MSc Program
Renewable Energy in Central and Eastern Europe

Refurbishment of Small Hydro Power Plants in Romania

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Affidavit

I, Norbert Bock, herby declare

1. that I am the sole author of the present Master's Thesis, Refurbishment of Small Hydro Power Plants in Romania, 108 pages, bound, and that I have not used any source or tool other than the referenced or any other illicit aid or tool,

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2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

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Executive Summary

Renewable Energy from Small Hydro Power Plants is in general a very environmental-friendly way of producing electrical energy. At the moment the existing SHPPs in Romania stem mainly from the last decade of the communist regime and were built and set into operation in the years 1983-1989. In the last two decades these power plants have not seen much maintenance and some of them were abandoned completely.

The objective of this work is to show different aspects of refurbishing these SHPPs, which are on one hand of old fashioned and not reliable technique, but use on the other hand quite interesting locations from a hydrological point of view. The author has practical experience, as he is deeply involved in a large refurbishment program of SHPPs in Romania. Literature study and discussions with other owners of SHPPs in Romania are additional sources of information.

At the end of 2008 European leaders responded unequivocally to the global energy and climate crisis by agreeing to the Renewable Energy Directive. The decision, hailed by the renewable industry and many environmental friendly organizations as a historic moment, will enable renewable energy technology to be developed throughout Europe. One major task is to bring the well developed Austrian SHPP know how to Romania and to adapt it to the local situation.

For the first time, each member state has a legally binding renewable target for 2020 along with a clear trajectory to follow. By June 2010 also Romania – like all the other countries – will draw up a National Action Plan detailing the ways in which they are to meet the 2020 target, which will then be submitted to the Commission for assessment.

Romania has to increase its share of energy from renewable sources in gross final consumption from a value of 17,8% in 2005 to a targeted 24% in 2020, according to Annex I in the Directive of the European Parliament and of the council 2008/0016 – On the promotion of the use of energy from renewable sources (amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC).

This can be done with a substantial contribution from refurbishing the existing SHPPs, where a doubling of production is a reachable goal. Austria in comparison has to increase this value from 23,3% in 2005 to 34% in 2020, where also SHPPs are one of the main supporting columns to reach this goal.

Especially in Romania there is still a huge potential for renewable energies waiting for identification and construction. The Small Hydro Power Plants, per definition and per Romanian "Renewable Energy Law" supported hydro power plants smaller than 10 MW rated power, have certainly some tradition originating especially from the last years of Ceausescu era. There is a huge potential available in refurbishing the existing SHPPs and in planning and building additional projects in the whole territory of Romania.

The refurbishment of SHPPs in Romania contributes to face the current economic crisis, as SHPP renovation provides jobs especially in rural areas while reducing electricity costs, energy dependence, energy imports and fuel price risks.

The major conclusion from the analysis is that the successful refurbishment of the existing SHPPs is only possible with a deep understanding of all juridical, technical and economical aspects. If all works are done in a structured way, profitability is achievable in taking the old existing equipment as basis. On only few locations completely new systems have to be installed.

How positively the refurbishment works will influence the energy production in the next years and if the set production targets can be reached, is a topic for close investigation and monitoring in the next years.

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List of Abbreviations

Institutions
ANRE – Romanian Regulator
CONEL – Former Integrated Electricity Company of Romania
EC – European Commission
EREC – European Renewable Energy Council
EU – European Union
ICEMENERG - Institutul de Cercetări şi Modernizări Energetice, Romania
IEA – International Energy Agency
ISPH – Planning Institute for HPPs
OPCOM – Romanian trade exchange for electrical power and Green Certificates
OPTRES - Project OPTRES “Assessment and optimisation of renewable support schemes in the European electricity market”, lead by Fraunhofer Institute

Units
Bn - Billion
EUR – Euro(s)
GJ – Giga joule
GWh – Giga watt hours
Mio EUR – Million Euros
MWh – Mega watt hours
MWe – Mega watt electric
MWt – Mega watt thermal
PJ – Peta joule
LEI or RON – Romanian currency
Toe – tons oil equivalent

Terms and Abbreviations
BRP – Balancing Responsible Party
CEE – Central and Eastern Europe
CHP – Combined Heat and Power
CO2 – Carbon Dioxide
EEX – European Power Exchange in Leipzig
EGO – Emergency Government Ordinance
EIA – Environmental Impact Assessment
E-RES - Electricity produced from Renewable Energy Sources
DAM – Day ahead Market
DSO – Distribution System Operator
FDI – Foreign Direct Investment
GC – Green Certificates
GD – Government Directive
HPP – Hydro Power Plant
NES – National Energy System
PV – Photo Voltaic
RE – Renewable Energy
RES – Renewable Energy Source
SEAP – Electronic Tender Platform
SHP – Small Hydro Power
SHPP – Small Hydro Power Plant
TPEC –Total Primary Energy Consumption
TSO –Transmission System Operator

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1. Introduction

The European policy framework for renewable energies has developed significantly over the past few years. Specific targets were defined on the EU level to achieve a dynamic increase of the share of renewables in the European Union's energy mix in order to comply with the tough objectives of climate change mitigation and the Kyoto protocol and also to secure a sustainable energy supply to the member states of EU and to achieve a reduction of dependence on energy imports and conventional energy sources. The promotion of electricity from renewable sources of energy has become a very high European Community priority.

EU member states have to abide by these goals set out on the European level and need to adjust their national energy strategies and policies accordingly. Small hydropower (SHP) is the most mature and proven of all renewable energy technologies – maybe with the exception of large hydro power - and has a long historical track-record. Consequently it has received increased attention and governments have identified good reasons to support its development in the future. SHP is a valuable addition to the various sources of energy production and can contribute significantly to Europe's strive to achieve its RE- and greenhouse gas emission-targets. For instance in Austria about 9% of the whole electricity production comes from SHP. In Romania this share is much lower at the moment – less than 1% of electrical energy are produced in SHPPs.

With the enlargement of the European Union, new markets and opportunities have opened up to transfer experiences in SHP development from old to new member states. The total installed SHP-capacity and the electricity produced from existing installations in these countries is still much lower than in the EU-15, and small hydropower has a considerable potential for expansion. With EU-accession, support mechanisms have been introduced and international investors see an incentive for project development in the new member states. Both the erection of new SHPPs and the refurbishment and modernisation of existing weirs, dams, storage reservoirs and ponds provide interesting investment opportunities in CEE.

Most important for the investor / producer in project development are stable incomes and a relatively high rate of return, which are fuelled by respective support mechanisms like feed-in tariffs or – in the case of Romania - Green Certificates.

From an environmental perspective, the reduction of CO_2 emissions is of great importance in the new member states. Also, the modernisation and restoration of existing infrastructure provides for additional gains. SHP growth can be a valuable part of policy measures that aim to ensure supply of energy while protecting the environment and maintaining energy quality parameters at prices acceptable to the general public. SHPPs are very well accepted by government, population and various stake holders in the Romanian society.

The following pages deal with the refurbishment of SHPPs in Romania, mainly erected in the last years of the Ceausescu regime.

Romania and its Economy

Romania is a parliamentary republic since the downturn of communism under Mr. Ceausescu. The 334-member Chamber of Deputies (the lower house of parliament) and 137-member Senate (the upper house of parliament) are elected for four-year terms. Since December 2008 the government has been a coalition between the centre-right Democratic Liberal Party (DLP) the party of the prime minister, Emil Boc and the Social Democratic Party (SDP). Consequently some new managers of state owned companies like Hidroelectrica were nominated.

Romania is one of the largest countries in Central and Eastern Europe, with an estimated population of 21.5 mio in 2008. The population has been falling in recent years, as a result of a low birth rate and emigration. Many Romanians have moved to other EU member states to seek work and income. It is estimated that, at the end of 2007, around 2 million Romanians were temporarily working abroad, mainly in Spain and Italy.

Graph 01: Political Map of Romania

Source: Google maps

Romania experienced rapid economic growth in 2003-08, mainly as a consequence of strong growth in personal consumption and foreign investment, but this is set to turn negative in 2009 as the economy suffers a recession. Despite recent strong economic growth, Romania lags behind most of the other new EU member states in Eastern Europe on measures like GDP per head at purchasing power parity (PPP).

Inflation fell gradually until 2007, but has risen in 2008, as lower unemployment has led to faster growth in wage costs, and as rising world prices for food and energy have pushed up costs of materials. 2009 brought a decrease of inflation like in most countries. Romania has run a current-account deficit for many years, but the deficit has been covered to a large degree by inflows of foreign direct investment (FDI). The current-account deficit increased sharply in 2006-08 as imports rose rapidly, but is falling now as one of the consequences of the economic crises. The government is in favour of Romania joining the Euro zone, and has set a timetable for Euro adoption in 2014. The Lei is not yet member of the EU's exchange-rate mechanism (ERM2), and floats freely. The Lei sank to a new low, of Lei 4.3 : € 1, in January and February 2009, from which it develops sideward.

Graph 02: Exchange Rate LEI to EURO

Source: Investkredit Austria

Romania is one of the few EU states that are close to energy self-sufficiency, and it is striving to improve on this by putting the development of nuclear power at the centre of its energy strategy.
Romania's domestic energy resources are diversified and relatively substantial. However, coal is the only energy resource that is available in the long term, with reserves of coal, mainly lignite, estimated at 4.1bn tonnes.

The estimated depletion date for reserves of both crude oil and natural gas is 14 years. Gas production has been declining for several years and imports, largely from Russia, account for more than 30% of natural gas consumption. Overall, dependency on imported energy accounted for 41% of consumption in 2008.
Romania's environmental record has been poor, even by regional standards. The European Commission's annual reports have repeatedly criticised government for giving insufficient priority to environmental protection, which has resulted in high levels of air pollution, low energy efficiency and weaknesses in water and waste management. A lot of old power plants, mainly coal fired, have to be closed in the next years.

The Renewable Energy Directive – some key points

Energy is central to our lives and our economy. We rely on it for transport, for heating and cooling our homes, and running our factories, farms and businesses. Natural gas, oil and coal are a finite resource and there burning is a major cause of global warming. So we should no longer take energy from fossil fuels for granted. We must create a European integrated energy and environment policy based on clear targets and timetables for moving to a low-carbon economy and saving energy.

In December 2008 EU leaders adopted a comprehensive and ambitious package of measures to reduce the EU's contribution to global warming and ensure reliable, affordable and sufficient supplies of energy. The most far-reaching approach ever of European energy policy, the package aims to make European states the world leaders in renewable energy and low-carbon technologies.

Driving the policy is the EU's bid to achieve a 20% reduction in its greenhouse gas emissions by 2020 (compared with 1990 levels), mainly by boosting the use of renewable energy and curbing energy consumption. The energy efficiency shall be improved by 20% until the year 2020. The measures will also reduce dependence on imports of natural gas and oil and help shelter the economy from volatile energy prices and uncertain supplies.

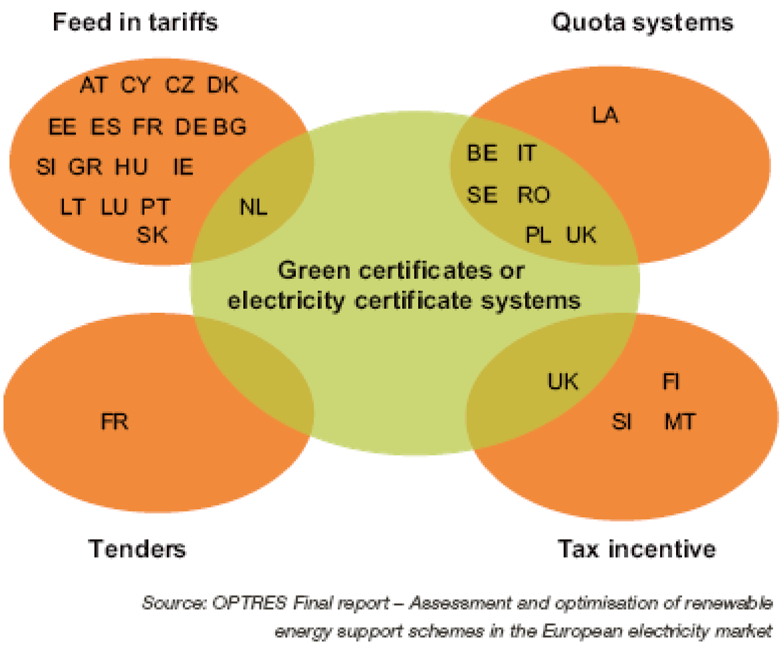
More than 50% of the EU's total energy comes from countries outside the Union – and the percentage is growing. Much of that energy comes from Russia, whose disputes with transit countries have repeatedly endangered supplies in recent years.

So as one target it was defined that 20% of total energy shall come from renewable sources by 2020.

- The EU's overall 20% renewable energy target for 2020 has been divided into legally binding targets for the 27 member states, averaging out at 20%.
- The member states have an "indicative trajectory" to follow in the run-up to 2020.
- Each member state must outline how it will meet its target in a National Renewable Energy Action Plan to be submitted by June 2010.
- Every two years member states will submit a progress report to the European Commission. Based on these reports, the European Commission will publish its own report the following year.
- An online "Transparency Platform" will allow member states to access and exchange information on the directive and on achieving the targets.
- To help them achieve their targets, member states can work together, for example on renewable sources projects and, under certain conditions, with non-EU countries.
- Guarantees of origin (GoO) will be used to prove that a given quantity of energy was produced from renewable sources.
- Member states will have to streamline authorisation processes for renewable energy projects.
- They will also have to develop power grid infrastructure and to guarantee electricity from renewable sources gets priority grid access.

Romania is supporting the enlargement of capacities to produce electrical energy from renewable sources via a support system of Green Certificates combined with a Quota system. So Romania joins system with the second largest number of countries choosing a respective support system. The largest group of countries rely on the efficiency of Feed in Tariffs, which has proven to be very successful in supporting rapid expansion of renewable energy production as long as the system is stable and enjoys strong political support like in Germany.

Graph 03 Renewable Energy Support Schemes throughout Europe



Source: Optres Final Report RES Schemes

The advantages of small hydropower are obvious: it does not produce greenhouse gas emissions; it is a renewable energy sources whose environmental impacts could be reduced through improved legislative frameworks, innovative technologies, enhanced operating methods and the willingness of actors to integrate ecological concerns; finally, SHP contributes to sustainable development by being economically feasible, providing clean energy and allowing decentralized production and supplying less developed, dispersed areas. So the environmentally feasible and profitable locations should be developed as soon as possible. Also existing SHPPs should be brought to a state-of-the-art level of power production.

2. The Energy Sector in Romania and Renewables

2.1 General Information about the Energy System

Romania has a well established energy system, which was built up mainly during communist time. Since 1990 the investments into the energy system were rather scarce, but the future potential and resources especially in the renewable field - especially in water and wind turbines - is quite high.

The total primary energy consumption in Romania had been significantly cut down after 1989, mainly due to changes in the economy sector connected with closing of non efficient enterprises (3.039 PJ in 1989 and 1.544 PJ in 1999). After this decline there has been an increase of primary energy consumption in the last years since 2005. Industry is the most energy consuming sector in Romania, with 40% share on final energy consumption.

Table 01: Energy Statistics Romania 2005

Main Energy statistics (2005):	
Gross inland energy consumption (in 1,000 toe):	39,14
Final energy consumption (in 1,000 toe):	24,50
Primary energy production (in 1,000 toe):	27,45
Net energy imports (in 1,000 toe):	10,71
Final electricity consumption (in TWh):	39,04
Gross electricity generation (in TWh):	59,41
Total heat production (in TJ):	3,04

Source: Energy Agency Austria

Electricity

In August 2000 the vertically integrated national energy company RENEL was split up into 4 independent companies:

SC TERMOELECTRICA SA (energy and heat production; conventional thermal power plants)

SC HIDROELECTRICA SA (energy production; hydro power plants)

SC ELECTRICA SA (distribution system operator and supplier)

SC TRANSELECTRICA SA (transmission system operator).

Additionally SC NUCLEARELECTRICA SA operates the only nuclear power plant Cernavoda, which will be enlarged with another two or even four blocks in the next years.

Today there are seven big companies active in the field of power production, which still remain with the main shareholder being the state. Additionally about 20 smaller producers are active. At the end of 2004 the installed power in Romania was approximately 22 GW, of which 69% in thermal power plants, 28% in hydro power plants and 3% in nuclear power plants. In the year 2007 the energy production developed as in the following table:

Table 02: Development of Electricity Production Romania 2007

Consumul și producția 2007

Luna	Consumul total	Energie nucleară	Energie cărbune	Energie hidrocarburi	Energie hidro	Import (+) Export (-)
ian	5.250,31	529	2.452	1.615	951	-297
feb	4.887,28	478	2.310	1.306	1.163	-370
mar	5.186,29	529	2.324	1.215	1.488	-370
apr	4.447,25	514	1.913	670	1.323	27
mai	4.623,20	525	1.978	624	1.481	15
iun	4.594,24	502	2.178	697	1.348	-131
iul	4.920,42	516	2.407	880	1.261	-144
aug	4.728,08	570	2.248	674	1.094	141
sept	4.547,07	707	2.155	533	1.260	-109
oct	5.055,79	839	2.297	682	1.444	-207
nov	5.412,37	949	2.213	995	1.586	-332
dec	5.644,87	1.051	2.236	1.163	1.517	-323
Total 2007	59.297,17	7.709	26.711	11.054	15.916	-2.100

Source: Hidroelectrica, Annual Report 2007

The Romanian sector of power generation is not concentrated. The largest power generator is Hidroelectrica with roughly 29% share on total production followed by another five power generators with roughly 6 to14% share (each) and two other companies with 3 to 6% share (each). The remaining share of 14% relates to smaller power generating companies.

Table 03: Power Producers Romania 2006

Producer	Electricity production		
	TJ	GWh	%
S.C. „Termoelectrica" S.A.	6482	1800	3,2%
S.C."Electrocentrale Bucure ti" S.A.	26716	7421	13,3%
S.C. "Electrocentrale Rovinari" S.A.	20117	5588	10,0%
S.C. "Electrocentrale Turceni" S.A.	20464	5684	10,2%
S.C. „Electrocentrale Deva" S.A.	13171	3659	6,6%
S.C. „Hidroelectrica" S.A.	59159	16433	29,4%
S.N. „Nuclearelectrica" S.A.	19973	5548	9,9%
Auto-producers	7211	2003	3,6%
Other generators	27652	7681	13,8%
TOTAL	**200945**	**55817**	**100,0%**

Source: ANRE statistics 2006

Hydro Power Plants - HIDROELECTRICA

Hidroelectrica is the commercial company in charge of generating and selling of electric power from hydro power plants and it provides power system services. Partly the company also fulfills water supply services and water management services.

Hidroelectrica S.A. owns a total amount of 350 hydropower plants and pumping stations summing up a total installed capacity of 6.3 GW, from which 81,5 MW are in pump-storage stations. The electricity production per year is about 15 TWh to17 TWh. The largest and most important hydro power plant with six 175 MW units is Portile de Fier I (Iron Gate), 40% of Hidroelectrica's output is from the Iron Gates Hydropower plants. This biggest project on the Danube River was built in the early

1970 as a joint venture project between Romania and neighbouring Yugoslavia. In addition to Portile de Fier, there are eleven other hydroelectric facilities with capacities of at least 100 MW, and dozens of medium-sized facilities of at least 30 MW. Collectively, these medium sized power stations represent about 40% of Romania's currently-operating hydroelectric generating capacity.

From the administrative point of view the hydro power plants are organized in 12 secondary headquarters having a legal person subsidiary statute. A summary of the subsidiaries is shown in the table.

Table 04: Subsidiaries of Hidroelectrica Romania 2007

No.	Subsidiary	No.of the plants+ Pumping Stations	Installed Capacity [MW]	Annual energy GWh/year
1	SH Ramnicu Valcea	26	1180,08	2751,36
2	SH Portile de Fier	3	1397,6	6561
3	SH Bistrita	81	667,23	1761,13
4	SH Cluj	59	565,84	1096,39
5	SH Curtea de Arges	67	635,93	1286,1
6	SH Hateg	24	488,9	850,29
7	SH Sebes	7	358,25	609,73
8	SH Targu Jiu	17	206,2	504,9
9	SH Caransebes	11	164,37	303,7
10	SH Buzau	13	97,84	301,7
11	SH Slatina	8	379	889
12	SH Sibiu	34	147,1	383,07
	TOTAL	**350**	**6288,47**	**17298,35**

Source: Hidroelectrica, Annual Report 2007

The investment program of Hidroelectrica in 2008-2010 is designed to start the construction of new capacities that will add 78 MW and about 360 GWh to the company's production in the following two years.

Along with nuclear power plant operator Nuclearelectrica, Hidroelectrica was one of few power producers to register a rise in sales to the local market during a first quarter 2009 when electricity consumption slumped by 10% year-on-year. On the basis of projected sales and expenditure budgets, the company expects a slight fall in full-year revenues and profit this year. Its guidance for 2009 projects turnover of 625 million Euro and a gross profit of 17,5 million Euro. In 2008, Hidroelectrica posted turnover of Lei 2,44 billion (664,1 million Euro), a rise of 18,5% on 2007, and a net profit of Lei 68,4 million (18,5 million Euro), up 30% on 2007. According to the company, about 73% of its estimated 15,2 TWh output this year will be sold on the competitive large business market with the remainder to be supplied to households and small business users.

Nuclear Power Plants

Romania operates, at the Cernavoda Nuclear Power Plant, a Canadian-designed CANDU 6 type reactor with a nominal capacity of 700 MWe. This unit has been licensed following the Canadian licensing requirements for similar reactors in Canada. Cernavoda Unit 1 provides about 10% of the country's electricity.
Since August 2007, Unit 2 of Cernavoda is completed and operational. The installed capacity of Unit 2 is again 700 MWe. Nuclearelectrica is planning to build two further reactors with a capacity of 720 MWe each. It has therefore invited binding bids for investors interested in forming a public-private partnership with Nuclearelectrica.
As regards nuclear safety, Romania has continued to develop the legislative and regulatory framework. However, no progress has been achieved in dealing with fuel spent and nuclear waste. Legislation has been harmonised with the adoption of orders for approving EURATOM safeguards, on radiological safety norms in September 2001, and on international transit of nuclear materials through Romanian space in February 2002. Nuclearelectrica S.A., who is managing the nuclear facility, is owned by the Romanian Government.

The following table shows the electricity production balance in the last months, where Romania was a net exporter.

Table 05: Electricity Production Balance in 2008 and 2009

No.	Indicator	MU	April 2008	April 2009	%	Jan-Apr 2008	Jan-Apr 2009	%
0	1	2	3	4	5=4/3*100	6	7	8=7/6*100
1	Generated electricity	TWh	5.11	4.32	84.42	22.72*	20.07	88.33
2	Delivered electricity	TWh	4.72	4.01	84.92	20.83*	18.52	88.91
3	Import	TWh	0.05	0.03	60.36	0.26	0.35	133.31
4	Export	TWh	0.43	0.28	64.29	2.22	1.72	77.38
5	Internal consumption	TWh	4.34	3.76	86.70	18.88*	17.15	90.87
6	Consumption of household consumers on the regulated market	TWh	0.83	0.88	106.02	3.57	3.88	108.68
7	Consumption of non-households consumption	TWh	2.89	2.32	80.28	12.07	10.04	83.18
7.1	*on the regulated market*	TWh	*1.03*	*0.94*	*91.26*	*4.51**	*4.27*	*94.68*
7.2	*on the competitive market*	TWh	*1.86*	*1.38*	*74.19*	*7.56*	*5.77*	*76.32*
8	Transmission – Injection component	TWh	4.61	3.86	83.75	20.50	18.22	88.87
9	Transmission – Extraction component	TWh	4.69	3.97	84.62	20.76	18.56	89.40
10	System services	TWh	4.69	3.97	84.62	20.76	18.56	89.40
11	Actual transmission grid losses	TWh	0.08	0.07	83.60	0.34	0.32	93.56
12	Heat generated for delivery	Tcal	1279.84	1123.89	87.82	9367.66*	8736.16	93.26
13	Heat in co-generation	Tcal	1089.25	893.61	82.04	7597.71*	7384.18	97.19

Note: 1. Data shown in the table neither include the energy produced by the generators who do not own dispatchable units (positions 1 & 2) nor the energy delivered to the consumers directly connected to the power plants (positions 6 & 7).

Source: Monthly Report April 2009 of ANRE

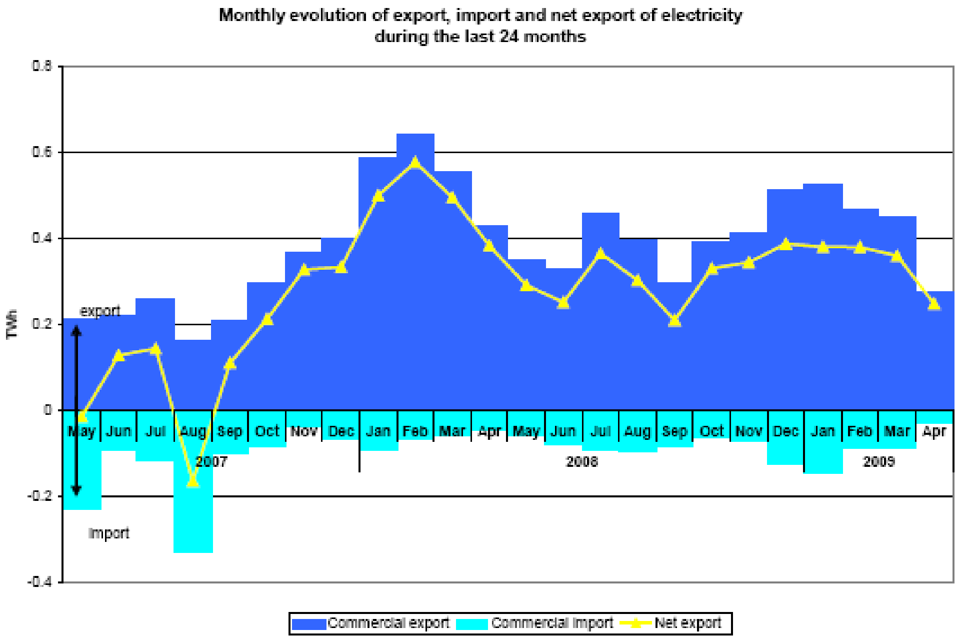
Electricity grid

Romania has an extensive interconnected power transmission and distribution network with an overall length of about 600.000 km, and a total transformer capacity of about 172.000 MVA. The national grid operates on 750 kV, 400 kV, and 220 kV for transmission and 20 kV, 10 kV, 6 kV, 1 kV and 0.4 kV for distribution.

Transelectrica is the responsible TSO in Romania) and is a member of UCTE and observer in CENTREL. In the last time Romania exported more electrical energy than it imported from other countries.

The transmission network is interconnected with those of neighbouring countries - by 750 kV (4,000 MWe capacity), 400 kV (2,500 MWe capacity), and two 110 kV tie-lines with Ukraine; a 400 kV line with Hungary (currently operating at 220 kV, with a planned capacity of 1,200 MWe); 750 kV (4,000 MWe capacity), 400 kV (2,500 MWe capacity), and 220 kV (260 MWe capacity) lines to Bulgaria; and one 400 kV (1,200 MWe capacity) and two 110 kV lines with Serbia; and two 110 kV lines with Moldavia.

Graph 04: Energy Export – Import Balance May 2007 to April 2009



Source: Monthly reports of CN Transelectrica SA – processed by MG

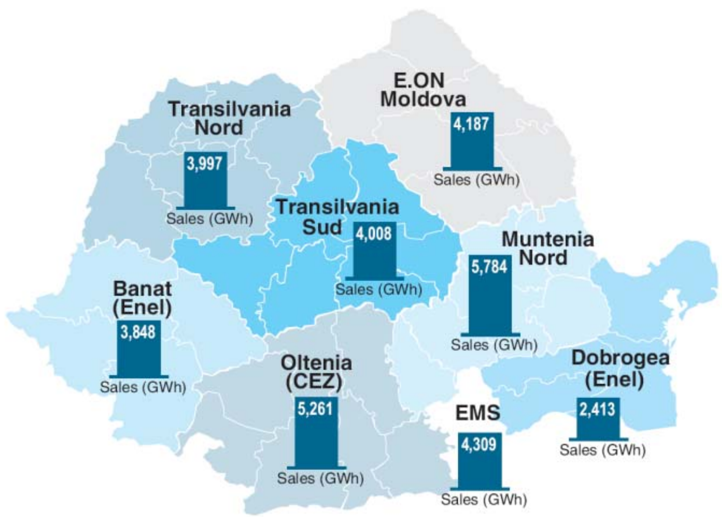
Source: Transelectrica April 2009

The most notable enterprises in the sector of power distribution and supply are definitely the companies origining from once incorporated and united Electrica S.A. - a former state-owned company, subordinated to the Ministry of Economy and

Commerce, which was broadly privatised and sold to foreign investors like EON, CEZ and ENEL. There are now eight power supply / distribution businesses.

The electricity market has been widely opened by July 2005 (83,5%) and full market liberalization was completed in July 2007 since when all consumers can choose their power supplier.

Graph 05: Distribution System Operators



Source: Transelectrica, Distribution System Operators

Oil

Romania's oil reserves are estimated at 82 Mt. The Oil production has been decreasing since 1997 (2001: 6 Mt). Oil imports have declined from 22 Mt in 1989 to 9 Mt in 2005. The refining capacity has been reduced from 740 000 bl/d in 1992 to 517 000 bl/d in 2005. Romania imports mainly crude oil (40% of all imported sources) from Russian Federation and Kazakhstan.
With the opening of 15 oil and gas blocks for exploration in 1996, and the influx of western technology, Romanian reserves and production are expected to rise slightly in the coming years. The share of oil in primary energy consumption is 23%. The biggest company Petrom was sold to Austrian OMV, which supports a broad investment program.

Gas

Romania's gas reserves are estimated at 394 Gm3. The share of imports from Russia, via a pipeline through Ukraine, is increasing and now accounts for 30% of the country's consumption. The share of gas in the country's primary energy consumption has dropped from 45% in 1990 to 35% in 2005.

A significant part of natural gas is imported already. And there is a tendency towards increasing of natural gas import mainly due to a recent increase of gas consumption and successive depletion of domestic natural resources. If the share of imported natural gas on total consumption in period 1990-2002 was 20-25%, it is forecasted to grow up to 60-65% in 2010. The process of liberalization of the gas market in Romania started in August 2001. The opening of the market continued in subsequent years, and in July 2006 reached 75%.

Coal

Romania's reserves of coal and lignite are 800 Mt and 2.8 Gt, respectively. Most of these reserves are lignite and sub-bituminous coal, with the largest reserves located in the Jiu Valley. The share of coal and lignite in the country's primary energy consumption is 24%.

Coal represents one of the most important geological resources of energy on the planet (74%), followed by natural gas (20%) and petroleum (6%)14. The reserves of the Jiu Valley are estimated at 930 million tonnes which, if exploited at the rate of 10 Million tonnes per year, will last for another 93 years.

But the coal industry in Romania had to restructure tremendously. Since 1989 half of the 45.000 workers in the mining industry lost their jobs. And still coal production is not competitive compared with the world market.

2.2 Renewables in Romania

Although there was no specific target for renewable energy sources utilization set in The Accession Treaty, the Romanian government set a target for the share of RES (including large HPP) on gross electricity consumption at the level of 33% by 2010. Despite the share of RES on gross electricity consumption dropped from 31,3% in 1997 to 29,87% in 2004, the goal should be achieved till the set deadline.

The most utilized renewable energy sources nowadays are hydro energy, especially for power generation, and biomass serving for production of heat and preparation of domestic hot water. Utilization of the other RES as wind, solar, geothermal, biogas or biomass for production of bio fuels is very low.

The share of RES on gross domestic consumption in 2005 was 12,78% (i.e. 5,004,000 toe / 209,717,640 GJ). The final energy consumption of RES in 2005 (excluding electricity) was 3,248,000 toe (136,123,680 GJ). The share of RES on total primary energy production in Romania in 2005 was roughly 18,39% (5,048,000 toe). Out of this, 1,737,000 toe covered hydro energy (including large HPP, but excluding pumped storages), the biggest amount (3,229,000 toe) covered biomass and 82,000 toe of energy was obtained from geothermal energy.

Hydropower

Nearly all RES-E in Romania is generated from hydro power. Production from large-scale hydro power totalled 15,855 GWh in 2004. The share taken up by small-scale hydro power is moderate, with 658 GWh in 2004. The average growth rate of hydro power is small (on average 5% per year between 1997 and 2004), despite a large potential (6 TWh smaller than 10 MW). Up to 5.000 locations in Romania are favourable for SHPPs.

In 2006, the majority of all RES-E was generated through large-scale hydro power. To a large extent, the high potential of small-scale hydro power has remained untouched.

The power generation from hydro power plants in 2005 was as following, source is ANRE:

Hydro with installed capacity < 1 MW:
77 GWh (equivalent to installed output of 63 MW)

Hydro with installed capacity > 1 & <10 MW:
599 GWh (equivalent to installed output of 262 MW)

Hydro with installed capacity > 10 MW:
19.530 GWh (equivalent to installed output of 5,964 MW)

Bio energy

Romania is covered by 40% of agricultural land and 27% of forest. The share of biomass in the total energy of the country was 10,94% in 1998. Currently, biomass is used only for heating purposes, direct burning for cooking and hot water preparation. About 95% of the biomass currently used is firewood and agricultural waste, the rest is wood waste from industrial processes: The average installed capacity in sawmills is 3.3 MWth. Biogas has been used in the past to a larger amount. Today, the number of large pig and cattle units is decreasing. Legislation on bio fuels was transposed into national legislation in December 2005. In 2007 the first Romanian bio fuel production facility was installed. The factory in Vaslui will have a production capacity of 25,000 tonnes a year. The country is now taking first actions in order to fulfil the regulations given by the European Union, to replace 10% of petrol and diesel with biodiesel or alternative forms of mobility like electrical cars.

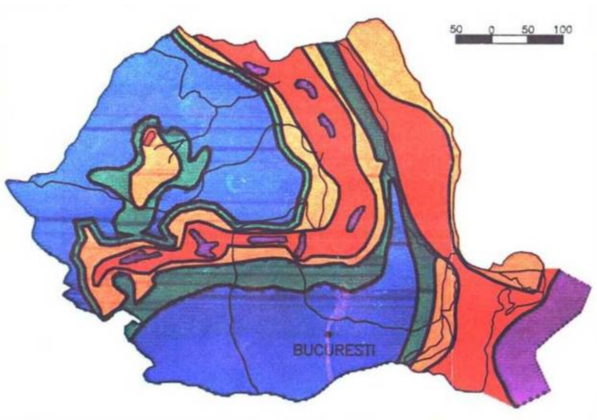
Biomass Energy Resource

Potential biomass is regionally distributed over Romania. Fuel wood and wood waste is mostly found in the Carpathians and Sub-Carpathians, while agricultural waste is available in the South Plain and Moldavia, biogas in the South and Western plains. In their Renewable Energy Resource Assessment for Romania, the EBRD estimates the South Plain region most promising for the utilization of agricultural waste, and the Carpathian and Subcarpathian mountains as most promising for the development of district-heating plants from firewood and wood waste in a range of 1-15 MWth.

Wind energy

Romania is considered to have the highest wind energy potential in the region. There were 3 MW of installed capacity recorded by the end of 2006 in Romania – only Cyprus, Malta and Slovenia had a lower penetration of wind energy out of all EU-27 member states. The Romanian government has set a target to enlarge the capacity up to 200 MW by 2010. A country wide wind atlas was issued by the "Energy Research and Modernizing Institute" (ICEMENERG), in 1993. It indicates wind speeds of 4,5 – 11,5 m/s at 50m height in various areas, notably off-shore.

Graph 06: Wind Atlas Romania



Source: ICEMENERG, Wind Atlas of Romania,
red and violet areas with highest potential

Large areas with wind speeds above 11m/s are identified. In the meantime there are a lot of different projects summing up to some 1.000 MW, mainly located in the eastern areas around the black sea, in Moldavia and also in the Carpathian region.

ANRE issued Order no. 51/2009 for approving the technical conditions of connecting the wind turbines/units to the public electricity grids – Technical Norms (in addition to Technical Code of transmission grid and Technical Code of distribution grid). This document specifies the minimal technical requirements to be accomplished by wind turbines in order to receive authorisation to connect to the public electricity grid with respect to NES security. Moreover, the document stipulates restrictions on the upper limit of total installed power in wind turbines for which the connection authorisation can be issued in order to maintain a safe level of NES security of supply. According to this, TSO has the obligation to determine the maximum total power that can be installed in this type of power units and the additional capacity reserve necessary for the safe operation of NES.

Solar energy

Starting with 1979, a large scale program for various solar applications has been implemented: solar domestic hot water systems for hotels at the Black Sea, for apartment blocks, solar drying for agricultural products or solar cooling for fish preservation. However due to poor quality, lack of maintenance and a stop of activities with the market reform in 1990, only 10% of the installed 1 mio m2 of collector area is still in operation. Currently, some demonstrative capacities, below 1 kW are installed.
The average solar radiation in Romania ranges from 1,100 to 1,300 kWh/m2 per year. A solar radiation map has been issued by the National Institute of Meteorology and Hydrology. There are good opportunities for solar energy development, and experiences from the past can be used. In the Renewable Energy Resource Assessment, the EBRD estimates domestic solar water heating for public buildings and hotels, passive solar systems, and stand alone systems for sites far from the grid, to be the most promising applications.

First PV pilot installations are installed and the further development will be supported by the renewable energy law.

Geothermal Energy

Geothermal resources have been used in Romania since the 1960s. At present, 137 MWth are used from 61 active wells producing hot water in the temperature range of 55-115°C. The geothermal water resources are public property according to the Romanian Constitution. No electrical energy can be produced at these low levels of temperature profitably.

Table 06: Present Use of Geothermal Resources in Romania

Space heating and hot water preparation, for domestic use	38%
Recreational purposes	30%
Greenhouse heating	19%
Industrial processes: wood drying, milk pasteurization	11%
Fish farming	2%

Source: EBRD, present use of geothermal resources in Romania

There is a Romanian Geothermal Resources Map in the European Commission's Blue Book on Geothermal Resources.
The proven reserves, including wells already drilled, are about 200 PJ for 20 years. Opportunities for geothermal development in Romania are good, but only for thermal applications, not for electricity production. The EBRD in the Renewable Energy Resource Assessment consider application in existing district heating systems in cities nearby the geothermal resources.

2.3 Major Authorities and Procedures for Renewables

Energy Administration and Institutions, Funds and Programmes

In the following lines the main institutions on the energy field are described.

Ministry of Economy and Commerce (MEC)
The Ministry of Economy and Commerce (according to the Government Decision no. 738/2003 establishing its organizing and functioning) is responsible, inter alia, for drawing up the national energy strategy regarding to the energy sector evolution, such as power and thermal energy, hydroelectric and nuclear power, oil, natural gas, mineral resources, mine-geology fields.

The National Electricity and Heat Regulatory (ANRE)
ANRE, established according to the Law no.99/2000, is organized as an independent public legal person of national interest under the Prime Minister co-ordination. Its mission is to create and implement fair and independent regulations to ensure an efficient, transparent and stable functioning of the electricity and heat sector and market while protecting the interests of consumers and investors.
ANRE issues, sets up and monitors mandatory regulations to be implemented at national level with a view to ensuring the proper functioning of the electricity sector and market in terms of efficiency, competition, transparency and consumer protection.

Green Certificates Market Operator (OPCOM)
OPCOM is a legal body which assures Green Certificates trading and determines the prices on the Centralized Green Certificates Market, performing the functions established by the Regulation for organizing and functioning of the Green Certificates Market (Order no. 15 / 2005 issued by ANRE).

Ministry of Agriculture, Forests, Water and Environment (MAPAM)
The Ministry of Agriculture, Forests, Waters and Environment is responsible for the development of the general environmental policy and specific legislation related to water management and environmental protection. Responsibility for the implementation of the environmental policy at local level lies with local authorities.

In the context of increased decentralization, enhanced responsibilities were attributed to the 42 County Environmental Protection Agencies, which are responsible for environmental factors monitoring and are entitled to issue the environmental permits and authorizations.
The Ministry of Agriculture is also responsible for the Romanian Water Authorities, called Apele Romana, which takes care of flood control, river bed management and some special topics like irrigation management.

Institute for Studies and Power Engineering (ISPE)
ISPE founded in 1949, is a Consulting & Engineering Company 100% private. ISPE developed, through its projects, practically all the National Power System, from the generation up to the transmission and distribution systems for heat and power. The ISPE's medium and long-term development goals follow closely the Romanian strategy for EU integration, adoption and application of EU directives.

Start-Up an E-RES generation capacity, what papers are needed

Legal documents issued by the local administration authorities such as:

- OCPI Certificate (urbanistic approval) for the lands related to the constructions necessary to the rehabilitation project;
- City planning certificate – includes also details about all the notifications to be obtained;
- Building authorisation

Legal documents issued by the distribution system operator, the E-RES producer will be connected to (successing companies to the former Electrica):

- Location approval – issued according to the Methodology for issuing the location approval, ANRE Order no. 38/2003;
- Technical connection approval – issued according to the Regulation on users connection to the local electricity network, approved by GD no.867/2003.

Legal documents issued by ANRE:

- Incorporation authorisation (set-up authorization) according to the Regulation on electricity sector licensing and authorising, approved by GD no.540/2004, further completed and modified, approved by GD no.553/2007; only for power units with installed power higher than 1 MW.

- E-RES generation licence according to the Regulation on electricity sector licensing and authorising, approved by GD no.540/2004, further completed and modified, approved by GD no.553/2007;
- Qualification certificate for the electricity priority production – according to the Regulation for qualification of the electricity priority production from renewable energy sources, approved by ANRE Order no. 39/2006.

Other permits are:

- Telecom approvals;
- Waters management certificates from the respective subsidiary of Apele Romana;
- Geotechnical study if necessary (dam reconstruction);
- Sanitary Approval from the municipality in which the SHPP is located;
- Fire Police Approval.

Necessary steps for starting-up a generation capacity based on renewables, trading and benefitting from the promotion system

There are some steps which have to be taken to participate in the Romanian energy market as a SHPP operator.

- Obtaining the authorisations and approvals needed for building-up the generation capacity from the local authorities
- Building up the generation capacity
- Obtaining the production licence from ANRE
- Obtaining the qualification certificate for the electricity priority production
- Registration at the Electricity Market Operator (SC OPCOM SA) – for selling energy on the DAM (Day Ahead Market)
- Registration at TSO (CN Transelectrica SA) – for obtaining the Green Certificates (GC)
- Registration at the Green Certificates Market Operator (SC OPCOM SA) – for participating on the centralized market of the Green Certificates.

The producer may sell the electricity produced from renewable energy sources (E-RES) on the electricity market, as any other electricity producer, obtaining the market price. For covering the entire generation costs and for obtaining a reasonable profit, the producer receives Green Certificates for each MWh of electricity supplied in the electricity network, depending on technology and size of the production facility. This Green Certificate may be traded within the price limits legally set-up.

The E-RES producer may sell the E-RES within a bilateral contact or on the DAM.

Each month the E-RES producer:

- Receives GC from TSO for the E-RES supplied in the electricity network
- Sells GC within a bilateral contract or on the centralized market of the Green Certificates,
- Receives the money for the sold GC
- Inform the Green Certificates market operator about the sold GC within the bilateral contracts

If the annual GC offer has been lower than the annual GC demand, at the end of the year, the E-RES producer receives for each offered but unsold GC the minimum value legally set up for that year.

To whom and how is the E-RES sold

E-RES may be sold:

- Within bilateral contracts, to electricity suppliers or eligible consumers, at negotiated prices
- Within bilateral contracts, to electricity distributors/suppliers which have concession contracts with right of exclusivity and which are legally obliged to buy, at the request of E-RES producers connected to the distribution networks from their area of exclusivity, the electricity they produced at regulated prices
- On the centralized Day Ahead Market (DAM).

When selling E-RES on DAM:

- E-RES has priority on the electricity market transactions
- The price for E-RES is the market clearing price
- If its E-RES is not accepted during a certain dispatch interval (the generation-consumption is balanced only through bilateral contracts), the E-RES producer submits physical notifications for imbalance and receives the price set up for such situations.

The E-RES Promotion System in Romania

E-RES produced from wind, solar, geothermal, biomass energy, waves, hydrogen as well as the electricity produced in hydro power units with installed power less or equal than 10 MW, put into function or modernized starting with 2004 benefits from the Promotion System.

Romania has adopted the mandatory quota system combined with the trade system with minimum and maximum price limits legally set up for the Green Certificates.

For each year between 2005 and 2012, the mandatory quotas for E-RES the electricity suppliers have to comply with are set up by law. There is a speciality in the law, that windfarms have to go into operation latestly in the year 2014 to gain the Green Certificates.

The electricity suppliers demonstrate the compliance with the quota system by the number of Green Certificates they buy each year. This number has to be equal to the mandatory quota value multiplied by supplied electricity quantity.

In case the suppliers do not comply with the annual mandatory quota, they will pay to the TSO the value of the Green Certificates they were unable to buy, in this way:

- since 2005 up to 2007, at a value which represents one and half the maximum trade value of Green Certificates;
- starting with 1st January 2008, at a value which represents double of the maximum trade value of Green Certificates. This is a strong incentive for suppliers to fulfil their quota and it will bring the GC price up.

How and to whom the Green Certificates are sold

- GC are issued by TSO following the producer's request and after he obtains the qualification certificate for priority production from ANRE
- The E-RES power units for priority production are qualified:
    - Annually
    - For the entire E-RES production
    - For the entire capacity
- The E-RES is qualified as uncontrolled priority production except:
    - The E-RES produced from biomass and conventional energy sources
    - The E-RES produced from geothermal sources
    - The E-RES produced from hydro sources from power units with at least 1 day control on the water flow, for instance when the SHPP is situated on a dam-food
- The E-RES producers receive monthly from TSO one Green Certificate for each MWh of electricity delivered into the network. The Green Certificates are allocated based on the data supplied by the network operators (DSOs) the producers are connected to
- The E-RES producers may sell the Green Certificates:
    - Within bilateral contracts to electricity suppliers, at negotiated prices;
    - Monthly, on the centralized market of Green Certificates, organised and administrated by the Green Certificates market operator
- The price for traded Green Certificates must be comprised between the minimum and maximum values
- Between 2005 and 2008, the minimum and maximum prices for Green Certificate were 24 Euro/certificate and 42 Euro/certificate, which are calculated at exchange rate from Romanian National Bank, for the last working day of December in the preceding year. With the new Renewable Energy Law the minimum and maximum price are adopted to 27 Euro/ certificate and 55 Euro/certificate
- If the annual offer of Green Certificates is higher than the annual demand of Green Certificates from the suppliers, in the following year the E-RES producer will receive from TSO the minimum price set up by ANRE for each unsold Green Certificate.

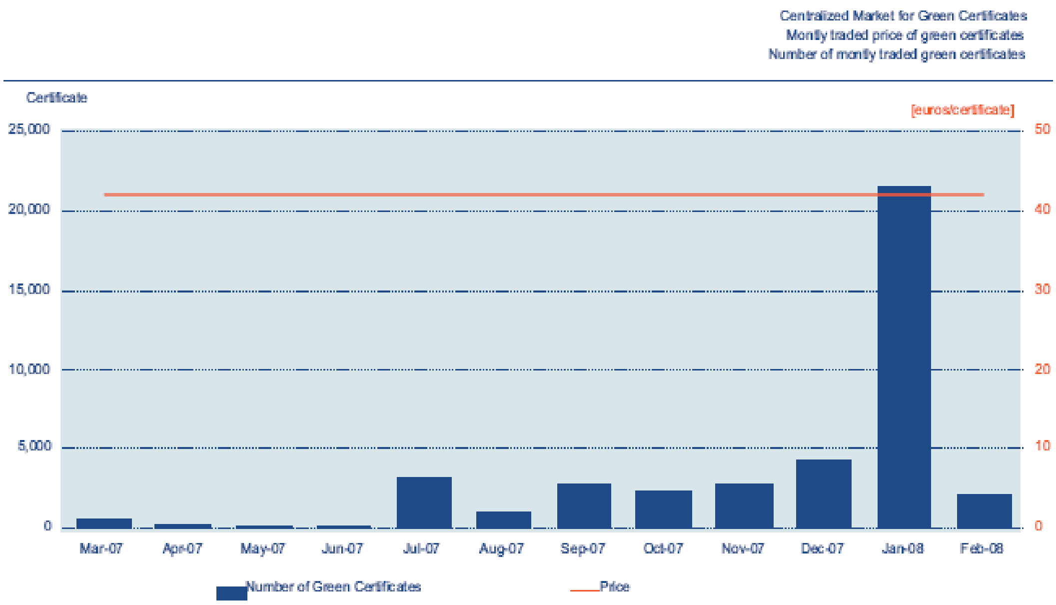
Table 07: Number of Green Certificates Traded

Centralized Market for Green Certificates	2007	2006
Green Certificates Trades		
Number	41,364	20,939
Value [Euro]	1,737,234	879,415

Source: Annual Report 2007, Opcom

In 2007 89% of all Green Certificates submitted were traded via the trading platform of OPCOM in the year 2007. Only the remaining 11% were traded via bilateral contracts. The price of the Green Certificates reached the maximum price of 42 €/MWh. Most Green Certificates are traded in January, because there most of the Green Certificates are distributed from OPCOM. In 2008 and 2009 the price for Green Certificates reached the new maximum value of 55 €/MWh.

Graph 07: Green Certificate Trade



Source: Annual Report 2007, Opcom

What Authority has which Responsibilities for the GC-System

ANRE

- Monitor the development and the functioning of the Green Certificate market.

TSO, Transelectrica:

- Issue on monthly basis the Green Certificates;
- Inform on monthly basis the E-RES producers, ANRE and the Green Certificates market operator about the producers receiving the GC and their hierarchy;
- Invoice and collect the money from the electricity suppliers not complying with their mandatory quota.

Green Certificates Market Operator / OPCOM:

- Publish annual prognosis of national offer and demand of Green Certificates;
- Register the bilateral contracts and the information concerning the transactions between the E-RES producers and electricity suppliers;
- Create the GC Register and keep it up-to-date;
- Register the participants to the Green Certificates market;
- Ensure a proper functioning of the Green Certificates market;
- Publish on monthly basis the cumulated demand and offer of Green Certificates from the beginning of the year;
- Send a monthly report to ANRE regarding the evolution of Green Certificates market.

DSO, Distribution system operators:

- Send to the producers on monthly basis the E-RES quantities supplied by these in the network.

This system has to be followed precisely to take part on the Romanian power market for SHPPs.

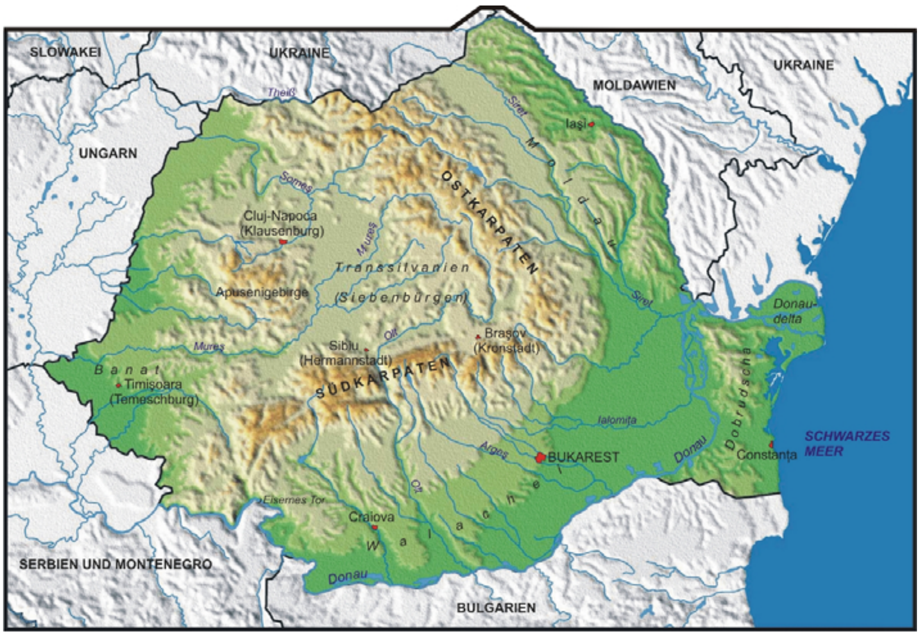
At the moment the SHPP producers have to deliver production quantities on a monthly base to the DSOs, which have to be actualized day ahead. But they do not have to take care for the balancing energy. If the forecasted energy can not be reached for instance because of lack of water, flood or technical problems, no penalties have to be paid.

3. Small Hydropower Plants in Romania

3.1 Potential of Small Hydro Power Plants

Almost the whole power generation from RES depends nowadays on hydro power plants. The overall hydro-electric potential is estimated to be 40 TWh. But the share of small-scale hydro power plants on total electricity generated by HPP in 2005 was very small, approximately 3,35%. Even the average growth rate of hydro power was small in the last years (5% per year in the period of 1997–2004), despite the existence of a significant potential (6 TWh/year). There are henceforth very good opportunities for more accelerated development of hydro-power facilities. For about 5.000 locations are appropriate for SHPPs in Romania.

Graph 08: Geographical Map of Romania



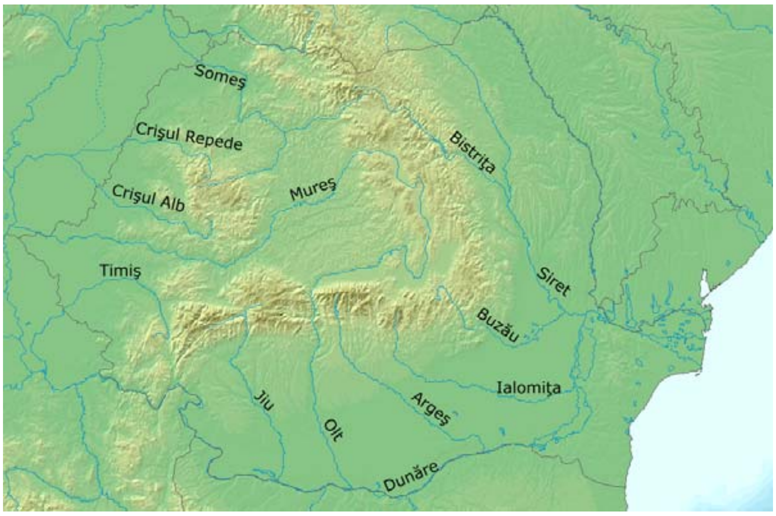
Source: Google Maps

At the beginning there were only few companies and groups interested in developing and operating SHPPs. The market of power production is still regulated and only few private investors are already active. Due to the introduction of a solid funding system with Green Certificates the interest has grown significantly.

The largest potential for SHPPs is in the East-Carpathians, in the South-Carpathians and in the Apusenian Mountains, which can be seen easily in the above map.

The renewable electricity produced in Romania is mainly obtained from hydro energy resources. Depending on the hydrological conditions of the year (rainy, average, drought), the green energy production may be more or less about 30% of the total electricity produced in Romania. But there are a lot of possibilities for SHPP, as the following maps show.

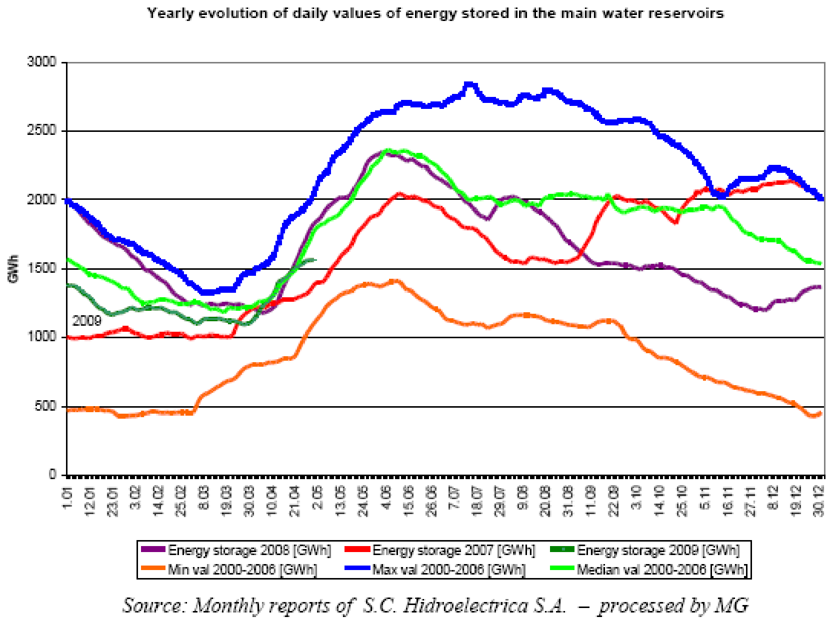
Graph 09: Plan of Big Rivers in Romania



Source: Wikipedia

The electricity generated from hydro resources depends on and at the same time influences the energy stored in the main water reservoirs. The following graph presents the evolution of the amounts of energy storage in April 2009 compared to daily values in 2007 and 2008 and to minimum, maximum and median values during 2000-2006. A lot of SHPPs are situated downstream of such big reservoirs.

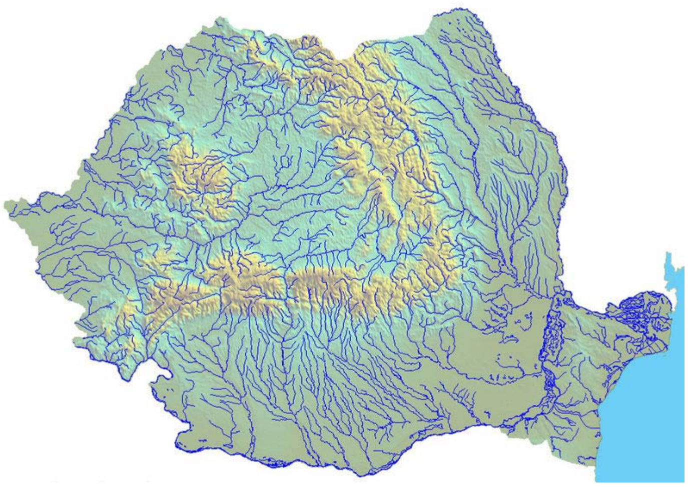
Graph 10: Yearly Evolution of Energy Stored in the main Water Reservoirs



Source: ANRE monthly report April 2009

The following graph gives a good overview of the many smaller rivers, which can be exploited by SHPPs.

Graph 11: Plan of Smaller Rivers in Romania



Source: Encyclopaedia Britannica

In the next table the list of all rivers longer then 200 km are summarised.

Table 08: List of Rivers in Romania longer than 200 km

River name	Length of the river (km)	Drainage area (km²)
Danube	1,075	
Mureş	761	27,89
Prut	742	10,99
Olt	615	24,05
Siret	559	42,89
Ialomiţa	417	10,35
Someş	376	15,74
Argeş	350	12,55
Jiu	339	10,08
Buzău	302	5,26
Dâmboviţa	286	2,82
Bistriţa	283	7,04
Jijia	275	5,76
Târnava Mare	246	6,25
Timiş	244	5,67
Crişul Alb	234	4,24
Vedea	224	5,43
Moldova	213	4,30
Bârlad	207	7,22

Source: Wikipedia

In the period 1989-2004, no large investments were performed in new hydro power plants except some projects of Hidroelectrica started before 1989 and finished afterwards, and the refurbishment of some existing plants with the operation duration of the out of date equipment.

In the perspective of the Romanian adhesion to EU, the adoption of a modern legislation by ANRE, the introduction of the subvention by Green Certificates for each MWh produced from renewable sources and the beginning of the micro hydro electric power plants privatization, several foreign investors wishing to invest in the hydro market came to the Romanian market, besides some Romanian companies expressing the same interest. As to the privatization occurring so far, companies from Romania, Italy, Portugal and Austria among others have purchased micro hydroelectric power plants.

Besides of Wienstrom 25 other companies obtained the operating licence for operating SHPPs within the system of not controllable priority production until November 2008. Also the wind companies are listed.

Table 09: Companies with Operating Licence in Romania

Item no.	Producer's denomination	Producer's licence no.	SRE type	Pi [MW]	Type production units
1	S.C. HIDROELECTRICA S.A.	332	hydro	142.077	Not dispachable
2	S.C. ELSID S.A.	768	hydro	29.598	Not dispachable
3	S.C. ISPH S.A.	624	hydro	12.470	Not dispachable
4	S.C. LUXTEN LIGHTING COMPANY S.A.	737	hydro	10.525	Not dispachable
5	S.C. COMPLEXUL ENERGETIC TURCENI S.A.	602	hydro	9.900	Not dispachable
6	UZINSIDER GENERAL CONTRACTOR S.A.	546	hydro	7.000	Not dispachable
7	S.C. ESPE ENERGIA S.R.L.	660	hydro	6.180	Not dispachable
8	Energy Holding S.R.L.	642	hydro	5.950	Not dispachable
9	S.C. ELECTROMAGNETICA S.A.	769	hydro	3.637	Not dispachable
10	S.C. ROMENERGO S.A.	836	hydro	2.030	Not dispachable
11	S.C. ROMELECTRO S.A.	744	hydro	1.640	Not dispachable
12	Administraţia Naţională "APELE ROMÂNE"	696	hydro	1.304	Not dispachable
13	S.C. UZINA MECANICĂ SADU S.A., Filiala C.N. ROMARM S.A.	653	hydro	1.200	Not dispachable
14	S.C. COLTERM S.A.	596	hydro	1.200	Not dispachable
15	S.C. HIDRAL INVEST S.A.	14	hydro	0.848	Not dispachable
16	S.C. APAVIL S.A. VÂLCEA	678	hydro	0.710	Not dispachable
17	S.C. HYDROCONSTRUCŢIA S.A.	777	hydro	0.600	Not dispachable
18	S.C. TERMOFOREST S.R.L.	792	hydro	0.526	Not dispachable
19	S.C. SOBIS Solutions S.R.L.	793	hydro	0.236	Not dispachable
20	**S.C. EVIVA HIDRO Bucureşti**	**778**	**hydro**	**0.202**	**Not dispachable**
21	S.C. Apa Serv Valea Jiului S.A.	806	hydro	0.200	Not dispachable

22	S.C. ELEREX S.R.L.	828	hydro	0.100	Not dispachable
23	S.C. NEPTUN S.A.	780	hydro	0.071	Not dispachable
24	S.C. BALKAN HYDRO-POWER SRL	834	hydro	0.038	Not dispachable
25	Asociaţia familială Atomei Gheorghe	846	hydro	0.014	Not dispachable
26	S.C. HOLROM Renewable Energy S.R.L.	715	wind	2.65	Not dispachable
27	S.C. ELECTROGRUP ENERGY S.R.L.	807	wind	2.24	Not dispachable
28	S.C. GREEN ENERGY GRUP S.R.L.	789	wind	1.95	Not dispachable
29	S.C. HYDRO WIND POWER S.R.L.	790	wind	1.35	Not dispachable
30	S.C. ECOPROD ENERGY S.R.L.	700	wind	0.66	Not dispachable
31	S.C. ELECTRIC PROD S.A.	781	wind	0.60	Not dispachable
32	S.C. E MARKET S.R.L.	770	wind	0.30	Not dispachable
33	S.C. ELECTRIC PROD S.A.	753	wind	0.29	Not dispachable
34	S.C. SERVOPLANT ECO ENERGIE S.R.L.	808	wind	0.29	Not dispachable
35	S.C. GREEN ENERGY GRUP S.R.L.	656	wind	0.25	Not dispachable
36	S.C. HYDRO WIND POWER S.R.L.	845	wind	0.25	Not dispachable
37	S.C. GERVIS S.A.	800	wind	0.10	Not dispachable
38	S.C. SERVOPLANT ECO ENERGIE S.R.L.	791	wind	0.09	Not dispachable

Source: Eviva Hydro, producers with production licenses in November 2008, shortly before Wienstrom got the production license

3.2 Tendering Procedure of Hidroelectrica

Small hydropower plants for sale from Hidroelectrica

In 2004 the by far largest SHPP owner was Hidroelectrica. However, in order to allow for opening the hydro market to private companies and, in accordance with the Romanian commitments towards EU, in 2004 Hidroelectrica started a privatization process of 150 SHPPs. At present, Hidroelectrica sold more than half of SHPPs that it owned at the beginning of the privatization process.

The process to sell the 150 small hydro power plants had also the purpose of rehabilitation and modernization of these SHPPs. Hidroelectrica organized open tenders (Dutch auctions) to which companies from Romania as well as from Czech Republic, Singapore, France, Austria and Italy took part.

The first auction took place in December 2004, selling a number of 18 (eighteen) small hydro power plants with the following details:

- In the Gilort river basin, Gorj county, the Novaci 1 – 5 SHPPs –
  ISPH, Romanian company;
- In the Firiza river basin, Maramureş county, 5 SHPPs –
  ESPE, company from Italy;
- In the Bistrita river basin, Olt county, SHPPs Tomşani 1-3 –
  ISPH, Romanian company;
- In the Topolog river basin, Arges county – SHPPs Cepari, Suici, Salatrucu De Jos, Salatrucu De Sus and Vadu Frumos –
  ENERGY HOLDING, Romanian company.

Regulations regarding the open outcry auction for selling the SHPP assets packages

General provisions

This Regulation contains the rules regarding the organization and development of the Open Outcry Auction for selling the common assets package and shall be supplemented with the provisions of the Submission File.

- Place, date and time of starting the Open Outcry Auction: the Open Outcry Auction shall take place on the date and time specified in the announcement, at the head office of S.C. Hidroelectrica S.A., Strada C-tin Nacu nr. 3, sector 2, Bucharest.
- The auction participation fee shall be 2500 Lei, V.A.T. not added.
- The auction commission shall be made of 9 members.
- The outcry auction shall take place validly in the presence of at least two accepted bidders. In exceptional cases, if a single accepted bidder is presented, which offers the auction starting price, such bidder shall be declared the successful bidder.

- The auction starting price shall be the price specified in the auction announcement and shall be made of the offer price for the assets package, which represents the sum of the offer prices for each asset in the assets package subject to sale. The bidding step shall be 5% applied to the auction starting price.
- The Auction Commission shall be validly convened in the presence of at least five members. The Auction Commission reserves the right to invite persons who are not part of the Auction Commission and who provide the necessary or specialized assistance in its activity to assist to the development of the Open Outcry Auction.

Participation in the auction

In order to be able to participate in the Outcry Auction, the persons interested shall submit the participation documents to the head office of S.C. Hidroelectrica S.A., prior to the deadline specified in the announcement.

- The marking of sealed envelopes containing the bids with the following data shall be mandatory, under the pain of not opening the envelopes which fail to comply entirely with this form requirement and of removing the given bidder from the competition.
- The bidder's name, address or registered office, respectively, phone and fax numbers.
- Name of the auction's organizer.
- Name of the asset subject to sale.
- The envelope shall bear the stamp of the registry office of SC HIDROELECTRICA SA and shall mandatorily be marked with the date and time of the bid submission.
- Prior to the beginning of the Open Outcry Auction meeting, the President of the Auction Commission shall verify the identity of the persons representing the accepted Bidders and the powers of attorney for representation and shall hand over identification number cards to such persons, in compliance with their registration number on the list containing the accepted bidders. The registration number shall be established according to the time and date of the Participation Documents submission.

- Prior to the beginning of the actual auction, the President of the Auction Commission shall announce the name of the bidding company, the common assets package subject to sale, the auction starting price, the bidding step, the name and registration numbers of the accepted Bidders and the manner of performing the Open Outcry Auction, ensuring that each accepted Bidder (their representatives, respectively) has understood the auction procedure.
- The presence of the bidders when opening the qualification documents shall be mandatory, under the pain of not opening the envelope containing their bid, which shall result in removing the given bidder from the competition.

The actual competitive outcry auction

- The President shall open the outcry auction by announcing the auction starting price. During the action, the accepted bidders shall be entitled to announce, by calling or raising the participation card, a price equal or higher than the price announced by the President of the Auction Commission. If the auction starting price is offered, the tendering process is started. If no bidder offers the auction starting price, the tendering procedure has to be stopped and the relevant SHPPs stay in the property of Hidroelectrica. Until now all packages could be sold, except of the two packages on Neagra Sarului, where acid water is running due to a sulphur mine.
- If the auction starting price is offered, the President of the Auction Commission shall continue to increase the price by one bidding step at a time. If there is only one bidder at the last price increase, there will be 10 minutes of waiting and afterwards the President shall announce the award of the auction to the bidder accepting the price resulted from the last price increase. In case two or more bidders make the same price offer, if none of the bidders accepts the price at the next increasing step, the Auction Commission shall declare winner the bidder holding the smallest card number.
- If no bidder offers the auction starting price with full payment, the President shall wait for 10 minutes and afterwards shall announce the end of the auction session with no winning bidder or the decrease in the starting price, according to the approval received from the General Meeting of Shareholders of SC HIDROELECTRICA SA.

- A bidder's failure to offer the price corresponding to a previous bidding step shall not limit its right to bid for a subsequent bidding step.
- At the auction closing, the President shall announce the winning bidder, in case a winning bidder was appointed, shall declare the auction session closed and shall prepare the auction minutes, which shall be signed by the members of the Auction Commission, the winning bidder, in case a winning bidder was appointed, and by the other bidders. Any refusal to sign the minutes shall be recorded in its content.

Final provisions

During the development of the auction session, the following actions shall be forbidden:

- To disturb the auction session, by any means.
- Concerted actions of the participants, for the purpose of influencing the results.
- To spread false information likely to influence the auction result.
- Any other actions contrary to the auction purpose, likely to affect its competitive nature.
- In case the auction session is disturbed, by any means, the President shall warn the bidder in question. If the given bidder continues to disturb the auction session, the President shall order the removal of such bidder from the room where the auction takes place.
- Failure to comply with any provisions under the Regulation regarding the development of the open outcry auction for selling the common assets package, as well as with any provisions of the normative acts forming the legal framework for the development of the assets selling procedure, as presented in the Section "Assets Selling Offer", shall entitles S.C. Hidroelectrica S.A. to remove the given bidder from the competition.

Sales Purchase Agreement Obligations

The assets sales purchase agreement signed between the buying companies and Hidroelectrica comprises some obligations. Below the main obligations are briefly described:

- To produce electrical power for 10 years starting from the date of buying;
- Not to change, transfer, guarantee loans with the assets for 5 years from the date of buying.
- To inform Hidroelectrica of the change of the company’s head office or name.
- To inform the respective agency of environmental protection with respect to the environmental obligations undertaken within 60 days from the date of buying.
- To inform Hidroelectrica about obtaining the environmental certificates from the respective environmental agency.
- To invest a certain amount of money in 5 years from the date of buying.
- To inform Hidroelectrica of the yearly performed investments, sending a document drawn up by an audit company.
- To maintain a financial guarantee for each investing year.
- To deliver to Hidroelectrica the financial guarantee within 30 days from the beginning of each year until the whole investment plan is completed.

This is the complete list of the already sold SHPPs:

Table 10: Sold SHPP in Romania

LICITATII		Pachet MHC-uri din bazinul raului / Judet	Nr MHC - uri	Ofertant adjudecatar
2004	1	Novaci, Gorj	5	ISPH SA
	2	Bistrita, Valcea	3	ISPH SA
	3	Firiza, Maramures	5	ESPE
	4	Topolog, Arges	5	ENERGY HOLDING
2005	5	Doftana, Prahova	7	LUXTEN&ISPH
	6	Manaileasa, Valcea	3	ROMELECTRO
2006	7	Suceava, Suceava	10	ELECTROMAGNETICA
	8	Iuhod, Mures	2	HIDROCONSTRUCTIA SA
	9	Casin, Bacau	5	EVIVA HIDRO SRL
	10	Iod, Mures	3	HIDROCONSTRUCTIA SA
2008	11	Ilfov, Dambovita	5	WIENSTROM GmbH
	12	Suha Mare, Suceava	4	ROMENERGO SA
	13	Suha Mica, Suceava	3	ROMENERGO SA
	14	Fenes, Alba	2	WIENSTROM GmbH
	15	Sovata, Mures	2	WIENSTROM GmbH
	16	Moldova, Suceava	6	WIENSTROM GmbH
	17	Dorna, Suceava	2	WIENSTROM GmbH
	18	Gurghiu, Mureş	4	WIENSTROM GmbH
	19	Olteţ, Gorj	3	WIENSTROM GmbH
	20	Negrişoara, Suceava	2	WIENSTROM GmbH
	21	Tur, Satu Mare	1	SC BENY ALEX SRL
	22	Ialomita, Dambovita	5	WIENSTROM GmbH
TOTAL PRIVATIZARE MHC = 87 MHC - uri				

Source: Hidroelectrica Homepage, Privatizare

And there are still 63 SHPPs which are waiting to be auctioned, status August 2009:

Table 11: SHPP to be auctioned

Denumire MHC/CHEMP	Judet/Râul	An PIF	Pi. (Kw)	Ep (Mwh)	Nr. grup
Plai Monah	SV/Neagra Şarului	1992	1620	5100	3
Gura Haitii 1	SV/Neagra Şarului	1987	1260	2910	2
Gura Haitii 2	SV/Neagra Şarului	1990	1000	2467	2
Lucaciu	SV/Pârâul cu Peşti	1989	380	736	2
Panaci	SV/Călimănel	1986	440	1440	2
Barnar	SV/Barnar	1983	450	3000	1
Neagra Sarului1	SV/Neagra Şarului	1987	750	1941	2
Neagra Sarului2	SV/Neagra Şarului	1990	1832	3916	2
Saru Dornei 1	SV/Neagra Şarului	1987	1829	8190	2
Saru Dornei 2	SV/Neagra Şarului	1989	1260	3773	2
Fălticeni	SV/alim.cu apă	1984	260	1521	2
Vicov	SV/Suceava	2000	636	1908	3
Hemeiuşi	BC/Canal CHE	1985	85	478	1
Caraliţa	BC/Trotuş	1994	1000	4400	3
Capra 2	NT/Capra	1987	375	1100	2
Capra 3	NT/Capra	1990	1230	3512	3
Cracau	NT/Cracău	2001	745	1952	2
Bucecea	SV/Siret	1983	1200	4200	2
Rogojeşti	SV/Siret	1988	3200	9060	3
Poiana Uzului	BC/	1976	4100	14000	2
Roznov	NT/Bistriţa	1984	180	760	1
Cernavoda	CT/Canal Dun.	1998	3150	19650	1
Lopătari	BZ/Slănic	1986	840	2180	1
Mânzăleşti	BZ/Slănic	1987	940	4400	1
Chiojd 1	BZ/Bâsca	1987	690	2100	1
Chiojd 2	BZ/Bâsca	1987	750	2100	1
Chiojd 3	BZ/Bâsca	1988	620	3208	2
Greşu	VN/Putna	1987	900	2760	2
Nedelea 1	PH/Teleajen	1987	750	2350	4
Nedelea 2	PH/Teleajen	1986	900	2900	4
Valea Fetei	PH/Valea Fetei	1994	130	320	1
Somesul Rece	CJ/Somesul Mic	1986	280	500	3
Floresti II	CJ/Somesul Mic	1986	1300	5200	6
Cluj 1	CJ/Somesul Mic	1988	940	3800	6
Chiuzbaia	MM/Chiuzbaia	1987	495	1750	3
Izvoarele	MM/Runcu	1987	592	2072	4
Viseut	MM/Viseu	1988	718	1800	3
Borsa Complex	MM/Viseu	1994	1418	2500	3
Baru Mare	HD/Muncel	1986	440	970	1
Valea Cracului1	HD/Valea Cracului	1987	536	1266	2
Valea Cracului2	HD/Valea Cracului	1987	415	1240	2
Valea Cracului3	HD/Valea Cracului	1988	560	1290	3
Zeicani	HD/Valea Cracului	1986	365	870	2
Valea de Pesti	HD/Valea de Pesti	1984	200	720	1
Buta	HD/Buta	1994	491	1153	2
Cincis	HD/Cerna	1985	850	3500	1

Bistra Nouă	CS/Bistra	1989	675	2717	1
Surduc	TM/Ac. Surduc	1986	1700	4300	2
Iosăşel	AR/Iosăşel	1990	126	330	1
Dezna	AR/Sebiş	1986	98	352	1
Sebiş	AR/Sebiş	1994	270	580	2
Marga	CS/Marga	1996	1260	2000	2
Rasinari	SB/Rasinari	1987	60	380	2
Sebesu de Jos	SB/Sebes	1984	30	92	
Talmaciu	SB/Sadu	1985	235	700	2
Tarlung 1	BV/Tarlung	1984	730	4230	1
Bran 0	BV/Turcu	1988	560	1800	2
Bran 1	BV/Turcu	1987	640	2500	2
Bran Vechi	BV/Turcu		120	390	2
Tarlung 2	BV/Tarlung		1800	4230	3
Lesu	BH/Iad	1976	3400	6400	1
Astileu I	BH/Crisu Repede	1955	2800	14000	4
Astileu II	BH/Crisu Repede	1982	1000	7600	1
TOTAL = 63 MHC-uri			**65.806**	**227.564**	

Source: Hidroelectrica Homepage, privatizare

4. Refurbishment of Small Hydro Power Plants in Romania

4.1 From a juridical perspective

4.1.1 Juridical Frame Work and Renewable Energy Law

As in many other European States the electricity market was liberalized in the recent years. These are the main steps in Romania:

- GD 365/1998 – vertically integrated monopoly – RENEL – was split in. separated distribution and supply companies (SC Electrica SA) and generation companies (SC Termoelectrica SA and SC Hidroelectrica SA) were established within a new company - CONEL SA. Two other electricity generators (SN Nuclearelectrica SA and RAAN) were separately established; transmission, system services and market administration were separately organised, within CONEL SA; the relationships between parties within the electricity sector were settled based on contracts.
- GD 122/2000 – electricity market opens at 10%.
- GD 627/2000 – CONEL holding is dissolved.
- September 2000 – launch of the compulsory electricity spot market in Romania, administrated by OPCOM and organized based on pool model;
- GD 1342/2001 – SC Electrica SA splits in 8 subsidiaries for electricity distribution and supply.
- GD 1524/2002 – SC Termoelectrica SA reorganizes in several separate legal entities for generation.
- July 2005 – launch of the new market model, based on:
  - voluntary spot market, with both sides offers and bilateral settlement;
  - compulsory balancing market, with TSO as single counterparty;
  - financial responsibilities of the balancing are allocated to the BRP;
- GD 644/2005 – electricity market opens at 83.5%.
- November 2005 – launch of the Green Certificates market.

- December 2005 – launch of the centralized market for bilateral contracts.
- GD 638/2007 – fully opening of electricity and gas markets; transactions on the day-ahead market (OPCOM as central counterparty).

There is now an extensive legal framework existing in Romania, adapted to necessities of the liberalized Electricity Market according to European Union Directives.

Primary legislation on RES

- The Electricity Law no. 13/2007
- GD no. 1535/2003 regarding the approval of the Strategy of use the renewable energy sources
- GD no. 443/2003 regarding the promotion of electricity produced from renewable energy sources
- GD no. 1429/2004 regarding the approval of the Regulation of guarantee the origin of electricity produced from renewable energy sources
- GD no. 1892/2004 regarding the system for promotion of electricity produced from renewable energy sources
- GD no. 958/2005 in order to modify GD no. 443/2003 regarding the promotion of electricity produced from renewable energy sources and to modify and complete GD no. 1892/2004 regarding the system for promotion of electricity produced from renewable energy sources

Secondary legislation on RES

- The Procedure for monitoring the issuance the guaranties of origin, approved by ANRE Order no. 23/2004
- The Regulation of organisation and functioning of the Green Certificates market, approved by ANRE Order no. 22/2006
- The Procedure for allocation the amount of money collected from the suppliers for quota non-compliance, approved by ANRE Order no. 45/2005
- ANRE Order no. 46/2005 for the approval of the modification of the mandatory quotas for acquisition of GC by the electricity suppliers for 2005

- ANRE Order no. 37/2006 for the approval of the modification of the mandatory quotas for acquisition of GC by the electricity suppliers for 2006
- ANRE Order no. 52/2005 for establishing the acquisition tariff for the electricity produced by hydroelectric producers with no portfolio contracts and by the producers which benefit, according to the law, of the E-RES promotion system
- Procedure for monitoring the Green Certificates market, approved by ANRE Order no. 38/2006
- The Regulation for qualification of the electricity priority production from renewable energy sources, approved by ANRE Order no. 39/3006

New Renewable Energy Law, set in force in November 2008

Although the new Renewable Energy Law is set in force and the notification of the European Commission was submitted positively, in September 2009 the law is not yet executed, as the secondary legislation is missing. The new Renewable Energy Law will bring a significant improvement in comparison with the old Renewable Energy Law and as soon as in force, will support projects on good locations in a sufficient way.

The promotion system established by the law applies for a period of:

a) 15 years, for the electric power produced in new electric power groups

b) 5 years, for the electric power produced in wind electric power groups/stations from the import, which had also been used for the production of electric power on the territory of other states

c) 10 years, for the electric power produced in hydroelectric power stations/groups of maximum 10 MW, refurbished

d) 3 years, for the electric power produced in hydroelectric power stations/groups of maximum 10 MW, not refurbished

e) 10 years, for the thermal energy from geothermal sources in stations of at least 5 Wth.

The transport and system operator issues Green Certificates on a monthly basis to the producers for the quantity of electric power produced from renewable energy sources and effectively delivered in the electric power network and/or to the consumer.

The producers of electric power from renewable sources receive:

a) a Green Certificate for each 1 MWh produced and delivered in the electric power network from new hydroelectric stations/groups or from refurbished hydroelectric stations/group of maximum 10 MW

b) a Green Certificate for each 2 MWh delivered in the electric power network from hydroelectric stations with an installed power comprised between 1 and 10 MW, which do not fall under the provisions of letter a)

c) two Green Certificates for each 1 MWh delivered in the electric power network from hydroelectric stations with an installed power of up to 1 MW/unit

d) two Green Certificates, until 2015, and a green certificate, starting from 2016, for each 1 MWh delivered in the electric power network by the producers of electric power from wind energy

e) 3 Green Certificates for each 1 MWh delivered in the electric power network by the producers of electric power from biomass, biogas, bioliquid, waste fermentation gas, geothermal power and associated combustible gases

f) 4 Green Certificates for each 1 MWh delivered in the electric power network by the producers of electric power from solar power.

The secondary legislation of this law is still missing, as mentioned above, but it is expected in the coming months. Especially the exact definition of refurbished SHPPs is of interest. In the old law the simplified rule for refurbishment was a reinvestment of about 30% of the original investment. A commission decided if the invest was high enough to fulfil this rule.

4.1.2 Operating Licence and Incorporation Authorization

In order to obtain a licence for energy production, the applicant forwards to the Competent Authority ANRE an application in compliance with the framework of Romanian energy laws. The application, all the documentation attached by the applicant, in compliance with the provisions of this Regulation, as well as all the communication has to be written in Romanian language. The following documents are to be attached to the application:

a) The articles of incorporation (duplicate);
b) Originals (or notary public certified duplicates) of the document certifying the company's registration and the standing of the applying legal person, issued by the Trade Register not earlier that 10 days prior to the day when the application is submitted to the Competent Authority;
c) The Tax Registration Certificate (original or notary certified duplicate) of the applying legal person, issued by the County department for Public finance, Bucharest department for Public finance or Department of administration of large size contributors within Bucharest and Ilfov county area, respectively.
d) The environmental permit or authorization;
e) Photocopies of the financial statements of the applicant, of the previous year, in accordance with the Accounting Law, No. 82/1991, republished; in what regards subsidiary companies, registered the year of the requests for a licence, have to add the photocopy of the previous year financial statement of the company/parent company, save the situation when that company/parent company is a licence holder; if the applicant is a company entirely owned by a company/foreign company, he must annex to the application the previous year financial statement of the company/foreign company, as an authorized translation from a notary public in Romania;
f) Curriculum vitae for the general manager of the undertaking, describing his or her managerial training and experience in that field;
g) Curriculum vitae for the manager responsible for the development of the activity that is to be authorised / licensed, describing his or her experience in that field.

Additionally, in order to obtain a licence for the commercial operation of the electricity generation units, the applicant, legal person, has to attach to its application, apart from the documents mentioned before, the following:
a) A description, for each headquarter, of the capacities for:
electricity generation / heat and electricity in cogeneration and, where appropriate, for the electricity transmission, that is, substations and transformer substations, electric lines, used by the applicant including for providing distribution to some operators of electric networks or to some other users; the documentation has to include, the single wire diagrams of the above mentioned capacities, and shall indicate the separations points between the applicant's facilities and those belonging to the network operator and also the separation points from the applicant's facilities and those belonging to the users linked by direct lines;
b) The applicant's organisational chart describing the organisation's structure at the moment of application, emphasizing the responsible department for the activity to be licensed;
c) Staffing report, describing the staff's structure, for each speciality and proving staff's training for the activity to be licensed;
d) Organisation and Operation Rules or the Quality Assurance manual (whole document or excerpts only) to describe the responsibilities in the company;
e) A business plan for the activity to be licensed, for the application year and for the next years.

Rights of the Licensee

Access to the public electricity network: In accordance with the provisions of Article 31 of the Electricity Law no. 318/2003, the Licensee shall have the right for access to the public electricity network used for the electricity transmission and distribution and it has the right to obtain, according to the law, a passageway for its own electric lines.

Acting on the electricity market: During the period of validity of the Licence, in respect with the provisions of the regulations and of the Commercial Code, the Licensee shall have the right to:

Make transactions with electricity, by:

- Selling the generated electricity while commercially operating the electricity generation station which is specified in Annex B of the Licence, on the wholesale electricity market, through negotiated or regulated contracts (including exports), for certain periods and/or transactions on the day ahead market
- Purchasing of electricity (for the plant demand or for top-up or standby purposes) and in order to fulfil the contractual obligations that the Licensee has assumed as producer
- Providing ancillary services; for this purpose the Licensee must be qualified as an ancillary services provider by the Transport & System Operator, following the specific procedure issued by the Transport & System Operator and approved for by the Competent Authority.

Take the benefit of the preferences related to trading of the generated electricity as priority production and/or the support systems applied for the electricity generated from RES, in respect with the legal provisions.

Transfer its responsibility for balancing, to a Balance Responsible Party which was registered by the Transport & System Operator, as provided in the Commercial Code.

In addition to the generation activities authorised by this Licence, the Licensee may carry out:

- Activities of electricity distribution and transforming and/or connection services for the Distribution Operator or for the Transport & System Operator, using the switchyards and the electric lines listed in the Annex C of this Licence.
- Electricity supply to those final consumers which are connected to the bush bars of the electricity generating sets or to the switchyards through the Licensee’s own lines or lines which belong to the final consumer so supplied.
- Provide ancillary services

The rights to use the land and to have access to the land: For the period of validity of the Licence, the Licensee has the following rights:

- The right to use the land to ensure the normal operation and the overhauls, repairs and other works alike, of the energy capacity specified in Annex B of the Licence;
- The right to have access of underground, surface or air with a view to assembling the electricity lines or other associated equipment as well as the access to their location, under the provisions of the law;
- The right to obtain restriction or suspension of any activities that might endanger people and goods or the normal operation of the energy capacities;
- The right to have access to public utilities.
- A legal right of access shall be established on the lands of third parties that are included in the area of the protection and safety zones of the energy capacities, for instance of land used for the pressure pipe.

The usage and the access rights over the public or private ownership of the state and of the local authority shall be **exempted from the payment of taxes** and other liabilities imposed by central and local government authorities.

For possible damages caused during the interventions for retrofitting, repairs, overhauls and other emergency interventions, **licence holders shall pay compensations to owners** from the vicinity of the energy capacity.

4.1.3 Process for Getting Green Certificates

For the promotion of the production of electricity from Renewable Energy Sources, a system of Green Certificates is in place, including a purchase obligation for distribution companies and the obligation to fulfil an annual quota of purchased green electricity. The document which proves that a quantity of 1 MWh of electricity was produced from renewable energy sources is called Green Certificate. At the end of each year, distribution companies have to deliver a certain amount of "Green

Certificates" corresponding with the annual quota. Since October 2005, the certificates are being traded at the newly created electricity market administrator OPCOM. It is a legal person which assures Green Certificates trading and determines the prices on the Centralized Green Certificates Market, performing the functions established by the Regulation for organizing and functioning of the Green Certificates Market (Order No. 15 / 2005 issued by ANRE). According to the Energy Law, all producers of electricity have equal access to the network. The tariffs are regularly adapted to the actual production costs by the Romanian Regulator, ANRE.

The Green Certificate Trade is being operated by the following market mechanisms:

- Bilateral contracts concluded between producers and suppliers
- Centralized auction within the Centralized Market of Green Certificates.

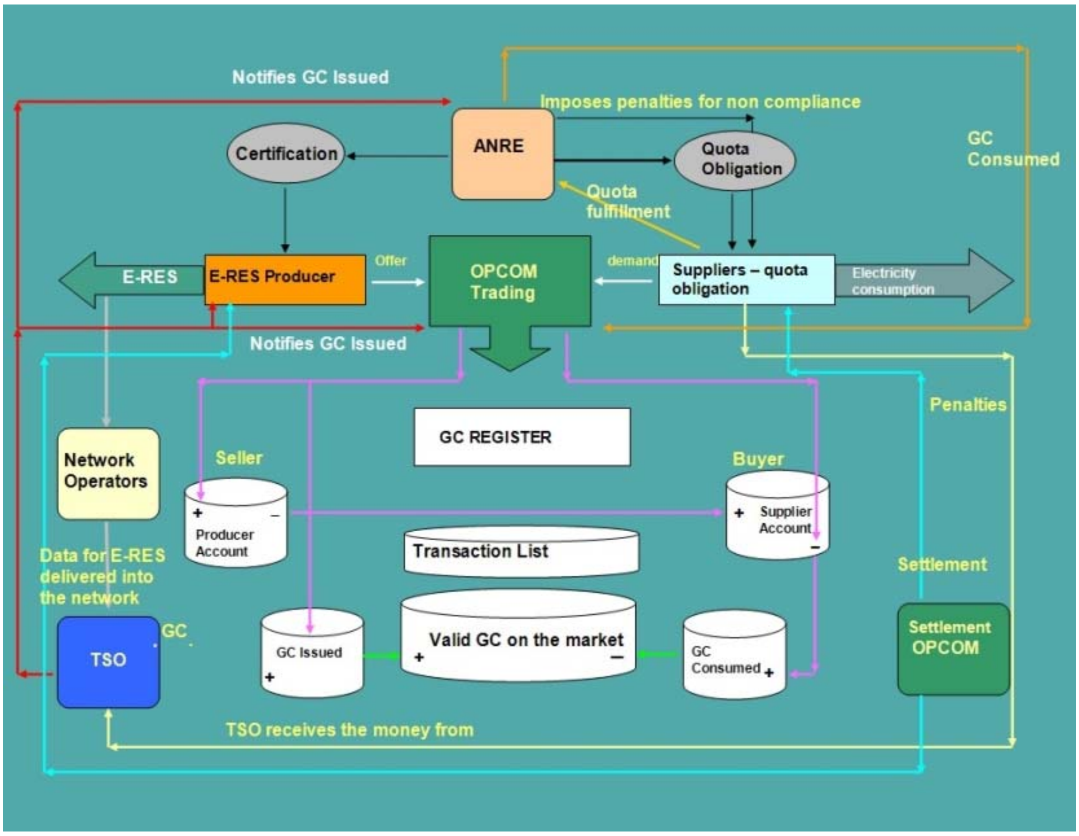
The Centralized Green Certificates Market is supposed to assure competition, transparency, non-discrimination; trading prices reduction and determination of the reference prices for other transactions on the Green Certificates Market.
The price of Green Certificates varies in the range established by the Government Decision, [Pmin ÷ Pmax]. The minimum price is imposed in order to protect the producers and the maximum price to protect the consumers.

With the new Renewable Energy Law, set in force in November 2008, the values for Green Certificates have been set to minimum 27 Euro/certificate and maximum 55 Euro/certificate, calculated at the exchange course (Euro/Lei) established by the Romanian National Bank, for the last working day of the December of the previous year.

The annual mandatory quota produced from renewable energy sources for the period 2005-2012 have been set as follows:

0.7% in 2005;
2.22% in 2006;
3.74% in 2007;
5.26% in 2008;
6.78% in 2009 and
8.3% in 2010-2012.

Graph 12: System of Green Certificates Administration



Source: ANRE Annual Report 2008

Bilateral contracts market

The energy is traded on competitive component of bilateral contracts market by medium of:

- Bilateral contracts concluded between producers and suppliers, in order to assure the consumption afferent to eligible consumers
- Import / export contracts concluded by producers / suppliers
- Bilateral contracts concluded by suppliers, others than the ones which sell to captive consumers on regulated prices.

The prices of these contracts are negotiated and confidential and in some cases the quantities are firm. The System Operator sends Settlement Notes based on accomplished/contracted quantities.
On regulated component of bilateral contracts market are processing contracts to tariffs/prices regulated by ANRE decisions. The contracts concluded between producers and captive consumer suppliers have fixed quantities and the System Operator sends the Settlement Notes based on these quantities and on regulated prices.

Day Ahead Market

Another significant “component of electricity wholesale market on where is traded active electricity for each trading interval of the corresponding delivery day, based on the offers submitted by the registered participants” inside is the Day ahead Market (DAM). The Day ahead Market rules (provided in chapter 5 of the Commercial Code of the Wholesale Electricity Market, approved by Ordinance of ANRE No. 24 from 22 October 2004) create a centralized market framework where the Romanian wholesale electricity market participants sell and buy electricity. That centralized framework is necessary to:

- Facilitate the setting up of a competitive, transparent and non-discriminative wholesale electricity market in Romania
- Reduce the trading prices for electricity
- Establish the reference prices for other wholesale electricity market transactions

- Optimize the use of the limited interconnection capacities with the neighbouring countries integrating the use of the respective capacities in the Centralized Day Ahead Market.

Sale of renewable electricity on the Day Ahead Market has priority on the electricity market transactions. The price of renewable electricity is the market clearing price and if it is not accepted during a certain dispatch interval (the generation-consumption is balanced only through bilateral contracts), the renewable electricity producer submits physical notifications for imbalance and receives the price set up for such situations.

4.1.4 Public Procurement Obligations

For companies active in the field of energy production - i.e. for companies which obtained the production licence - a restrictive public procurement practice has to be fulfilled. These regulations come from the European Union legislation and were adopted in Romanian law during the joining process of the EU.

The following types of agreements are subject to the Romanian public procurement requirements:

1. Works agreements: are the agreements having as object the design and performance of works in relation to any of the activities provided in Appendix 1 to the Emergency Government Ordinance 34/2006 or the erection of a construction and the erection by any means of any construction in accordance with the necessity and objective of the contracting authority. “Construction” is defined as follows: a number of construction works of buildings or civil constructions having a technical or economical purpose.
2. Supply agreements: are the agreements having as object supplying one or more products by way of purchase, including in instalments, rental or leasing with or without an option to acquire. The main object of such an agreement is the supply of products, following that the supply of services/works of setting up and putting into operation of such products represents only a secondary object, in close connection to the main one.

3. Services agreements: are the agreements having as object the supply of one or more services in accordance with Appendixes 2A and 2B of EGO 34/2006. This agreement has as main object the supply of services, following that the performance of activities as the ones provided by Appendix 1 to EGO 34/2006 represents only a secondary object, in close connection to the main one.

These categories of agreements are important as they represent one of the criteria in accordance to which the contracting authority can choose the public procurements method it applies.

Mention should be made that agreements having as object the acquisition or rental of land, existing buildings, other immovables or of any rights over them are excluded from the necessity for public procurement. However, the agreements for financial services that are concluded in connection with the sale-purchase or rental agreement are subject to the public procurement requirements. Arbitrage and conciliation services, hiring workforce and research and development services that do not benefit exclusively to the contracting authority are also excluded from the public procurement requirements.

Public Procurement Procedures

Public procurement can be done in several manners:

a) Open auction: any interested company has the right to submit an offer;
b) Restricted auction: any company has the right to submit its pre-qualification documentation, following that only the selected candidates have the right to submit the actual offer;
c) Competitive dialogue: any company has the right to submit its pre-qualification documentation and the contracting authority conducts a dialogue with the selected candidates, for the purposes of identifying one or more solutions that answer the necessities of the contracting authority, following that on the basis of such solution/solutions, the selected candidates draft the final offer;
d) Negotiation: the contracting authority conducts talks with the selected candidates and negotiates the contractual provisions, including the price,

with one or more of the selected candidates. The negotiation can be: i) negotiation with the prior publication of a participation announcement and ii) negotiation without the prior publication of a participation announcement;

e) Request for offers: the simplified procedure by which the contracting authority requests offers from more companies.

The contracting authority has a right to directly acquire products, services and works, as long as the value of the agreement is lower than 15,000 Euros. The EGO provides also for an interdiction for contracting authorities to divide the agreement into several agreements as not to meet the 15,000 Euros threshold or to under-evaluate the agreement for the same purposes. To this end, the relevant legislation provides for methods to determine the value of the agreements, Articles 25 – 30 of EGO 34/2006.

The contracting authorities have the obligation to conclude agreements subject to EGO 34/2006 by way of open auctions and restricted auctions. The other types of public procurement can be used under the special terms and conditions described herein below.

The Tender Book

The contracting authority has the obligation to mention in the tender book all its requirements, criteria, rules and any other necessary information in order to ensure that the bidder /candidate has all the necessary and correct information in regard to the public procurement procedure. The tendering documentation needs to contain: information regarding the contracting authority, instructions in regard to deadlines and other formalities that need to be fulfilled, the minimum qualification requirements and the necessary documents to be submitted, the tender book or the descriptive documentation (for the competitive dialogue and negotiation procedure), instructions in regard to the drafting of the technical and financial proposals, detailed and complete information regarding the awarding criteria, instructions regarding possible claims and information regarding mandatory provisions in the future agreement. Articles 33 – 40 of EGO 34/2006 provide in details the rules for drafting the tendering documentation.

General Rules to be abided by the Contracting Authority

The publication of the tender announcement: the contracting authority is obligated to publish the intention announcements, participation announcements and the awarding announcements.

In case of services and supply agreements with a value greater than 400,000 Euros and in case of works agreements with a value exceeding 5,000,000 Euros, the participation announcements need to be published in the Official Journal of the European Union besides SEAP, the electronic tender platform. To this end SEAP is obligated to transmit such announcements for publication to the Official Journal of the European Union.

Furthermore, in the case of agreements exceeding the abovementioned thresholds, the contracting authority needs to provide all the information provided by Appendix 3A of EGO 34/2006 in the announcements.

Awarding the Public Procurement Agreement

The contracting authority can either conclude a framework agreement or a simple agreement. Framework agreements are generally concluded following an open or restricted auction. The term of a framework agreement cannot exceed 4 years except for exceptional circumstances.

In a term of 20 days from the date of the opening of the offers, depending of the type of public procurement that has been applied, the contracting authority has the obligation to establish the winning offer on the basis of the awarding criterion/criteria provided by the participation announcement and the tender documentation, in case the bidder fulfils all the selection and qualification criteria. The contracting authority has the right to postpone the evaluation period with at most another 20 days for grounded reasons.

For further information regarding the awarding of the agreement please see Articles 170-216 from EGO 34/2006.

4.2 From a Technical Perspective

During the last years of the Ceausescu regime the decision was taken to build two hundred SHPPs to secure electricity supply in the rural area of the country. Due to the fact of a monopolistic approach there were specialized companies for the different tasks.

- The Institute of Meteorology was responsible for providing all necessary hydrological data.
- The former federal planning organization – now called ISPH – was responsible of the planning of nearly all of these SHPPs
- The former federal hydro construction company – now called Aqua Project – was responsible for construction of dams, intakes, weirs and tailraces
- UCM-Resita was responsible for all electro-mechanical equipment of the SHPPs
- The former integrated electricity company (integrated CONEL) – one of the succession-companies is Hidroelectrica for all HPPs – was responsible for operation of all plants
- The former federal maintenance organization – now called Hidroserv – was responsible for all repair and maintenance works

There was no intensive exchange of ideas with other countries especially in Western Europe. So the used technology was influenced more by Russian engineers. The equipment is comparably simple, but often useable despite of poor maintenance during the last 20 years.

Some of the SHPPs which suffered from more severe damages were not repaired any more and did not operate for 10 or 20 years. On these locations it is even a bigger task to achieve the start of production again, as the technical equipment suffered during these periods of non-production. The intake is congested, the pressure pipes often leaking. All mechanical equipment is corroded and all electrical equipment is not useable any more.

4.2.1 Intakes

The intake has the function to divert the projected amount of water into a pressure pipe or a canal, thereby producing the minimum possible head loss. Further on the intake shall separate debris and sediments, which can destroy the turbine from the conducted water. The intake has to handle different flow conditions in rivers from flood situations to periods of very small flow during winter time or during dry seasons.

There are three main topics, which have to be taken into consideration:

- Hydraulic structure to optimally separate sediments from the useable water
- Low maintenance requirements and good flood resistance for low costs during operation
- Good environmental performance, possibility for aquatic animals to pass the weir.

In the SHPPs there can be found two classical intake types: power intakes and diversion intakes.

Power intake

Mainly on reservoir-lakes there are intakes, which supply water directly to the penstock.

- Water intake from a concreted shaft, connected to the lake via a gate. Normally there is also a trash rack located, which is quite often out of function. Via a second gate the water goes to the penstock.
- Siphon intake, where the penstock is dived directly into the lake and a vacuum pump is necessary to get the siphon active.

When refurbishing the SHPPs below such intakes, it has to be taken into consideration, that the levels of the lakes are not constant, but vary considerably during the year. There are more then 450 artificial lakes in Romania, which serve different purposes.

Mostly these lakes are multi-purpose lakes and the priority of use for such lakes is:

- Drinking water supply
- Flood protection
- Irrigation
- Supply of water for industries
- Cultivating fish
- Energetic usage.

Unfortunately the priority of energetic usage is often low and the water management – which is done by Apele Romana – does not take into consideration the needs of SHPPs like maximum head or continuous debits.

Graph 13: Example of Siphon-Type Intake, SHPP below a Dam

Source: Picture Archive Wienstrom GmbH

When refurbishing the SHPPs you find the following situation regarding the three main topics of intakes:

- Hydraulic structure to optimally separate sediments from the useable water
  - ➔ Very often the lakes are full of sediments, so that the intakes are already sometimes too low and the sediments have to be removed
- Low maintenance requirements and good flood resistance for low costs during operation

- There are no trash rack cleaning machines functional, the installed machines are frequently out of operation
- Good environmental performance, possibility for aquatic animals to pass the weir.
  - These dams normally do not have fish ladders. As the dams belong to Apele Romana, this is no topic during refurbishing of the SHPPs.

Diversion intake

Mainly on rivers the intake diverts water to canals, which deliver the water to desilters/settling chambers. These conveyance intakes can be classified into lateral and drop intakes.

- Lateral intakes are normally situated in outer river bends, to prevent bed load from entering the intake

Graph 14: Example of Lateral Intake

Source: Picture Archive Wienstrom GmbH

- Drop intakes are generally used in steep rivers, but are also installed in normal river bed situations in Romania and are very similar to the well known Tyrolean intakes. Residual water provision can frequently be found, like in the picture below, to ensure environmentally good conditions.

Graph 15: Example of Drop Intake

Source: Picture Archive Wienstrom GmbH

In the standard situation these intakes are connected via a canal or tunnel to an open desilter/sediment trap, which uses quite a big volume and low velocity to clear the water from sand and grease. Despite of the big volume especially in mountainous regions the construction of the desilter does not fulfil the function of cleaning the water sufficiently from sediments to avoid damages of the hydro mechanical equipment. Quite often the velocity is too high, sometimes the maintenance is bad and the desilter is not filled completely.

Some SHPPs are plagued by silt at certain times of the year, especially in spring and during high water. Silt erosion of the hydraulic turbines is typically controlled by desilters/settling chambers and turbine protective coatings. Tests on curved hydraulic conduits show that on the outside curve of the conduit (equivalent to the pressure side of a Francis turbine blade, even at relatively low velocity, particles above 1.000 micrometers in diameter will not follow the hydraulic contour and will impact upon and damage the hydraulic surface. Particles with diameters between 100 and 1.000 micrometer will tend to be channelled along the outer hydraulic contour and their propensity for damage will be progressively less. For particles with diameters below 100 micrometer the surface damage increases considerably. This is because small particles become entrained in the turbulent boundary layer, which encases all hydraulic surfaces, and results in a sand blasting of the surface. Overall erosion from fine particles, if in sufficient quantity, can be as great as that from large particles.

Erosion rate is essentially proportional to concentration over the practical operating range for a hydropower unit, but there are indications that at higher concentrations at which HPPs typically no longer operate, a power law my be more appropriate.
The effect of particles on cavitation in hydraulic reaction turbines is twofold:

- Particles 50 micrometer in diameter or less provide nuclei for cavitation bubbles, leading to premature commencement of incipient cavitation earlier than in pure water.
- The second, equally serious effect of hydro-abrasive erosion is that it locally changes the hydraulic contour, which in turn disrupts the flow and increases both the propensity for and the intensity of the cavitation bubble implosion. The impacts from the implosion of the cavitation bubbles fatigue and loosen the hydraulic surface, adding to the erosion damage and making it easier for the impacting particles to remove damaged material.

The combination of cavitation and erosion is referred to as synergistic effect, the damage resulting from the combination of the two being far greater than the sum of each effect acting alone. Many turbines in Romania suffer from these effects and are damaged massively.

Also environmental aspects were taken into account by the planners of the SHPPs in the eighties of the last century. Some 30% of the intakes are equipped with fish ladders. But nearly no fish ladder is operating sufficiently, partly because of planning failures, partly because of poor maintenance.

Graph 16: Example of Fish Ladder

Source: Picture Archive Wienstrom GmbH

The desilters are normally equipped with a possibility for caterpillars to enter the desilter and remove the sediments. Hydraulic cleaning is installed only in about 30% of the installations. Where it is installed, it does not work sufficiently because of bad hydraulic constructions.

Graph 17: Example of Desilter

Source: Picture Archive Wienstrom GmbH

The installed spillways are normally big enough to work even in flood situations. If two catchment areas are collected for the same penstock system, normally a surge tower is erected to handle water hammers.

Run of river intakes

This type of SHPP, where a dam is built directly in the river bed only for the purpose of power production, was not used in Romania for SHPPs. In this situation all the water in the river bed can be used for energy production up to the rated flow of the turbines. This type was only used for medium and large hydro power plants.

When refurbishing the SHPPs you can find the following situation regarding the three main topics of diversion intakes:

- Hydraulic structure to optimally separate sediments from the useable water
  - ➔ Very often the hydraulic path does not work perfectly. The two main reasons are design failures like to small Tyrolean racks, which can not swallow the planned amount of water or too high water speed in the desilter.
  - ➔ Other reasons for malfunction are bad maintenance of the intake, which is not or only partly filled or is not equipped with level sensors, so that the level of the desilter is not kept constant. First measures are therefore installing of level control and optimisation of the water management.
  - ➔ Hydraulic cleaning, if installed, very often does not work. There have to be done reconstructions to enable this functionality.

- Low maintenance requirements and good flood resistance for low costs during operation
  - ➔ There are no trash-rack cleaning machines in operation - the rarely installed machines are frequently out of operation. Also the gaps between the bars of the rack are normally too big. As standard round bars are used, where stones can stick easily instead of modern rectangular designs.
  - ➔ All intakes are without automatic control. Either electrical drives are installed or the gates have to be moved manually. This has to be changed step by step to achieve fully automated operation of the intakes

- Good environmental performance, possibility for aquatic animals to pass the weir.
  - ➔ At about 30% of the weirs fish ladders are installed. Due to bad maintenance maximum 10% are functioning at least part of the time with favourable water flow. The fish ladders suffer from quick sedimentation and have to be cleaned

very often. Reconstruction requires very often heavy changes and is expensive.

The environmental flow (also called minimum flow or residual flow) is fixed in the exploitation contracts with Apele Romana. There are different possibilities to ensure these environmental flows. The fish ladders can be used for applying these flows, if they are constructed accordingly. Quite often an additional construction is necessary, to ensure the permanent flow of water in all flow situations – especially in the dry season.

4.2.2 Penstocks / Pressure Pipes

The penstock has to convey water from the intake or desilter to the powerhouse. The most economical arrangement for a penstock has to be found in a complex planning procedure, where different parameters have to be defined.

- Location of the penstock, close to the river bed or more distant
- Diameter of the penstock, depending on the required flow and the losses accepted
- Material of the penstock, selected according to ground conditions, accessibility, weight, jointing system and costs
- Wall thickness to resist the maximum internal hydraulic pressure including transient surge pressure at emergency shut down of the SHPP
- Construction over or under the ground, depending on factors like nature of the ground itself or environmental requirements.

About two thirds of the penstocks are made with concrete pipes and about one third of the penstocks are made with metal pipes. The biggest problems are leakages in the concrete pipes, not only at the joints but also in the middle of the tubes coming from bad material used for the concrete and maybe also from water hammers. Metal penstocks are quite often protected by concrete constructions especially when the penstock was built close to the river bed. Due to poor erosion protection against the river the concrete constructions are damaged on some locations and the metal pipes ran out of their original positions, making unnecessary hot spots for leakages due to cracks in the metal or concrete pipes.

Very often for erosion protection gabions (metal wire cages) are used instead of solid rocks. With this technique the effect of about 1m3 sized water-construction stones can be achieved by avoiding transport problems of these stones and transport costs. The stones for these gabions are frequently taken from the river bed.

Graph 18: Example of Erosion and Erosion Protection

Source: Picture Archive Wienstrom GmbH

The head (height of fall) in comparison to the length of the penstock is in not so good situations about 0,015 to 0,03, in better locations also values above 0,05 can be reached.

When refurbishing the SHPPs you find the following situation regarding the main parameters of pressure pipes:

- Location of the penstock
    - ➔ Quite often the penstocks are laid very close to the river bed. The river bed is moving over time and due to erosion the penstocks get in danger of being destroyed during floods
    - ➔ Quite frequently expensive measures of erosion protection are necessary, either with water construction stones ore with gabions, if possible filled with stones directly from the river bed.

- Diameter of the penstock
    - ➔ Normally the diameters of the penstocks are chosen quite well, so that the rated flow stays always below 3 m/sec, sometimes even below 2 m/sec for rated flows
    - ➔ Unfortunately the inner surface of the penstocks is too rough to achieve low losses. Coating during the refurbishment process is quite expensive, as the lengths of the penstocks are quite extensive.

- Material of the penstock, selected according to ground conditions, accessibility, weight, jointing system and costs
    - ➔ The two chosen materials are concrete and metal with additional concrete constructions
    - ➔ Metal pipes are of good quality and normally well protected on the outside
    - ➔ The concrete pipes are in principle okay too, but the connection sealing between the concrete pipes tends to leak on different spots. The water hammer resistance is not very high any more. The situation gets worse because of very long pressure pipes in comparison to the heads, for instance 6 km for 100 m head. Of course the risk of damage can be reduced with adapted closing times of the valves and gates.

- Wall thickness to resist the maximum internal hydraulic pressure including transient surge pressure at emergency shut down of the SHPP
    - ➔ Metal pipes and concrete pipes have sufficient wall thicknesses correlated to the head
    - ➔ If leakages occur at concrete pipes, different methods of handling this problem are possible. Either the leaking section is replaced by a metal pipe, or with smaller leakages a mantle of concrete is applied. Also the bandaging from outside can be successful with smaller leakages.

- If leakages occur at concrete pipes, first welding is used as repair method. If this is not possible or successful, a new metal pipe has to be installed.

- Construction over or under the ground,
  - Normally the penstocks are laid under the ground
  - Penstocks can also be laid over the ground in certain situations, for instance when the SHPP is located on the foot of the dam.

Very often the data concerning head are not according to the project and therefore not reliable. Topographical measurements are expensive, but necessary to optimise the whole system. Also flow measurements have to be executed to evaluate the efficiency improvements done by refurbishment.

4.2.3 Turbines and Generators

The hydraulic turbine transforms the potential energy (and kinetic energy) of the water to mechanical rotational energy. There are two different mechanisms:

- Reaction turbines: The water applies a force on the face of the runner blades, which decreases as it flows through the turbine. Francis turbines and Kaplan turbines are in this category
- Impulse turbines: The water pressure is converted into kinetic energy before entering the runner. Pelton turbines and Cross Flow turbines (Banki, Michell) belong to this category.

The most important parameters for choosing the right turbine are head and flow. Each turbine type has its specific field of application – with overlapping zones, where two or more types of turbines can be used efficiently.

Table 12: Head Variation Ranges

Turbine type	Head range in metres
Kaplan and Propeller	2 < Hn < 30
Francis	25 < Hn < 200
Pelton	50 < Hn < 1300
Cross Flow	5 < Hn < 150

Source: Kössler GmbH

For lower heads mainly Kaplan and for sites with low flow variations and low head variations the cheaper Propeller turbines have been used.

For medium heads the Francis turbines are dominating, but quite often without real turbine control via the wicket gates. Also some Cross Flow (Banki) turbines have been used up to 1000 kW of rated power.

For higher heads up to 120 m Francis turbines have been used in Romania so far. The comparably simple and inexpensive Pelton turbines were not used in the SHPPs in Romania.

Table 13: Flow and Head Variation Effects

Turbine type	Acceptance of flow variation	Acceptance of head variation
Kaplan	High	High
Propeller	Low	Low
Francis	Medium	Low
Pelton	High	Low
Cross Flow	Medium	Medium

Source: Esha Guidebook

Kaplan / Propeller turbine EOS

The development of this S-type Kaplan / Propeller turbine – done by UCM-Resita - aimed at developing a turbine, which could be located on different sites with different heads and flows. The EOS turbines are a family which can be used in different low head situations.

- EOS 350
- EOS 500
- EOS 700
- EOS 900
- EOS 1.100

The figures describe the diameter of the rotors. So for instance the EOS 700 , which is used most frequently, has a rotor diameter of 700 mm.

A wide range of applications can be covered by each type of turbine, and even a wider range can be covered by the whole family of EOS.

As an example the technical characteristics of EOS 700 can be seen.

With EOS 1100 for instance flows up to 8 m3/sec and powers up to 1.400 kW can be reached.

Table 14: Flow and Head Variation Acceptance for EOS 700

EOS 700				
Nominal rotation speed (1/min)	428,6	500	600	750
Net head (m)	2,8-6,8	3,8-9,2	5,4-13,3	8,5-20,8
Rated flow (m3/sec)	1,2-2,1	1,3-2,5	1,6-3,0	2,0-3,8
Power at the coupling (kW)	22-107	35-144	62-302	121-990

Source: Microturbine hidraulice de tip EOS, UCM-Resita

The asynchronous generators were adopted according to the above table. The “natural” rotations speed of the turbines is not reached completely, but only approximately, as the speed of the asynchronous generator determines also the turbine rotation. This does not lead to a very high efficiency of the EOS family, but leads to very standardized approaches during project development, construction and maintenance.

Description of refurbishment of one EOS turbine

Characteristics of the EOS 700 propeller-turbine with fixed 4-blade runner and 12 pieces of guiding vanes connected to the guiding apparatus. The guiding apparatus was electrically driven and shall be constructed new with a hydraulic cylinder for opening, the closing is done by a dead weight.

Rated data of the SHPP
Head: 7,25m
Rated flow: 1,8 m3/sec
Rotation speed: 500 rotation/min
Year of construction of the turbine: 1988
Turbine power: 90 kW
Supplier: UCM Resita

1. **Runner**

Disassembly of the runner. Sandblasting of the runner blades. Measurement of hydraulic profile of the runner blades. Welding and optimising runner gap. Renewing of all fixing elements. Adjusting to the optimal calculated angel. Painting with corrosion protection.

Graph 19: Runner in old Status, with welded Runner Blades, strong Corrosion

Source: Picture made during refurbishment works at EFG

Graph 20: Runner in new Status

Source: Picture made during refurbishment works at EFG

2. **Turbine Axis**

The turbine axis had to be renewed completely due to welding signs and problems during demounting of the runner.

Graph 21: Turbine Axis in the old and new Status

Source: Picture made during refurbishment works at EFG

3. **Bearings**

The bearings had to be renewed and the small parts of the bearings were made so that an optimal centralisation and rotation of the axis could be ensured.

Graph 22: Bush of the downstream Bearing

Source: Picture made during refurbishment works at EFG

4. **Casing of the Turbine**

Disassembling the 2-part casing. Cleaning and sandblasting. Rework at the bearing locations. Applying a new corrosion protection.

Graph 23: Disassembly of the Casing

Source: Picture made during refurbishment works at EFG

5. **Wicket Gate**

Reworking of the 12 guiding vanes to avoid problems with correct running. Servo cylinder and hydraulic aggregate instead of electric motor.

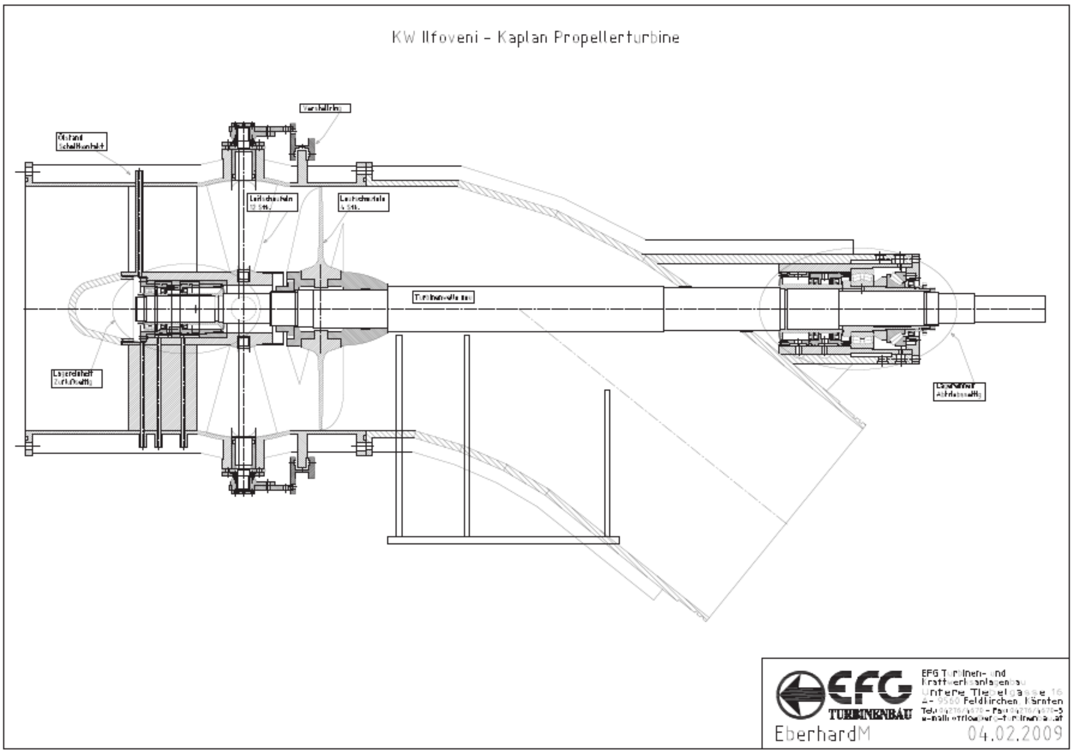
Graph 24: Hydraulic Aggregate with Cylinder for the Wicket Gates

Source: Picture made during refurbishment works at EFG

Graph 25: Refurbished Turbine EOS 700

Source: Picture made during refurbishment works at EFG

Graph 26: Drawing of EOS 700



Source: Drawing made from the EOS 700 at company EFG

To summarize the findings, this type of turbine was designed as a robust machine, which can work on different locations with different flows and heads. It is a simple and cheap design – single regulated only. The achieved efficiency of about 80-85% after refurbishment is considerably lower than modern western design which is normally above 90%.

Francis turbines

UCM-Resita also developed a family of Francis turbines, which could be used for SHPPs in different locations.

FO 90/390, FO 90/570, FO 125/640, FO 190/720, FO 230/720

For instance the technical characteristics of the biggest machine in the optimal working point are calculated as follows.

Table 15: Flow and head variation acceptance for FO 230/720

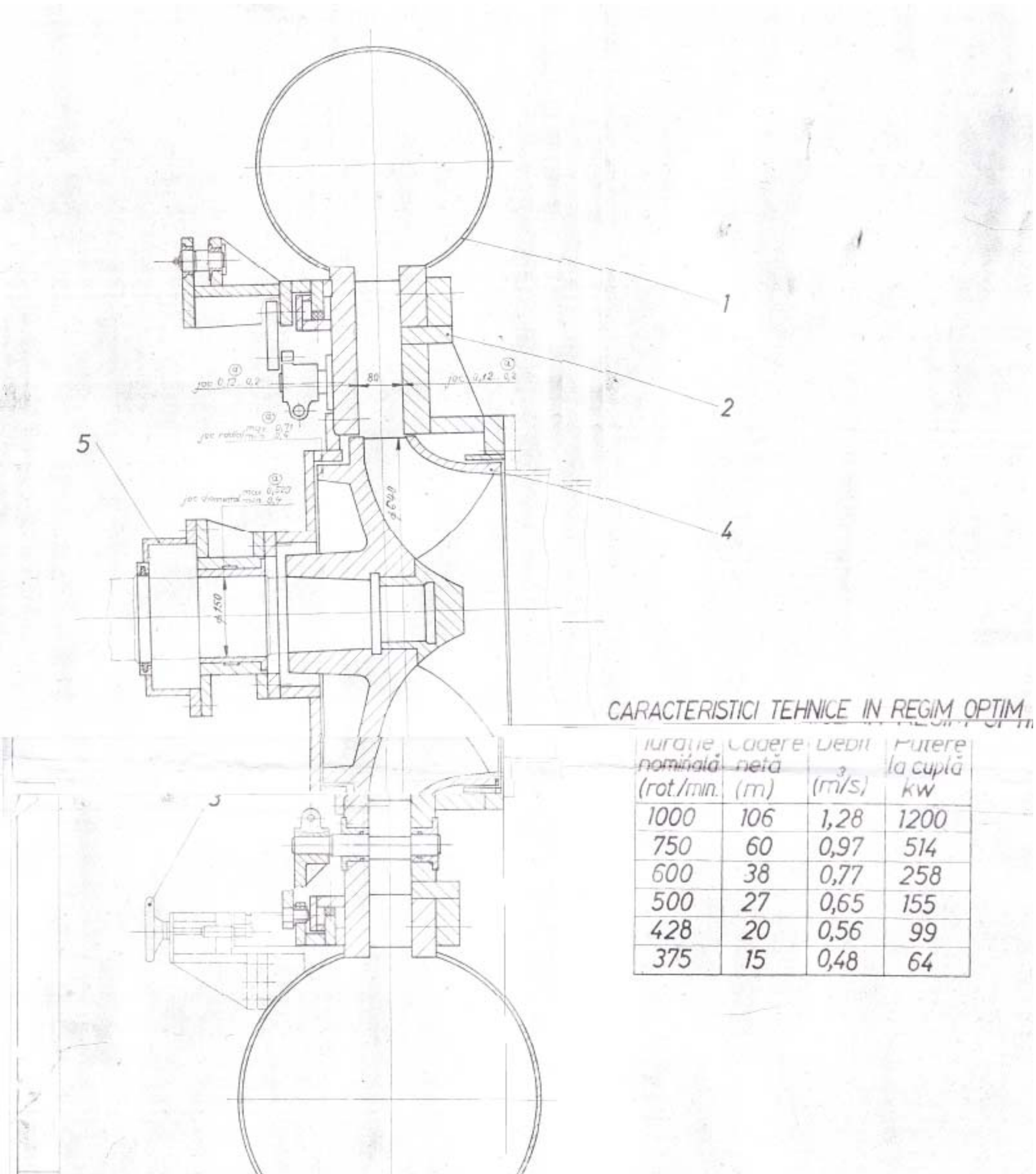
FO 230/720				
Nominal rotation speed (1/min)	600	500	428	375
Net head (m)	42	29	21	16
Rated flow (m3/sec)	3,19	2,65	2,26	1,97
Power at the coupling (kW)	1183	678	419	278

Source: Drawing of turbina hidraulica done by UCM Resita

Francis turbines FO 125/640

The development of this Francis turbine which is the smaller brother of 230/720 – again done by UCM-Resita - aimed at developing multi-site machine. Also with this turbine the head and flow define the most efficient rotation speed and the respective generator was applied. In the drawing also the technical characteristic of this turbine can be examined.

Graph 27: Drawing of Francis 125/640



Source: Drawing of turbine hidraulica done by UCM Resita

Due to suboptimal sealing of the runner there flows a lot of water to the rear side of the turbine and produces a back pressure, which has to be released by thick water tubes. A lot of turbulences occur. A technical redesign has to be executed to improve the efficiency of the Francis turbines from Resita.

To summarize the findings for Francis turbines, this type of turbine was designed as a robust machine, which can work on different locations with different flows and heads. It is a simple and cheap design. Very often the runners are in a bad shape with hydraulically not optimal shapes. After refurbishment an efficiency of about 80-85% can be achieved.

Wicket gates and butterfly valves

Very often the wicket gates and butterfly valves are driven by an electric motor. During refurbishment of the turbines hydraulic solutions shall be implemented.

Generators and speed increasers

There are two types of generators with different characteristics

- Synchronous generators which are equipped with a DC electric excitation system
- Asynchronous generators which are squirrel-cage induction motors.

For powers less then 1.000 kW in Romania the low cost and simple asynchronous generators were used, which require some reactive power compensation via capacitors. Very often this equipment does not work any more, so very high reactive currents occur in these generators, which are sometimes higher than the active currents. One of the first measures there is to install a (in some steps switchable) compensation to reduce the losses in the generators.

Only for powers above 1.000 kW synchronous generators were used.

Efficiency measurements of the asynchronous generators showed efficiencies between 93% and 96%, which is not too bad for these simple and mostly 25 years old equipment.

Generators have specific synchronisation speeds, depending on the number of poles. Synchronisation is done normally quite simple by switching to the grid as soon as the rotational speed of turbine and generator correspond to the grid frequency. Quite high transient voltages and current peaks occur.

In Romania the following generator rotation speeds are used:

Table 16: Generator Synchronisation Speed

Number of poles	Frequency
4	1500
6	1000
8	750
10	600
12	500
16	375

Source: Own Market study on generators used in SHPPs in Romania

Nearly at all sites speed increasers could be avoided, thus reducing complexity of the system and maintenance costs. On the other hand sometimes the turbines are not running at their optimum rotation speed, thus reducing the efficiency of the turbines.

4.2.4 Electrical Installation and Cubicles

The electrical installation in the SHPPs in Romania is normally 20 years old and reaches end of the life cycle. Very often basic measuring devices even for electrical power and electrical currents are missing.

Graph 28: Comparison of old and new Cubicle

Source: Picture Archive Wienstrom GmbH

To install an automated system some measuring parameters are obligatory:

- Active power of each turbine producing
- Reactive power of each turbine producing or phase angle cos phi
- Current of each phase of each producing turbine
- Produced energy of each turbine in the last 15 minutes
- Temperature of the turbine and generator bearings
- Rotation speed of each turbine
- Level of the intake
- Level of the tailrace

- Frequency, phase angle and voltage of the grid

The protection system has to contain:

- Power switches for each generator
- Reverse power relay
- Differential current relays
- Ground fault relay and protection
- Timed over current
- Over speed of the turbine
- Earthing arrangement, frequently measured once a year
- Line circuit breaker and line disconnection switch on the medium voltage side
- Fuses

All these devices have to be installed during refurbishing activities.

In the following lines a control scheme of one SHPP with 2 turbines and a siphon penstock is described: Scheme for two ridged machines

- At nominal rotation connect
- Water level in area of 2.5 m – announcement via GSM
- Transfer GSM: power/level/status (on failure – on stand by)
- Announcement whether vacuum system is in operation

- Level 1 reached, the first turbine "start"
- Level 2 reached, the second machine "start"
- And vice versa to drive down to "stop"
- Optional "turbine 1" or “turbine 2“ with priority to go into operation first

Start process

- Level reached
- Clearance net
- Security facilities
  - Emergency stop

    - Reverse power
    - Excess rotation
    - Over power
    - Ramp - up overrun
- Then "start" begins

Vacuum

- In accordance with signal from vacuum tank

Displays

- Active power
- Reactive power
- Grid currents
- Generator currents
- Compensation (if generator is connected to grid)

4.2.5 Grid Connections

The electrical grid in Romania was well established in the communist era. Due to very low investments in the last 20 years there are a lot of faults occurring nowadays. In one – quite bad - specific SHPP grid failures occur 1 to 2 times a week on average.

Graph 29: Example of Grid Connection

Source: Picture Archive Wienstrom GmbH

In most of the cases the transformer belongs to the SHPPs. In some cases the transformers belong to the DSO. Measurement of the produced energy is very often done on the low voltage side. For invoicing the produced energy, normally 1% of the energy is subtracted for transformer losses and transmission losses. If the SHPP owner wants to avoid these losses, he can install a medium voltage measurement after the transformer.

4.2.6 Automation and Scada Systems

The SHPPs in Romania are normally attended by operating personnel and do not have automatic control systems. Therefore the personnel costs are quite high. Step by step the production facilities have to be automated and provided with a remote access and control system.

Concept of SHPP control at the location of the SHPP and SCADA system with remote control, which is installed in SHPPs during refurbishment:

At the location of the SHPP

Fully automatic operation
All functions of the SHPP are possible with operating personnel. The SHPP must include the necessary relays and devices to detect malfunctioning of a serious nature and then act to bring the unit or the entire plant to a safe de-energised condition. So the SHPP stays in a secure operating mode all the time:

- Failure at grid connection, voltage low/high, frequency low/high
- Over current, over voltage, over rotation speed
- No water available (penstock, water level).

Automatic start up is possible (after well defined failure statuses like „Grid-failure” or “Water missing”).

Optimization:
Die turbine control keeps the turbine in an optimal working point considering the available water flow / water level. The turbine control communicates with the supervisory SHPP control.
If there are more than one turbine, the different turbines have fixed priorities of operation and are switched on and off according to water flow / water level.

Data collection and archiving:
All 5 minutes a set of data is collected and archived with the following parameters:

- Active power turbine 1-4
- Reactive power turbine 1-4
- Pruduced energy kWh per turbine 1-4
- Current in the 3 phases per turbine 1-4
- cos phi
- Temperature of bearings or Oil level in the bearings if available
- Level of the intake – if available or pressure value of the penstock.

These data are collected and made readily available for making operating decisions and stored in a database for later evaluation of plant performance and statistical analyses.

Control of intake, trash rack cleaning, gates, siphon-penstocks:
The control of all relevant equipment in the intake area shall be operable with remote control.

Also trash rack cleaning machines will be installed, which can be controlled and operated ideally with level-difference sensors.

The filling of Siphon-penstocks runs automatically via a vacuum pump.

The communication between power house and intake is realized via fibre optic cable, copper cable or with radio (if sight contact is possible). Sometimes old telephone lines are available, which fulfil this task.

Reactive power compensation:
With asynchronous generators phase-shifting capacitors via power house control are necessary, to keep a specified cos phi. With synchronous generators the cos phi can be controlled via the excitation equipment.

The SHPP should further be able to communicate with cascaded SHPP upstream and downstream, to prepare for start and stop according to the water management.

SCADA system with remote control

The installation of a computer controlled system is the goal of the refurbishment activities. It must be possible to access the control system from a remote location and override any automatic decision.

Failure Management
If a failure status occurs, the control center gets an automatic alarm and can see and influence the status of the singe SHPP. Typically there is a internet platform installed, which is accessible from each internet connection and the different tasks are attributed to special users. The functionalities and rights of such users are protected via a username / password system. So it can be avoided that unauthorized persons influence the SHPP.
The failure messages are transferred also via SMS, Fax, E-Mail or voice-alarm functions to the selected group of persons.

Process-Visualisation
The process visualisation makes control of the SHPP easier. All major components of the SHPP and the relevant measuring data shall be visible.

- Intake
- Penstock
- Turbine
- Generator
- Tailrace
- Medium voltage parameters

This process visualisation can be uploaded with intenet connections on different places.

- Control centre (1 in Romania)
- Regional centres (3-5 in Romania)
- Additionally directly in the SHPP or from the intake or from the upstream or downstream SHPP, as the different situations require.

Statistical Analysis

For statistical analysis it must be possible to export data rows of collected data to Excel, where additional calculation can take place. Fault anticipation is an important enhancement to the control system. Using a sophisticated program – an expert system – it is even possible to anticipate faults before they occur and take corrective action via a maintenance activity.

Alarm System – Burglary Protection

Also the alarm system of the SHPP shall be part of the control system. If somebody enters the SHPP without prior deactivation of the SHPP an alarm message will be generated.

With motion sensors, opening sensors or even a supervision camera a good surveillance of the SHPP can be guaranteed.

4.3 From an economical perspective

4.3.1 Refurbishment Investments and Funding

The SHPPs have to be bought for a certain price, which develops in the open outcry tender procedure. A certain risk is the exchange rate between Euro and LEU, which was in the first half of 2008 about 3,6 and jumped to about 4,2 in the first half of the year 2009.

According to the Asset Sales Purchase Agreement of the SHPPs from Hidroelectrica, a certain investment has to be done during the first five years starting with the take over of the facilities. These investments have to run conform to a business plan, which has to be submitted during the tender procedure. Hidroelectrica proposes the height of the investments, which were fixed by the asset evaluation company Iprolam SRL.
As is the experience of some companies, which have bought SHPPs from Hidroelectrica, the necessary investments to reach a technically acceptable status including automation is about double the originally from Hidroelectrica announced and required investments.

European Union and National Funds Application / Types of Funds that can be obtained

For the development of projects in the renewable power production in Romania, it is possible to have access to two types of funds from:

- The Interim Body for Energy under the Ministry of Economy, http://oie.minind.ro;
- Agency Fund for the Environment under the Ministry of the Environment, http://www.afm.ro.

The interim Body for Energy

Within the program developed, EU funds are available, as well as contributions of the Romanian state as follows:

Table 17: Available Funds between 2008 and 2013

Year	TOTAL EU and national public funds [Million Euros]
2008	20,9
2009	30,6
2010	39,7
2011	41,4
2012	35,8
2013	31,6

Source: Romanian Ministry of Environment

Thus, it is possible to obtain a maximum of 70% European funds from the total of the eligible expenses of the project.
During 2008, only one application session was released in the period of 11.08.2008 - 30.09.2008. A number of projects were rewarded with funds, but got this information one year later, in August 2009. The next application session is expected for autumn 2009.

The total budget for this “Operational Program Environment” (2007-2013) is about 5,6 billion Euros. The subsidies thereof from the European Union, coming from the European Fund for Regional Development (EFRE) accumulates to 4,5 billion Euros, the rest being financed by the Romanian state. Out of that sum there is an amount of 458,54 mio Euros planned for the Energy sector.

Funds by AFM (Romanian Ministry of Environment)

The Ministry of the Environment has opened an agency denominated Fund Agency for the Environment dealing, among other activities, with the support of the increase of the electricity production from renewable energy sources.
According to this fund, it is possible to obtain a maximum of 50% funds from AFM from the total of the project eligible expenses.

In 2008, two applications sessions were released in the periods:
• 01.02.2008 – 07.03.2008;
• 10.10.2008 – 28.11.2008.

4.3.2 Water Costs

Each producing SHPP has to conclude an agreement for the use of water resources with Apele Romana, the Romanian water authorities.

There are two terms to be respected, one is related to the flow and one is related to the head. Of course the water costs decrease, when efficient turbines are used.

Flow
The now regulated tariff for the use of water resources if of 0,25 Lei / 1.000 cubic meters, which gives about 5 Euro/MWh on average. This is a regulated standard agreement and the price is also a regulated price. This flow is normally not measured directly, but recalculated from the electrical production – considering a certain value of efficiency of the SHPP.
The SHPP producer holds water management authorizations for each SHPP. By these authorizations it has the obligation to maintain a compulsory minimum flow – depending on the river, but comparable to Austrian conditions. This minimum flow is fixed normally between MjNQT and NNQ. In case the flow drops below this value, the respective SHPP needs to be stopped. This minimum flow incurs a not neglect-able reduction of production possibilities, but insures the survival of aquatic fauna and flora and gives a precious contribution to environmental protection.

Head

Only when the SHPP is located below a dam owned by Apele Romana, a second term is added to the calculation of water costs, which take into account the head of the used water and the operating hours per month.

4.3.3 Grid Costs

Normally each producer has to carry also costs for the feeding in of electricity to the grid. These costs partly have to be paid to the DSO and partly to the TSO.

Each DSO has its special price for grid-feed in, but they do not differ more then 15%.

At the moment there is a regulated feed in tariff, which also covers the grid costs and is described in the chapter 4.3.5.

Description of the Connection Process

Some SHPPs which have to be refurbished were out of operation for many years. The grid connection has to be renewed completely, at least from an administrative point of view – all permits have to be submitted. From a technical point of view during the years the overall situation of the grid might have changed and a new study of grid connection has to be incorporated.

Users are connected to electric networks of public interest in accordance with the Regulation approved under the Governmental Decision (GD) no. 90/12.02.2008, which was applied beginning with June 13th 2008.

- Submitting the connection application and the documents needed in order to get the technical connection notice
- Issuing the technical connection notice
- Concluding the connection contract
- Contracting and execution of work, reception and commissioning of connection installations.

The connection request and supporting documentation attached to it have to be submitted directly or sent by post to Transelectrica S.A, Technical Division – Network Planning Department.

The connection request has to comprise the following data:

- Identification data of the generation or consumption place; user's coordinates as well as the legal representative's; designer's or supplier's coordinates
- Type of installations in the generation or consumption place for which connection is requested
- Estimated date that is requested to energise the installations in the generation or consumption place, as well as the power output foreseen to be generated or consumed
- Data about the electricity metering unit or information as required to determine one
- The applicant's own responsibility statement with respect to the truthfulness of the data and the conformity to the original of copy documents attached to the application
- The list of documents that constitute the documentation attached to the application according to art. 12 of GD 90/2008.

The documentation attached to the connection request has to include:

- Location approval – copy, for the objective or installations that are mounted on the respective generation or consumption place
- Solution study for the connection to the electricity grid
- Technical and power data characterising the user's generation or consumption place;
- Urbanism certificate - copy, within its validity term
- Scale plan showing the location in the area of the generation / consumption place endorsed by the issuer of the urbanism certificate and attached to it, for new constructions;
- Copy of the registration certificate in the Commercial Register
- Ownership title or any other deed certifying the utilisation right over the land, enclosure or building constituting the generation or consumption place for which the connection is requested - copy

- Building authorisation within its validity term - copy, in case the connection of a building site is also requested for construction.

Transelectrica S.A determines the connection solution to the electric grid under a solution study elaborated according to the user's data and requests and to the characteristics of the electric network. Transelectrica S.A draws up the solution study and the user pays for it. Transelectrica S.A will cooperate with the respective DSO to have them endorse the solution study and to determine the best connection solution, as well as in order to issue the technical connection notice.

The user should select one of the solving variants established under the study and express his opinion in writing within maximum 2 months from the study elaboration date. Within 7 days from the registration of the connection request Transelectrica SA checks up the submitted documentation and sends the user the invoice for the issuance tariff of the technical connection notice.
The user requests Transelectrica SA to conclude the connection contract when he has received the written technical connection. Within 10 calendar days from application registration and compliance with the requirements Transelectrica SA, Technical Division submits the user the draft connection contract.
Transelectrica SA and the user conclude the contract.
The work for grid connection is contracted and executed.
The connection installation is commissioned.
The user's installation is energised.

4.3.4 Other Operation Costs

There are some additional costs, which have to be accurately planned and controlled. These costs can be categorized roughly in technical costs, personnel costs and administrative costs.

Technical costs are all costs which are necessary to keep the technical operation of the power plant in a well performing status. The most important part is the maintenance costs, where normally the costs are distinguished between plannable maintenance work and only generally budgetable repair works. Also telecommunication costs for GPRS communication or fixed line communication is summarized here.

The most important costs at the beginning of the refurbishment are the personnel costs for operating of the SHPPs, as most of the power plants can not be left unattended during the complete operation time. As soon as the SHPPs are automated these costs can be reduced step by step.

A third category of costs are the administrative costs, where insurance costs, costs for the company, costs for bookkeeping and yearly financial report can be found. Also some taxes have to be paid according to Romanian law. And of course the general manager and an assistant is part of these costs.

4.3.5 Feed in Tariffs and Green Certificates

Each SHPP owner has to conclude a sale-purchase agreement for electricity produced in the facilities qualified for priority non-controllable production with the respective DSO. The prices for which the electricity is sold at present are the regulated prices of:

In case the SHPP does not benefit from the Green Certificates scheme:
- 140,24 Lei/MWh for night hours (22.00-7.00) and
- 229,87 Lei/MWh for day hours (7.00-22.00).

In case a turbine of the SHPP benefits from the GC scheme the price is 132 Lei/MWh.

Further on the SHPP owner has to conclude an agreement for balancing services in relation to the Balancing Energy Market with the respective DSO. It has to be payed a monthly fee of about 1000 Lei for these services per SHPP group.

Legal Basis for these Prices/Tariffs for the Period 2006-2008

I. Priority energy for low voltage connection

a) 2008 - Order No. 44/2007 issued by the President of ANRE in force since November 9, 2007

Producers of electricity, holders of hydro-electric power stations with an installed power of 10 MW at the most, qualified for uncontrollable/controllable priority production that do not benefit, according to law, from the support scheme through Green Certificates, can sell the electricity produced at the regulated price of:

- 140,24 Lei/MWh for night hours (22.00-7.00) and
- 229,87 Lei/MWh for day hours (7.00-22.00).

Producers of electricity holders production units qualified for uncontrollable / controllable priority production, that benefit, according to law, from the support scheme through Green Certificates, can sell the electricity produced at the regulated price of 132 Lei/MWh.

b) 2007 - Order No. 52/2005 in force since January the 1st, 2006

Producers of hydro-electricity that do not participate at the Green Certificate market can sell electricity produced in hydro power stations having an installed power of 10 MW at the most to the distribution and supply companies that have concession agreements with an exclusivity right at the price of:

- 140,24 Lei/MWh for night hours (22.00-6.00), and
- 229,87 Lei/MWh for day hours (6.00-22.00).

II. Green Certificates

a) 2008 – Law No. 220/2008 in force since November 6, 2008 (secondary legislation still missing)

Minimum value – 27 Euros/certificate and Maximum value – 55 Euros/certificate

b) 2007 – Government Decision No. 958/2005 in force since September 6, 2005

Minimum value – 24 Euros/certificate and Maximum value – 42 Euros/certificate

The SHPP owner, who wants to take part in the Romanian energy market and support systems, has to conclude an energy supply agreement with the respective DSO for the electricity it consumes. The present tariff for such electricity is the regulated tariff E2, in value of:

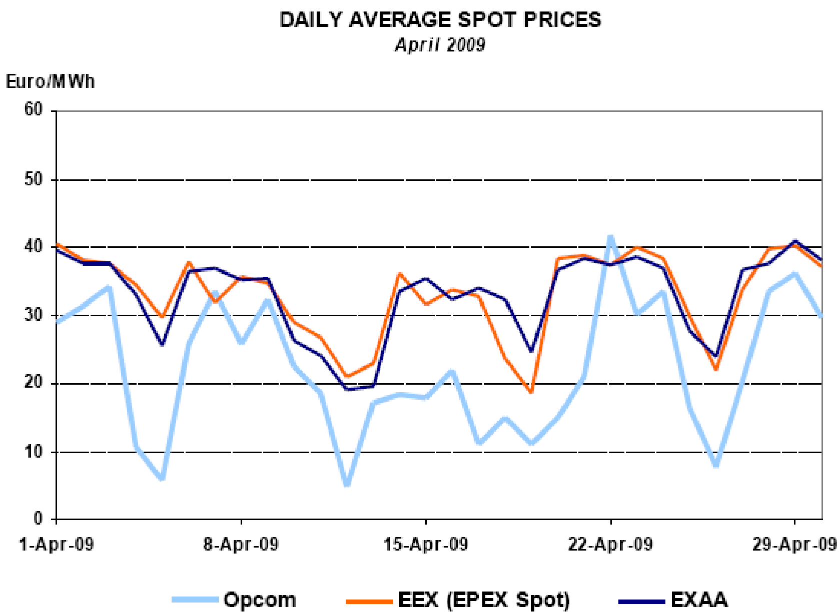
Day time (7.00-22.00) – 354,0 Lei/MWh

Night time (22.00-7.00) – 212,5 Lei/MWh.

As these tariffs are quite low, it is better for the SHPP producer, to feed in each produced MWh to receive the feed in tariff and the GCs and to buy the used energy of the power house (for lighting, pumping).

The Spot Prices in Romania are quite low at the moment, but follow the EEX.

Graph 30: Spot Prices in Romania



Source: ANRE monthly report April 2009

5. Conclusions

Hydroelectric power plants play a significant role in Romania's production of electricity from renewable energy sources. Hydropower provides clean energy with negligible emissions of greenhouse gas and pollution.

Small hydropower plants were usually owned by the state controlled energy utilities and are nowadays more and more privately owned and have experienced a small but steady rise in capacity over the last few years. Even if SHP only makes a small contribution to Romania's RES production, they are an important and necessary part of the country's renewable energy mix. An additional advantage is their potential contribution to rural development and strengthening of energy security and grid infrastructure in remote parts of the country.

To organize the refurbishment process of a SHPP it is necessary to observe a lot of items, which are all decisive for successful implementation. It is important to cover the whole project from a juridical, technical and economical perspective.

As in many other countries the laws regulating the field of energy production are changing rapidly and create new frame-conditions, which can be favourable for a specific activity or not. It is also very important to follow all the rules of the Romanian state in a strict way – from water contract via environmental regulations to the grid connection – to avoid any administrative problems.

The technical equipment of the SHPPs is in a mixed shape. Some SHPPs did not see much maintenance works in the last twenty years; others are in a quite good status of technical availability. The most critical part of the SHPP is the turbine, which is not as efficient as in Austria, but the old turbines can be refurbished and can be brought to reliable performance. In principle with all refurbishment steps the following simple principle should be followed:

- make a careful and thorough analysis of the location
- make a comprehensive diagnosis of the refurbishment steps for each module
- set a production goal for the SHPP after refurbishment
- implement the refurbishment steps, starting with the ones which bring the fastest and biggest benefits.

From an economical point of view the operation costs are a critical factor. Water- and grid-costs can not be influenced dramatically. In the past the SHPPs were controlled by people at 24 hours operation time. Although the wages and salaries in Romania are lower then in Austria, these costs have a significant influence on overall profitability.

So an automation program has to be started to bring the SHPPs to fully automated production mode. The people can be trained and used for maintenance works. In Romania the build-operate-own model is used for SHPPs, so the ownership of the plant does only end when the production is stopped. This differs from the approach in many other South Eastern European countries, were only licenses are submitted.

If all relevant items are respected accordingly, SHPPs in Romania can be operated successfully and profitably.

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Electricity Law no. 13/2007

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New Renewable Energy Law no. 367/2008

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http://www.anre.ro

The Interim Body for Energy under the Ministry of Economy

http://oie.minind.ro

Agency Fund for the Environment under the Ministry of the Environment

www.afm.ro

Hidroelectrica

www.hidroelectrica.ro

Energy trade exchange OPCOM

www.opcom.ro

Transelectrica, TSO

www.transelectrica.ro

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www.esha.be

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www.agro.ro

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