used. Electric rates are set basically at fixed industrial and residential consumption rates, with the residential rate being heavily subsidized.

Electric rate structuring is based almost solely on consumption and demand charges are not levied. Time-of-day use rates are not practiced, and a limited amount of on-peak, off-peak rate differential is practiced sporadically.

Utilization - Energy utilization has been regulated on an allotment basis in the past, and the guidelines for this allotment are still practiced. Each plant is allocated a quantity of energy based on established energy intensity guidelines. If the plant's production meets certain quotas, the energy allotment is established accordingly. There are no incentives for attaining established levels of production with less energy. In fact, it can be argued that a disincentive exists since the energy allotment may be reduced for attaining increased efficiency. Past practice has been for the plant operating personnel to inflate their energy requirements so as to ensure enough energy would be available to meet the production quotas. This practice is still in existence. Since the conventional profit incentive has not existed, energy costs were passed on as a part of product pricing. In fact, reduced energy costs would have required a corresponding decrease in product pricing, leaving no gain for the industrial user at all. Instead, the plant would face exposure to possible shortages of inputs necessary to meet production quotas. Some minor disincentives do exist, including a power factor penalty and peak consumption electric rates, but these are not significant factors in energy usage. There is a theoretical penalty for exceeding the energy allotment (see Appendix C), but in practice the allotment is set high enough that these penalties are rarely enforced.

In summary, both the adoption of incentive programs and the removal of disincentives are necessary to promote energy efficiency. Incentive programs would be based on economically justifiable investment to promote energy efficiency, not on subsidies or directives. Until these incentives are in place there will be little impetus for industry to invest in energy efficient equipment and technology. In addition, energy producers/distributors will continue to be unable to manage the supply situation.

Capital

Foreign capital is in short supply. The past government completely closed off industry to foreign capital and the acquisition of foreign equipment and technology. The current policy allows a company that earns foreign capital to retain half for its own use. Most foreign capital is used to import the raw materials necessary for production. Most of the companies visited did not have a capital improvement budget, only a maintenance and repair budget. However, with the new guidelines, the plants will soon have limited foreign funds to invest in plant modernization and upgrades. Since foreign capital is scarce, most will probably be allocated for production improvement. This does represent an opportunity to acquire energy efficient equipment and technology as a part of plant upgrades, however, it is doubtful that

purely energy efficiency projects will be funded. This is particularly true with the unstable energy pricing and allocation situation.

Technology

Most Romanian plants use outdated production and energy utilization technologies. Our audits showed the following major deficiencies:

1. Combustion Monitoring and Controls - Lack of monitoring and controls is probably the biggest contributing factor in inefficient energy utilization. Combustion monitoring is virtually non existent, as are combustion controls. Even major combined cycle plants (~500MW range) tune their steam boilers by 'feel and experience' - flame color and occasional ORSAT analysis only. Major improvements are possible throughout the country at every boiler, furnace, and fuel fired piece of equipment. The first step would be more accurate monitoring, followed by the introduction of controls and automation. A conservative estimate would be to assume that the entire industrial base consumption of fuel oil and fuel gas could be reduced by 10% or more, simply by installing adequate combustion controls.

2. Steam Systems - Improvements are possible in the following areas: better insulation, condensate recovery, automated controls, boiler upgrades, and system balancing. Many companies did not have an accurate idea of how steam was utilized and consumed. Basic heat and material balances are often non-existent. Our audits showed 20% and higher savings are possible through steam system maintenance and upgrades.

3. Electrical - Improvements in power factor and motor efficiency are potential areas of energy efficiency. This is an area where the power producers should modify their policies, i.e. substantial penalties and/or incentives.

4. Waste Heat Recovery - Generally the concept is well applied, however, additional waste heat recovery is possible. New equipment would increase the overall recovery rate at many plants. A more thorough analysis of heat and material balances at major plants would highlight these opportunities.

5. Automated Controls - This is another major area of opportunity. While the cost incentive is lower here due to a vast pool of inexpensive labor, the opportunity for increased efficiency and energy reduction is significant.

6. Energy Efficient Equipment - Most manufacturing equipment is technologically out of date. New equipment and manufacturing techniques would reduce energy intensity in all sectors.

7. Energy Monitoring - All plants could benefit from a plant wide energy management program consisting of monitoring, control, and general management. Modern methods of instrumentation to gather information, and computerized reporting and management would provide the information necessary to track energy consumption and to establish programs of energy reduction and allocation. Most plants are not even aware of how energy is utilized within their own facilities.

8. Turndown Capability - Romanian industry can be categorized as large and centrally planned, with plant design, equipment and technology oriented towards maintaining full production. All the plants that were audited were operating at 50% capacity or less. Yet, the equipment and technology were not designed to run at these low production rates. The result is large equipment running on heavy recycle rates and/or utilizing excessive amounts of energy per unit of production. Several plants had virtually constant energy consumption regardless of production throughput. This will be a major decision area as plant managers decide where, and if, to invest in new capital equipment.

All of these areas represent an opportunity for the industrial base to modernize and increase production while decreasing energy intensity and consumption. The technologies and equipment are readily available in the U.S., and the plant operating personnel are open to the introduction of modern techniques and equipment.

Sponsorship

The only government organization actively concerned with energy efficiency is the Romanian Agency for Energy Conservation (AEC), under the Ministry of Resources and Industry. However, their role is more of a watchdog agency concerned with reporting and monitoring energy use. In the past, the AEC has directly influenced plant operations by its authority to recommend penalties and set energy allocations. Under the new government, much of their authority has been diluted, and attempts are being made to change the role of the agency to one of promoting energy conservation and technology. However, these efforts have met with only limited success. Because of their past role, many enterprises are suspicious and unwilling to work with their agents. The AEC has no more access to modern technology or capital than the industries being monitored, thus they have little to offer a company trying to increase its efficiency. In fact, AEC's past role in policing energy intensity standards has created a fundamental adversarial relationship with the companies now starting to privatize. There is still a concern that AEC will cut allotments or cast the company in a unfavorable status as it attempts to privatize. Thus the need for a proactive entity which could offer the emerging private sector some assistance with energy efficiency still exists. There is the potential to change the role of the AEC and to assist energy

producers with an active program of energy efficiency incentives and assistance. However, this will require foreign technical and financial assistance for at least several years.

Summary

Industrial energy efficiency in Romania is perhaps ten to fifteen years behind the U.S in terms of technology and equipment, and even further behind in management and government policies. However, the climate is ripe for rapid adjustment. The following conditions would accelerate the adoption of energy efficiency measures:

- Technical Assistance - Technical assistance still needs promotion and sponsorship in all industrial sectors. Key components include direct contact between newly privatized industry and U.S. suppliers; cooperation with U.S. universities; and the creation of non-government organizations (NGO) which could establish cooperative agreements with U.S. societies and professional energy management organizations. The Polytechnic University of Bucharest has expressed interest in rapidly upgrading its curriculum through exchange programs with U.S. universities (See Appendix D).

- Capital - Potentially available through International Financial Institutions loans. This would require the establishment of clear GOR policies with respect to foreign investment to encourage American suppliers and businesses to invest in Romania. The potential exists for Build-Operate-Transfer (BOT) and Build-Operate-Own (BOO) projects to modernize Romanian industry.

- GOR Policies - Establishment of energy incentive price reform and regulatory changes would help provide incentives for energy efficiency. Encouragement of GOR agency reform to adopt a proactive energy efficiency stance and the creation of partially GOR supported NGOs to promote energy efficiency are possible.

Continued foreign assistance will be needed in all these areas to assist the GOR in rapidly adopting energy efficient measures.

3.0 Decision Making Practices for Capital Investment

Romania is emerging from a centrally planned economy to a partial free market economy which will be competing with other emerging Eastern Europe economies, and with the world economy as a whole, for foreign capital and markets. In order to accomplish this transition, the concept of capital investment will necessarily rest more and more with private enterprise. Some of these private entities are open and enthusiastic about planning their own destiny and are ready to compete. However, most are not. In order to assess the present climate for decision making practice, industrial history shall be reviewed.

Historical Investment Practice

Romania industry functioned within a strict centrally planned economic system. Decisions regarding capital investment were made at a central ministry level with little regard for the needs of individual plants. Even the smallest capital improvements were evaluated and decided upon at the central level. Inquiries about this system produced predictable responses. Most plant managers felt that their needs were ignored and recommendations for improvements at the plant level were not recognized. Instead, central planners dictated to industries as a whole. For example, the Urzicheni Soybean Processing Facility was required to make certain changes to the process based on modifications to other facilities. The central planning authority dictated the change to all soybean processing facilities, even though they used different equipment and processes. The change at Urzicheni actually resulted in a decrease in capacity. Plant staff were forced to reverse the modifications using their own repair/maintenance budget, but did not report the activity. Yearly production quotas were still met so as to please the central planners. Judging by the operation and location of Romanian industry, capital investment decisions appear to be primarily politically motivated rather than economically justified. This concept was expressed by all of the Romanian government and industry people who were contacted by this program.

The most far reaching effect of this practice is that managers at the plant level do not have a good understanding of the decision making process, and are reluctant to accept the responsibility. There is still a predominant atmosphere of waiting for direction on investment decisions. Even with available capital, managers are hesitant to commit to investment decisions, preferring to seek guidance from central ministries. The economy as a whole is still very much regulated in some sectors which has a limiting effect on all sectors. For example, a private company which maintains its own power plant and produces power and thermal energy for export cannot set its own export prices, and often must sell energy at an economic loss. It is dependent on regulatory agencies which have no clear policy. Thus, capital investment in this area is non-existent without a clear and defined price structure and policies for adjusting prices. Until this situation changes it will be difficult even for aggressive managers to accurately make investment decisions.

Current Investment Practice

The GOR is gradually loosening the restrictions on private capital investment. Unfortunately, they have removed almost all restrictions and subsidies on supply costs, while continuing to regulate the prices of products and services within the country. This has the effect of squeezing most companies between rising costs of production and restricted prices of products. As a consequence, most companies are actively seeking to export their products to earn convertible currency. In this manner, foreign capital is starting to flow directly to private companies. The GOR has established an income sharing policy whereby a private company is allowed to retain half of the foreign capital it generates, subject to a corporate income tax. The company is free to make its own investment decisions with this capital. This has both benefits and drawbacks. The primary benefit is the potential for modernization it gives to the company, free of GOR intervention and uninformed central planners. The drawback is that few companies are prepared for this responsibility and are also ill equipped with the decision making tools and methodologies to make the right decisions. Even the concept of retained earnings for capital investment is new to many managers.

The immediate impact on energy conservation and efficiency projects will be minimal. Romanian industry is understandably interested in increasing production, quality, and automation. Energy is viewed as a secondary constraint. However, the increasingly independent investment climate also creates new opportunities to attach energy efficiency projects to other capital projects. What is needed to motivate this activity is the following:

1. Clearly defined GOR regulatory and policy environment. If the rules are clear, management can make sound investment decisions based on energy efficiency.

2. Available sources of information on U.S. technology and products need to be accessible, and actively promoted.

3. Training for plant management staff on the capital investment decision making process.

There is a very great opportunity for U.S. suppliers in Eastern Europe at this time. By providing some guidance on policy and training in capital investment decision making, USAID can set the stage for U.S. business opportunities and the growth of sound decision making practices in the country.

4.0 Management Practices

Many of the energy management practices in Romania are a corollary to the investment decision making practices described previously. The concept of a centrally planned society and economy permeates down through the plant structure as well. Some key observations:

1. Decision making within the plant tends to be concentrated at the top, residing with the Plant Director or his key management staff. The concept of delegation of authority is almost non-existent. This results in severely restricted flow of information. Decisions are not questioned, operating personnel do not participate, and there is no incentive for contributing new ideas to improve the operation. Even the smallest decisions are usually passed on to the very top management, who often have neither the time nor the knowledge to make informed and timely decisions.

2. The Plant Directors tend to rely on the Central Ministry to provide overall direction for the facility, and to set standards of production. Many Plant Directors were queried about their ideas to improve production. All deferred to their respective Ministry to address the question. Few managers felt that they had the authority to institute production improvement at their respective plants without direction from the Ministry. Even within the hierarchy of management (i.e., Plant Director to Board of Directors to the Ministry) the assignment of responsibility and authority is unclear. In many respects, the system is designed to dilute responsibility. Unfortunately, it also inhibits informed decision making and timely responses.

3. Most plants are severely overstaffed, some with 100% excess personnel. Plant management realizes that this situation has to change, but have not pushed for staff reductions. They appear to be waiting on direction from the Ministry.

4. All plant managers are hampered by a lack of production information, particularly with respect to energy consumption. They know the plant output and overall energy usage, but are largely uninformed about specific in-plant usage, bottlenecks, energy wasters, etc. The common reason is lack of metering and control, but there is also a lack of any comprehensive in-plant energy program.

5. The enterprise organizational structure is somewhat fragmented into illogical groups which rarely communicate with each other. For example, we often found that the responsible energy engineer was placed in the organization far removed from either production or maintenance. Thus, his role was reduced

to that of maintaining records, not actually 'managing' the energy consumption of the plant.

Another important observation is the apparent unwillingness to take on responsibility and authority. Most plant management will cite the constraints put upon them by their respective Ministries, yet have done little within their sphere of authority to change matters. Virtually no incentives exist in any of the plants to improve the operation, and managers have shown no inclination to initiate such programs.

Until the general environment of management practice changes to a more proactive one, changes will come about slowly. More importantly, as plants acquire new capital and responsibility, investment decisions are in danger of being based on conservative methods which minimize risk and liability, rather than on growth potential. The political and social impact of major staff reductions will also influence decisions to improve efficiency and productivity.

5.0 Program Structure

The Industrial Energy Efficiency Program was well structured to meet the immediate needs of the industrial sector for energy efficiency. The basic concept of no-cost\low-cost improvements was sound and applicable. The following summary findings are offered:

1. Romanian industry tends to be centrally concentrated in large facilities under the direction of a particular sectoral ministry. Therefore, this program addressed large facilities.

2. The program was not designed with enough resources to do a thorough energy audit of such large facilities. Efforts were concentrated on those areas identified as having the largest impact on energy efficiency, and which could be replicated throughout the facility and in similar plants.

3. This program is only a 'first step' in the process of improving energy efficiency. Much of our efforts have only laid the basic groundwork in identification of energy efficiency opportunities.

4. Program efforts were concentrated on basic energy monitoring, data gathering, and supplying monitoring equipment to the GOR. The next logical steps are: 1) introduction of advanced control systems; 2) installation of energy efficient equipment; and 3) adoption of energy management methodologies. In Romania, these areas are one step beyond low-cost\no-cost.

Strengths

The primary strength of the program was its fast track nature, which addressed manageable deficiencies and produced immediate results. The program focussed on the clear and obvious needs of the industrial sector for energy efficiency. It brought expertise and advanced equipment directly to the source, with few constraints and a clearly defined mission. It also provided the GOR with advanced tools (energy audit equipment, computers, etc.) and training that can be utilized to carry on with the program. USAID has ensured that GOR agencies, and participating industrial facilities, have the tools and knowledge to continue with this clearly defined program. The subsequent achievements will be their own, and they can take credit for them.

Weaknesses

The only significant weakness in the program was simply in the limited amount of resources to address a truly enormous inefficient energy situation. The task at hand and the solutions were clear and obvious. However, the limited budget and short time frame only permitted us to make a start.

APPENDIX A
Recommendations for a Long-Term USAID Sponsored Energy Efficiency Program

Romania will need continued assistance beyond the current short term emergency energy assistance program. A long-term program would sustain the accomplishments of this initial effort, and build a solid base for further gains in energy efficiency. The key program elements would be the following:

Technology Transfer - Romania industry is still largely way behind other countries in modern methods of energy utilization and efficiency measures. Technology transfer would be the foundation of the long-term program.

Capital - Significant infusions of foreign capital will be required to obtain new technology and equipment.

Institutional - The energy community in Romania needs to be strengthened to support long-term gains in energy efficiency. USAID could enhance this process through a pluralistic approach which would include the GOR agencies, academia, and the emerging private sector engineering and service firms.

Management/Organizational - Technical assistance and training in effective management and organizational dynamics will be essential. The entire management base of private enterprise and the GOR agencies needs this assistance.

USAID has the opportunity to assemble a comprehensive energy assistance plan which would include and support all of these areas. The program would combine technology transfer, institutional strengthening, and assistance with obtaining foreign capital into one comprehensive program. The emergency assistance program has been oriented toward the demand sector, RMA would recommend that the supply sector also be included. Romania has major problems in the energy supply, generation, and distribution sector which need to be addressed. A more detailed description of the program components follows.

Technology Transfer

The transfer of energy efficient technology to Romania should prove to be easier than in developing countries. Romania has a strong technological base to build upon; both in its technical community, and in the production facilities. While many plants may be old and somewhat outdated, Romanian technical staff have maintained the facilities well and most plants are capable of operating at design production levels. Therefore, technology transfer will enhance the operation and reduce energy intensity levels without immediate major process changes. The following five technology transfer components are recommended as the core program:

1. Low-cost\no-cost Energy Efficiency Improvements - A continuing program of energy audits, fuel-fired equipment analysis and tune-up, and general recommendations on reducing energy intensity in thermal and electrical systems at minimal cost. This would be a joint effort between a long-term technical assistance contractor and the counterpart Romanian Agency for

Energy Conservation. It is anticipated that the findings of the energy audits would identify opportunities for other program components.

2. Technology Transfer through Demonstration Projects - This next step would assist companies in acquiring energy efficient technology and equipment that is proven and readily available from U.S. suppliers. Similar to other USAID programs, a plan of applicable technologies and targeted industries would be developed. A private sector implementation mechanism would be adopted. The program would be a joint effort between industry, the GOR and USAID.

3. Energy Efficiency through Process Improvement - This step would consist of short-term consultants working with major Romanian industries to identify and recommend major process changes for energy efficiency. It is anticipated that technical assistance alone would be provided, with the company seeking funding from International Financial Institutions or foreign partners.

4. Power Infrastructure - An assessment of the existing power infrastructure and a rehabilitation plan for bringing the supply side up to demand levels. The program would consist of an assessment of generating facilities (existing thermal and future nuclear), rehabilitation technologies and costs, distribution losses and similar rehabilitation technology/costs, and a ten year plan of infrastructure development to meet future growth. It is anticipated that this plan would form the basis for financing from International Financial Institutions.

5. Refining Infrastructure - An assessment of existing refining capacity and product quality with the goal of assessing the downstream effects of low grade fuel oil on consumers. The end result would be a plan of recommended upgrades to existing refineries and/or downstream users. An additional part of this component would examine the environmental impact and recommend remedies. USAID would likely fund only the study. However, demonstration projects such as high efficiency scrubber technology could be considered for direct funding by USAID.

It is recommended that these five elements be implemented through a long-term technical assistance contract, implemented by a specialized energy and environmental consulting firm. Short-term consultants can be brought on for particular elements. It is further recommended that a long-term commitment by the counterpart agency be obtained, and the program be a joint effort with the consultant working out of the Agency offices. Another essential element would be the provision for local contracts and the development of Romanian private sector technical capability in the energy technology field. This should be a high priority. There would be considerable opportunity for U.S. suppliers under this program and the U.S. Foreign Commercial Service should be actively involved.

Capital

Capital availability is a major problem for Romanian industry. Foreign capital is necessary to acquire foreign technology, yet Romania's ability to attract foreign investment is very limited. Most of the plants we visited are actively seeking foreign partners, yet there are few takers. This is unfortunate as there is considerable potential in the existing industries and technical personnel. The major problem appears to be the somewhat uncertain political situation, and the perception that Romanian industry is too far behind other East European countries to be profitable. The best way to move the industrial base beyond these perceived barriers is through demonstration projects. RMA would recommend that USAID consider several alternative means of providing capital:

- Linking USAID technical assistance to International Financial Institution (IFI) loans. This is an ideal match of grant funds (technical assistance) with major capital investment tied to loans. The industries which qualify for these loans will tend to have the highest potential for success, since it is a loan, not a grant. Also, countries are reluctant to accept loans for what they perceive as expensive technical assistance. This approach would 'leverage' the financial capabilities of the IFI's with USAID assistance.

- Limited Capital for Demonstration Projects - A program of providing limited capital for demonstration projects is a sound and proven approach. This can be structured on a cost sharing basis, loan, or by direct grant. RMA would recommend that this be explored with the GOR so as to provide essential assistance but require a commitment on the part of IFI's, GOR and the private sector.

- Linking USAID technical assistance to private foreign suppliers and/or partners - Similar to the approach with IFI's, this mechanism would leverage USAID assistance to foreign investors who might otherwise be reluctant to invest in the country.

Whatever mechanisms are adopted, it will be essential to coordinate USAID technical assistance with potential sources of capital. Romania needs significant capital to make real progress in energy efficiency, and USAID can leverage its assistance to help bring this about.

Institutional

An essential element of the program would be institutional strengthening to support the other program components. This would involve most of the typical elements:

1. Training - Technical training would be provided for the GOR counterpart agency personnel and selected industry representatives through a program of in-country seminars, specific industrial sector training courses, U.S. sponsored training in specific technologies, and the supply of training materials (short courses, videos, etc). Training would also be available to private individuals,

similar to University extension courses offered in the U.S.

2. Energy Associations (NGO's) - Sponsorship for starting up an NGO and/or professional association of energy managers. For example, several U.S. professional associations would be interested in establishing chapters in Romania, and providing guidance on how to manage a professional association.

3. Energy Policy and/or Price Reform - A continuation of the initial efforts completed under the Emergency Energy Program is recommended. This element would be expanded to include energy incentive programs for large industrial users and the energy supply entities.

Management/Organizational

The findings of this program clearly illustrate the need to change much of the existing management and organizational structure throughout Romanian enterprise. The USAID program could support this change, primarily through training and direct private enterprise assistance:

1. Training - Training in management and organizational techniques would be provided to select enterprises, probably based on their likelihood of survival in the change to a market-based economy. U.S. training would be an important element of this component.

2. Direct Assistance - USAID could sponsor individual consultants to work directly with selected enterprises on management and organizational restructuring. Demonstrations could readily be identified for enterprises within selected sectors.

Assistance with management techniques and organizational structure will lay the groundwork for effective energy programs to be implemented.

Schedule/Budget

The follow-on program should be initiated as soon as possible in order to maintain the momentum generated by this initial effort. The following milestone schedule is recommended:

PID Prepared	6/30/91
Funding Approved	7/31/91
Contract RFP Released	8/31/91
Contract Awarded	9/30/91
Contractor Mobilized	9/15/91
Program Elements Defined	12/31/91

Technology Transfer
Capital
Institutional
Staffing
Logistics
etc.

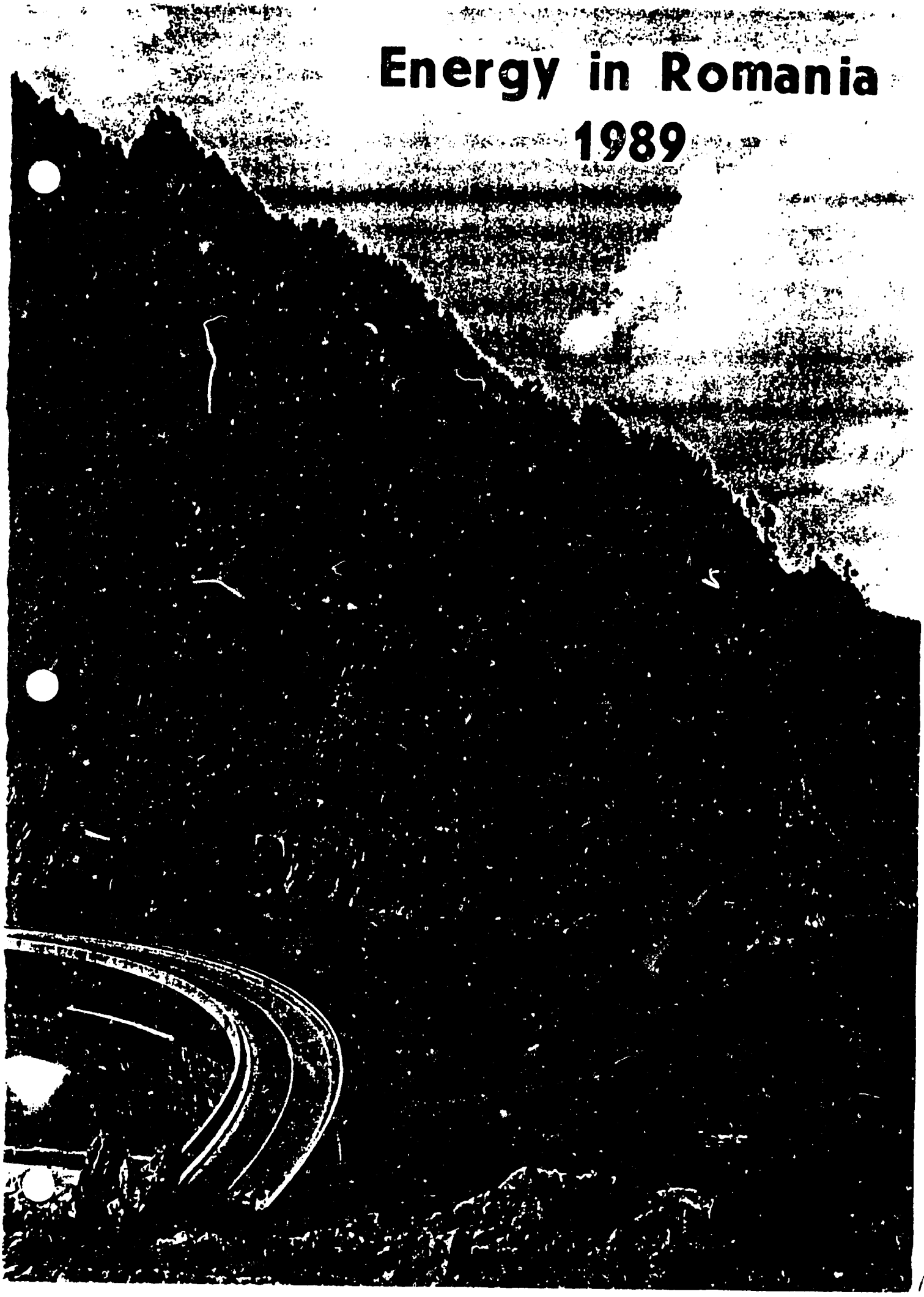
Program Begins (full start) 1/1/92

	91	92	93	94
Program Approval set up	xxx			
Technology Transfer				
Low-cost No-cost	xxxxxxxxxx			
Demonstration Projects		xxxxxxxxxxx		
Process Improvement			xxxxxx	
Power Infrastructure		xxxx		
Refining Infrastructure		xxxx		
Institutional Activities	xxxxxxxxxxxxxxx			

In order to accomplish this broad spectrum of activities, it is recommended that USAID budget $1 million/year for technical assistance, and approximately $10 million for demonstration projects, for a total of $15 Million over a five year period. This is a minimum level of effort, and could be considerably expanded with additional demonstration projects.

APPENDIX B
Supporting Data

Energy in Romania
1989



DEVELOPMENT OF ROMANIAN POWER SYSTEM

1. GENERAL

In the operation of the Romanian power system, a series of great difficulties were encountered such as: power and electric energy deficits which led to the limitations and disconnections of consumers, reduction of the operation frequency up to the limits which troubled the system safety as well as to the uninterconnected operation with the power systems of the neighbouring countries.

The electric and thermal energy supplied to the consumers has depended on the fuel quantity and quality and on the plant available capacity.

2. INSTALLED CAPACITY IN POWER PLANTS

At the end of 1989 the installed power in the power plants was of 22904 MW, out of which 17320 MW (75,6%) in the thermal power plants and 5584 MW (24,4%) in the hydroelectric power plants.

The installed power in the coal thermal power plants was of 8.[illegible]8 MW (38%) out of which of about 81% in the condensation units and of 19% in the cogeneration units.

The installed power in the hydrocarbons thermal power plants was of 8612 MW (37,6%) out of which about 40% in the condensation units and 60% in the cogeneration units.

The public power plants totalized in 1989 an installed power of 21008 MW (91,7%) and those of the self producers an installed power of 1896 MW (8,3%).

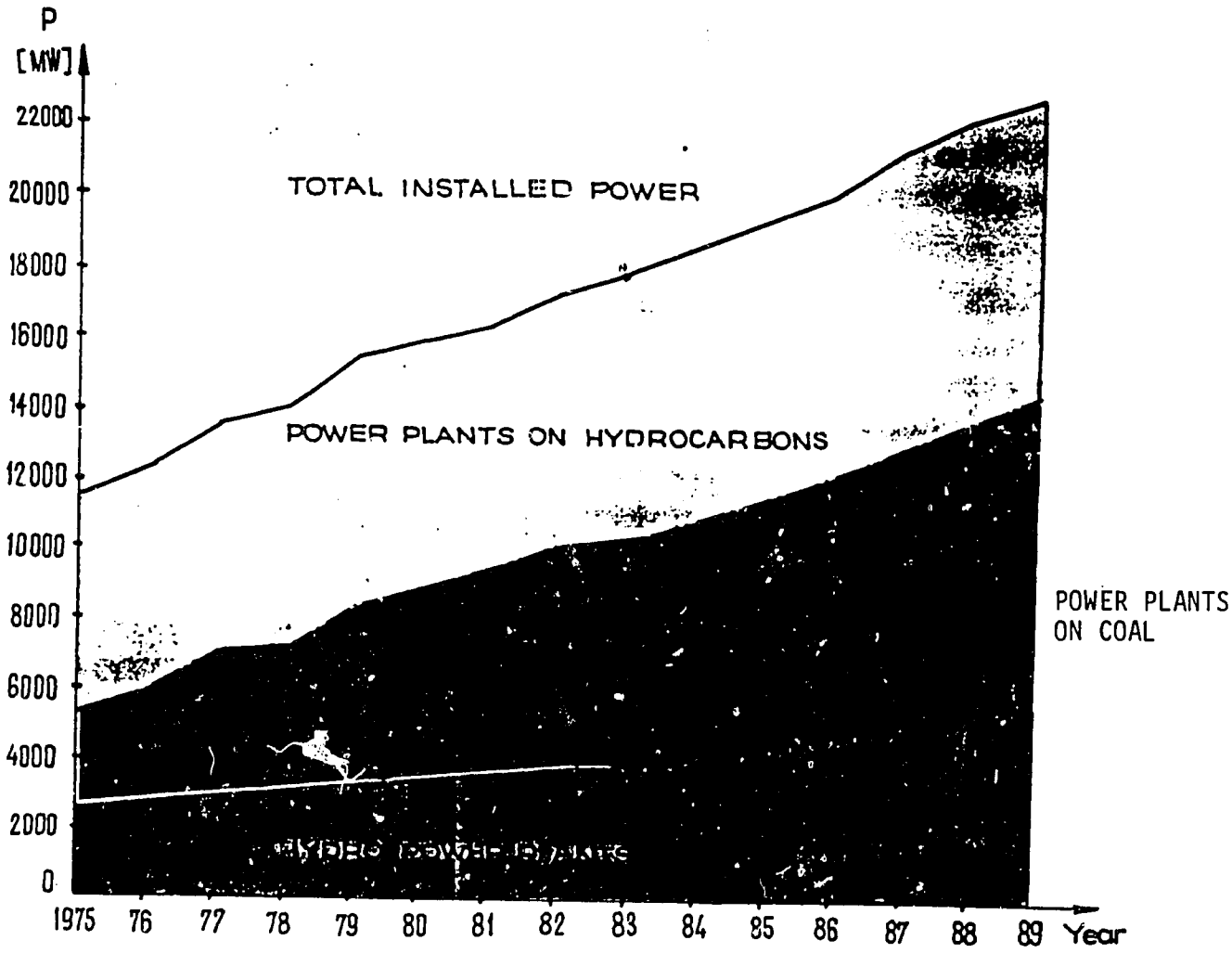
The annual utilization time of the installed power in the public plants was of 3366 hours at the end of 1989.

Between 1990 and 1995 an increase of the installed power with about 3400 MW was provided out of which about 2100 MW in the conventional plants and 1300 MW in the hydroelectric power plants.

During this period the erection works will continue at the Cernavoda NPP which will be equipped with 5 units of 700 MW.

26

EVOLUTION OF INSTALLED POWER PLANTS



I. DEVELOPMENT OF POWER PLANTS

Anul	Total	Hydro		Thermal					
				Total		From which on			
						coal		hydrocarbons	
	MW	MW	%	MW	%	MW	%	MW	%
1970	7346	1200	16,3	6146	83,7	—	—	—	—
1975	11578	2632	22,7	8946	77,3	2898	25,0	6048	52,3
1980	16109	3445	21,4	12654	78,6	5578	34,6	7076	44,0
1985	19576	4421	22,6	15155	77,4	7378	37,7	7777	39,7
1986	20393	4707	23,1	15686	76,9	7528	36,9	8158	40,0
1987	21731	5057	23,2	16674	76,8	8135	37,5	8539	39,3
1988	22377	5421	24,2	16956	75,8	8308	37,1	8748	38,7
1989	22904	5584	24,4	17320	75,6	8708	38,0	8612	37,6

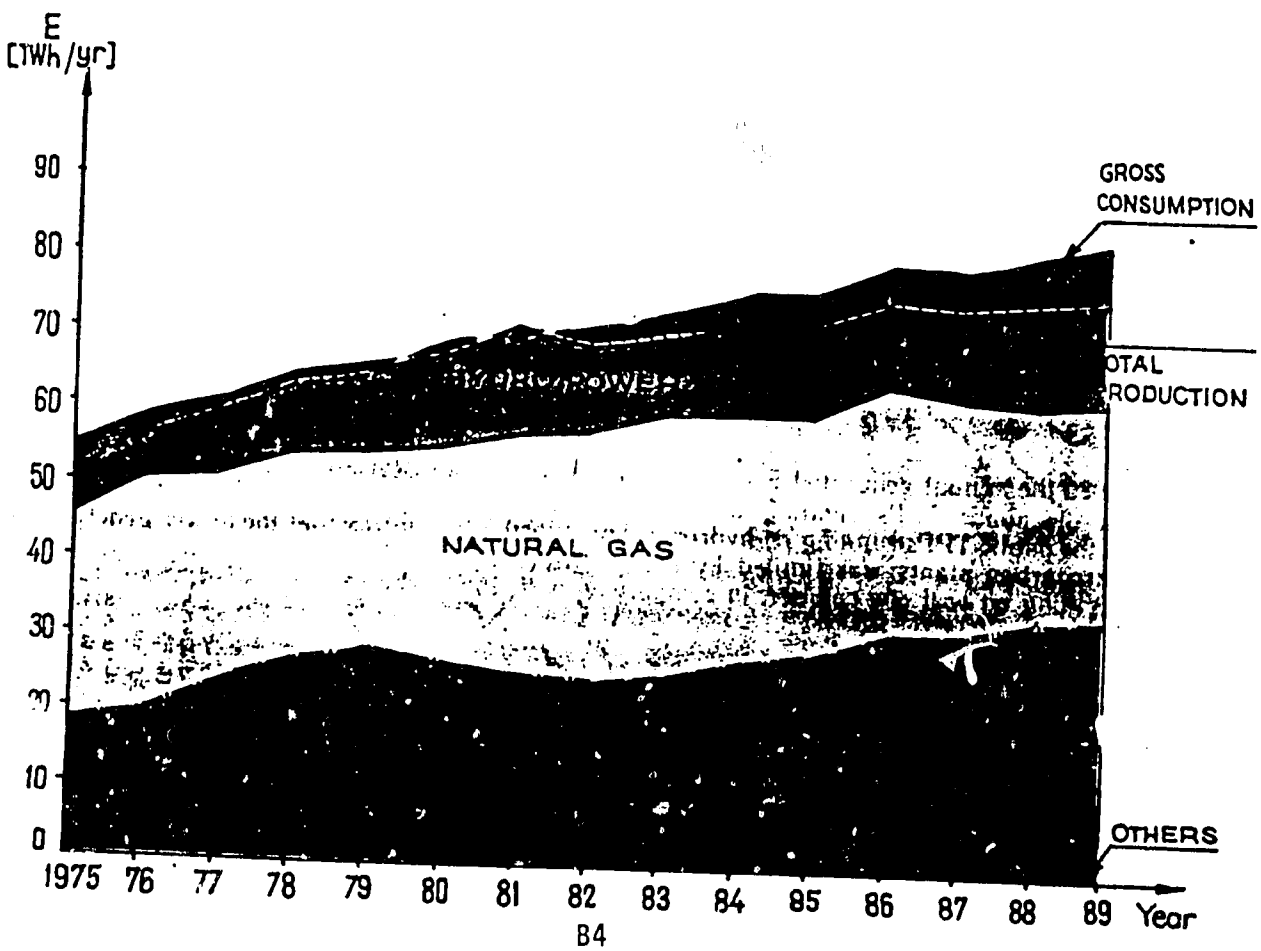
2. NEW INSTALLED PLANTS

	1976—1980		1981—1985		1986		1987		1988		1989	
	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
New installed powers TOTAL	4481,5	100,0	3334	100,0	745,4	100,0	1035,8	100,0	465,6	100,0	491,7	100,0
from which:												
1. COAL	2705	60,4	1794	53,8	200	26,8	656	63,3	200	43,0	270	54,9
from which:												
— brown coal	420	9,4	—	—	—	—	—	—	—	—	—	—
— lignite	2285	51,0	1794	53,8	200	26,8	656	63,3	200	43,0	270	54,9
2. HYDROCARBONS	973	21,7	570	17,1	184	24,7	64	6,2	—	—	56	11,4
3. HYDRO	803,5	17,9	970	29,1	361,4	48,5	315,8	30,5	265,6	57,0	165,7	33,7

3. GENERATION OF ELECTRIC AND THERMAL ENERGY

In 1989 the generation of the electric energy was of 75,851 billion kWh out of which 72,539 billion kWh (95,6%) were produced by the public plants. So that the generation of the electric energy in the thermal power plants was of 63,223 billion kWh (83,35%) and in the hydro power plants it was of 12,628 billion kWh (16,65%).

EVOLUTION OF PRODUCTION AND GROSS CONSUMPTION OF ELECTRICITY



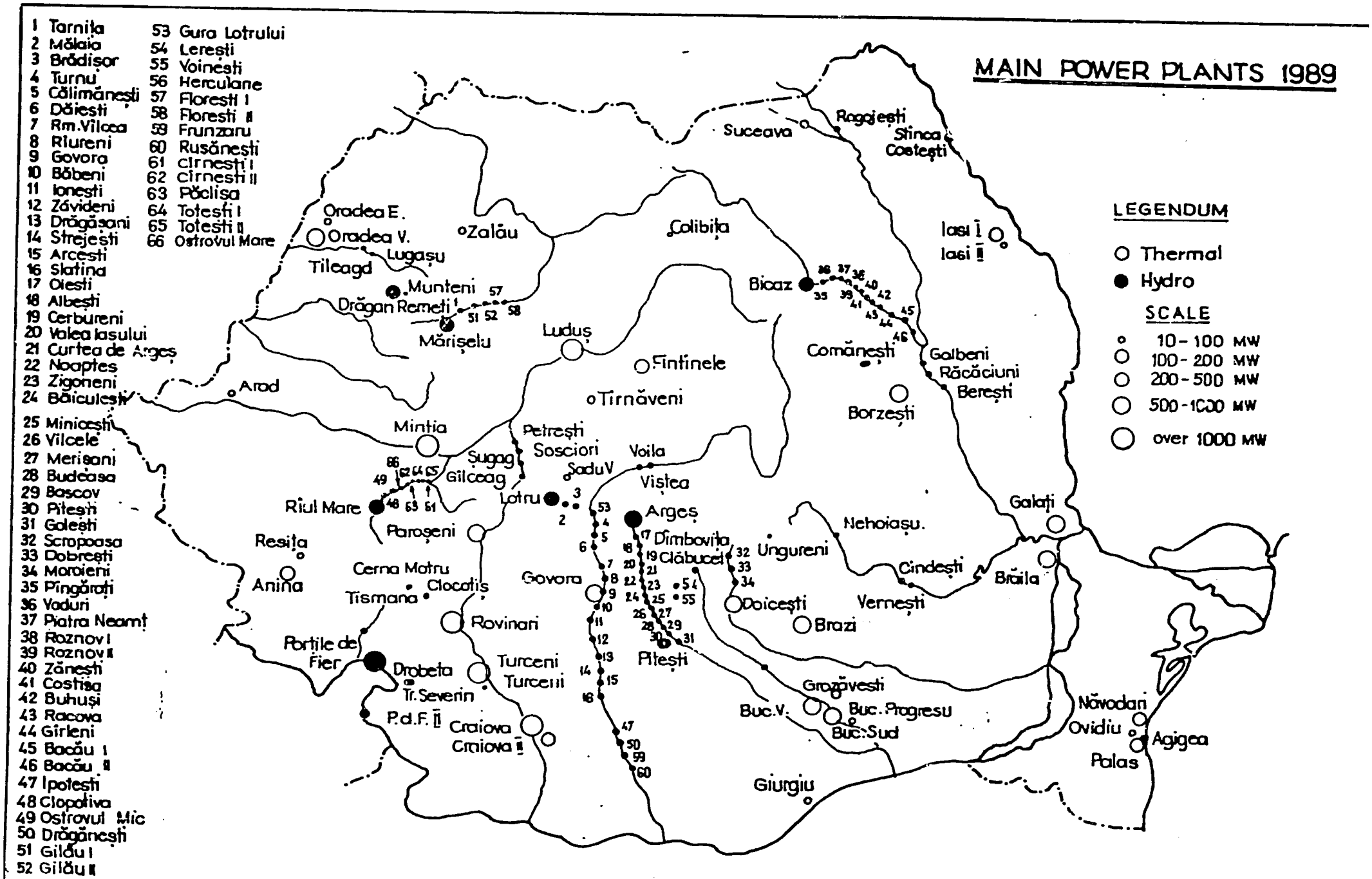
28

3. EVOLUTION OF MAXIMAL GENERATING UNIT INSTALLED IN THE POWER SYSTEM

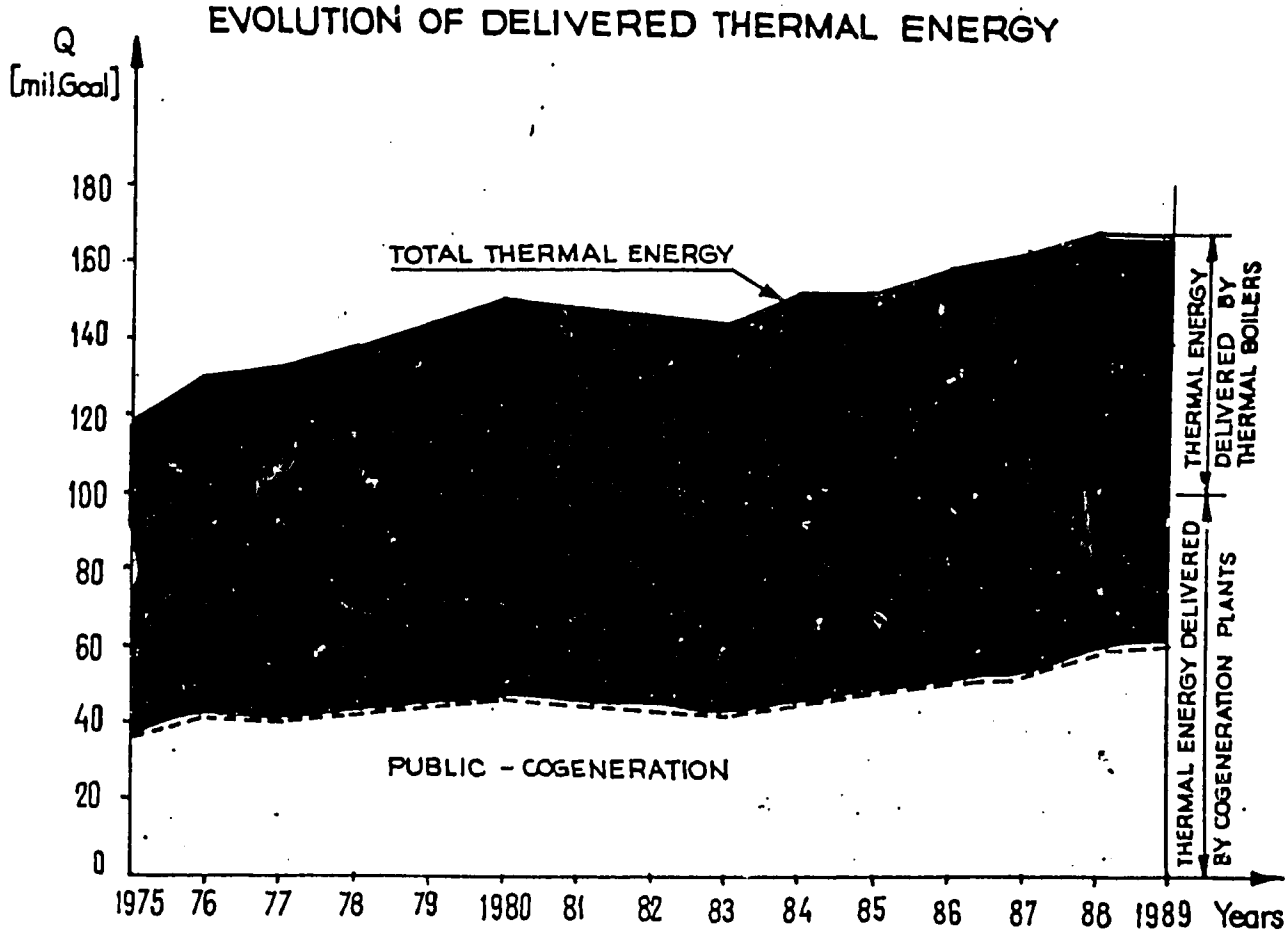
Name of the power plant	Maximal generating unit (MW)	Commissioning year
A. THERMAL UNITS		
A.1 STEAM UNITS		
— Crăciăveşti	20	1928
— Fîntînele	25	1954
— Paroşeni	50	1956
— Luduş — Iernut	100	1963
— Paroşeni	150	1964
— Luduş — Iernut	200	1966
— Craiova — Işalniţa	315	1967
— Rovinari	330	1976
A.2 COGENERATION UNITS		
- Buşteni	1,5	1912
Bod	1,95	1927
— Buşteni	4,5	1934
— Tîrnaveni	12	1941
— Borzeşti I	25	1955
— Borzeşti I	50	1960
— Bucureşti Sud	100	1967
— Bucureşti Sud	125	1975
— Palas	120/150	1979
B. HYDRO UNITS		
B.1 PELTON		
— Dobreşti — Ialomiţa	4	1930
— Moroieni — Ialomiţa	7,5	1953
— Sadu V — Sadu	7,7	1955
— Ciunget — Lotru	170	1972
B.2 FRANCIS		
Bicaz — Bistriţa	27,5	1960
- Bicaz — Bistriţa	50	1962
- Vidraru — Argeş	55	1966
— Mărişelu — Someş	73,3	1977
— Gilceag — Sebeş	75	1980
— Retezat — Riul Mare	167,5	1986
B.3 KAPLAN		
— Roznov I — Bistriţa	3,5	1963
— Roznov II — Bistriţa	7	1964
— Pîngăraţi — Bistriţa	11,5	1964
— Vaduri — Bistriţa	22	1966
— Porţile de Fier I — Dunăre	175	1970
B.4 BULB		
— Slatina — Olt	13	1981
— Porţile de Fier II — Dunăre	27	1985

In 1989 the annual generated average power was of about 3420 MW (40% of the installed power) at the public TPPs running on coal and of about 3440 MW (55% of the installed power) at the public TPPs running on hydrocarbons. Worthy to mention that the power generation of the hydrocarbon plants was limited by the quantities of the allocated hydrocarbons. At the plants operating on coal one can see, in comparison with 1988, when the installed power raised,

29


MAIN POWER PLANTS 1989
LEGENDUM
Thermal
Hydro
SCALE
10 - 100 MW
100 - 200 MW
200 - 500 MW
500 - 1000 MW
over 1000 MW
1 Tarnita
2 Mălaia
3 Brădișor
4 Turnu
5 Călimănești
6 Dăiesti
7 Rm.Vîlcea
8 Rîureni
9 Govora
10 Bobeni
11 Ionesti
12 Zăvideni
13 Drăgășani
14 Strejești
15 Arcesti
16 Slatina
17 Olesti
18 Albești
19 Cerbureni
20 Valea Iasului
21 Curtea de Argeș
22 Noaptes
23 Zigoneni
24 Băiculești
25 Minicesti
26 Vîlcele
27 Merișani
28 Budeasa
29 Bascov
30 Pitesti
31 Golesti
32 Scropoasa
33 Dobresti
34 Moroieni
35 Pîngărați
36 Vaduri
37 Piatra Neamț
38 Roznov I
39 Roznov II
40 Zănesti
41 Costisa
42 Buhuși
43 Racova
44 Girleni
45 Bacău I
46 Bacău II
47 Ipotesti
48 Clopotiva
49 Ostrovul Mic
50 Drăgănesti
51 Gilău I
52 Gilău II
53 Gura Lotrului
54 Lerești
55 Voinesti
56 Herculane
57 Floresti I
58 Floresti II
59 Frunzaru
60 Rusănesti
61 Cîrnesti I
62 Cîrnesti II
63 Pătlisa
64 Totesti I
65 Totesti II
66 Ostrovul Mare
Suceava
Rogojesti
Stînca Costesti
Iasi I
Iasi II
Oradea E.
Oradea V.
Zalău
Colibița
Tileagd
Lugașu
Munteni
Drăgan Remeti
Mărișelu
Bicaz
Comănesti
Galbeni
Răcăciuni
Berești
Borzesti
Ludus
Fîntînele
Tîrnăveni
Arad
Mintia
Petresti
Sosciori
Voila
Sugag
Gilceag
SaduV
Vistea
Rîul Mare
Lotru
Arges
Galați
Nehoiasu.
Paroșeni
Resita
Ungureni
Anina
Cerna Motru
Clocotis
Govora
Cîndesti
Brăila
Tismana
Doicesti
Vernesti
Rovinari
Brazi
Porțile de Fier
Drobeta
Turceni
Pitesti
Tr.Severin
Grozăvesti
Buc.V.
Buc.Progresu
Buc.Sud
Năvodari
Ovidiu
Agigea
Palas
P.d.F. II
Craiova
Craiova II
Giurgiu

B6



a lowering of the average power obtained, especially due to the quality of the coal used and to the reduced additional hydrocarbons; this was due to the reduced availabilities of the new installed capacities and to the reduced load in CHP plants as a consequence of lowering the heat delivered to the consumers.

From hydrologic standpoint, 1989 was a dry year that led to a power generation in hydropower plants of 12,53 billion kWh, being 7,5% smaller than that of 1988.

In 1989 the power really used in the power system did not exceed 50% of the installed power.

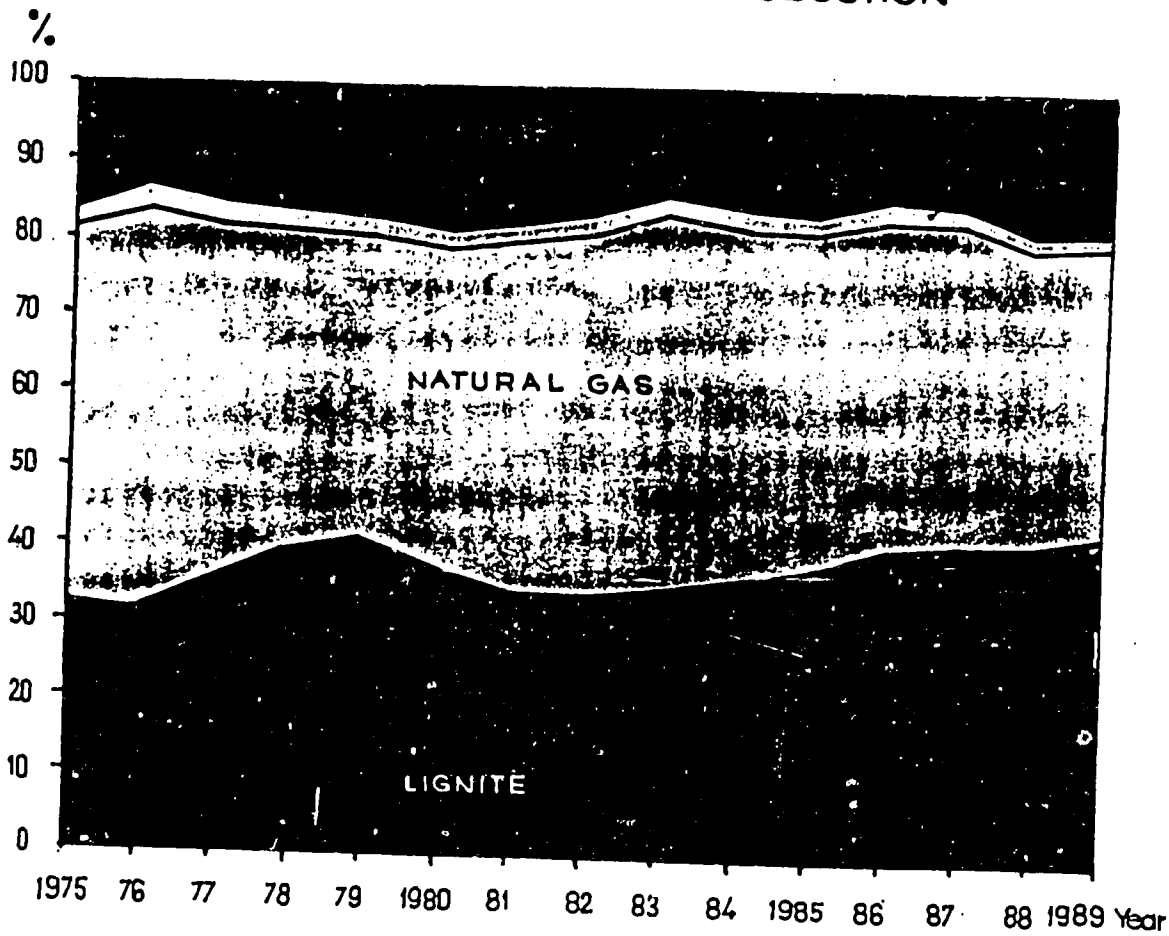
4. SPECIFIC CONSUMPTION OF FUEL FOR ELECTRICITY PRODUCTION

(gcc/kWh)

	1975	1980	1985	1986	1987	1988	1989
COUNTRY AVERAGE	318,0	325,0	353,1	356,9	350,7	360,1	357,4
from which:							
— COAL	359,0	383,0	412,4	427,3	412,1	426,4	417,2
lignite	359,0	401,0	423,9	434,1	423,9	422,3	415,4
— OIL PRODUCTS	320,0	323,0	300,1	306,8	304,4	287,8	299,1
— NATURAL GAS	294,0	288,0	327,7	330,1	324,1	322,8	323,9
— RECOVERED SOURCES	346,0	331,0	368,7	376,7	363,8	370,8	375,5
— OTHERS	264,0	(698)	263,1	280,1	281,3	205,8	220,1

31

BREAKDOWN OF ELECTRICITY PRODUCTION



In 1989 the thermal energy supplied by thermal power plants and thermal plants was of 168,296 thousand Gcal out of which 99,945 thousand Gcal (59,3%) in cogeneration plants and 68,351 thousand Gcal (40,7%) in thermal plants. The thermal energy supplied by the public plants was of 64,487 thousand Gcal, out of which 16,610 thousand Gcal in the coal plants and 47,289 thousand Gcal in the hydrocarbon plants.

In 1989, 51,313 thousand of tons of equivalent coal were used for the generation of power and thermal energy, out of which 22,594 thousand tons of equivalent coal (44%) for the generation of electric energy and 28,719 thousand tons of equivalent coal (56%) for the generation of the thermal energy.

5. EVOLUTION OF MAIN THERMAL ENERGY CONSUMERS

(Tcal)

	1975	1980	1985	1986	1987	1988	1989
Total thermal energy consumption from which:	115012	147862	148350	154361	157071	168527	181706
1. Industry	84833	104479	111546	117143	119377	123800	136909
2. Constructions	2558	3191	1476	1499	1546	1672	1383
3. Transport — telecomunications	1373	1273	866	850	642	786	767
4. Agriculture — forestry	7394	8839	6481	5836	6050	6165	5462
5. Municipality	7494	8401	7599	7384	7900	8013	7751
6. Domestic	12330	20006	18662	20468	20747	21690	23097

Out of the total fuel used for the generation of electric energy in 1989, coal represents 10,180 thousand tons of equivalent coal (45%) and hydrocarbons, recovered energy resources and other fuels 12,414 thousand tons of equivalent coal (55%).

Out of the total fuel used for the generation of thermal energy in 1989, coal represents 3,627 thousand tons of equivalent coal (12,6%) and hydrocarbons, recovered energy resources and other fuels 25,092 thousand tons of equivalent coal (87,4%).

On the whole of the fuel consumption for the generation of the electric and thermal energy in 1989, the use of the coal was of 27% and of hydrocarbons, recovered energy resources and other fuels was of 73%.

4. POSSIBILITIES OF COVERING THE POWER ENERGY CONSUMPTION

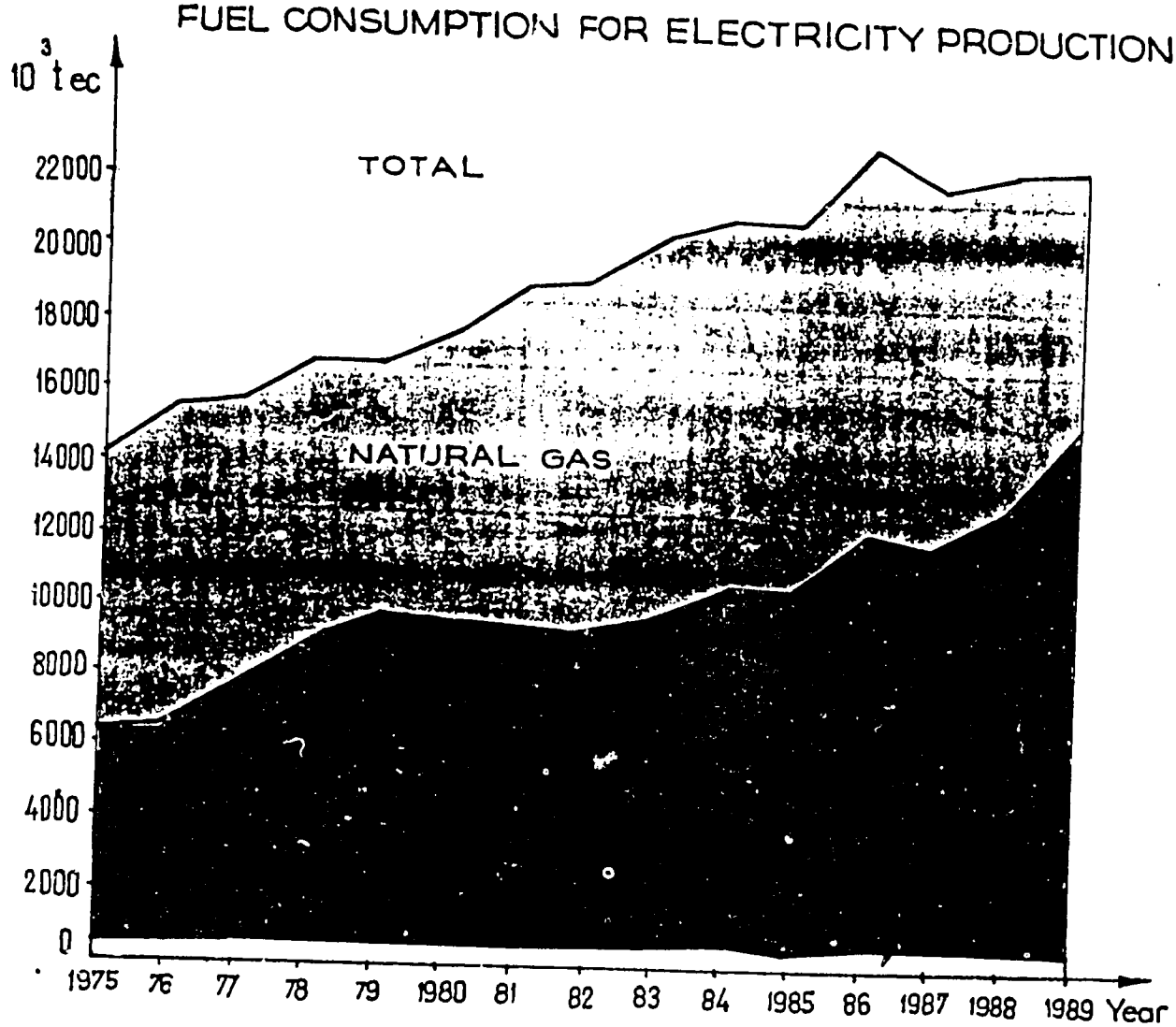
In 1989 the gross power consumption was of 83,662 billion kWh, the technological consumption was of 7,62 billion kWh (9,08%) for plants and of 4,63 billion kWh (5,5%) for power networks.

For covering the power consumption in 1989 the power energy import was of 7,818 billion kWh which represents 10,3% of the power generation.

6. ELECTRICITY BALANCE

(GWh)

	1970	1975	1980	1985	1986	1987	1988	1989
I Production	35088	53721	67486	71819	75478	74079	75322	75851
Imports	28	502	472	3259	4430	5150	7199	7811
Exports	2413	3007	49	—	—	—	—	—
II Gross consumption	32703	51216	67909	75078	79908	79229	82521	83662
Internal consumption in power plant	3104	4390	5954	6585	7044	7026	7294	7626
— for electricity production	2288	3197	4457	4770	5124	5019	5095	5298
Network losses	3529	4059	4026	3855	4113	4052	4295	4635
III Net consumption	26070	42767	57929	64638	68751	68151	70932	71401
Industry	19596	32702	43692	49311	52861	52707	55056	55573
Constructions	662	978	1501	1308	1354	1512	1568	1511
Transport — telecomunications	500	1068	1924	2430	2580	2583	2824	2921
Agriculture — forestry	710	2014	2821	3948	4135	3904	3666	4169
Municipality	2363	2051	2638	2567	2633	2637	2861	2932
Domestic	2239	3717	4889	4814	4992	4807	4482	4296



7. ELECTRICITY CONSUMPTION OF MAIN INDUSTRIAL BRANCHES

(GWh)

	1975	1980	1985	1986	1987	1988	1989
TOTAL INDUSTRY	32702	43692	49311	52861	52707	55056	55574
from which:							
1. Extraction and fuel processing	2594	3430	4955	5381	5695	6290	6530
from which:							
— coal	717	1521	1475	1524	1636	1678	2042
— coke industry	83	118	197	205	208	267	246
— crude oil and oil gases extraction	1033	1335	1835	1979	1963	2118	2175
— crude oil processing	758	950	1274	1441	1635	1932	1801
2. Iron metallurgy	3432	6022	8071	8584	8449	8729	9018
3. Nonferrous metallurgy	4547	5959	5667	6077	6215	6374	6297
4. Machinery	4657	6320	7393	7886	8035	8410	8808
5. Chemicals	8807	11098	11808	12762	11983	12259	12267
6. Building materials	2155	2716	2413	2804	2723	2723	2676
7. Wood exploitation and processing	981	1184	1144	1219	1189	1188	1154
8. Celullose — paper	1388	1630	1500	1641	1616	1791	1709
9. Ceramics	213	312	373	352	366	389	360
10. Light industry	1490	1873	1859	1975	1948	1938	1863
— textiles	1294	1637	1627	1732	1689	1700	1629
— cloth manufacturing	85	84	86	88	87	94	95
— leather goods	111	152	146	155	172	144	139
11. Food industry	1139	1391	1601	1788	1734	1796	1743

8. INCREASING RATES OF GROSS ELECTRICITY CONSUMPTION

	1966 — 70	1971 — 75	1976 — 80	1981 — 85	1986 — 89
Annual average rate (%)	14,1	9,4	5,8	2,0	2,5
Doubling time (years)	5,2	7,7	12,3	34,5	28,0

9. EVOLUTION OF GLOBAL PER CAPITA CONSUMPTION

Consumption (kWh/cap)	1975	1980	1985	1986	1987	1988	1989
Gross total	2411	3059	3304	3501	3450	3570	3614
Net total	2013	2609	2844	3012	2970	3069	3276
Industrial	1539	1968	2170	2316	2297	2382	2400
Domestic	175	220	212	219	209	194	186
Municipal	97	119	113	115	115	124	127

It can be noticed that the rate of growth of the power gross consumption between 1986 and 1989 was of 2,7% which was strongly influenced by the restrictive energy policy. It can be noticed that if the power gross consumption of industry increased during years, reaching 77,9% of the total in 1989, the domestic and urban consumption lowered, reaching 6,0% and 4,1% respectively of the total in 1989. These variations can be noticed in the development of the specific power consumptions.

In 1989 the total net consumption was of 3276 kWh/capita and the domestic consumption was of 186 kWh/capita (with 4,2% smaller than in 1988).

5. ELECTRIC NETWORKS

The development of the power transmission and distribution networks in Romania was carried in correlation with the general evolution of the national power system.

In the first stage (1950 — 1960) of the development of the national power system, a network of 110 kV lines was built through which all the important power plants of the country were connected.

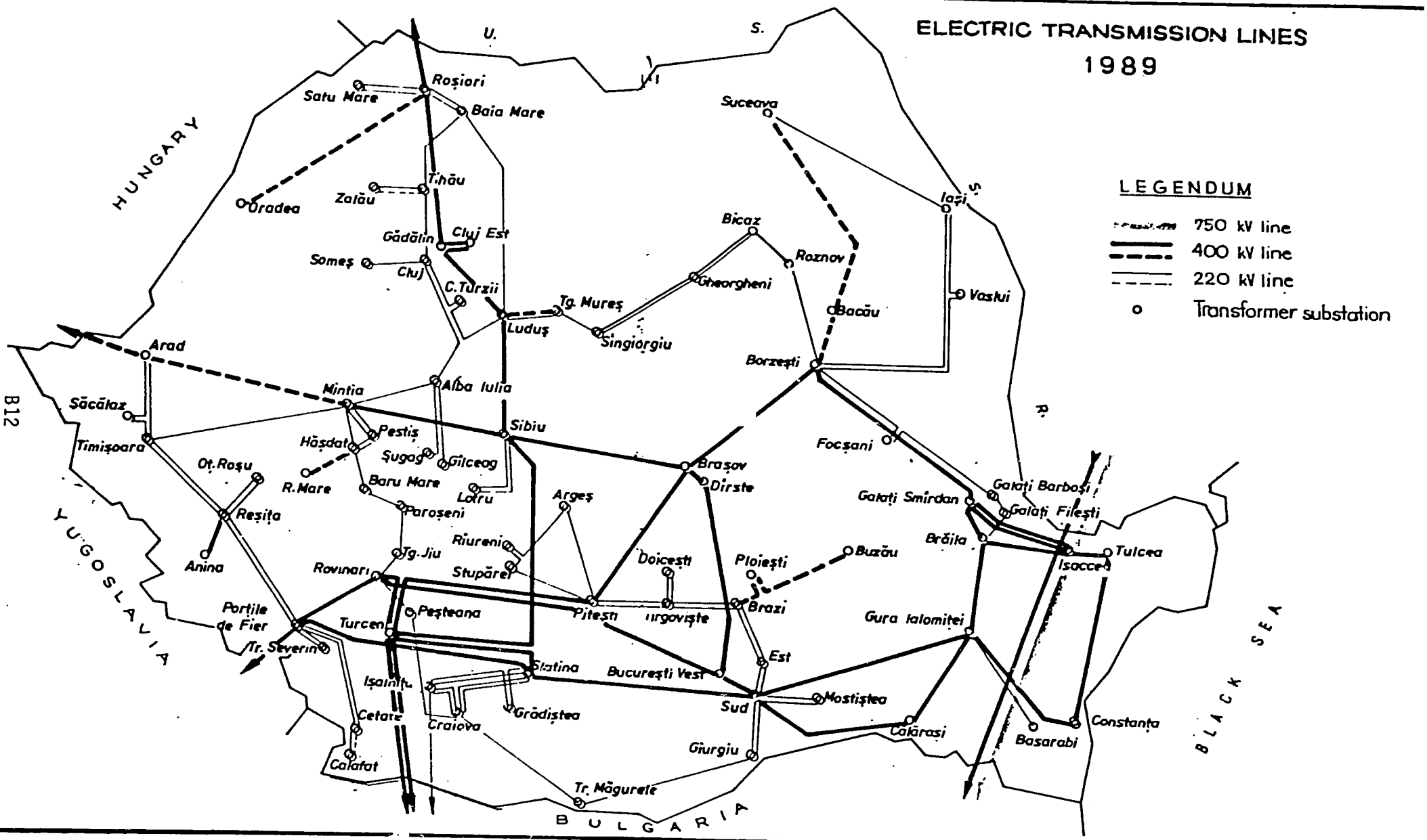
After 1960, along with the continuous increasing of the consumption and generation requirements and implicitly the increase of the transmitted power, the transmission network at 220 kV voltage and, after a very short period of time, at 400 kV voltage, was developed.

A power system interconnected by 750 kV, 400 kV and 220 kV lines with the power systems of the neighbouring countries was developed in Romania of today.

The developmentof the distribution networks of medium and low voltage was correlated with the increasing number of the power consumers and their distribution all over the country.

At present there is in operation a medium voltage distribution network with development only at 20 kV and 6 kV and a low voltage distribution network at 0,4 kV.

35


ELECTRIC TRANSMISSION LINES
1989
LEGENDUM
750 kV line
400 kV line
220 kV line
Transformer substation
HUNGARY
YUGOSLAVIA
BULGARIA
BLACK SEA
U.
S.
R.
Roșiori
Satu Mare
Baia Mare
Suceava
Oradea
Zalău
Tihău
Iași
Bicaz
Gădălin
Cluj Est
Roznov
Someș
Cluj
C.Turzii
Gheorgheni
Vaslui
Tg. Mureș
Bacău
Luduș
Singiorgiu
Arad
Borzești
Mintia
Alba Iulia
Săcălaz
Sibiu
Pestiș
Focșani
Timișoara
Hășdat
Șugag
Gilceag
Brașov
Ot.Roșu
R.Mare
Baru Mare
Dîrste
Galați Barboși
Galați Smîrdan
Galați Filești
Lotru
Argeș
Paroșeni
Reșița
Brăila
Riureni
Tulcea
Anina
Tg.Jiu
Doicești
Ploiești
Buzău
Isaccea
Rovinari
Stupărei
Porțile de Fier
Pitești
Târgoviște
Brazi
Pașteana
Turceni
Gura Ialomiței
Tr. Severin
Est
Slatina
București Vest
Mostiștea
Ișalița
Sud
Cetate
Craiova
Grădiștea
Călărași
Constanța
Basarabi
Giurgiu
Calafat
Tr. Măgurele

B12

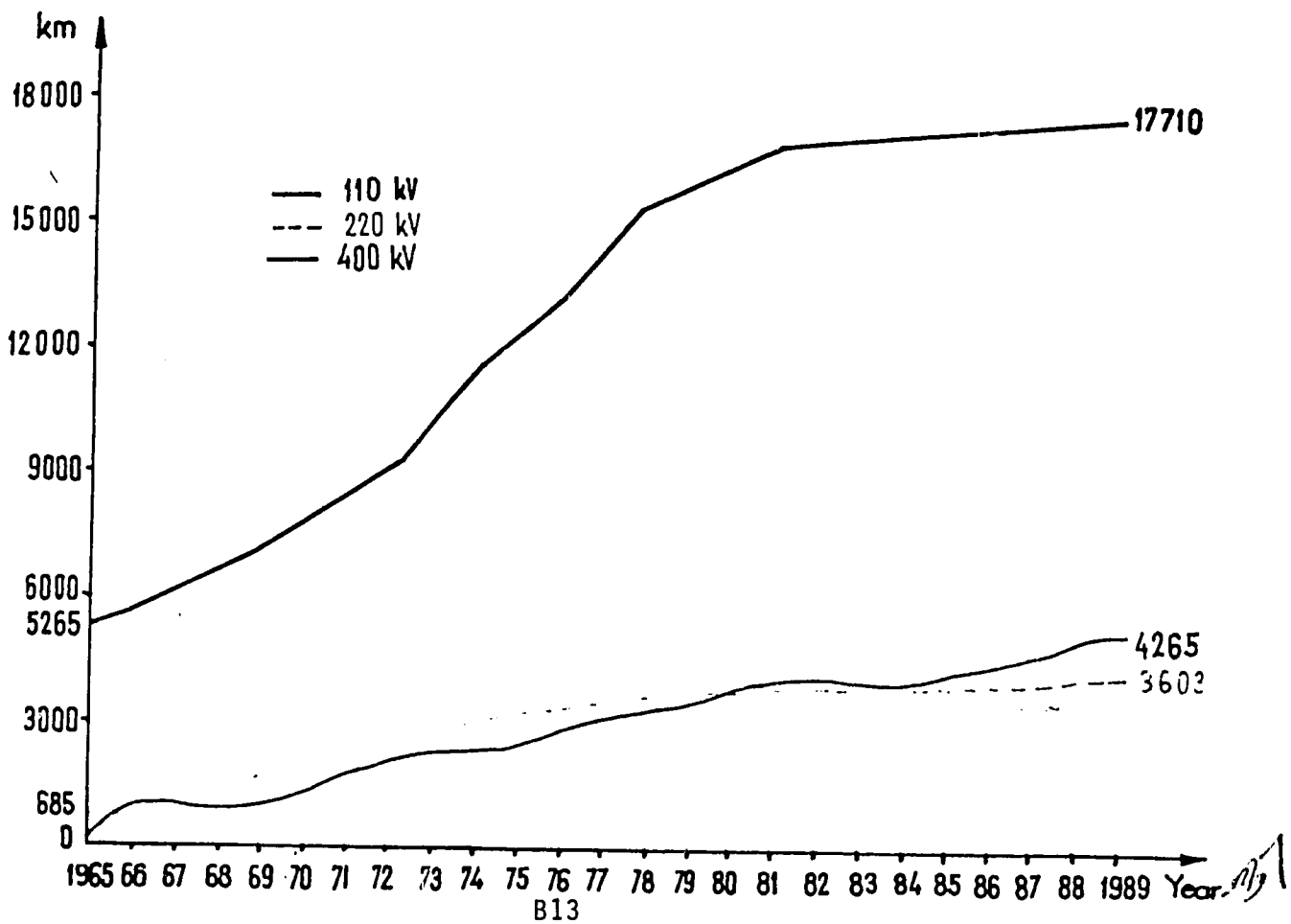
10. TRANSFORMER SUBSTATIONS
1970 — 1985

Nr. crt.		1970		1975		1980		1985	
		NR.	MVA	NR.	MVA	NR.	MVA	NR.	MVA
	TOTAL	39259	43223	54928	84811	70351	129422	79244	150527
	from which:								
1	750 kV	—	—	—	—	—	—	—	—
2	400 kV	1	533	8	6101	15	11290	33	16346
3	220 kV	30	9491	46	16907	64	22322	60	23678
4	110 kV	329	14750	571	28127	908	46376	1119	59661
5	60 ... 1kV	38899	18449	54303	33676	69364	49434	78032	50842

1986 — 1989

Nr. crt.		1986		1987		1988		1989	
		NR.	MVA	NR.	MVA	NR.	MVA	NR.	MVA
	TOTAL	80178	155957	80754	166434	82092	167949	82596	169930
	from which:								
1	750 kV		—	1	2500	1	2500	1	2500
2	400 kV	33	17410	34	18861	35	19903	36	20700
3	220 kV	62	23559	61	23721	60	23741	59	23530
4	110 kV	1137	62035	1161	66300	1186	66300	1200	66700
5	60 ... 1 kV	78947	52953	79497	55049	80810	55445	81300	56500

EVOLUTION OF ELECTRIC TRANSMISSION LINES



APPENDIX C
Penalties for Exceeding Energy Allotment

GOVERNMENT OF ROMANIA

D E C R E E

regarding measures to be taken with the view of reasonable utilization of natural gases and thermo-electric power.

The Government of Romania decides:

Art.1-(1) The economic agents are forbidden to exceed the contracted quantities of natural gases and thermo-electric power.

(2) When the quantities are exceeded, penalties will be put into operation, according to the enclosure that makes integral part of this Decree.

(3) When due to producing possibilities the feeding of existing economic agents is no longer carried-out, the providing will be stopped with a previous notice of five days.

Art.2- In order to reduce the consumptions of natural gases and thermo-electric power in comparison with the contracted quantities, the suppliers will grant reductions to the economic agents; for each percentage of consumption reduction, a percentage of 1% of discount will be accorded.

Art.3-(1) The economic agents that have their own currency resources can import-in order to carry-out supplementary products for exportation in currency, or for delivery on the domestic market, in lei- by means of the suppliers, supplementary quantities of natural gases and electric power, in comparison with those stipulated in the contracts, concluded taking also into account the material balance.

(2) The invoiced costs for the economic agents that contract observing the conditions of paragraph (1) will comprise the costs in currency and the suppliers' transportation and distribution costs, calculated in lei.

Art. 4- The penalties that were raised by applying the provision of Art.1, paragraph(2), diminished with the discounts granted in accordance with Art.2, will be deposited in the budget of the State, in order to fill the budget of the Romanian Agency for Energy Conservation, that will be utilized exclusively for financiation of the projects approved by the Resources and Industry Ministry with

the view of power consumption reduction, substitution of hydrocarbons and extension of the utilization of inconvenient energy resources.

Prime-Minister,
Petre Roman
1991, January, 31

Bucharest
1991, January, 31

40

ENCLOSURE

PENALTIES

for the quantities of natural gases and thermo-electric power supplementary consumed, in comparison with those consumed daily, monthly, and trimestrial, due to approved balances.

Supplementary consumptions, in the range:	Penalties
1oo-1o5%	1,5 times the approved prices
1o5-11o%	2 times the approved prices
11o-115%	2,5 times the approved prices
115-12o%	3 times the approved prices
more than 12o%	4 times the approved prices

APPENDIX D
Letter of Intention - Bucharest Polytechnic

Polytechnical Institute of Bucharest
Faculty of Energetics

Str. Splaiul Independentei Nr. 313, Sector 6, Tel 313975
77206, Bucharest, Romania

LETTER OF INTENTIONS

The Faculty of Energetics achieves, by its structure and educational programs, the education of the majority of the energy engineers of Romania and by the recycling courses, the improvement of the technical knowledge in the field of energy for a lot of specialists.

Thanks to its own research activity in the field of industrial energetics, it is interested in developping cooperation activities with governmental and non-governmental organisations (also private companies and enterprises) and supporting by its position every scientifical and technical symposium, conference, seminary, etc, scheduled by theese organisations in Romania.

At the same time it wishes, through cooperation activities, to modernize its laboratories and to offer to Romanian specialists the opportunity of constant scientific and technical contacts with American specialists.

Our maximal priority perfectionning directions are:

- Modernising the measurement, automatisation and computational devices
- Obtaining the access to the utilitary software libraries in the university and research field
- Changing specialists and lectors in common interest fields and developping common research activities.

Dean

Dr. Dumitru-Cezar Ionescu

43

APPENDIX E
List of Abbreviations

AC	= alternating current
amps	= amperes
atm	= atmosphere = 14.696 pounds per square inch
bar	= 100,000 pascals = 14.504 pounds per square inch
Btu	= British thermal unit
cfm	= cubic feet per minute
cm	= centimeter = 0.3937 inches
cm^2	= square centimeter = 0.155 square inches
CO	= carbon monoxide
CO_2	= carbon dioxide
°C	= degree Celsius = T[°F] = 9/5 T[°C] + 32
°F	= degree Fahrenheit
°R	= degrees Rankine = T[°F] = T[°R] + 460
eff	= efficiency
ex air	= excess air
Gcal	= gigacalorie = 1 billion calories = 3.968 million BTU
GJ	= gigajoules = 1 billion joules
gph	= U.S. gallons per hour
gpm	= U.S. gallons per minute
GWh	= gigawatt hours = 1 billion watt hours
H_2	= hydrogen
H_2O	= water
H_2SO_4	= sulfuric acid
hectare	= 10,000 square meters = 2.471 acres
hectoliter	= 100 liters = 26.42 U.S. gallons
Hg	= mercury
hr	= hour
Hz	= hertz = cycles per second
J	= joules
Kcal	= kilocalories = 1 thousand calories = 3.968 BTU
kg	= kilogram = 2.2046 pounds
Kgcc	= 7,000 Kcal = 27,776 BTU
kJ	= kilojoules = 1 thousand joules = 0.947813 BTU
km	= kilometer = 0.621 miles
kN	= kilonewton = 1 thousand newtons
kPa	= kilo pascals = 1 thousand pascals = 146.96 pounds per square inch
kV	= kilovolts = 1 thousand volts
kVa	= kilovolt-amperes
kvar	= kilovars = 1 thousand volt-amperes (reactive)
kW	= kilowatt = 1 thousand watts
kWh	= kilowatt hour = 1 thousand watt hours
lbs	= pounds
liter	= 0.2642 U.S. gallons = 0.03532 cubic feet
m	= meter = 39.37 inches
m^2	= square meter = 10.76 square feet
m^3	= cubic meter = 35.31 cubic feet

ma	= milliampere = 0.001 amperes
metric ton	= 1 thousand kilograms = 1.1023 U.S. tons
mg	= milligrams
min	= minute
MJ	= megajoules
mm	= millimeter = 0.03937 inches
MPa	= 1 million pascals = 146.96 pounds per square inch
MVA	= megavolt-amperes
MW	= megawatt = 1 million watts
MWh	= megawatt hours = 1 million watt hours
NG	= natural gas
nm	= nanometer
Nm^3	= cubic meters at standard conditions of temperature and pressure (20°C and 1 atmosphere)
NO_X	= nitrogen oxide
O_2	= oxygen
P	= pressure
PC	= personal computer
ppm	= parts per million
psi	= pounds per square inch
psig	= pounds per square inch (gauge)
R	= thermal resistance
s	= second
SO_2	= sulfur dioxide
sq ft	= square feet
Tcal	= teracalorie = 1 trillion calories = 3.968 billion BTU
T	= temperature
V	= volts
vars	= volt-amps (reactive)
VSD	= variable speed drive
yr	= year