Country Report on Small Hydro Power

ROMANIA

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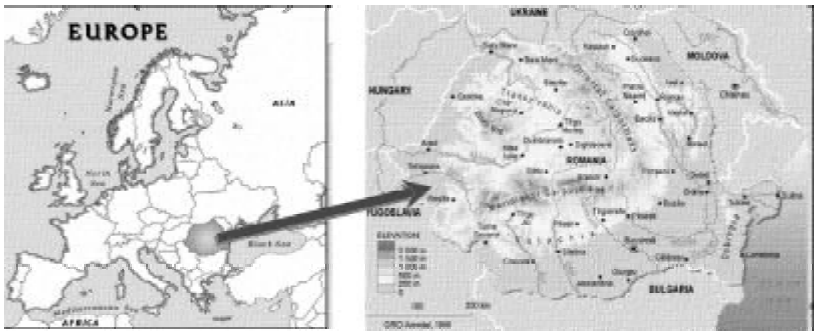

- **Location**: Romania is situated in the south-east of Central Europe, in the lower Danube basin, bordering in East with the Black Sea
- **Population:** 21.6 mill. inhabitants
- **Gross domestic product**: about 40 bill. USD
- **Electricity**: total production 54.7 TWh
- 55.9 % - Thermo
- 29.4 % - Hydro
- 10.1 % - Nuclear
- 4.6 % - IPP

1 ENERGY SECTOR

General data (2002):

- Total installed capacity 19,972 MW of which:
  - 13,009 MW - Termoelectrica
  - 5,803 MW - Hidroelectrica
  - 700 MW - Nuclearelectrica
- Total electricity generation 53,860 GWh of which:
  - 31,461 GWh - Termoelectrica
  - 14,480 GWh - Hidroelectrica
  - 5,446 GWh – Nuclearelectrica
- Electricity transmission:
  - Transmission lines total length: 9,684 km
  - Overall installed capacity: 35,948 MW (77 stations)
  - Electricity transmitted in 2002: 32,600 GWh
- The distribution of electrical energy:
  - 8.5 customers in Romania
  - 858 substations
  - 65,660 substations

Main companies acting in this sector:

- TERMOELECTRICA SA - electricity generation and supply, heat generation, transmission, distribution and supply using coal or hydrocarbons as fuel;
- HIDROELECTRICA SA - electricity generation in hydro power plants and power supply;
- NUCLEARELECTRICA SA - electricity generation using nuclear fuel, nuclear fuel production;
- TRANSELECTRICA SA - electricity transmission and dispatching, organisation and administration of power market, international electricity transit;
- ELECTRICA SA - electricity distribution and supply, exploitation and development of distribution and telecommunication systems.
- The activity of these companies is carried on based on licenses granted by the National Energy Regulating Authority (N.E.R.A).

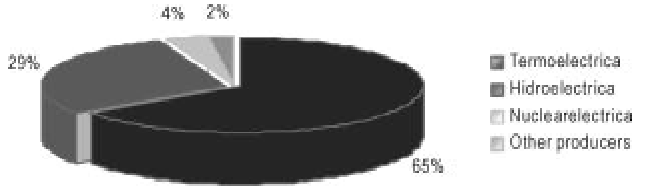

Fig.1 Energy sector

Fig.2 Electric power production in 2002

Main objectives of national energy strategy:

- Passing of the European Union regulations into the Romanian legislation regarding power efficiency and safety in the field of nuclear power;
- Restructuring energy sector;
- Ensuring the power needs of Romania at lower prices, by diversifying the sources and creating new infrastructures;
- Creation of integrated power plants, for which the sphere of activity shall include the electric and thermal power generation, based on coal as well;
- Operation of the national power system under safety and reliability conditions;
- Environmental protection by judicious use of the power resources;
- Interconnection of the national transport network to main European networks, and also to the infrastructure in construction.

Power sector privatisation:

- The privatization of the energy sector must take into account the development of an efficient energy market that would ensure the sustained growth of power generation at a high quality, in accordance with the European standards and the European environmental programs.
- In the field of electrical and thermal energy production is considered the privatisation of several plants with the participation of strategic investors through the following methods:

➢ Joint ventures - Public Private Partnership;
➢ B.O.T. (Build - Operate - Transfer);
➢ B.O.O. (Build - Own - Operate).

2 HIDROELECTRICA

S.C. HIDROELECTRICA S.A.

- Object of activity: generation and supply of electrical power;
- Installed capacity: about 5800 MW, with a productivity of 16 TWh / year in average, that means 40% from the total installed power possible to be achieved;
- Power generated in 2002: 14,500 GWh;
- Assets: 129 hydroelectric plants - 326 hydro aggregates;
- Economic feasible hydropower potential of Romania – 40,000 GWh / year.

Main objectives:

- Rehabilitation / modernisation of aggregates amounting to 985 MW, 196 Mill USD;
- New capacity development, about 800 MW, 1.3 bill. USD, as follows:

➢ continuing the works at the hydroelectric plants being under construction, for an installed power of about 200MW with an investment over 100 mill. USD;
➢ 21 objectives will be accomplished by attracting private domestic and international capital, under public-private partnership frames:
➢ joint ventures;
➢ B.O.T. (Build – Operate - Transfer);
➢ B.O.O. (Build – Own - Operate).

3 FROM THE BEGINNING…

The first starts as regards the flow energy use in our country could be found very long time ago, when Romans were ruling, the written documents describing the water tympanum and rotary cup as wheels to irrigate, the mill wheels or the crank falling mills to crush the minerals.

The first hydroelectric plant in ROMANIA which was documentarily attested was the Grozavesti plant built in 1889 on the Ciurel lake, BUCHAREST, having a 2×180 HP power. It has been in operation until 1912 when it was replaced with TPP Grozavesti.

The first mixed power plant in Romania, Sadu One, was built in 1896 in the Sadu Valley at 18 km from Sibiu town.

Twenty-one hydroelectric plants have been accomplished in Romania, having an installed power of 4550 kW, among which we mention HPP Sinaia I (4 ×250 kW) that has been in operation since 1898. Sinaia HPP is not important from the energetic point of view because it has no impressive power. But that time, it was the greatest power plant in Romania. It was then when it was achieved the first three - phased electric generation at 50 Hz. In 1889, Sinaia HPP was interconnected to Doftana TPP by an 8 kV line, on wood poles. It was the first

interconnected operation of two power plant, the first interconnection line and in the same time the first 8kV line in Romania. Sinaia HPP operates even today, with three of the four groups initially installed, one of groups being replaced in 1927 by a new aggregate which had superior efficiency.

4 DEVELOPING…

During the period of 1900 - 1930 we continued to build hydropower plants (excepting the war period), therefore in 1930 the hydroelectric plants power was 30 MW, with a 75 GWh generation.

During the period of 1928 - 1930 Dobresti HPP was built and put in operation and it will remain the plant with the greatest installed power in the country until 1960, when the first hydro aggregate of Stejaru HPP was put in operation.

In 1933 it was carried out the first development schedule of the Romanian hydropower potential by Professor Dorin Pavel, which was published in the work entitled "Plan General d'Amenagement des forces hydrauliques en Roumanie". Starting with the evaluation of the developing the Danube, the schedule presented in a unique and modern concept the development schedules and the technical - economic indicators of a number of 567 hydroelectric plants.

5 … FOR FUTURE

1961 - 1970: Stations summing up altogether 960 MW power installed were brought into operation 1971 - 1980: Were brought into operation at their capacity the Iron Gates HPP, Ciunget - Lotru HPP, the first power plants from the Olt river development, having a total power installed of 2130 MW;

1981 - 1990: A very large number of aggregates was brought into operation, 145~about 45 % of the entire number of aggregates being in operation at present in HPP, having Pi= 3.2 MW. The total power installed in this decade is about 2110 MW power plants;

1991 - 2000: 452 MW were brought into operation in power plants, the execution of which has started before 1989.

2001: It have been achieved the following commissions:

- HA 10 - 27,5 MW The additional power station Yugoslavia - Portile de Fier II;
- HA 1 - 3,8 MW CHE Dragoslavele - Dambovita Development;
- The accumulation of Cornetu - The development of Olt Defileu and the first rotation of HA 1 - CHE Cornetu.

2002: It have been achieved the commissioning of HA1 - 16,6 MW at CHE

- Cornetu and following the commissioning of HA II in Dec.

The total power installed of the hydroelectric plants in Romania reaches at present at 6017 MW, producing 17,262 GWh / year in the average hydrologic year.

6 DEVELOPMENTS

Included developments	No.of plants and Pumping statipns	Installed power MW	Annual energy GWh/year
Lotru, Olt	26	1180,80	2751,36
Dunare, Portile de Fier I si II	3	1378,2	6561
Bistrita, Siret, Prut	81	667,73	1761,1
Somesul Cald, Cris, Dragan, lad	59	565,84	1096,39
Arges, Dambotita, Raul Targului	65	634,34	1281,89
Raul Mare	24	488,9	850,29
Sebes, Fenes	6	348,2	609,73
Cerna, Motru, Tismana, Jiu	17	206,2	504,9
Bistrita Marului, Cerna	11	164,37	303,7
Buzau, Canal Dunare-Marea Neagra	13	98,19	3017
Olt	8	379	889
Olt Sadu, Cibin, Tarlung	34	149,55	387,69
Total	**347**	**6260,78**	**17298,78**

Romanian hydro energetic potential is 40000GWh / year.
It is already installed about 40%, out of witch SHP about 4000 GWh / year.

7 SMALL HYDRO POWER

In Romania the first SHP's are recorded at the end of 19th century, some of them being up to now under operation. Until 1975 those were considered uninteresting from economic point of view but later the SHP's caught again the attention.

Today Romania's hydropower producer HIDROELECTRICA operates 386 micro hydropower plants. According to sector analysts there may be about 5000 locations in Romania suitable for the construction of SHP's

Conventionally, the sites comprised in the Romanian micro hydroelectric program had been classified

having in view the installed capacity as follows:

- SHP with installed capacity from 200 up to 3600 kW
- MHP (micro hydropower plants) with installed capacity from 20 up to 200 kW
- AHP (artizanal hydropower plants) with installed capacity below 20kW

Type	Installed capacity (kW)	No. of units
SHP	200-3000	200
MHP	20 - 200	30
AHP	Below 20	No data

Applied constructive solutions:

The SHP and MHP development schemes had been adopted according to the specific hydraulic and topogeologic conditions for each site. As dominant schemes we meet cascade developments with diversions under pressure, no surge tank and equipped with one or tow units. The installed discharges are equal or higher than 2-2.5 times as the average discharge. Intakes are usually on the run of the river with compensating reservoir having a volume so dimensioned to ensure minimum half an hour operation at rated capacity.

In the aim to decrease the power stations investments and the construction periods the constructive solutions as the equipments are standardized as possible as much.

Turbine type and dimensions:

The following types and dimensions had been established in order to cover the heads from 2 up to 150m and discharges field from 0.63 up to 6.3 m^3/s.

1. EOS – helicoidally, horizontal with S shape circuit; rotor diameters: 500, 700, 900 and 1100mm;
2. FO – Francis horizontal; rotor diameters 390, 570, 640 and 720 mm;
3. Banki with diameters of 200, 300 and 400 mm;
4. MLU- micro units used at large scale- vertical helicoidally turbine with the rotor diameters of 250mm and metallic spiral chamber.

For the AHP horizontal Pelton turbines or pumps manufactured by AVERSA factory in Bucharest as series production had been used to.

The rotation speeds and the blades positions for EOS turbines had been so established function of the ratio head/discharge in the aim to ensure a stable operation at maximum efficiency of the appropriate turbine type.

Generator types and dimensions

For the standard turbines coupling mentioned before horizontal asynchronous generators carried out by RESITA Building Machineries Factory or motors manufactured by Bucharest Electric Machines Factory as series production had been provided. Their main characteristics are:

1. Speed range from 300 up to 750 rpm;
2. Power from 75 up to 800 kW.

Hydromechanics equipment types and dimensions

Both for hydropower plants and water intakes the main hydromechanics equipments are standardized.

Standard solutions for structures

Function of the turbines and generators type and dimensions, had been drawn up standard details for the hydropower plant structures.

The water intakes had been carried out as Tyrolean intakes standardizing their construction for the following sizes at cached maximum discharges: 0.63, 1, 1.6, 2.5, 4 and 6.3 m^3/s.

The constructive solutions for headraces and downstream joint to the river had been considered powerfully prevalent of the particular natural conditions of each development so they hadn't been comprised within standardization actions.

In case of developments carried out to the existent storages located in plain regions siphon type headraces are prevailing. At the beginning the Owners had required these solutions in the aim to do not affect the safety and the operation conditions.

8 INTERNATIONAL COOPERATION

ALGERIA: Drawing-up of projects and Technical assistance

Performance projects and technical assistance for the dams: Koudiat-Medaour, Sidi-Yacoub, El-Fakia; -Consultancy services and technical assistance for Electricite de France.

Bolivia: Preliminary studies and Investigations

Evaluatioan of energy resources and preparation of the national electrification program HPSs Rositas-Rio Grande , Iola, San Jose.

Central African Republic

Preliminary report on the hydropower development of Lobaye River (M'Baiki HPS).

Preliminary assessment of the hydropower potential of Sahgha-Mambere, Lobaye, M'Poko Rivers.

Columbia: Preliminary studies and Investigations

Organization of Colombian power sector, inventory of hydropower resources as an alternative for thermal power plants, long-term development of power system.

GERMANY: Technical assistance

Co-operation at the hydropower project in the third countries (Bataang Agam HPS-Indonezia, Mukungawa HPS –Rwanda).

IRAN: Preliminary studies and Investigations

Recognition and preliminary studies for water supply systems of towns: Ghom and Yazd; Shah Reza; Ardakan and Yazd; Irrigations in the Mazlagham plain.

Studies related to the possibilities of dam construction the Iranian-Turkish border rivers.

Drawing-up of projects

Feasibility studies, final project and contract document related to Vafregan (arch H=125 m), Noubaran (arch H=59,5m) Barun (earth H=77m) dams and Saveh HPS of 10 MW.

Tender evaluation and contract conclusion for the construction of Vafregan dam.

Updating of the feasibility studies, drawing-up of final design, tender documents for alavian rock fill dam (H=75m) and HPS (6MW), and Marun rock fill dam(H=175 m) and HPS (145 MW) .

Expertise related to the spillway refurbishment of Karun dams (16200 cm/s).

LEBANON: Drawing-up of projects

Feasibility studies related to the development of Oronte (11,6MW-Hermel HPS) and Yammouneh (11, 7MW-Chlifa HPS) water courses.

Expertise of the water supply system of Beirut town and technical assistance for drawing-up the performance design.

NEPAL: Technical assistance

Technical assistance services at Bhote Koshi dam through HARZA Engineering International-USA.

PERU: Technical assistance

Engineering geological studies and hydrotechnical structures related to the hydroelectric projects.

SYRIA: Preliminary studies and Investigations

Lay-out for development of dams and water storages in the coastal areas.

Performing of project and technical assistance during construction and commissioning of the raw water supply system of Banyas Rafinery.

TURKEY: Drawing-up of projects

Multiporpose development scheme of Seyhan river and fesibility report related to Catalan earth dam (H=94 m) and 155MW HPS, Imamoglu irrigation tunnel.

Engineering services related to delivery, erection and commissioning of the mechanical and electric equipment of Kapulukaya HPS (3×18.2MW) and Kilickaya (135MW switchaed, 35 kV indoor switchyard).

Consultancy services and technical assitance for HARZA Eng.Int.-USA for Boyabat development (Dam and HPS with 500 MW power).

9 ENERGY RESEARCH AND MODERNIZING INSTITUTE —ICEMENERG SA

ICEMENERG is specialized in the fields of power plants, substations and electric networks, performing two types of activities:

- Scientific Research and Engineering.
- Technical Assistance and Service.

As a part of a scientific research and engineering activity, prognoses, studies and research works are performed for the safe operations of the power generating equipment, as well as for the transmission, distribution and utilization of heat and power.

The institute develops research works for raising the technical level in the design, manufacture and operation of the power equipment and for increasing efficiency of power plants, substations and networks.

The Institute ensures technical assistance for commissioning and service for a wide range of electric and electronic equipment.

ICEMENERG is endowed with laboratories, workshops, test stands and up-to-date testing equipment and employs highly qualified personnel.

10 ENVIRONMENT – ENERGY CENTER

SPRTI – Policies, Regulation, Information Technology Department

- Policies, Regulations, System Methodologies.
- Methods for the determination of the service costs in the electricity transmission and distribution system.
- Economic mechanisms and instruments characteristic of the electricity market.
- Energy development strategies.
- SCADA systems for the power plants and high voltage electric substations management.
- Modern electricity and heat measurement / billing systems.
- Modern systems for the monitoring / measurement of the hydroelectric power plants.
- Consultancy and technical assistance in telecommunications fields.
- Hardware and Software Technical Assistance.

SME – Environmental & Echo technologies Department

De polluting Installations, Noxious Measurements and Environmental Protection.

LMN – New materials laboratory

New materials and technologies for sustainable energetically development and power equipment maintenance.

LUER – Energy efficiency & renewable laboratory

- Energy efficiency in industry, tertiary and domestic sector.
- Energy efficiency in buildings and for municipalities.
- Small and medium scale combined heat & power systems for industry, district heating and residential.
- Power management; energy efficiency quality and labelling.
- Procedures and facilities for energy efficiency certification of domestic appliances.
- Renewable energy sources: solar, wind, micro-hydro, geothermal, biomass.

11 TRANSMISSION AND DISTRIBUTION CENTER

SESR - Electric Equipment, Substation and Networks Department Electric Transformers and Apparatus.

LATP – Automation and protections laboratory.

ODE - Energy Documentation Office.

REFERENCES:

The Electricity and Thermal Power Generation, Transmission and Distribution Review (includes the Energy Information Bulletin).

The review of "National Electricity Company" – CONEL – presents the actual activities carried out for the NPS efficient operation, the causes of failures and events occurred in the plant enterprises and electric networks, labour safety and protection legislation, economic and organizational aspects, technical solutions for the energy sector retrofitting, repairs technologies, measures for the safe operation of the power installations, tariffs and costs of electricity and related services.

Power Standards Bulletin

The publication comprises the standards which are most frequently requested by the electricity and thermal power generators and users.

The Catalogue of the National Electricity company – CONEL

The catalogue includes the titles of the regulations in force for electricity and thermal power generation, transmission and distribution – design, operation, repairs and supply. The catalogue offers you general energy specifications, specifications for specific activities and installations, as well as internal regulations. The standards included in the catalogue are grouped according to works and installations types.

12 ELECTRICITY AND HEAT GENERATION CENTER

STM - Thermal & Mechanical Department.

SEDM - Metal Expertise and Diagnosis Department.

SAHME - Automations, Hydropower and Electrical Machines Department.

Automation in power developments:

Designing and implementation of computerized survey systems of processes in power plants and substation.

Expert's finding, diagnosis and determining the performances for all types of RAV's; REH's repairing and maintenance.

Execution of the power plants Teletype dispatching systems utilizing the real time computers.

Hydropower stations:

Commissioning, warranty and performance tests.

Analyses of the hydropower balance and prognosis of the spring floods, rain -drain.

Flood Wave passing over on hydropower plants waterfalls.

Optimisation the hydraulic turbines servo system.

Development of optimum retrofitting, upgrading and maintenance solutions.

On-line monitoring and diagnosis algorithms and development of monitoring installations.

13 ICEMENERG INTERNATIONAL EXPERIENCE

1. Technical assistance for putting in operation of the water treatment plant (demineralization, softening) and boilers chemical cleaning, before putting in operation from:
   - El-Mex Factory - Egypt
   - Banias Rafinery - Syria
   - Kirkalle - Turkey
   - Sînjar – Iraq

2. Co-operation with ARIONEX - Switzerland Comp. for ion exchangers demi-water procedure MULTREEX;
3. Expertise of the 107 RH reactor material of the Bania – Syria refinery.
4. Design and development of a flow metering installation at Gezende hydroelectric power plant - Turkey.
5. Dielectric testing and commissioning test monitoring, as well as warranty tests at Rovinari ES together with GEC Alsthom - France. ■