KPMG

Hidroelectrica SA

CO_2 reduction by modernization of 4 hydro units within Portile de Fier II

Baseline study

July 2003

This report contains 48 pages and 3 appendices

Contents

1 Project information

1.1 Project characteristics

1.1.1 Supplier's name and address:

Company name: HIDROELECTRICA S.A.

Address: 3, Constantin Nacu Street, sector 2

Zip code + city address: 70219, Bucureşti

Postal address: 3, Constantin Nacu Street, sector 2

Zip code + city postal address: 70219, Bucureşti

Country: Romania

Contact person: Mr. Eugen Pena

Job title: General Manager, Hidroelectrica S.A.

Telephone number: + 40 1 303 25 60

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1.1.2 Local contact

Company name: Hidroecentrale Portile de Fier II, Subsidiary of Hidroelectrica

Address: Drobeta-Turnu Severin, Calea Timisoarei nr. 2, Mehedinti county

Zip code + city address: 1500

Postal address: Drobeta-Turnu Severin, Calea Timisoarei nr. 2, Mehedinti county

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1.1.3 Other parties involved (co-investor, owner, operator, user, etc.)

Not applicable.

1.2 Project abstract

1.2.1 Project title

The present project is entitled: Modernization of first 4 hydro units within Portile de Fier II hydropower plant.

1.2.2 Abstract

The project consists in overhauling and modernization of 4 units out of the existing 8 within Portile de Fier II hydropower plant. For these first 4 units the rehabilitation works are in progress and according to the contract concluded by Hidroelectrica with the company VA TECH HYDRO Ltd., they should be finalized in 2007. The remaining 4 units will also have to be refurbished by the end of 2010.

The scope of the modernization is to increase the economic efficiency of the hydropower plant by improving its reliability, by raising the power reserve and the output of the plant, thus meeting the conditions required for aligning and including it into the ancillary service category. The supplementary installed power in these four hydro-units will be 22 MW, which will lead to a supplementary energy of 212.133 GWh/year. Information on supplementary energy calculation is presented in Appendix 1. Modernization works on all 8 units will lead to upgrading the hydropower units and associated installations and their life duration will be extended by 30 years.

More information on the project is presented in Appendix 2.

1.2.3 Project location

The Portile de Fier II hydropower plant is located on the Danube River, km D862 + 800, close to Ostrovul Mare, Gogosu, Mehedinti county, Romania.

In Appendix 3 is presented a map showing the project location.

1.2.4 Project starting date

The project was launched in 2003.

Construction starting date: 2003

The construction works for first 4 hydro units were initiated in 2003.

1.2.5 Construction finishing date

The construction works for the first 4 hydro units are expected to be finalized in 2007.

1.3 Background and justification

The Hydropower and Navigation System (SHEN) of Porţile de Fier II was turn into operation between 1984 and 1986 and was built on the river Danube by Romania and by Yugoslavia under the 1977 Agreement.

Each of these countries owns one hydropower plant, with installed power of 216 MW each, equipped with 8 units (Kaplan horizontal hollow turbines, KOT 28-7,45, directly connected with synchronous, horizontal generators, encapsulate Type HOSC 776-125-96-27).

The company Hidroelectrica SA, created through Governmental Decision no. 627 issued on 1 August 2000, manages the Romanian hydropower plants.

Many operational disturbances occurred during the years, which were mainly caused by the poor reliability of certain important equipment; damages on rotor and switch column (Unit 3 and Unit 6) have led to extended unavailability of units, thus recording significant energy losses. At the same time modernization of automatic governors appeared as an immediate necessity in order to protect units for high output operations.

The works in progress have as a scope the increase of economic efficiency by creating higher reliability, by raising the power reserve and the output of the plant, thus meeting the conditions required for aligning and including the hydropower plant into the ancillary service unit category.

The modernization works on all the eight units will lead to upgrading the hydropower units and associated installations in order to extend their life span by around 30 years, through the substantial increase of equipment reliability.

Through the Government Decision no. 848 issued in August 2001, the modernization works have been awarded to the company VA TECH HYDRO Ltd. The modernization works are performed in accordance with the stipulations of the contract no. 2I/50765/09 concluded in November 2001: "Overhauling and Modernization of the Porţile de Fier II Hydropower Plant". According to the above-mentioned contract, all the eight units of the plant should be modernized between 2003 and 2010; the first 4 hydro units should be refurbished in the period 2003-2007.

All new equipment and spare parts used for upgrading and modernization of the hydro-units are produced in Romania.

1.4 Intervention

This subchapter describes the goals, the purpose, the results and the activities of the project.

1.4.1 Goals

The main goals of this project are:

- To use the clean energy production (the project has low environmental impact both in the construction and in the operation phases);
- To generate an additional electricity of approximately 212.133 GWh/year;
- To reduce the quantity of air emissions through the replacement of the electricity produced by fuel fired power plants;

1.4.2 Purpose

The main purpose of the project is to supply additional electricity to the National Electricity Network.

1.4.3 Results

The expected result of the project is to increase the installed capacity of the 4 hydro units with 22 MW. This should lead to additional electricity generated of approximately 212.133 GWh/year and also to the improvement of the national electricity supply system.

1.4.4 Activities

The activities performed during this project aiming to rehabilitate and to modernize the hydro units will mainly consist of:

1. *Turbine (including regulating system):*

- removal and disassembly;
- manufacturing new equipment in the factory (the necessary spare parts that have to be replaced);
- transportation to workshop and refurbishment of a number of existent equipment;
- temporary corrosion preventing protection applied in workshop;
- transportation of (new / refurbished) equipment from the workshop to the site;
- permanent corrosion preventing protection applied on site;
- reassembly and erection of turbine;
- start-up testing;

2. *Generator*

- removal;
- transportation to the workshop and refurbishment of certain subassemblies;
- refurbishment on site;
- transportation of equipment (new / refurbished) from workshop to site;
- corrosion protection application;
- placing generators and excitation systems;
- connection to existent equipment which was not scope of refurbishment;
- commissioning tests;

3. *Auxiliary installation*

- installation removal;
- checking up components technical condition;
- transportation into site of certain new components;
- refurbishment of components not to be replaced;
- replacing of some component parts;
- corrosion prevention protection application;
- performance of commissioning tests.

2 GHG sources and sinks and project boundaries

This chapter presents all GHG emissions sources and sinks relevant for the project boundaries. The scope is to clearly establish which emissions will and will not need to be estimated/measured in the baseline study and in the monitoring phase.

2.1 Project boundaries

The project boundaries were set by taking into account all relevant GHG emissions effects that can either be controlled or influenced by the project and by considering those related to activities one step downstream and one step upstream of the project.

The following aspects are considered to be outside the project boundaries:

- Grid electricity losses (the difference between electricity supplied to the grid and the electricity supplied to the final customer) - being out of the project influence or control they will not be considered;
- Emission one step upstream – being significantly less than 1% of the annual GHG emission reduction (see section 2.3.1) they will be ignored;
- Emissions one step downstream of the project - being out of the project influence or control they will not be considered (see section 2.3.2);
- Emissions resulting from other plants operation - being out of the project influence or control they will not be considered (see section 2.4).

2.2 Direct on-site emissions

The emissions resulting from the activities performed on project site in order to generate the electricity represent the direct on-site emissions. The process of producing electricity by using hydropower is considered a clean process, which means that no GHG are emitted during the electricity production, therefore **the direct on-site emissions are considered to be zero.**

2.3 Direct off site emissions

Direct off-site emissions involve emissions upstream and downstream of the project, which are directly influenced by the activity of the project.

2.3.1 One-step upstream emissions

The only GHG emissions one step upstream of the present project (modernization of 4 hydro units within Portile de Fier II hydropower plant) are those generated during the transportation of the necessary equipment and spare parts used for upgrading the hydro units.

Table1 presents the spare parts, which will have to be transported, the related distances and the number of necessary trips to be made, taking into account that the trucks may usually transport around 10 tones cargo.

Table 1 – Spare parts transportation data

Run. no.	Parts denomination	Distance (km)	No. of trips	Total distance (km)
1	2	*3*	*4*	*5*
TURBINES				
1	Rotor blades – about 40 tones * 4 turbines	1,500	16	24,000
2	Turbine spare parts – about 25 tones*4 turbines	1,500	10	15,000
3	Direction equipment – about 15 tones*4 generators	1,500	6	9,000
GENERATORS				
4	New equipment – about 14 tones*4 generators	1,600	6	9,600
AUXILIARY EQUIPMENT				
5	New equipment – about 30 tones	1,500	3	4,500
TOTAL DISTANCE				**62,100**

The total distance (km) that will be transited in order to bring the spare parts for the four hydro units can be determined by multiplying columns 3*4 and by summarizing then the obtained values. Therefore, this distance is of: 62,100 km.

Considering that the spare parts for all four groups will be transported during one year (which is not realistic because the modernization will be gradually made) a total value of around 62,100 km (a conservative approach) will be necessary to be done for transporting the equipment for the four hydro units.

Because it was not possible to obtain specific national data on car emissions, the emissions factor for vehicles recommended by UNEP in: "*The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses and Non-Commercial Organizations, United Nations Environment Program, 2000*" was used.

According to the above-mentioned document the emission factors for vehicles are:

Table 2 - CO_2 Emission Factor

Transport	CO_2 Emission Factor	
	t CO_2/kilometre	t CO_2/mile
Average Petrol Car[1]	0.000185	0.000299
Average Diesel Car	0.000156	0.000251
HGV	0.000782	0.001260

Normally, in Romania the trucks used for transport are Diesel fired trucks. Therefore, the emissions generated during the transport are:

Quantity of CO_2 = Distance*Emission factor

[1] Based on INFRAS data

Quantity of CO_2 = 62,100 km*0.000156 t CO_2/km = 9.6876 t CO_2.

Considering the analyzed scenarios and selecting the smallest figure related to the emissions within the project boundaries, which is 116,036 t CO_2 annual emission reduction related to S2, and calculating the percentage of emissions due to the transport from this figure, it results: 9.6876 /116,036 = 0.0000835, which is 0.00835%, significantly less than 1% and considering the most conservative approach for calculations. Consequently, **the one-step upstream emissions are ignored**.

2.3.2 One-step downstream emissions

The one-step downstream emissions are not within the control of the project developer because there will be no control of the electricity flows generated by each plant after entering the grid.

For the above-mentioned reasons, **all direct off-site emissions of the project are considered to be zero**.

2.4 Indirect on-site emissions

The indirect on-site emissions include the emissions generated in case modifications will occur in the demand of services triggered by the implementation of the present project (e.g shifts in demand and/or supply of electricity). Since this potential situation is a scenario of what results will have the non-development of the project, it is considered to be a baseline situation and will be taken into account in the baseline scenarios. These indirect on-site emissions are not considered as project emissions because they are not directly concerning the project. It is possible that the modernization of the 4 hydro units within Portile de Fier II will have a certain impact upon the development of other power plants. This impact is not under the project developer control, as well as the emissions resulting from other power plants operations.

The on-site electricity losses, given by the difference between the electricity produced (gross) and the electricity delivered to the grid (net) are also indirect on-site emissions. For the Portile de Fier II hydropower plant a supplementary output of 212.133 GWh/year was calculated. Therefore, the above-mention difference is already considered.

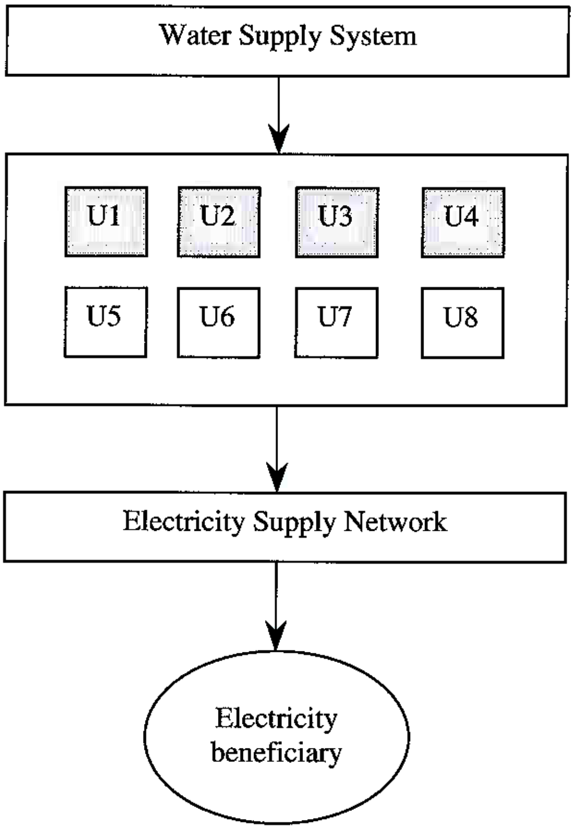
The last type of indirect on-site emissions identified for this project is represented by the grid losses, which are out of the project influence or control; therefore they will not be considered within the project boundaries. Moreover, these losses affect all types of electricity production (hydro, nuclear or thermal) and they are the same with or without project implementation.

2.5 Indirect off-site emissions

The indirect referred off-site emissions are those caused by the changes in emissions and sequestration activities parallel to the project, generated by the implementation of the project.

Being out of the project developer control these emissions are out of the project boundaries. Therefore, the **indirect off-site emissions of the project are considered to be zero**.

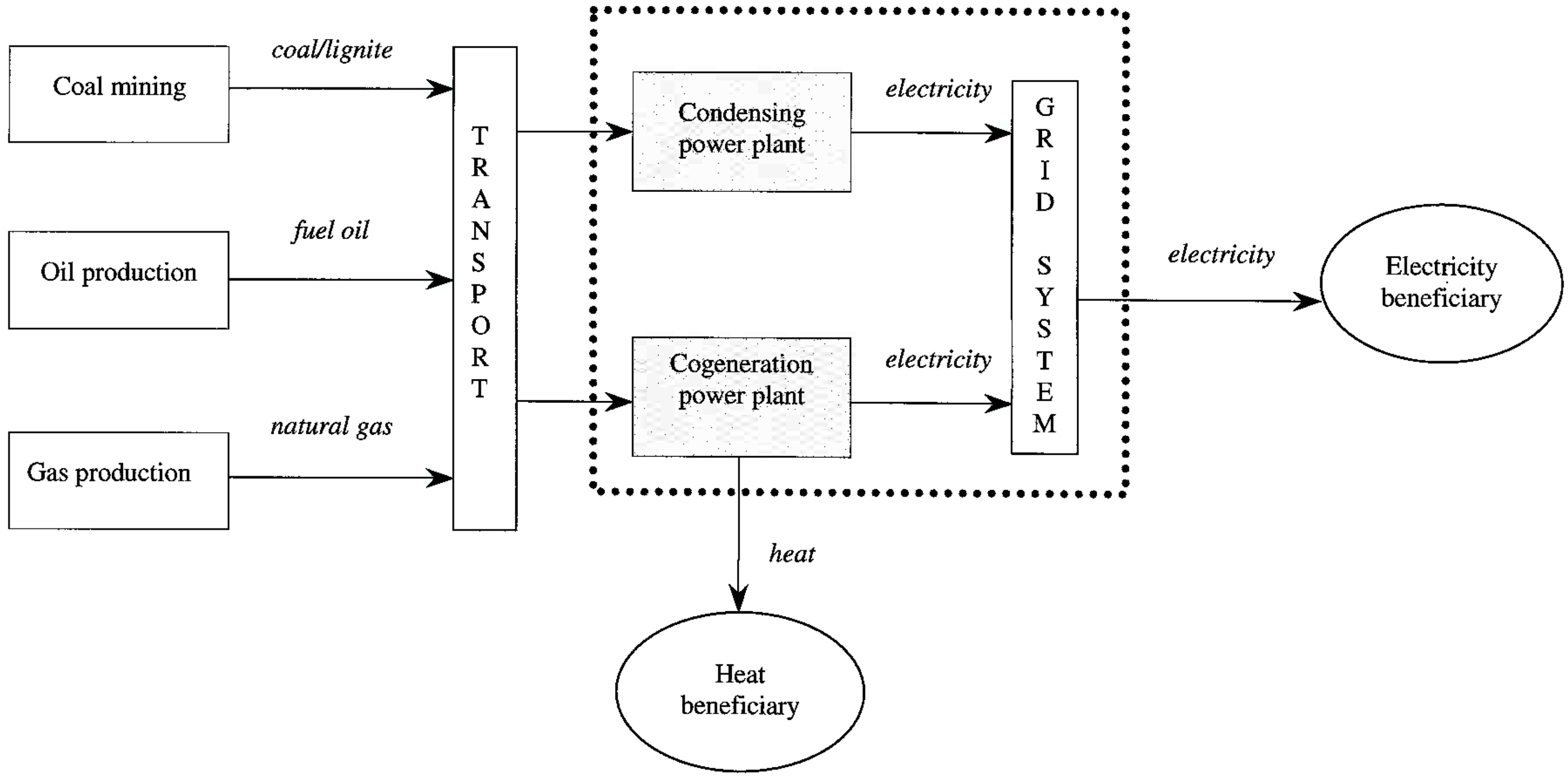
Fig.1 - Flowchart of the project illustrating its main components and connections



Note: The hydro units that will be modernized in this project are: U1 - U4

Figure 2, inserted below, presents the current delivery system, only including thermal power plants, as the project is assumed only to displace fossil fuel fired plants.

Fig. 2 – Current delivery system

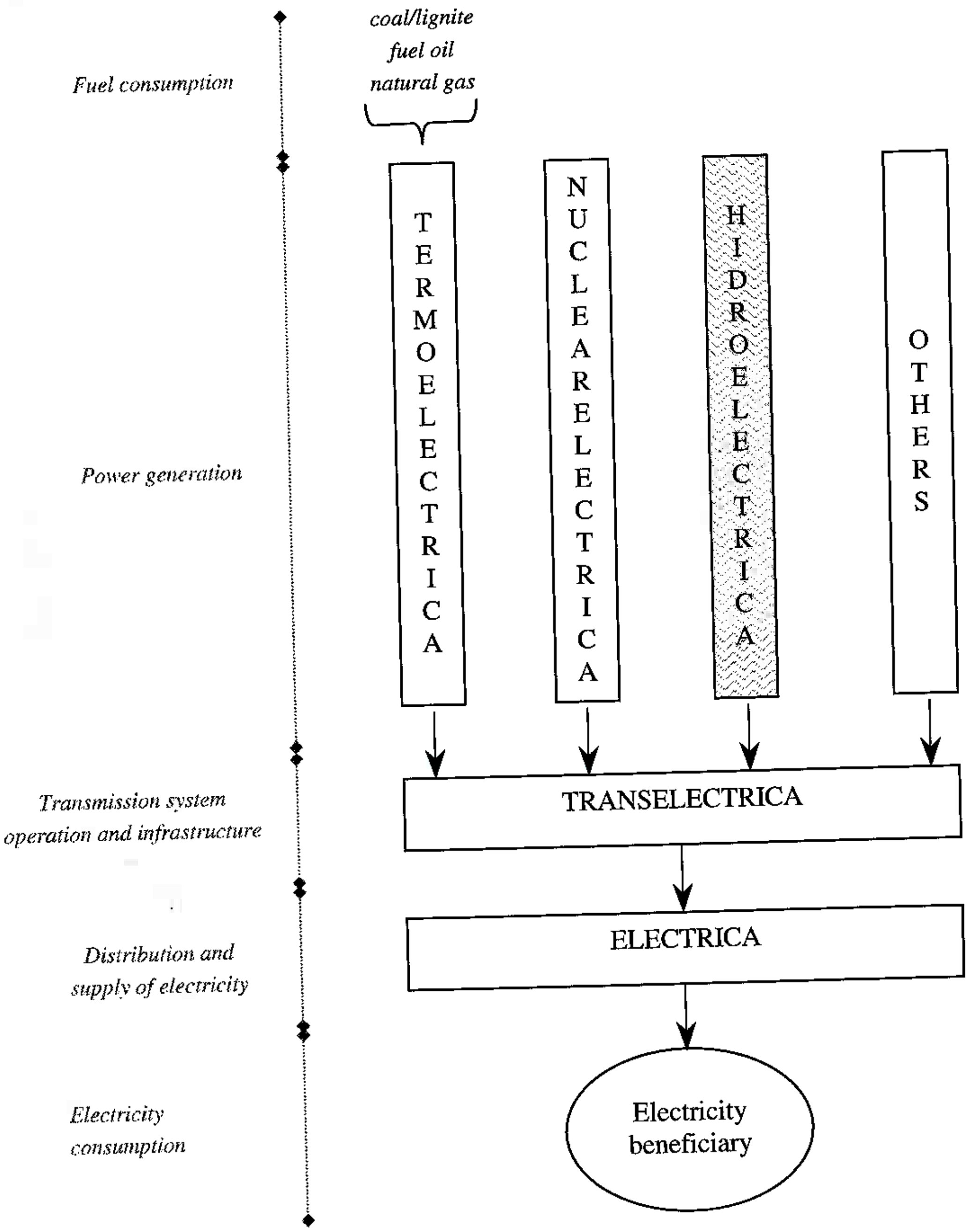


As presented in the above flowchart, only direct on site emissions will be taken into account in the analysis of the baseline scenario. The GHG emissions related to the production of the fossil fuels itself, the construction of the power plants, pipelines etc. and transport as well as downstream emissions are not taken into account.

3 The current delivery system

Figure 3 illustrates the current Romanian electricity delivery system pinpointing its main components and their connections:

Figure 3 – Romanian electricity delivery system



3.1 Description of the Romanian current electricity delivery system

3.1.1 Main players of the Romanian electricity sector

The electricity sector in Romania is under a process of transition from a monopolist structure to a competitive energy market in order to ensure safety in electricity supply, quality of electricity supply, efficient use of fuel, direct market relations between producers, energy/services suppliers and customers, as mentioned in "Guide to Energy Market, 2001"- STAT USA[2].

Since June 2003, when the cabinet of the Romanian Government was reorganized, The Ministry of Energy and Commerce is supervising the energy sector, therefore it is responsible for the policy and the strategy to be implemented in this field.

The whole economic and technical operation and development of the electricity sector is regulated, ruled and monitored by the National Electricity and Heat Regulatory Authority (ANRE), set up by an Emergency Ordinance, in October 1998, as a public institution, independent and autonomous.

In 1998 the nuclear sector was separated and CONEL (The National Electricity Company) was created. Based on Government Decision no. 627 issued in 2000, the former CONEL was split in the existing 4 independent state owned companies:

- Transelectrica SA – National Company for Electricity Transport;
- Termoelectrica SA – Commercial Company for Electricity and Heat Production;
- Hidroelectrica SA - Commercial Company for Electricity Production;
- Electrica SA - Company for Electricity Distribution and Supply.

Besides the above-mentioned firms, other operators on the electricity market are: Nuclearelectrica SA (National Nuclear Power Production Company) and several electricity independent or auto-producers.

The functions that *Transelectrica SA* has to fulfill, directly or through its subsidiaries, are: transmission and system operator of the National Electricity System; metering operator of the Romanian wholesale electricity market; and commercial operator of the Romanian Wholesale Electricity Market. The latter function is executed by Opcom S.A., a subsidiary of Transelectrica.

The most important electricity generating company is *Termoelectrica SA*. Its mission is to generate and to supply thermal and electric power. The functioning systems of the thermal

[2] STAT-USA, an agency in the Economics and Statistics Administration, U.S. Department of Commerce

power plants used for electricity production are based on condensation or on cogeneration. The latter system, beside electricity also generates thermal energy for district heating. The types of fuel currently used in the thermal power plants include coal/lignite and hydrocarbons. Since 2002 Termoelectrica has 11 branches and a subsidiary (SE Deva), within 17 power plants are in operation.

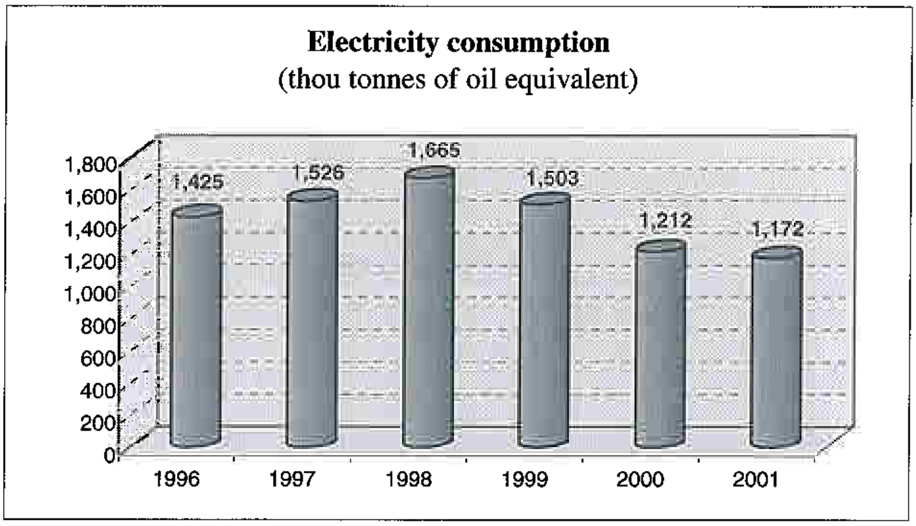
Hidroelectrica S.A. is the second Romanian major electricity producer who's objective is to generate electricity from hydropower resources by operating in conditions of safety and efficiency, to supply system technological services necessary to guarantee the safety of the national power systems operation and to supply regional/national water management services. According to Government Decision no.857/2002, the activities of Maintenance and Repairing were externalized and were taken over by eight new HIDROSERV branches, established as legally independent companies.

The main object of activity of *Electrica S.A.* is the electricity distribution and supply as well as the operation and development of distribution, telecommunication and IT systems compatible with the existing transmission and generation facilities. According to Government Decision no.1342/1991, Electrica SA was split in 8 subsidiaries. The privatization process was initiated for two out of these 8 subsidiaries, respectively for Electrica Banat and for Electrica Dobrogea.

3.1.2 Status and adequacy of the current delivery system

In June 2001, The Romanian Government approved the National Energetic Strategy on medium term – period 2001-2004. According to this document (Government Decision 647/2001), the total installed power capacity in electric plants was 22,589 MW - at the beginning of the year 2000. The technological level of the capacities is relatively low. Several investments for thermal plants and for hydropower plants initiated since 1990 are in different execution stages. The elements of electricity transportation system are characterized by a medium wear degree of 56% - for stations and respectively of 67% - for grid lines. Since 1990 up to now, the evolution of electricity consumption was directly influenced by the collapse of industrial activities, being characterized by a significant decrease followed by slight increasing. The reduced electricity consumption caused financial difficulties for the main players of the electricity market, triggering the slowing down of investments and rehabilitation development. The Romanian energetic safety has been and still is affected by the poor financial capabilities of the companies activating in the energetic sector. According to the data provided by The Romanian Statistical Yearbook, the 2002 edition, the gross domestic electricity consumption varied between 1996 and 2001 as illustrated in Figure 4:

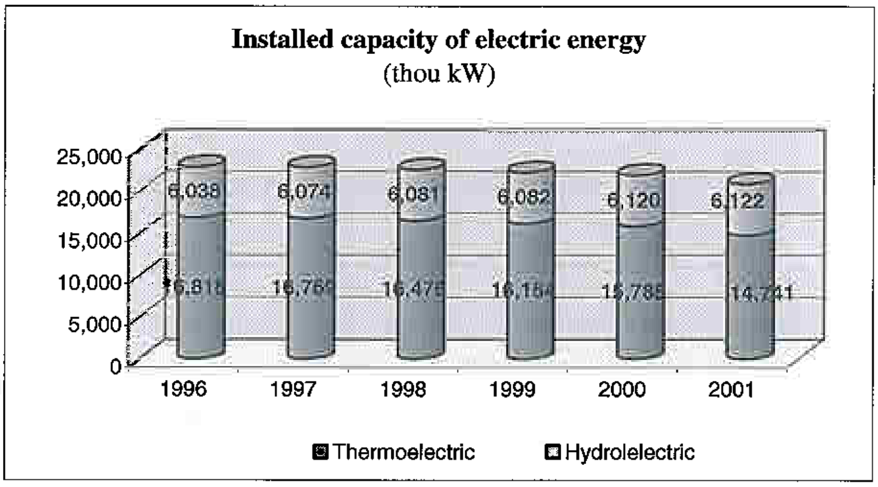
Figure 4 – Electricity consumption 1996-2001



Note: Oil equivalent – 10,000 kcal/kg

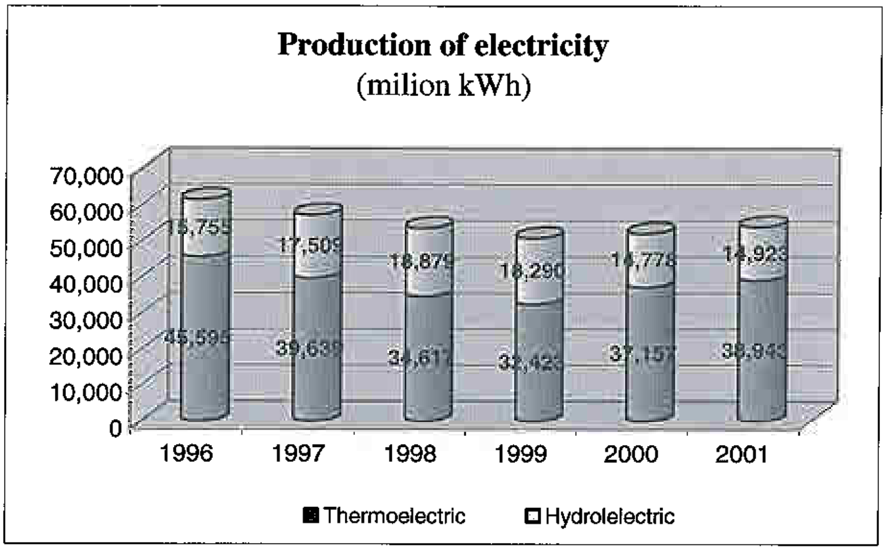
The variation of installed capacity of electric energy between 1996 and 2001 according to the above-mentioned data source is presented in Figure 5:

Figure 5 – Installed capacity of electric energy – 1996-2001



The data extracted from The Romanian Statistical Yearbook (2002) indicate an evolution of the electric energy production as illustrated in Figure 6:

Figure 6 – Production of electricity – 1996-2001

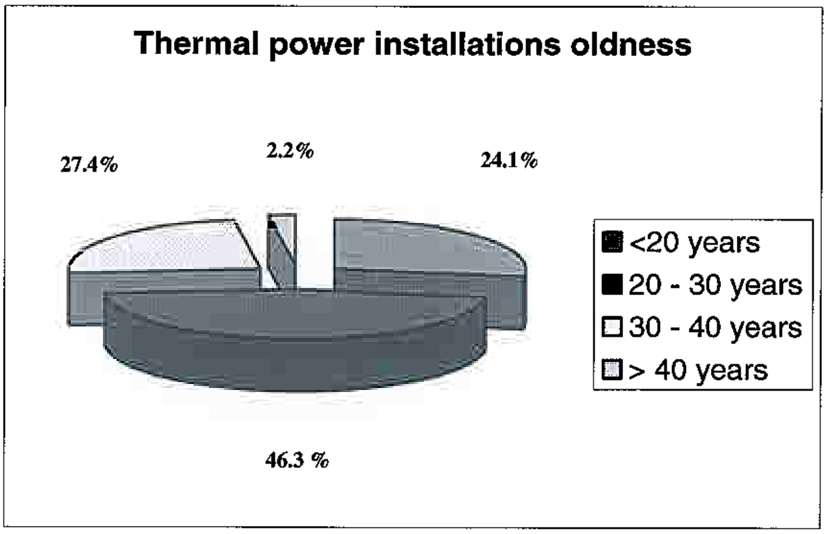


Adequacy of the current delivery system

Most of the thermal and hydro capacities built before 1989 become redundant because of the decline in electricity consumption and of the lack of financing sources. Approximately 60% of the current power capacity is more than 20 years old (EIA 2000).

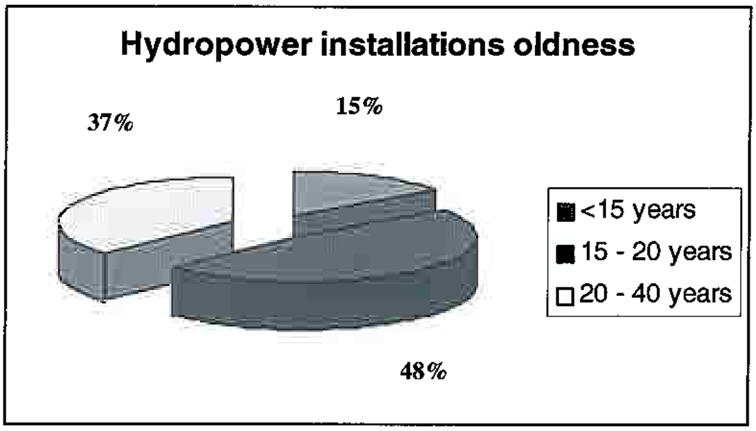
Figures 7 and 8 present the situation related to power installations oldness.

Figure 7 – Thermal power installations oldness



Source: SC Termoelectrica Annual Report 2000

Figure 8 - Hydropower installation oldness



Source: http://www.hidroelectrica.ro

Both Romanian medium term and long term energy strategy point out the necessity for rehabilitation power capacity and installation of modern and efficient equipment. However, the lack of cash availability for the energetic companies is mentioned. The Romanian Government focuses in finding additional funding possibilities for energy capacities modernization.

3.2 Operation modes of the Romanian current electricity delivery system

The main sources for production of electricity in Romania are thermal (coal, heavy oil and natural gas fired), hydro and nuclear.

3.2.1 Thermal power plants

The types of fuel used for electricity production within the thermal power plants are: lignite, hard coal, fuel oil, natural gas or a combination of gas and fuel oil. As mentioned in section 3.1.1, the functioning systems of the thermal power plants used for electricity production are based on condensation or on cogeneration. The latter system, beside electricity also generates thermal energy for district heating. The Table 3 presents details regarding the main thermal power plants of Temoelectrica: the installed power, the plant type and the fuel used in 2002.

Table 3 - Main thermal power plants of Temoelectrica

Run. no.	Thermal Plant	Total MW	Plant Type	Fuel used
1	Borzesti 1	420	condensing	gas and fuel oil
2	Braila	960	Cogeneration	gas and oil fuel
3	Bucuresti Sud	550	Cogeneration	gas and fuel oil
4	Progresul	200	cogeneration	gas and fuel oil
5	Bucharest West	250	cogeneration	gas and fuel oil

6	Bucharest Grozavesti	100	cogeneration	gas and fuel oil
7	Titan	8	cogeneration	gas and fuel oil
8	Craiova II	300	cogeneration	lignite
9	Isalnita	630	condensing	lignite
10	Palas	250	cogeneration	fuel oil
11	Mintia	1,260	cogeneration	hard coal
12	Doicesti	400	cogeneration	lignite
13	Galati	535	cogeneration	gas and fuel oil
14	Iernut	800	condensing	gas
15	Paroseni	300	cogeneration	hard coal
16	Rovinari	1,320	condensing	lignite
17	Turceni	1,980	condensing	lignite

Source: S.C. Termoelectrica S.A.

3.2.2 Hydropower plants

During the year 2002 the output of the Romanian hydropower sector was of 16,072 GWh, out of which 15,902 GWh have been produced in hydropower plants managed by Hidroelectrica (28.8% of internal gross production), in the context of a normal year (91% of the average water flow). This output has been generated using the natural inflow and stocking a volume of water equivalent to 264 GWh in the large reservoirs.

From the administrative point of view, the hydropower plants are organized in 12 subsidiaries, as follows:

Table 4 – Hidroelectrica subsidiaries

No.	Subsidiary	Pi (MW)	E_{year} (GWh/year)[3]
1	Bistriţa	667.73	1761.13
2	Buzău	98.19	301.70
3	Caransebeş	164.37	303.70
4	Cluj	565.84	1096.39
5	Curtea de Argeş	634.34	1281.89
6	Haţeg	488.99	850.29
7	Porţile de Fier	1378.20	6561.00
8	Râmnicu Vâlcea	1180.08	2751.36
9	Sebeş	348.25	609.73
10	Sibiu	149.55	387.69
11	Slatina	379.00	889.00
12	Târgu Jiu	206.24	504.90
TOTAL		**6,260.78**	**17,298.77**

Source: Hidroelectrica SA – Environmental Report 2002

[3] Energy in an hydrological medium year

3.2.3 Nuclear power plants

Nuclearelectrica SA is a state owned company, which produces nuclear-generated electricity, heat and CANDU 6 type nuclear fuel. The mission of the company is to operate the Cernavoda Units NPP (Nuclear Power Plant) - in a competitive, safe and environmental friendly manner so that the production will be optimized and the economic lifetime of the plant will be maintained as long as possible. This first NPP ever built in Romania was designated to operate with 5 units of 700 MWe each. Currently only one out of the 5 units is functioning. Cernavoda Nuclear Power Plant is a CANDU 6 type NPP CANDU (CANadian Deuterium Uranium), a Canadian design power reactor type.

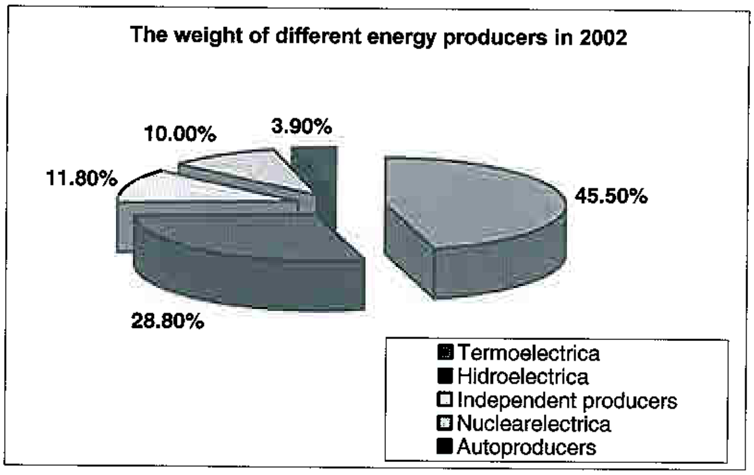
According to the information made available by ANEIR (National Association of Romanian Exporters and Importers) on 18 May 2001, the commercial contract for the completion and commissioning of the Cernavoda Unit 2 Project was signed by the Nuclearelectrica SA and its partners AECL - Canada and ANSALDO - Italy. The commercial operation of Cernavoda Unit 2 NPP was scheduled to start 54 months after effective date. The national participation in this project, planned to be completed by the year 2005, comprises important contributions of the nuclear industrial infrastructure developed in Romania for the CANDU power plants, such as: the initial heavy water inventory the nuclear fuel, the specific materials, equipment and components as well as specific technical design support.

In 2001 the construction works at the reactor buildings were mostly performed. The main equipment is already installed and the installation of the fuel channels was finalized in 1999. By the end of 2001, the Unit 2 was about 40% completed.

Source: Nuclearelectrica web site

Figure 9 presents the weight of energy producers according to the energy source.

Figure 9 - The weight of different energy producers in 2002



Source: Hidroelectrica SA – Environmental Report 2002

A total of 55,215.28 GWh were produced in 2002 in Romania. From the total of 16,072 GWh hydro-energy, Hidroelectrica produced 15,902 GWh (28.8%). Independent producers generated the rest of 170 GWh hydro-energy. These also produced 6,345.4 GWh in fossil fuel fired installations.

3.3 National energetic strategy

As mentioned in section 3.1.2, the Government Decision no. 647/2001 sets forth The National Strategy for the Energetic Development of Romania on Medium Term 2001-2004, who's main objective is to create an efficient energy market in order to ensure sustainable development, safe energy supply, observing the EU standards related to efficient energy usage and environmental protection. The following objectives derive from the main objective:

- using specific market economy mechanisms in energy sector;
- interconnecting the national electro-energetic system with the system of the Organization for Coordinating the Electricity Transporters;
- ensuring safe and diversified supply resources and stocks for the secure operation of the energetic system;
- minimizing the negative environmental impacts of the energetic processes;
- completing and improving the legislative framework in energy field.

The following actions must be taken in order to implement the above-mentioned energetic strategy for the next 4 years and the respective action plan:

- to import maximum 40% of energy fuel (natural gas, fuel oil and coal) in order to ensure security in electric and thermal energy supply;
- to finalize the second unit of the Cernavoda plant as a priority of the energetic system development;
- to invest about 1 billion USD in finalizing hydro energetic capacities of more than 900 MW;
- to implement the investment programs (more than 2.8 billion USD) in the sector of electric and thermal energy production;
- to rehabilitate and modernize the national electricity transportation system and building the connection systems with the Organization for Coordinating the Electricity Transporters (450 million USD);
- to develop and modernize the electricity distribution system (335 million USD) and to implement the program for village area electrification (150 million USD);
- to implement the program for efficient energy use, adopting the EU regulations in this field (3 million USD);
- to privatize the electricity production and distribution systems in order to obtain financing sources, to ensure efficient management and to enter new markets;
- to create a market for energetic services in order to increase energy efficiency;
- to improve international cooperation in energy field;
- to improve environmental protection in energy field;
- to consolidate the restructuring process for the companies operating in energetic field;

- to apply EU policies and to harmonize the energetic policy and the respective legislation with the "acquis communitaire".

All the above-mentioned actions were included in the medium term energy strategy under the assumption that additional funding sources will have to be identified, as the National Government has no the possibility to budget all of them.

According to the National Energy Development Strategy on Long Term (2002-2015) of the Ministry of Industry and Resources, the energetic strategy of Romania is part of the general Romanian strategy: Romania will be part of the European Union, being fully compliant with the "acquis communitaire". Romanian energetic policy will be harmonized with the EU policy in this field and will be focused on the following aspects: safety, efficiency, environmental protection, customer rights and competitive market mechanisms.

Primary energy resources

Romania has significant fossil fuel and hydroelectric resources, and has the potential to be energy self-sufficient for several decades, however, Romania has become a net-importer of crude oil and gas due to obsolete equipment and a slow-down of investment in exploration and production of coal. The total net imports of energy resources are approx. 21% of TPES if not accounting imports of nuclear fuel[4]. The main imported energy commodities are crude oil, natural gas, petroleum products and nuclear fuel. Romania is exporter of coal and electricity. The share of fossil fuels on total primary energy consumption is 84%.

Table 5 - Primary energy sources balance of Romania (1999) in PJ

(PJ)	coal	crude oil	petrol. products	gas	nuclear	hydro	RES + waste	electricity	TOTAL
Domestic production	966,3	15,9		7,5	145,7	5,9	28,9		**1 170**
net imports	-224,8	247,4	81,2	311,5				-11,7	**404**
stock changes	35,6	-3,3	4,6	4,6					**41**
TPES	**777**	**260**	**86**	**324**	**146**	**6**	**29**	**-12**	**1 615**

Source: IEA

Electricity market liberalization

In October 1998, the National Electric and Heat Regulatory Authority (ANRE) was set up as an independent institution to regulate the electricity market. Romania is opening up its electricity market to be compatible with EU practices.

In February 2000, ANRE opened up 10% of the Romanian electricity market by allowing ten large industrial companies to select their electricity suppliers and granting electricity supply licenses to five independent electricity producers. In October 2000, the degree of liberalization was increased to 15%, which cleared the way for more large users, of more

[4] According to IEA statistics, nuclear energy is accounted as domestic energy source

than 100 GWh annually, to choose their suppliers of electricity. ANRE plans to open the energy market up further in the next few years.

Source: Country Profile – Romania- Review of Status of Emissions Trading Activities in CG11 Countries; ENVIROS-knowledgeinnovationsolutions- Project No.: ECZ-2024

4 Key factors influencing the baseline and the project

4.1 Legal

4.1.1 Romanian electricity sector

The current strategy in the Romanian energy sector is aiming to create a smooth functioning market economy, consistent with EU principles, legislation, mechanisms, institutions and policy.

According to "Good Practicies in Policies and Measures for Climate Change Mitigation" – Regional Environmental Center - 2002, the general legislative framework of the electricity sector is represented in Romania by several regulations (Emmergency Ordinances and Government Decisions) for setting up the functioning rules of the main players acting on the electricity market.

Based on this general framework, the stipulations of *The European Directive 96/92/EC* regarding common rules for the internal market in electricity were transposed into Romanian legislation when several regulations were issued, including technical and commercial codes.

The provisions of *The European Directive 90/377/CEE* concerning a Community procedure to improve the transparency of gas and electricity prices charged to industrial end-users were transposed in Romanian legislation through the ANRE Order no.15/2001.

In perspective, Romanian authorities intend to issue a Government Decision for transposing the stipulations of *The European Directive 90/547/EEC* on the transit of electricity through transmission grids. Other two regulations should be issued in order to transpose the requirements of *The European Parliament Decision No 1254/96/EC* laying down a series of guidelines for trans-European energy networks and of *The European Council Decision no.391/96* laying down a series of measures aimed at creating a more favorable context for the development of trans-European networks in the energy sector.

4.1.2 Romanian GHG policies

Romania has signed and ratified the major international treaties and conventions in the field of environmental protection, including the Kyoto Protocol, which was transposed in Romanian legislation under the Law no.3/2001. Therefore, Romania committed itself to reduce the level of GHG emissions with 8% comparing with the GHG emissions level in 1989.

In order to satisfy the requirements of accession to the European Union, Romania has also developed several national strategies to promote sustainable development.

Countries like the Netherlands, Denmark, France and the United States are active in the energy and energy efficiency field in Romania with bilateral projects. A significant proportion of those resources has been directed towards improving energy efficiency, thus to reduce the GHG emissions. Part of this assistance has been motivated by the need to prepare Romania for accession to the European Union.

The energy sector is responsible for around one half of Romania's total CO_2 emissions. The high level of emissions from Romania's energy sector is in part a result of continued reliance on hard coal and lignite – which account for 62% of the sector's total emissions. However, the level of emissions is further increased by the general inefficiency with which power and heat are generated. Problems include: lack of operation and investment capital; use of obsolete equipment designed in the 1960s and 70s without regard to environmental considerations; poor maintenance and poor management.

The Ministry Order no.1144/2003 introduces a Register of Pollutants emitted into air/water by the companies performing activities with significant impact upon the environment. The Order not only presents the pollutants reporting methodology but it also outlines the work of the central environmental authority in collecting data related to emissions and their sources, and making them available to the public. The data contained within the above-mentioned register should be transmitted to the European Environmental Protection Agency. Among the air emissions pollutants to be reported we mention: CH_4, CO_2, N_2O and HFCs. The Order stipulates that The Register of Pollutants for the year 2002 will be made available to the public, by including it in the Ministry of Waters and Environmental Protection web site, in December 2003.

In June 2003, *The National Inventory Report 2001* was published on the website of the former Ministry of Waters and Environmental Protection, currently the Ministry of Agriculture, Forests, Waters and Environmental Protection. The inventory contains estimations based on calculations made for quantifying the following GHG emissions: CO_2, CH_4, N_2O, PFCs, HFCs and SF_6. The information necessary to develop the national inventory was provided by The National Institute for Statistics in the form of the Statistical Yearbook and by The National Research and Development Institute for Environmental Protection (ICIM). The emission factors used within the National Inventory Report 2001 were taken from the "Revised 1996 IPCC[5] Guidelines". The methodologies used for calculating the GHG emissions by sector are those indicated in "Revised 1996 IPCC Guidelines" and the Corinair 1996 calculation algorithm. In this national inventory it is stipulated the willingness to submit by the end of 2003 to the UNFCCC[6] Secretariat, the GHG inventories for the period 1989-2001.

[5] IPCC – Intergovernmental Panel on Climate Change

[6] UNFCCC - United Nations Framework Convention on Climate Change

4.2 Economic

There is a clear correlation between the economical growth of the country and the development of the energetic sector.

Within National Energetic Development Strategy on Long Term, Romanian Government considered two scenarios related to GDP and electricity production evolution. The Tables 6 and 7 present the macroeconomic and energetic indicators of Romania for the period 1998 – 2015, based on two development scenarios.

Table 6 – Macroeconomic and energetic factors of Romania

	1998	1999	2000	2001	2002	2003	2004	2005	2010	2015
	Realized						Estimation			
GDP increase (%)	-5.4	- 3.4	1.6	4.9	4.5	5.2	5.5	5.1	8.0	6.7
Electricity production increase (%)		- 8.3	2.7	2.1	2.8	1.8	2.0	1.6	4.0	3.5
Electricity (TWh)	53.5	50.7	52.0	53.9	55.5	54.3	55.0	55.5	65.5	77.0

Table 7 - Macroeconomic and energetic factors of Romania

	1998	1999	2000	2001	2002	2003	2004	2005	2010	2015
	Realized						Estimation			
GDP increase (%)	-5.4	- 3.4	1.6	4.9	4.5	5.2	5.5	5.1	6.5	6.0
Electricity production increase (%)		- 8.3	2.7	2.1	2.8	1.8	2.0	1.6	3.4	2.9
Electricity (TWh)	53.5	50.7	52.0	53.9	55.5	54.3	55.0	55.5	63.7	72.9

In The National Strategy for the Energetic Development of Romania on Medium Term 2001-2004 (detailed in section 3.3), it is anticipated an annual growth of electricity consumption of 4%.

Nevertheless, the production of electricity based on hydro-electricity is the cheapest form of electricity (e.g. in 2002 the hydro-electricity price was 5 times lower then the thermal-electricity price and 4 times lower than the price of nuclear electricity).

4.3 Political

The strategy of the current Romanian government, which will be in force until 2004, is focused on creating an efficient energy market in order to ensure sustainable development, safe energy supply, observing the EU standards related to efficient energy usage and environmental protection.

It is expected that all the coming governments will continue to support the accession of Romania to EU and therefore will continue to develop the preparation process for satisfying the economy criteria to be met, including those concerning the electricity sector. The most important criteria to be met for the Romanian electricity sector are the liberalisation of the electricity market and the compliance with the environmental regulations adopted or supported by the EU, including the Kyoto Protocol. It is likely that any of the coming Romanian governments, which will rule during the crediting period of the project, will support the development of the electricity sector as well as the reduction of the GHG emissions level.

4.4 Socio-demographic

The modification of Romania's socio-demographic characteristics that may occur during the crediting time cannot have a crucial impact upon the baseline emission values or upon the implementation of project.

4.5 Environmental

The Romanian environmental legislation is developing continuously and has been passing through a process of harmonization with EU regulations since 1995 when the first version of The Environmental Protection Law no.137 was published. Until the date when this baseline study was developed, many regulations were issued for the following environmental issues: air, waters and soil quality; nature protection; industrial pollution control; risk management; chemical substances; noise; nuclear safety; civil protection.

According to "National Programme for Romania's Accession to the European Union" published by the former Ministry of Waters and Environment Protection, an acquis communitaire transposition rate of 100% has been achieved for some legal acts in the following environmental sectors: waste management, water, nature protection, genetically modified organisms, nuclear safety. Successful legislation enforcement in this field depends widely on training level as well as on financial resource allocation necessary for technical endowment. By the PHARE programs, with the support of the European Union, will be assessed the costs for the implementation of the harmonized legislation by elaborating financial strategies that will enfold investment plans with yearly expenses, realistic methodologies for assessment of these costs, the database for the required investments, taking into account the approach in each field and each development region.

Among the latest Romanian environmental regulations we mention Government Decision no. 541/2003 that lays down limit values and methods for assessment of certain pollutants emitted into air by large burning installations.

Since June 2003, when the cabinet of the current Romanian Government was reorganized, The Ministry of Agriculture, Forests, Waters and Environment (MAFWE) is supervising the environmental protection activities. Being the central authority in the environmental protection field, MAFWE is expected to continue the harmonization of the Romanian environmental legislation with EU legislation.

The Ministry of Economy and Commerce is expected to continue the implementation of the National Strategy for the Energetic Development of Romania on medium term (2001-2004) and on long term (2002-2015). Both strategies stipulate several environmental protection actions to be undertaken in order to reduce the impact in energy sector.

On 25 June 2002 Hidroelectrica obtained the environmental agreement no.122 for performing the modernization works. According to this agreement issued by county Environmental Protection Inspectorate the project will be developed in compliance with the applicable Romanian environmental legislation.

4.6 Technical

According to the National Strategy for the Energetic Development of Romania on medium term (2001-2004), the technological level of electricity production capacities is relatively low; therefore significant investments should be made for turning into operation new electricity production facilities and for rehabilitating part of the existing ones.

The project Modernization of first 4 hydro units within Portile de Fier II hydropower plant is in concordance with the above-mention rehabilitation trend.

The hydropower generation is a clean process but is clearly depending on the water flow. Portile de Fier II hydropower plant is supplied with raw water catched from the Danube River. The last 10 years were dry but for the calculations made in the baseline a medium multi-annual flow of 5,520 m^3/s was taken into consideration, according to the information provided by Hidroelectrica. This flow corresponds to an analyzed period of 160 years.

According to "Southeastern Europe Regional Country Analysis Brief" developed by Energy Information Administration in December 2002, Romania has the largest power sector in southeastern Europe. However, approximately 60% of Romania's existing power capacity is more than 20 years old, and about 8 GW will need to be rehabilitated or replaced by 2010.

According to The National Energetic Strategy on medium term (2001-2004), an investment of 490 milion USD should be made until the end of the year 2004, in order to rehabilitate 10 thermal power groups with a total power generation capacity of 1.74 GW. The construction works already initiated for the hydropower plants summarizing a total power generation capacity of 183 MW should be finalized by the end of 2004. The remaining unfinished hydropower plants summarizing a total power generation capacity of 900 MW should be reevaluated; they will be finalized after 2004.

5 Identification of the most likely baseline and the associated GHG emissions

Baselines scenarios are images of the future, or alternative futures. They are neither predictions nor forecasts. Each scenario is one alternative image of how the future might unfold. They are hypothetical and therefore they are very unlikely to occur exactly as predicted. The baseline scenarios are usually based on an internally consistent set of assumptions about the key relationships and driving forces of change, which are derived from our understanding of both history and the current situation. The assumptions for the Portile de Fier II project baseline scenarios are presented below.

Assumptions applied to all scenarios

- *The Portile de Fier II project output of 212.133 GWh/year is used as input data for baseline scenarios;*
- *The crediting lifetime of the project is 2008 – 2012.*
- *The project output will not be changed during the crediting lifetime (2008 – 2012);*
- *On site electricity losses and grid losses are excluded from the system boundaries;*
- *The project will replace the electricity produced by fossil fuel power plants;*
- *The emissions taken into account are only related to electricity generation;*
- *The direct off-site and indirect off-site and on-site emissions are not included within the system boundaries;*
- *The electricity produced by "other producers" (independent power producers) is not included within the system boundaries;*
- *The hydro-energy (55.98 GWh) produced by Termoelectrica is not taken into account within the system boundaries;*
- *The electricity exported (around 1%) is not taken into account within the system boundaries;*
- *The data used in the baseline scenarios consist in characteristics of the Romanian electricity sector at national level;*
- *No data on a plant's installed capacity were used for calculation. Only data on generated output were considered input data;*
- *Data related to electricity supplied into the grid (net amount) were used. On site losses are not taken into account as they have already been considered;*
- *Only CO2 emissions are considered GHG emissions. Including other emissions (as CH_4 and N_2O) means higher average Carbon Emission Factor. Consequently the applied approach is more conservative.*

Besides the above-mentioned general assumptions, for each scenario some specific assumptions were also applied.

5.1 Description of the baseline scenarios

As a requirement of ERUPT guidelines, some future baseline scenarios will be proposed and analyzed. The recommendation is to consider the current situation as starting point.

Termoelectrica provided the project owner (Hidroelectrica) with the most recent general information on the thermal part of the electricity sector in Romania. This information is related to the year 2002. Consequently, this year has been selected as starting point for all baseline scenarios of the Portile de Fier II project.

The following scenarios have been analyzed:

- Scenario 1 (S1): unchanged current (2002) situation of the national electricity sector;
- Scenario 2 (S2): predefined baseline scenario for Romania (ERUPT Guidelines, Volume 2a, Project Design Document, Version 2.1, September 2002);
- Scenario 3 (S3): Replacement of thermal electricity based on existing performance of fossil fuel plants;
- Scenario 4 (S4): Replacement of thermal electricity based on existing performance of fossil fuel plants but taking into account correction for operations at margin; the efficiency of thermal plants remain constant in the future;
- Scenario 5 (S5): Replacement of thermal electricity taking into account the CO_2 emissions only for electricity and IPCC carbon emission factor (CEF).
- Scenario 6 (S6): the existing fossil fuel fired plants will gradually switch to natural gas as the only fuel in the next 30 years (2030); the corrections for cogeneration units are not taken into account;
- Scenario 7 (S7): the existing fossil fuel fired plants will use (gradually) only natural gas in the next 30 years (2032); the corrections for cogeneration units are taken into account.

5.1.1 Scenario 1 (S1): unchanged current (2002) efficiencies of the electricity plants

S1 baseline scenario is developed on the assumption that the performance of existing electricity system and the fuel mix will be the same during the future years. The Table 8 presents the average performance of electricity facilities in 2002.

Table 8 – Average performance of electricity facilities in 2002

Electricity (fuel) source	Output (GWh)	Output (*100 %)	Average CEF (t CO2/GWh)
Hydro	16072.00[7]	0.34	0.00
Nuclear	5521.53[8]	0.12	0.00
Lignite and Hard Coal	15329.00[9]	0.33	1,303.82
Gas and Fuel Oil (Hydrocarbons)	9719.00[10]	0.21	821.33

Average CEF for "Lignite and Hard Coal" and "Gas and Fuel" was calculated as following:

Table 9 and Table 10 present the emissions[11] of CO_2 (t) for Thermal Power Plants (TPP) on Lignite and Hard Coal and respective on Oil and Gas.

Table 9 - Lignite and Hard Coal Plants

Name of Plant	Fuel	Emissions (t CO2)
Craiova II	lignite	1,822,553.00
Isalnita	lignite	802,996.00
Mintia	hard coal	4,015,548.00
Doicesti	lignite	665,000.00
Paroseni	hard coal	442,801.70
Rovinari	lignite	5,847,504.00
Turceni	lignite	6,389,854.00
Total CO2		**19,986,256.70**

According to Termoelectrica data the electricity generated by lignite and hard coal fired plants in 2002 is 15,329 GWh. In this case:

Average CEF $_{\text{Lignite and Hard Coal}}$ = Total CO_2 emissions/Electricity generated

Average CEF $_{\text{Lignite and Hard Coal}}$ = 1303.82 t CO_2/GWh

Table 10 - Gas and Oil Fired Plants

Name of Plant	Fuel	Emissions (t CO2)
Borzesti 1	gas and fuel oil	220,079.50
Braila	gas and fuel oil	564,661.00

[7] Hidroeectrica annual environmental report
[8] Hidroelectrica technical report
[9] Termoelectrica data provided to Hidroelectrica
[10] Data provided by Termoelectrica
[11] Data provided by Termoelectrica SA

Bucuresti Sud	gas and fuel oil	1,877,518.00
Progresul	gas and fuel oil	820,964.70
Bucharest West	gas and fuel oil	931,054.50
Bucharest Grozavesti	gas and fuel oil	450,556.70
Titan	gas and fuel oil	92,034.30
Palas	fuel oil	575,117.00
Galati	gas and fuel oil	1,003,082.00
Iernut	gas	1,444,952.00
Total CO2		**7980019.70**

The electricity generated by gas and fuel oil fired plants in 2002 was 9,716 GWh.

Average $CEF_{\text{Oil and gas}}$ = CO_2 emissions/Electricity generated

Average $CEF_{\text{Oil and gas}}$ = 821.33 t CO_2/GWh

The weighted national average CEF for 2002 is then calculated as following:

$$CEF_{weighted\ average} = \sum EnergysharexAverageCEF$$

The values for energy share and average CEF for each type of produced energy (hydro, nuclear, lignite and hard coal and gas and fuel oil) are those from the Table 8.

$CEF_{\text{weighted average}}$ = (0.34*0)+(0.12*0)+(0.33*1,303.82)+(0.21*821.33)

The overall CEF including fossil, nuclear and hydro power is:

CEF = 599.65 t CO_2/GWh

The Project output is 212.133 GWh/year. The ERU's calculated according to S1 are presented in Table 11.

Table 11

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	599.65	599.65	599.65	599.65	599.65	599.65	599.65	599.65	599.65
ERU's (S1)	127,206	127,206	127,206	127,206	127,206	127,206	127,206	127,206	127,206

Total ERU's for crediting period (2008 – 2012) = 636,030 t CO_2

Taking into account that the first upgraded hydro-unit will operate in 2004, the second in 2005, the third in 2006 and the fourth in 2007, early credits for these years might be calculated. To assess these, a first weighted coefficient of 0.25 will be applied for the year 2004, 0.5 for the year 2005, 0.75 for 2006 and 1 for 2007 when all four units will be in operation. An additional coefficient of 0.8 will be used taking into account that it is possible the new unit put in operation in the respective year will not run exactly 12 months. Consequently, to calculate the yearly credits, a final coefficient of 0.2 for year 2004, 0.4 for 2005, 0.6 for 2006 and 0.8 for 2007, will be applied to the baseline calculations related to these years.

The Early Credits = 127,206*0.2 + 127,206*0.4+127,206*0.6+127,206*0.8 = 254,412 t CO_2

5.1.2 Scenario 2 (S2): predefined baseline scenario for Romania (ERUPT Guidelines, Volume 2a, Project Design Document, Version 2.1, September 2002)

The Table 12 presents the standardized emission factors as predefined by the ERUPT Guidelines, Volume 2a, Annex B, September 2002. These factors are related to all fossil fired plants and take into account the grid losses.

Table 12

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	620	611	602	593	584	575	565	556	547
ERU's (S2)	131,522	129,613	127,704	125,794	123,885	121,976	119,855	117,945	116,036

Total ERU's for crediting period (2008 – 2012) = 599,697 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

The Early Credits = 131,522*0.2+129,613*0.4+127,704*0.6+125,794*0.8 = 255,407.2 t CO_2

5.1.3 Scenario 3 (S3): Replacement of thermal electricity based on existing performance of fossil fuel plants

For scenario S1, it was considered the output of the project would replace the electricity produced based on the existing (2002) energy sources (hydro, nuclear, coal fired and gas and oil fuel fired). For scenario S3 it is considered that the project output will replace the electricity produced only by the thermal power plants (TPP). The efficiency of thermal plants will be considered unchanged during the next years. The project will not replace any hydropower and nuclear power plants output. Based on the most recent (2002) data on TPP it can be stated:

- Total electricity output of TPP's in 2002 was 25,045 GWh, out of which 15,329 GWh (61%) was generated by TPP's operating on lignite and hard coal and 9,716 GWh (39%) was generated by TPP's operating on fuel oil and natural gas;
- The $CEF_{\text{Lignite and hard coal}}$ = 1,303.82 t CO_2/GWh (see calculation for S1);

- The $CEF_{\text{Fuel oil and natural gas}}$ = 821.33 t/GWh (see calculation for S1).

In this case the average CEF for fossil fuel plants in 2002 is:

$$CEF_{weighted\ average} = \sum EnergysharexAverageCEF$$

CEF = (0.61*1303.82)+(0.39*821.33) = 1,116 t CO_2/GWh.

Table 13 presents the resulted CO_2 emissions calculation based on scenario S3.

Table 13

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116
ERU's (S3)	236,740	236,740	236,740	236,740	236,740	236,740	236,740	236,740	236,740

Total ERU's for crediting period (2008 – 2012) = 1,183,700 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

The Early Credits = 236,740*0.2+236,740*0.4+236,740*0.6+236,740*0.8 = 473,480 t CO_2

5.1.4 Scenario 4 (S4): Replacement of thermal electricity applying correction for operations at margin

The main assumption in the baseline scenario S4 is that the Portile de Fier II project output replaces only the electricity produced by TPP (in full) and the efficiency of thermal plants remains constant in the future. A correction factor in shares between electricity produced by TPP operating on lignite and hard coal and TPP operating on fuel oil and gas is applied for the fact that TPP's need modernization and generally these are operating at the margin (ERUPT Guidelines 2001, Volume 2a, Project Design Document, Version 2.1, 2002).

In practice, the plants with high variable cost (gas-fired) are more frequently operating at the margin than power plants with low or medium variable cost (coal-fired) power (ERUPT Guidelines 2002, Volume 2a, 2002).

The calculation was made as following:

- Total electricity output of TPP's in 2002 was 25,045 GWh, out of which 61% (D) was generated by TPP's operating on lignite and hard coal and 39% (C) was generated by TPP's operating on fuel oil and natural gas;

- Correction in shares for the fact that gas and oil fired power plants operate more frequently at the margin is done using formulas (ERUPT Guidelines 2001, Volume 2a, 2002):

$$C_{corrected} = C + 0.5*D \text{ and } D_{corrected} = 1 - C_{corrected}$$

$$C_{corrected} = 0.70$$

$$D_{corrected} = 0.30$$

- The baseline emission factor is then:

$$CEF_{corrected} = CEF_{Lignite\ and\ hard\ coal} * D_{corrected} + CEF_{Fuel\ oil\ and\ natural\ gas} * C_{corrected}$$

$$CEF_{corrected} = 1{,}303.82*0.30+821.33*0.7 = 966 \text{ t } CO_2/GWh$$

Consequently, the actual average CEF for TPP in 2002 is represented by the corrected CEF of 966 t CO_2/GWh. This correction takes into account the fact that fuel oil/natural gas fired plants are operating more frequently at the margin. This corrected CEF is higher than CEF of 639 tCO_2/GWh estimated for the year 2002 in Romania in Annex B of ERUPT Guidelines. The explanation for this situation might be the following:

1) baseline electricity grid CO_2 emission factors in ERUPT Guidelines were based on IEA energy database which is much more general. The data on actual (2002) performance of Romanian TPP's are based on the current registrations and reports of Termoelectrica's emissions; these are calculated based on registered fuel type and consumption and using the Corinaire and IPCC Guidelines.

2) for predefined baseline CEF was taken into account the site losses in electricity (difference between gross generated and net production, supplied to the grid). In calculation of the electric output this is based on net production of electricity. In case the predefined CEF is used in this calculation the site losses will be double accounted.

Table 14 presents the emissions reduction for scenario S4.

Table 14

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	966	966	966	966	966	966	966	966	966
ERU's (S4)	204,920	204,920	204,920	204,920	204,920	204,920	204,920	204,920	204,920

Total ERU's for crediting period (2008 – 2012) = 1,024,600 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

The Early Credits = 204,920*0.2+204,920*0.4+204,920*0.6+204,920*0.8 = 409,840 t CO_2

5.1.5 Scenario 5 (S5): Replacement of thermal electricity taking into account the CO_2 emissions related only to electricity

The baseline scenario S5 assumes that the Portile de Fier II project output replaces only the electricity produced by TPP. Because most of the TPP are producing electricity but also heat a correction of the CEF was done taking into account this situation. A practical and reasonably conservative estimate of baseline emissions based on the above mentioned assumptions is done according to ERUPT Guidelines. The paragraphs bellow describe the applied procedure for CO_2 emissions calculation.

In 2002 Termoelectrica produced a quantity of 15,519[12] TJ heat in lignite and coal fired plants and 56,396[13] TJ in gas and fuel oil (hydrocarbons) fired plants.

From Termoelectrica's data, the total fuel consumption for electricity and heat generation in 2002 was 11,378.7 kilotons (Kt), out of which 6,357.28 Kt coal and 5021.42 Kt hydrocarbons.

The Net Caloric Value (NCV) for coal in Romania is 13.188TJ/Kt [14]. In this case the lignite and hard coal consumption in 2002 was 6,357.28 Kt * 13.188 TJ/Kt = 83,840 TJ

Assuming that the gas and fuel oil (hydrocarbons) used in TPP's in Romania is similar with gas/diesel oil for which NCV is 43.33 TJ/Kt[15], the gas and fuel oil consumption in 2002 in TPP's was 5021.42 Kt * 43.33 TJ/Kt = 217,578 TJ

The amount of fuel for electricity alone is calculated[16] as following:

Fuel for electricity = total fuel – (heat production/0.90) all expressed in TJ

Table 15 presents the calculation of CO_2 emissions (t) related to electricity.

Table 15

Fuel type	Total fuel (TJ)	Heat production (TJ)	Fuel for electricity (TJ)	CEF[17] (t C/TJ)	CEF[18] (tCO_2/TJ)	Total CO_2 (t) related to electricity
Lignite and hard coal	83,840	15,519	66,596	25.85	94.79	6,312,635
Gas and Fuel Oil	217,578	56,396	154,916	20.20	74.07	11,474,628

[12] Figure provided by Termoelectrica
[13] Figure provided by Termoelectrica
[14] The GHG Indicator: UNEP Guidelines for Calculating GHG Emissions – Appendix 8
[15] The GHG Indicator: UNEP Guidelines for Calculating GHG Emissions – Appendix 8
[16] ERUPT Guidelines, Volume 2a, September 2002, Annex B
[17] IPCC 1996a
[18] IPCC 1996a

From the Termoelectrica data (see S1) a total of 25,045 GWh were produced by TPP in 2002, out of which 61% (D) was generated by TPP's operating on lignite and hard coal and 39% (C) was generated by TPP's operating on fuel oil and natural gas.

It can be stated that for producing 15,329 GWh electricity were released 6,312,635 t CO_2 and for producing 9,716 GWh electricity were released 11,474,628 t CO_2. This means an average $CEF_{\text{lignite and hard coal}} = 412$ t CO_2/GWh and $CEF_{\text{Oil and gas}} = 1{,}181$ t CO_2/GWh.

Correction in shares for the fact that gas and oil fired power plants operate more frequently at the margin is done using formulas (ERUPT Guidelines 2002, Volume 2a, Annex B):

$$C_{\text{corrected}} = C + 0.5*D \text{ and } D_{\text{corrected}} = 1 - C_{\text{corrected}}$$

$$C_{\text{corrected}} = 0.70$$

$$D_{\text{corrected}} = 0.30$$

The baseline emission factor is then:

$$CEF_{\text{corrected}} = CEF_{\text{Lignite and hard coal}} * D_{\text{corrected}} + CEF_{\text{Fuel oil and natural gas}} * C_{\text{corrected}}$$

$$CEF_{\text{corrected}} = 412 * 0.3 + 1{,}181 * 0.7 = 950 \text{ t } CO_2/GWh$$

It is assumed that the efficiency of TPP will not be changed.

Table 16 shows the project emissions reduction for baseline scenario S5

Table 16

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	950	950	950	950	950	950	950	950	950
ERU's (S4)	201,526	201,526	201,526	201,526	201,526	201,526	201,526	201,526	201,526

Total ERU's for crediting period (2008 – 2012) = 1,007,630 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

The Early Credits = 201,526*0.2+201,526*0.4+201,526*0.6+201,526*0.8 = 403,052 t CO_2

5.1.6 Scenario 6 (S6): the existing fossil fuel fired plants will use (gradually) only natural gas in the next 30 years (2032); the correction for cogeneration units are not taken into account

The emission estimate is based on a mixture of a current (2002) emission baseline (as calculated in scenario S4) and the emission factor[19] of new high-efficient gas-fired power production. The emission factor for such a plant is 388 t CO_2/GWh.

It is assumed that the new plants (gas-based) will have a reference efficiency of 52% over the whole period and the change from the current situation to the final one (all TPP will be gas-fired) will be made gradually. It is also assumed that this replacement of fuel will be done in 30 years. The emission factor for year Z is calculated using the following formula[20]:

$$Z = (30-t)/30*X + t/30*388$$

For the year 2002, t =0 and for 2032, t=30

X is corrected average actual CEF as calculated in scenario S4, respectively $CEF_{corrected}$ = 966 t CO_2/GWh. The allocation of CO_2 emissions between heat and electricity is not considered.

The Table 17 presents the project emissions reduction for baseline scenario S6 based on the assumption that in 30 years from 2002, all TPP will be gas-fired power production.

Table 17

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	927	908	889	870	850	831	812	793	773
ERU's (S6)	196,746	192,659	188,572	184,485	180,398	176,311	172,224	168,137	164,050

Total ERU's for crediting period (2008 – 2012) = 861,119 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

The Early Credits = 196,746*0.2+192,659*0.4+188,572*0.6+184,485*0.8 = 377,144 t CO_2

5.1.7 Scenario 7 (S7): the existing fossil fuel fired plants will use (gradually) only natural gas in the next 30 years (2032); the correction for cogeneration units are taken into account

The emission estimate procedure for scenario 7 is a similar one as for scenario S6, but taking into account the CO_2 emissions allocation between heat and power production. The carbon

[19] ERUPT Guidelenes, September 2002, Annex B

[20] ERUPT Guidelenes, September 2002, Annex B

emission factor for 2002 will be the one as calculated in S5. The emission factor[21] of new high-efficient gas-fired power production is 388 t CO_2/GWh as described in ERUPT Guidelines, September 2002, Annex B.

It is assumed that the new plants (gas-based) will have a reference efficiency of 52% over the whole period and the change from the current situation to the final one (all TPP will be gas-fired) will be made gradually. It is also assumed that this replacement of fuel will be done in 30 years. The emission factor for year Z is calculated using the following formula[22]:

$$Z = (30-t)/30*X + t/30*388$$

For the year 2002, t =0 and for 2032, t=30

X is corrected average actual CEF as calculated in scenario S5, respectively $CEF_{corrected}$ = 950 t CO_2/GWh. The allocation of CO_2 emissions between heat and electricity is consequently considered.

The Table 18 presents the project emissions reduction for baseline scenario S7 based on the assumption that in 30 years from 2002, all TPP will be gas-fired power production.

Table 18

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	913	894	875	856	838	819	800	781	763
ERU's (S7)	193,578	189,604	185,631	181,657	177,683	173,709	169,735	165,761	161,787

Total ERU's for crediting period (2008 – 2012) = 848,673 t CO_2

The same method for calculating the early credits as described for the Scenario 1, is used.

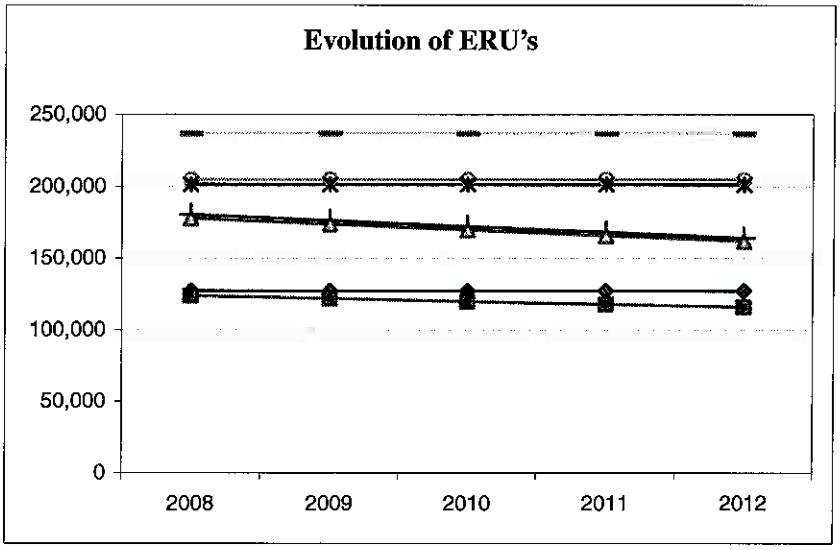
The Early Credits = 193,578*0.2+189,604*0.4+185,631*0.6+181,657*0.8 = 371,261 t CO_2

The evolution of ERU's during the crediting period for each of the six analyzed scenarios is illustrated in Figure 10.

21 ERUPT Guidelenes, September 2002, Annex B

22 ERUPT Guidelenes, September 2002, Annex B

Figure 10 – Evolution of ERU's



Legend: S1
S2
S3
S4
S5
S6
S7

5.2 Identification of the most likely baseline

The selection of the baseline is one of the most crucial elements of the JI project design as it largely determines the size of the emission reduction to be credited. In order to provide certitude and confidence the baseline emission factors, if validated accepted, will not be recalculated during the first crediting period (not before 2012). For this reason, taking into account the key factors (legal, economic, political, socio-demographic, environmental and technical) which could influence the future development of Romanian National Electricity Sector, the most conservative baseline scenario is selected as being most likely baseline in the associated GHG emission.

The facts that could affect the future electricity sector in Romania are described in the following paragraphs.

Romania is a contracting party to the UN Framework Convention on Climate Change since the 5th of June 1992. The Convention was ratified by the Romanian Parliament through Law

24/1994, which has as primary objective the stabilization of the quantity of GHG in the atmosphere, at a level that would prevent any anthropogenic disorder of the climate.
In November 1996 a National Committee for Climate Change was founded within the Ministry of Waters and Environmental Protection (currently Ministry of Agriculture, Waters, Forests and Environmental Protection).

Through the Law no 3/2001, Romania ratified the Kyoto Protocol regarding the United Nations framework Convention on climate change, being one of the first states which ratified this international document of a high importance for climate change issues.
In 2000 the implementation of the measures established by the Kyoto Protocol continued, aiming at two essential objectives:

- Observance of the commitment to reduce GHG; Romania committed to reduce the GHG emissions with 8% comparing with emission level in 1989, for the period 2008-2012;
- Adopting a set of market mechanisms, including transferable marketing licenses and the common application of the provisions, in cooperation with other countries.

The Romanian Energy Sector has been and to a large extent still is, plagued by the specific problems[23] faced by most countries in transition:

- Low efficiency of energy production and usage;
- High marginal cost of energy production;
- The poor current status of the power plants, most of them being commissioned in 1960's and 1970's; the required funds for investments and rehabilitation are high;
- The lack of necessary funds for plants rehabilitation and upgrading;
- Increases in energy prices that consistently exceed the general rate of inflation;
- Low collection rates especially from industrial users but also from individual consumers because of the high share of energy bills in total household expenditure;
- Poor record on energy conservation and compliance with national environmental requirements.

Since the political changes of 1989, the Romanian energy sector has benefited from grants, loans and technical assistance programs from the international community. Major donors include political institutions such as the European Commission and various United Nations agencies while loans have been arranged through the major international financial institutions, chiefly European Bank for Reconstruction and Development (EBRD) and the World Bank. In addition to multilateral projects, several individual countries, notably Denmark, the Netherlands, France and the United States are active in the energy and energy efficiency field in Romania with bilateral projects. A significant proportion of those

[23] REGIONAL ENVIRONMENTAL CENTER, *Good Practicies in Policies and Measures for Climate Change Mitigation,* 2002

resources has been directed towards improving energy efficiency, thus to reduce GHG emissions.

Romania is in the EU pre-accession period and this implies compliance with environmental EU requirements and liberalization and privatization of electricity market. Consequently, the current government policy is to develop an energy sector that promotes a market oriented economy. Within the privatization process in the energy sector the first target of Romanian government is to attract strong companies, acting on the EU market, preferably from big holding type companies, which are born today, through mergers, and which probably will dominate EU power market.

Although a special legal framework related to privatization has been implemented and several facilities are given to interested investors.

The baseline scenario to be applied for the Portile de Fier II project has to reflect the above-mentioned facts and to be the most conservative baseline at the same time. The baseline scenario S7 was selected as a starting point for the project. This represents a conservative approach because it is assumed a gradual improvement of energy sector (high efficiency fired plants will replace the existing ones in the next 30 years). S7 is based on the assumptions that the project output will replace only electricity produced by fossil fuel fired plants. The energy produced by hydro and nuclear units are not taken into consideration as nuclear plants cannot be switched of and on, and hydro-units are always 100% utilized operating at the margin

Corrections for co-generation units (heat-power CO_2 allocation) and production at the margin are taken into account.

The assumptions made for the predefined baseline considers that natural gas fired plants (that operate with a 52% efficiency) will replace all currently operational plants. It was also assumed that the share of natural gas fired plants is likely to increase compared to the share of fuel oil and lignite fired plants. However, it is not very likely that the share of natural gas fired plants will increase as rapidly over the next years because of the facts related to Romanian energy sector presented above.

The realistic and also conservative baseline was selected based on the fuel mix of TPP at 2002 level, the most recent available data on TPP performance. The average CEF related to electricity generation by TPP in 2002 is therefore selected as starting point of the baseline. Although we know that replacement of fuel oil and lignite fire plants is not likely to be completed (because of domestic production), assuming that gas-fired plants will replace all fossil fuel plants gradually in the next 30 years is a very conservative approach. Consequently the baseline scenario S7 was selected as being the most appropriate baseline for the project.

The reasons for not taking the other six baseline scenarios are presented below:

- Scenario S1: it is not likely that any changes will occur in the present fuel mix (for electricity production at national level) and in the plants efficiency. Additionally, the electricity produced by the project will not replace neither hydro nor nuclear electricity;

- Scenario S2: baseline electricity grid CO2 emission factors in ERUPT Guidelines were based on IEA energy database which is more general. The data on the performance of Romanian TPP's at the level of 2002 are based on registrations and reporting of CO_2 emissions for each TPP; the CO_2 calculations are done taking into account the type and quantity of fuel consumption and Corinnaire and IPCC Guidelines.

- Scenario S3: it is not likely that any changes will occur in the present fuel mix (for thermal electricity production at national level) and in the plants efficiency. Usually the gas fired TPP operate frequently at the margin because of high operational costs. This aspect has not been taken into account in S3;

- Scenario S4: the efficiency of TPP is not likely to remain unchanged in the future;

- Scenario S5: the efficiency of TPP is not likely to remain unchanged in the future;

- Scenario S6: the CO_2 emissions allocation between heat and power generation was not taken into account.

5.3 Baseline selection, specification and calculation of the associated emissions

As explained in item 5.2, the selected baseline scenario for the project is scenario 7, which was considered the most conservative scenario.

The emission estimate is based on a mixture of the current (2002) emission baseline (as calculated in scenario S5) and the emission factor[24] of new high-efficient gas-fired power production. The emission factor for such a plant is 388 t CO_2/GWh.

For the current situation a correction factor in power shares between electricity produced by TPP operating on lignite and hard coal and TPP operating on fuel oil and gas is applied taking into account that plants with high variable costs (fuel oil and gas fired) operate more frequently at the margin. In this case corrected CEF = 950 CO_2/GWh (see scenario S5).

It is also assumed that the new plants (gas-based) will have a reference efficiency of 52% over the whole period and that the change from the current situation to the final one (all TPP will be gas-fired) will be made gradually. It is also assumed that this replacement of fuel will be done in 30 years.

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[24] ERUPT Guidelenes, September 2002, Annex B

The ERU's calculation method is presented in chapter 5.1.7.

As the project is assumed only to displace fossil fuel fired plants for the baseline situation only on-site direct emissions were taken into account (see chapter 2 for motivations).

The Table 19 presents the baseline emissions based on the assumption that in 30 years from 2002, all TPP will become gradually gas-fired power production.

The project is expected to start 2004 and its output is 212.133 GWh/year.

Table 19

Period	2004	2005	2006	2007	2008	2009	2010	2011	2012
CEF (tCO2/GWh)	913	894	875	856	838	819	800	781	763
ERU's (S7)	193,578	189,604	185,631	181,657	177,683	173,709	169,735	165,761	161,787

Total ERU's for crediting period (2008 – 2012) = 848,673 t CO_2

The Early Credits = 193,578*0.2+189,604*0.4+185,631*0.6+181,657*0.8 = 371,261 t CO_2

6 Estimation of project emissions

6.1 Description of factors used for estimation of project emissions

The Portile de Fier II project consists in modernization of the 4 units (Unit 1, Unit 2, Unit 3 and Unit 4) of the hydropower plant, which will result in an increase of installed capacity of the 4 hydro units with 22 MW. This will lead to additional electricity generated of approximately 212.133 GWh/year and also to the improvement of the national electricity supply system.

Therefore, the main output of the project is additional electricity.

The main activities related to the modernization of 4 hydro-units are:

- Turbines refurbishment
- Generators rehabilitation
- Auxiliary installations refurbishment.

As it can be seen only rehabilitation works are done within the existing hydropower plant. These works will lead to an additional non-polluting power. This will generate a supplementary non-polluting energy production of 212.133 GWh/year in an average year.

The key factors for estimating the project emissions are:

- The activities (rehabilitation and refurbishment) performed to implement the project;
- The project output.

The project output is the generation of electricity and expected annual quantity is 212.133 GWh/year (as it was presented above).

The calculation of total output of the project is presented in Appendix 1.

6.2 Calculation of direct project emissions

Direct on-site emissions

As stated in chapter 2.2, direct on-site emissions include emissions from production of electricity on the site of the project.

Total direct project emissions/year = Project output $*CEF_{project}$

TDPE = 212.133 GWh/year * 0 t CO_2/GWh = 0 t CO_2

Hydropower is a clean energy source that is emissions free, and there will be no GHG emissions that are directly related to the use of hydropower for electricity production. Consequently, $CEF_{project}$ = 0 t/GWh and total direct project emissions until the end of crediting period is 0 t CO_2.

Direct off-site emissions

Direct off-site emissions are considered zero GHG emissions (see chapter 2.3); 0 t CO_2.

6.3 Calculation of indirect project emission effects (leakage)

As stated in chapters 2.4 and 2.5 indirect (on site and off site) project emissions will not be considered for the project case (as they are considered for the baseline scenarios).

Indirect project emission = 0 t CO_2.

6.4 Calculation of total project emissions

Project emissions are related to the generation of energy. As generation of hydropower is a clean process, the total project emissions during crediting period are assumed to be zero.

7 Crediting time

Start date of the project (all four units)	2007
Life time of the project	30 years
Crediting time of the project (only relevant if the project crediting time will end before 2012)	Five year – commitment period (2008 – 2012)

8 Estimation of emission reduction

The total emission reduction as a result of Portile de Fier II project implementation is calculated by deducting the project emissions from the baseline emissions.

Emission reduction /year = Baseline emissions/year – Project emissions/year

Total emissions reduction (t CO_2) = $\sum Emissionreduction / year$

Table 20 presents net emission reduction for the project:

Table 20

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Baseline emissions (t CO_2)	193,578	189,604	185,631	181,657	177,683	173,709	169,735	165,761	161,787
Project emissions (t CO_2)	0	0	0	0	0	0	0	0	0
Net emissions reduction (t CO_2)	193,578	189,604	185,631	181,657	177,683	173,709	169,735	165,761	161,787
Total ERU's commitment period = 848,673 t CO_2									
Total Early Credit Units = 371,261 t CO_2									

9 References

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Appendix 1: Project output calculation

Explanation of additional power amounts as generated in CHE PF II

1. Additional power installed in four units	22	MW
2, Operations Time for a sufficient additional power flow	3,500	h/year
3. Maximum additional Power	77.000	MWh/year
4. Nongenerated thermal power due to additional production in CHE PF I on restriction 1	70.000	MWh/year
5,Increase of Secondary Control Band from 21 to 29,5 MW/unit	34.00	MW
6,Utilisation time, lower half-band additional	8,760	h/year
7.Hydropower additionally generated for secondary control	148,920	MWh/year
8,TOTAL ADDITIONAL HYDROPOWER	218.920	MWh/year
9,Energy generated in Romanian thermal units for achieving a 34 MW band with technical Pmin 65% of Pn		
-Pn= 34,72*100/35	97	MW
-Band	34	MW
-Pmin	63	MW
Least energy to be generated as thermo =Pmin tech.*Tu(6)	553,131	MWh/year

Remarks.

To justify power amounts nongenerated in thermounits, the amount 553.131 GWh/year was not considered,only hydrogeneration in addition respectively 218.920 GWh/year, with a risk factor Kr =0,969 correction

10 Energy equivalent = Kr*En hidro(8)	212.133	MWh/year

Supplemental explanations to previously submitted data

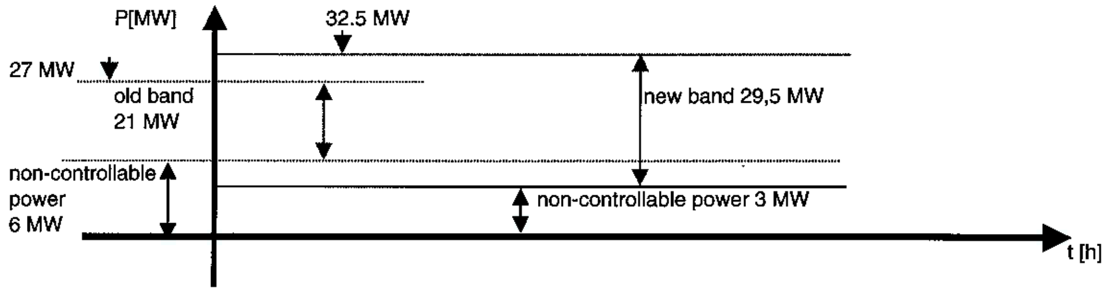
1 ADDITIONAL POWER output of the project
4 [unit] * 5.5 [MW/unit] = 22 MW

2 Operation time for a sufficient additional power-flow
3500 h/year - as resulted from multiannual statistics data

3 Estimated Additional Energy
22[MW]*3500[h/year]= 77,000 MWh/year

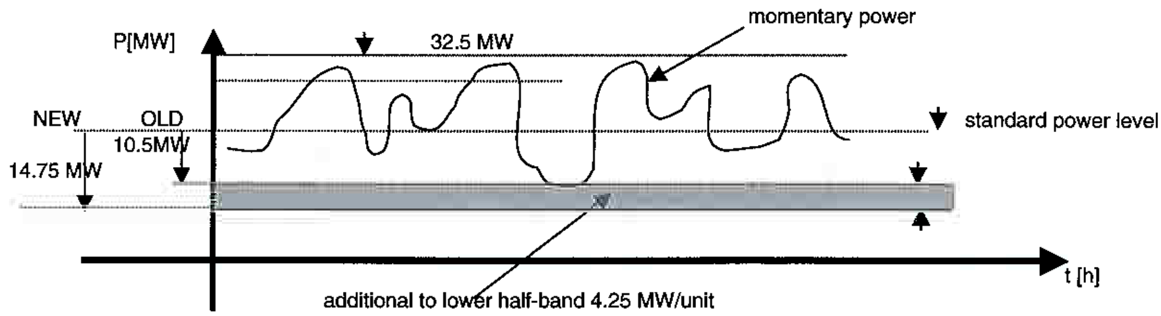
4 Nongenerated ThermoEnergy as a result of
additional production in CHE PF II on restriction 1
77,000 [MWh/year]*0,909091= 70,000 MWh/year
Coefficient 0.909091 results out of hourly statistics of year 2002 and shows the thermo nongenerated energy amount from the total hydro-generation as a consequence of commercial restriction 'R1' application
The purpose of this programming restriction, inserted for setting the merit order, is mainly the avoidance of spillouts

5 Increase of secondary control range from 21 to 29,5 MW/unit



total increase 4 [unit]*8,5 [MW/unit]= 34 MW

6 Utilisation time for additional lower half-band



In accordance with ANRE regulations the standard charging level (as programmed) shall be applied for coverage of lower half-band. The additional average power of 4*5,5=22MW is detrimental of the thermo power due to the fact that usage of generator for the secondary control places it in 'merit order' range from programming prior to thermal units. Considering the 'streamline' position of the plant and the post-modernisation upgrading efficiency , usage in secondary control will be done throughout the year.

7 The maximum additional hydro power generated for the secondary control 148920 MWh/year
8 TOTAL ADDITIONAL HYDROPOWER 218.920 MWh/year
10 ENERGY EQUIVALENT
Additional energy [MWh/year] * Kr (0.969) = 212.133 MWh/year

Coefficient Kr takes into account a number of factors that can influence the generation of additional power
-maintenance- annually 20[days]* 4[unit] approximate 80 days/year
-grid congestions annualy for 4 units approximate 12 days
-hourly hydrological risk
-unavailability of Secondary Control ,MES-SCADA, Telecomunication systems

Appendix 2: Project presentation

Location: Gogosu, Mehedinti County, km D 862 + 800

Investment Holder: S.C. Hidroelectrica S.A. – HPP Iron Gates (Iron Gates Hydropower Subsidiary)

A.1 Project Scope

Major overhaul and upgrading_ of 8 hydropower stations equipping the Iron Gates II HPP will lead to the following achievements:

- enhancement of equipment reliability and of units availability;
- upgrading the turbine average efficiency over the whole operation range;
- increase of hydro unit power reserves by providing new runner-blades assembly for improved power rates;
- expansion of turbine operation range towards larger inflows due to runner blade profiles;
- reduction of maintenance services by longer intervals between two major overhauls;
- replacement and modernization of automation, control and protection system for monitoring installations from the control room and as a perspective from a joint dispatcher of Iron Gates I, Iron Gates II and Gogosu hydropower plants.

After finalization of the works, all plant hydro units and equipment condition will provide a new 30 years functioning cycle.

** Note: any mention of Iron Gates II HPP below exclusively refers to the Romanian plant within the national Hydropower and Navigation System Iron Gates II.*

A.2 Description of Project

SHEN Iron Gates II (Hydropower and Navigation System) together with SHEN Iron Gates I provides for capitalization of hydropower potential of the Danube and for improvement of riverine navigation.

The retention, electric power generation and navigability-associated works within SHEN Iron Gates II are identified as such:

Iron Gates II HPP equipped with 8 hydro units, KOT 28 - 7,45 type turbine directly coupled with bulb generator.

Basic technical parameters for turbine and generator are:

- turbine KOT 28 - 7,45 (Kaplan Horizontal tube):
  - coupling rated output : 28 MW
  - calculation head : 7,45 m
  - useful inflow : 425 cu.m/sec
  - guaranteed head rate: 12,750- 44 m
  - runner diameter: 7500 mm
- generator HOSC 776/125-96 (horizontal, synchronous, capsulated bulb type) :
  - apparent rated output: 27550 kVA
  - power factor : 0,98
    - rated speed : 62,5 rpm
    - frequency : 50 Hz

The total working time for all the 8 hydro units recorded as of first unit commissioning (31.01.1985) up to 31.05.2001, amounted 909 485 hours; units have been operated in a relatively uniform rate, the working hours variable being in the range of 101.749 (HU6) and 122.035 (HU1). In this period the 8 hydro units supplied around 18.000 GWh.

The need to perform upgrading major overhaul works resulted from the following circumstances:

- elimination of certain faulty unit sections occurred as a result of reduced reliability of equipment and major subassemblies(turbine, generator, speed regulator, pressure oil unit); some of these damages led to prolonged outage of the unit;
- necessity to remove the weak points - as found both in the subassemblies and in the auxiliary installations due to the low quality of some materials used in the 1980's;
- necessity to update the speed regulator to reduce plant unavailability time after disconnection from the National Power System due to some failure, and to provide a

better unit protection by packing and implicitly increasing the turbine hydraulic efficiency;

- taking into account the upgrading works in Iron Gates I HPP- the need to reduce the time range when availability index inconsistency for the two plants are likely to appear.
- need to avoid (for 8-10 years to come) enhancing of the hydro units wear and tear process which could lead to higher operation/maintenance costs.

The upgrading major overhaul works of Iron Gates II will comprise either replacing or upgrading of some power plant subassemblies (turbine, generator) and of its auxiliary installations.

These works will be performed inside the factory and in site as well.

As for the plant power equipment the work stages are:

- Turbine (including the regulating system)
  - removal and disassembly;
  - manufacturing new equipment in the factory;
  - transportation to workshop and refurbishment of a number of existent equipment;
  - temporary corrosion preventing protection applied in workshop;
  - transportation of equipment (new / refurbished) from the workshop into site;
  - permanent corrosion preventing protection applied on site;
  - reassembly and erection of turbine;
  - start-up testing;

In order to reduce upgrading major overhaul works duration on the first unit to be refurbished (HU1R), supplemental replacement of runner hub is provided, while the runner blades driver will be entirely replaced.

Actually, from the operations period events as recorded it results that the turbine shafts on two of the hydro units (HU4 ; HU5) need to be replaced. If after the removal and disassembly of each turbine findings will indicate the impossibility of other equipment or subassembly to be refurbished, these shall be replaced as well.

- Generator (excitation system includingly)
  - removal;
  - transportation to the workshop and refurbishment of certain subassemblies;
  - refurbishment in site;
  - transportation of equipment (new / refurbished) from workshop into the site;
  - corrosion protection application;
  - placing generators and excitation systems;
  - connection to existent equipment which was not scope of refurbishment;
  - commissioning tests.

The refurbishment of as many as possible subassemblies of existent generators to be followed up.

Transportation and storage of new/refurbished subassemblies shall be provided under specific conditions as set by the manufacturer.

Concerning auxiliary installations of the plant and of hydro units, these shall be refurbished in site; in case of new subassemblies replacing part of actual components, these will be transported from the manufacturer and assembled on site.

Main operations to be performed are:

- installation removal;
- checking up components technical condition;
- transportation into site of certain new components;
- refurbishment of components not to be replaced;
- replacing of some component parts;
- corrosion prevention protection application;
- performance of commissioning tests.

Among new subassemblies: heating and ventilation systems, rotor cooling installation, stator cooling installation, grating panels, as well as different other components (pumps, hydraulic valves, oil pipes, filters, measuring and control instrumentation, fittings and plates, electric compressor, electric engines/motors, sealing elements).

Basic technical parameters for the turbine and generator after finalization of upgrading major overhauling:

- turbine
  - coupling rated power: 32,5 MW
  - calculation head : 7,45 m
  - useful inflow : 506 cum/sec
  - guaranteed head rate: 12,75- 44 m
  - runner diameter: 7500 mm
- generator
  - apparent rated output : 32 000 kVA
  - rated output factor : 0,98
  - rated speed: 62,5 rpm
  - rated frequency: 50 Hz.

A.3 Location Details

Iron Gates II HydroPower Plant is located on Danube main arm (km 862 + 800), in between the right bank of the isle Ostrovul Mare and the Yougoslav side plant.

Access into the isle Ostrovul Mare is practiced on roads: E 94 (Drobeta Turnu Severin – Şimian) - DN 56 A (Şimian – Hinova) – DJ (Hinova – Ostrovul Mare). Distance between County of Drobeta Turnu Severin and Iron Gates II HPP is of 56 km.

The major overhaul works for upgrading the 8 hydro units, shall be performed both inside of the hydropower station building itself as well as in the erection workshop located on territories expropriated in view of creating the Iron Gates II Hydropower and Navigation System, thus avoiding the temporary occupancy of new lands.

A.4 Project Achievement and Workability

The major overhaul works for upgrading 8 hydro units, shall be performed within a period of 104 months starting as of signing of the contract.

The first 20 months - the "preparatory" period- shall be destined for designing, engineering, material procurement, starting the manufacturing of longer execution cycle components on the one hand, while on the other hand for fulfillment of works in view of starting the hydro units refurbishing activities.

As mentioned before, once the works have been finalized all equipment and hydro units will be fully prepared to start a new operating cycle.

Appendix 3: Project location

Appendix 3 - Poject location: Portile de Fier II Hydropower Plant