

**Renewable Energy Country Profile
Version 0.6b**

These profiles are a work in progress. They are presented to the international community for review and comment. The profiles are undergoing continual updating for technical content, formatting, grammar, and other issues. Each country profile will be modified on a continuous basis as new information is made available.

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20.0 Romania

20.1 Overview of Electricity Supply

Electricity generation is primarily made up in Romania with thermal power plants (coal, natural gas, and oil), with the balance of electric production from hydroelectric and a recently commissioned nuclear facility.

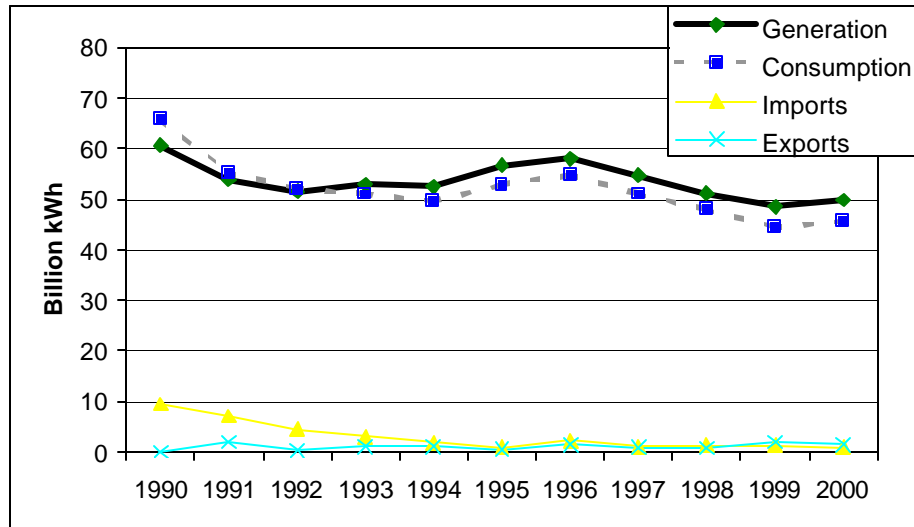
Fuel	Number of Facilities	Capacity (MWe)	Percent of Total
Nuclear	1	750	3.7%
Coal	15	8,649	42.7%
Oil	4	950	4.7%
Natural Gas	13	4,838	23.9%
Major Hydro*	42	5,068	25%
Other Renewables	--	--	--
Total	75	20,255	100%

*Encompasses all major hydroelectric facilities of >30MWe, the capacity accounts for about 77% of the total hydroelectric capacity.

Most of thermal capacity (coal, natural gas, and oil) consists of technology from the 1960's and 70's with about 60% of the capacity at over 20 years old. Because of this many plants have been decommissioned or "mothballed," with some of these undergoing refurbishment and modernization, while only the most efficient plants remain in operation. Romania has considerable hydroelectric resources with a maximum capacity of around 14,800 MWe. In addition to the already installed capacity there are 14 new projects in the planning phase with a capacity of 780 MWe. There are also 21 other projects in various states of development from drawings to partial construction. International tenders have been issued for the completion and subsequent privatization of these units. In a bid to add new generation capacity the first nuclear unit at Cernavoda was commissioned in 1996 with a capacity of 750 MWe. An additional 4 units are planned at this site with the second nearing completion with financing from Credit Suisse First Boston (CSFB). The other three are not currently under construction as financing for these units has not yet been arranged.

The shutdown of many of these thermal units has been possible because of the declining demand over the course of the 1990's, see Figure 20-1. However, demand has

begun to increase and is expected to continue this trend as the economy expands, thus many projects are underway to increase the generating capacity in Romania.



Privatization has proceeded slowly in Romania with many of the large industries still owned by the government. However, significant progress has been made with nearly 55% of GDP now coming from the private sector. Plans have been made to privatize the electric sector, however, the actual progress towards privatization has been slow to proceed. CONEL, the state owned electric utility, was responsible for 98% of the total electric generation in Romania, as well as the transmission and distribution system. In 2000 CONEL was split up into separate companies encompassing thermal power generation, hydro power generation, transmission, and distribution respectively. The distribution system was planned to have been split up in 8 separate regional networks with the first of these to be privatized in 2001. However, this process has been met with delays and the process is still underway to divide the distribution company into separate networks. The generation sector, however, is in active pursuit of foreign investors to participate in refurbishment and modernization of the existing thermal plants, thereby, partially privatizing these resources.

1.1.1 Wind Resources

Current Status of Wind Energy^{i,ii}

As of today there are only two wind/solar demonstration projects in Romania, consisting of 4 kW of wind and 0.85 kW of solar. Both are autonomous projects supplying needs of a household each. There were also two demonstration projects, at the Semenic Mountains and in Agigea (at Black Sea offshore, with units over 100 kW. Due to the lack of funds, lack of subsidies and a electricity production inferior to the estimations, these two projects are not in operation any longer. No other wind turbines operate in Romania.

Next to the grid connected, large scale wind parks Romania has another large opportunity; autonomous smaller wind and wind solar systems for providing the rural population, which makes up 45% of the population, with electricity.

A country wide wind-atlas, prepared by the Energy Research and Modernizing Institute (ICEMENERG SA) in 1993, is based on WA^SP software and meteorological data deservd during the period 1980-1990. Romanian wind atlas indicates wind speeds of 4.5 to 11.5 m/s at 50 m height in various areas of the country, notably off-shore.

No industry association was identified. However, ICEMENERG is the leading wind energy institute of the country, with state of the art capabilities. Following industry manufacturers were identified :

CMBosca-Towers (will reduce component and transportation costs considerably)

RESITA-RENK- Gearboxes

HIDROTIM- Controllers

With this manufacturing base Romania seems to be ready for technology transfer and subsequent local manufacturing.

One current project of 24.5 MW, consisting of 22 each 750 kW and 4 each 2 MW turbines, was identified. The project at Constanta at the Black Sea coast is being developed by ABB on an IPP (Independent Power Producer) basis and is in the stage of "investment approval". The average wind speed at hub-height is 6.2 m/s.

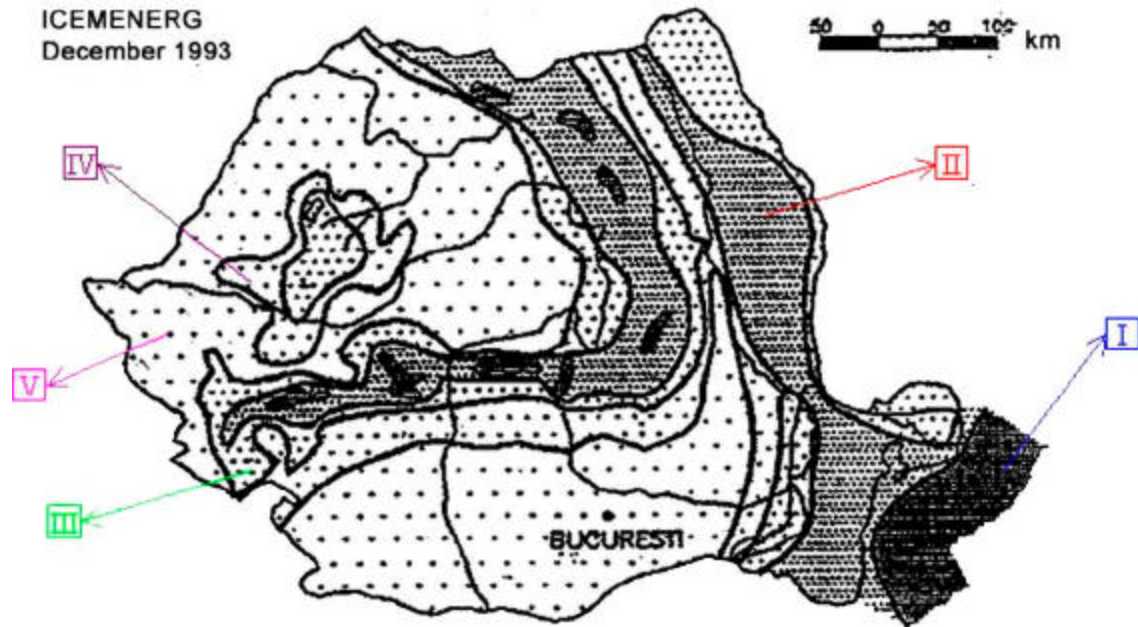
Based on the available wind atlas Romania has a very good technical potential for wind energy development.

Wind Energy Resource Potentialⁱⁱⁱ

The wind atlas developed by ICEMENERG identifies huge areas with wind speeds over 11 m/s depending on topography. Highest measured wind speed is at Calimani at an altitude of 2022 m, with annual average of 10.3 m/s at 10 m above ground.

Identification of Areas/Projects with High Potential for Wind Energy

The most promising areas



Wind Potential	A high mountains	B open sea	C sea coast	D open plain	E hills
I	>11.5	>9	>8.5	>7.5	>5
II	10-11.5	8-9	7-8.5	6.5-7.5	5-6
III	8.5-10	7-8	6-7	5.5-6.5	4.5-5
IV	7-8.5	5.5-7	5-6	4.5-5.5	3.5-4.5
V	<7	<5.5	<5	<4.5	<3.5

Wind atlas of Romania

Table 1-2 Romania Areas/Projects with High Potential for Wind Energy..

Project Name and Location	Size (MW)	Description, wind speeds at 10 m
Calimani		Average wind speed is 10.3 m/s, altitude 2022 m
Suceava		Average wind speed is 4.9 m/s, altitude 352 m
Radauti		Average wind speed is 5.2 m/s, altitude 389 m
Sulina, South-East part of Romania (Black Sea coast area)		Average wind speed is 7.1 m/s, sea level
Mangalia, South-East part of Romania (Black Sea coast area)		Average wind speed is 4.5 m/s, sea level
Constanta, South-East part of Romania (Black Sea coast area)		Average wind speed is 5.1 m/s, sea level
OFF-SHORE		Average wind speeds above 9 m/s
Alpine areas		Wind speed measured at 10 m is 5.5 – 9.5 m/s
Dobrogea & Moldova plateau		Wind speed measured at 10 m is 2.8 – 4.4 m/s
Carpath Mountains		

Barriers/Incentives for Wind Energy

Specific incentives for the implementation of wind projects in Romania include:

- Romania is closely observing the energy policy of the European Union, aiming to develop a competitive national energy market, integrated into European internal market. In this context, the Romanian Government approved the “National Strategy for Energy Development on Medium Term” (2001-2004), taking into consideration the energy developments in the European Union as well as the recent developments in the National Energy System (NES).
- Romania will also have to promote less polluting electricity sources, as a country who ratified the Kyoto Protocol.
- At Government level, there is a project law proposed by the Romanian Agency for Energy Conservation (ARCE) and the National Authority for Energy Regulation (ANRE), named Directive no.77, based on EU legislation, which is intended to be approved this year, and which will promote the incentive means for renewable promotion, in general.
- Restructuring and privatization of the energy sector aiming involvement of private investors has started
- Network access is regulated (Regulated Third Party Access-RTPA) according to the provisions of the Government Emergency Ordinance No 63/1998 and the Technical Codes of the Transport and Distribution Networks
- Availability of highly skilled man-power and manufacturing base.
- For autonomous small systems feed-in tariffs up to 11 - 13 €Cents possible

Specific barriers to the implementation of wind projects in Romania include:

- Lack of financing
- Low energy prices

Table 1-3. Romania Wind Energy Profile.

Current status of wind energy	
Installed capacity	None
Projects under construction	None
Supporting regulations?	None
Industry association?	Wind Energy Research Center of Politehnica University of Timisoara, Romania
Wind energy resource potential	
Level of information available	Very Good
Highest wind class	Class 6 (600 W/m ²)
Country-level wind atlas available?	Yes.
Estimated potential (PHARE Study)	5 X 10 ⁹ kWh/annum, economical potential
Estimated potential (PHARE Study)	3'000 MW
Target established?	Yes. 200 MW by 2010.
High wind speed locations	Various areas and off -shore
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1 : Country wide appraisal of wind resources, by state of the art wind measurements at 50 m Study 2 : an appraisal of legal and economical frame work
Identified areas/projects	24.5 MW Constanta, Black Sea coast, developed by ABB, 22 x 750 kW, 4 x 2 MW, investment approval stage
Incentives/barriers for wind energy	
Significant incentives	<ul style="list-style-type: none"> • Restructuring and privatization of the energy sector aiming involvement of private investors has started • Regulated grid access • Government commitment to EU regulations • Directive 77 which will regulate incentives for renewables on the way • Availability of skilled man-power and local manufacturing
Significant barriers	<ul style="list-style-type: none"> • High feed-in tariff for small systems • Lack of Financing • Low Energy Prices
Overall Prospects	<p>Very Good</p> <p>Except for the low energy prices, Romania can be ranked as the top candidate for wind energy development in this study. Well documented resources, broad range of applications from small autonomous units for rural areas to large off-shore potential, the government's will to comply with EU regulations all indicate a fertile ground worth tilling.</p>

ⁱ Final Report, Strategy on Renewable Energy Sources in Romania, EC - DG I PHARE Program, 1995

ⁱⁱ Interwind, Wind Energy Resource Questionnaire completed by ISPE, Bucharest, 2002

ⁱⁱⁱ Wind Atlas of Romania, ICEMENERG, 1993

1.1 Romania Renewable Energy Profile

1.1.1 Solar Resources

Current Status of Solar Energy

In Romania, starting from 1979, a large scale programme for various solar applications has been implemented (solar domestic hot water systems for hotels at the Black Sea and for apartment blocks, solar house near Bucharest, solar drying for agricultural products in the South Plain, solar cooling for fish preservation in Dobrogea region, industrial applications). A lot of efforts have been made in R+D activities and an important human potential and infrastructure were available. The peak of installations occurred in 1984-85.

The poor quality of the equipment and installation made in Romania and the lack of maintenance in many of the early installations resulted in a deep dissatisfaction, creating an additional barrier to further solar energy utilization. The manufacture, installation and R+D activities have practically stopped since 1990 because of the market reforming and the resulting difficult economic situation.

A small part (about 10%) of the installed 1.000.000 m² of collector area, is still in operation.

Recent demonstrative capacities, under 1 kW, have been installed at individual level (Energetica no 6, June 1999):

- combined solar/wind project located at Plesi locality, Alba county, consisting in 8 photo-voltaic modules of 53 W each and a wind turbine of 1000 W, for householder utilities supply
- combined solar/wind project located at Surducel locality, Bihor county, consisting in 8 photo-voltaic modules of 53 W each and a wind turbine of 3000 W, for householder utilities supply
- solar project located at Cermei locality, Arad county, consisting in 4 photo-voltaic modules of 53 W each

Also, two solar thermal systems with solar collectors Vitosol 300 have been installed in 2001 year at the mini-hotels Beta and Gamma in Costinesti locality - Constanta County, for domestic hot water preparation during the summer period. (Balkan OPET)

Specific legislation provisions for renewable energy sources development are very few and vague. There are several laws and regulations in force regarding investment in general, that may concern renewable energy sources development by private producers.

Solar Energy Resource Potential

The average solar radiation in Romania ranges from 1.100 to 1.300 kWh/m² per year for more than half of the country surface. (Energetica no 6, June 1999)

The solar radiation map for Romania, relayed on average multi-years data from the National Institute of Meteorology and Hydrology, is presented below.

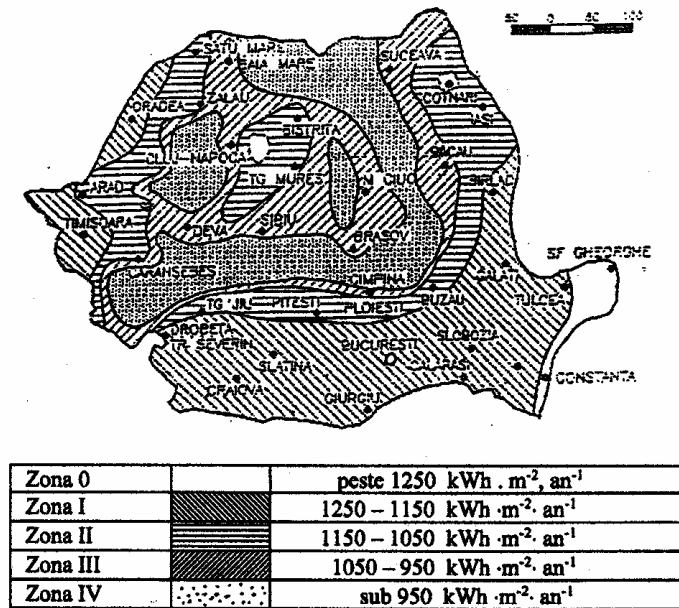


Figure 3 -1. The Romanian Solar Radiation Map (Energetica no 6, June 1999)

There is a detailed research regarding the potential areas for solar energy utilization. In 1996 year, it was established the Strategy on Renewable Energy Sources in Romania, under a project financed by European Commission – Directorate-General External Economic Relations (DG I/L3 PHARE). The project was carried out by the consortium LDK-COWI-AGIPLAN-CRES and NARE (local partner), under the leadership of LDK Greece. The project analyzed the current status of all RES in Romania (solar, wind, geothermal, biomass, hydro), the estimated potential and set out the general outline of the RES development till 2010 year.

Identification of Areas/Projects with High Potential for Solar Energy

There are good opportunities for solar development in Romania. Past experience could be utilised as a valuable lesson.

Table 3-2 lists areas in Romania with high potential for solar energy development, but all the country could be considered for solar thermal applications.

Table 3-2. Romanian Areas/Projects with High Potential for Solar Energy. (1996 RES Strategy)

Area	Size [MJ/m ² /year]
Black Sea coast	5.384
South plain	5.147
Danube Delta	5.046

The most promising applications are of the following types:

- domestic solar water heating for public buildings and hotels
- passive solar systems for existing buildings in order to increase energy performance, having in view that Romania presents a considerable passive solar technical potential, estimated at up to 1.202 ktoe for the buildings heating and 0.7 TWh for day lighting. (1996 RES Strategy)
- stand-alone plants for sites far from the grid (in the Danube Delta, Carpathian mountains area and the Romanian plain)

Barriers/Incentives for Solar Energy

At present there are no specific incentives for the implementation of solar projects in Romania. There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed to be implemented by the NAER, is estimated to be promoted.

The RES development would be encouraged by the entering into force of the Law no 73/2000 of Funds for Environment (modified and completed by Law no 293/2002) in June 2002, which stipulates the penalties for polluters.

At present, ISPE, as part of Balkan OPET, has finalized a brochure regarding the solar energy utilization advantages, which comprises punctual examples and it has been spreaded to the interested factors in Romania (mayoralities, non-governmental organizations, etc).

Specific barriers to the implementation of solar projects in Romania include:

- lack of incentive policy (subsidies, taxes exemption)
- lack of specific legislation
- lack of funds

Table 3-3. Romania Solar Energy Profile.

Current status of solar energy	
Installed capacity	Under 1 kW
Projects under construction	0 MW Total
Supporting regulations?	No at present. There will be some incentives beginning with the end of 2002 year when the Directive 77, proposed to be implemented, is estimated to be promoted.
Industry association?	No. There are some companies which trades solar installations
Solar energy resource potential	
Level of information available	Good
High range of solar insolation	1100 - 1300 kWh/m ² /year
Country-level solar atlas available?	Yes (Figure 3-1)
Target established?	No specific target, only general provisions
High solar insolation locations	Black Sea coast South plain Danube Delta Western plain
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Data measurements for certain choused locations
Identified areas/projects	Areas with high potential: - Black Sea coast

	<ul style="list-style-type: none"> - South plain - Danube Delta - Western plain Promising applications: <ul style="list-style-type: none"> - domestic water heating for houses, hotels, public buildings - space heating - passive heating systems for existing buildings in order to increase energy performance - stand-alone plants for sites far from the grid
Incentives/barriers for solar energy	
Significant incentives	There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed by the NAER, is estimated to be promoted
Significant barriers	Lack of incentive policy (subsidies, taxes exemption) Lack of specific legislation Lack of funds.
Overall Prospects	Good. The potential market for solar applications is very large in Romania

1.1.2 Geothermal Resources

Current Status of Geothermal Energy

The exploration and research for geothermal resources began in Romania in 1962-65. Till now, over 200 wells have been drilled, proving the existence of low enthalpy geothermal resources with temperature of 40-120⁰C. As a consequence, they can provide only thermal energy.

At present about 137 MWt are used from about 61 active wells producing hot water in the temperature range of 55-115 ⁰C. (Blue Book)

The main energetic uses of geothermal energy are (Geothermal Resources in Eastern Europe):

- space heating and hot water preparation for domestic use 38%
- balneological and recreation al purposes 30%
- greenhouse heating 34%
- industrial process heat - wood drying, milk pasteurization 11%
- fish farming 2%

Specific legislation provisions for geothermal energy sources development are very few and vague. There are several laws and regulations in force at present regarding investment in general, that may concern geothermal energy sources development by private producers.

According to the Romanian Constitution, geothermal water is “exclusively the object of public property”, as well as resources of any nature occurring in the underground.

Romanian industry is able to manufacture components for geothermal applications. Most of the existing equipment is manufactured in Romania as a concrete result of R+D activities (pre-insulated transmission pipes, stainless steel plate heat exchangers, scaling

inhibitors and associated injection pumps, circulation pumps, wellheads). Therefore, there is a qualified technical basis for further development.

Geothermal Energy Resource Potential

The Romanian hydrogeothermal systems, are located in the Western part of the country where most of the proven resources and operating schemes exist, and in the Southern part of the country where proven potential is identified.

Regarding the theoretical potential, the main locations are the West Plain, where most of the proven resources and operating schemes exist, and the South Plains where proven potential is identified in the region of Bucharest, as well as in the Carpathian Regions. From the theoretical perspective, Romania is endowed with the 3rd (after Italy and Greece) highest geothermal potential of all European countries. (1996 RES Strategy)

Romania's highest enthalpy geothermal resource of 3000C was identified at Tusnad-Bai. Five sites have a temperature over 100⁰C. (Geothermal Resources in Eastern Europe)

The technical potential in the most important areas is presented in the table 4-1.

Table 4-1. Main Technical Potential Areas (1996 RES Strategy)

Region	Potential energy production of the field (TJ/year)
Western Plain	4.300
Southern Carpathians (at the contact with the Getical Subcarpathians)	270
South Plains	720
Total	5.290

Economics of geothermal energy are conditioned by the capital cost resulting from the drilling of the well and the equipment of the well-head.

The total installed capacity of the Romania is 320 MW_t (for a reference temperature of 300C). At present only about 137 MW_t are used from about 60 wells, producing hot water in the range 55-115 °C. (Blue Book). High enthalpy prospects are identified in Sanandrei in the Western Plain (130 °C) and in Tusnad in the Eastern Carpathians (200 °C).

The proven reserves (with already drilled wells) are about 200000 TJ for 20 years (Blue Book).

The geothermal resources areas map :

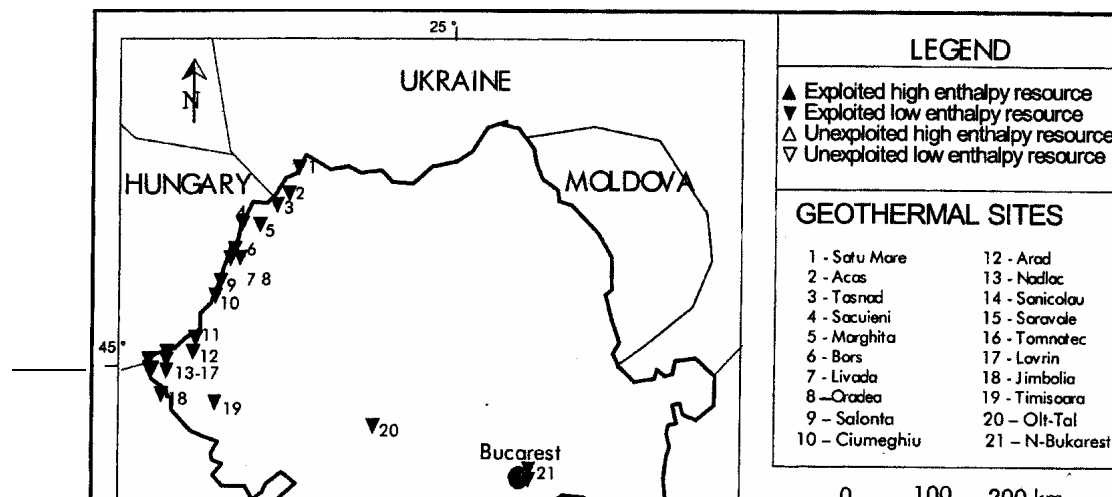


Figure 4 -1. The Romanian Geothermal Resources Map (Blue Book)

Identification of Areas/Projects with High Potential for Geothermal Energy

There are good opportunities for geothermal development in Romania, but only for the use of geothermal sources for thermal applications:

- mainly in existing DH supply system in the cities nearby the geothermal fields and in new DH schemes for smaller towns and large villages
- for industrial or agricultural uses

Possible projects could be in Calimanesti, Sannicolau Mare localities.

New, low temperature geothermal localities considered for development might be situated in localities from the Western Plain (Timisoara, Gataia) and the South Plain (Rosiorii de Vede, Draganesti Olt, Caracal, Corabia, Turnu Magurele).

Barriers/Incentives for Geothermal Energy

At present there are no specific incentives for the implementation of geothermal projects in Romania. There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed by the NAER, is estimated to be promoted.

The RES development could be encouraged by the new Law of funds for environment which entered into force in June 2002 and which stipulates penalties for polluters.

Specific barriers to the implementation of geothermal projects in Romania include:

- lack of incentive policy (subsidies, taxes exemption)
- lack of specific legislation
- lack of funds

Table 4-2. Romania Geothermal Energy Profile.

Current status of geothermal energy

Installed capacity (electric)	0 MWe Total
Installed capacity (thermal)	320 MW _{th} Total, from which about 137 MW _{th} are used from 60 wells
Projects under construction (electric)	0 MWe Total
Supporting regulations?	No at present. There will be some incentives beginning with the end of 2002 year when the Directive 77, proposed to be

Industry association?	implemented, is estimated to be promoted. No. But Romanian companies are able to manufacture components for geothermal applications.(most important located in Cluj Napoca and Bucharest cities)
Geothermal energy resource potential	
Level of information available	Good
Country geothermal atlas available?	Yes, at specialized company FORADEX
Estimated potential (electric)	0 kWh/yr or MW, gross (theoretical) potential 0 kWh/yr or MW, technical potential 0 kWh/yr or MW, economic potential
Target established?	No. Only generally.
High enthalpy geothermal locations	-
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	-
Identified areas/projects (electric)-(thermic)	6.9 MW _{th} at Caciulata locality 6.9 MW _{th} at Calimanesti locality 6.3 MW _{th} at Tomnatec locality 4.9 MW _{th} at Sannicolau Mare 24.7 MW _{th} at Santandrei locality
Incentives/barriers for geothermal	
Significant incentives	There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed by the NAER, is estimated to be promoted
Significant barriers	Lack of incentive policy (subsidies, taxes exemption) Lack of specific legislation Lack of funds.
Overall Prospects	Good. The geothermal energy presents some favorable opportunities, but only for thermal applications.

1.1.3 Biomass Resources

Current Status of Biomass Energy

In year 1998, the production of biomass reached 126.3 PJ and participated with 10.94% in the total energy of the country. In year 1999, the biomass production was of 118 PJ. About 70 % of the remarkable firewood resources are currently utilized. Also the utilization rates of industrial by-products are quite good: almost 40 % for solid by-products and over 80 % for black liquors. The great amount of other biomass usage consists solely of straw.

Biomass is currently used only for heating purposes.

Direct burning in the kilns, stoves for space heating, cooking and hot water preparation consumes about 95% and the main user is population. These furnaces have a nominal capacity between 0.8 kW to 4 kW, are hand stocked and with an average efficiency between 15% up to 50%.

For burning in thermal plant boilers to generate industrial steam and hot water in sawmills and in other industries, about 5% of biomass is used. In sawmills, the average installed capacity is 3,3 MW_{th}, in other industries 4,7 MW_{th}.

Table below presents the biomass gross consumption by main consumer types and heating systems for year 1999.

Table 5-1. Biomass Gross Consumption (PJ) for 1999 year (Balkan OPET)

Consumer types	Total biomass	out of which:	
		Firewood & agriculture waste, etc.	Wood waste from industrial processes
Total consumption	118.0	112.7	5.3
out of which:			
Direct use	109.6		
- agriculture & forestry	0.6	0.6	-
- paper & pulp industry & wood products	6.1	3.8	2.3
- construction	-	-	-
- population	105.1	105.1	-
- others	2.3	2.3	-
Heat generation in thermal plants	8.3	3.7	4.7
- district heating	0.02	-	0.02
- autoproducers	8.3	3.7	4.7

The existing autoproducers thermal plants account about 550 steam boilers. The biggest part of these boilers are indigenous manufactured and the capacities range from 0.3 MW to 5 MW and generate steam in range of 0.7 to 16 bar within a temperature of 114°C to 350°C. Most of the applications were built in the 1960's and 1970's and only a few of them were modernized and equipped with modern technology.

Biogas has been used in the past to a larger amount. Currently the number of big cattle and pig farms has decreased steadily.

At the end of 1999, two demonstrative projects were realized, as follows:

- two boilers running on liquid light fuel were replaced by two new boilers on sawdust with low calorific value of 8790 kJ/kg, at Thermal Plant Campeni, located in Campeni town, Alba county, under a PHARE project. The new boilers, type TERMADL 0.6, were manufactured by SC Terma Prod SRL Sibiu.
- new Thermal Plant with one boiler of 2.5 MW_{th} on sawdust and wood waste at Tasca village, Neamt county. with funds from Danish Agency for Environment Protection

The main Romanian legislation concerning environmental aspects and biomass utilization: Law no. 137/1995 on environment protection, Law no. 107/1996 on water protection, Forestry Code approved by Law no. 26/1996 Ordinance Ministry of Waters, Forests and Environment Protection. no. 462/1993 on evaluation of pollutant emission, Ordinance Ministry of Waters, Forests and Environment Protection. no. 125/1996 on regulation procedure for economical and social activities having environmental impact (Balkan OPET)

Biomass Energy Resource Potential

The biomass sector in Romania is characterized by a twofold regional distribution. About 90% of fuelwood and 55% of wood waste, are found in the Carpathians and Subcarpathians. About 54% of agricultural wastes are found in the South Plain and Moldavia. About 52% of biogas are found in the South Plain and the Western Plains.

From the total surface of Romania, the agricultural area represents about 40% and the forest areas represents about 27%.

In Romanian statistical records, all biomass is grouped in two categories:

- firewood & agriculture waste, etc., which accounts about 95% of the total
- wood waste from industrial processes with about 5%.

From the total “firewood & agriculture waste, etc.” it is estimated that only a share of 30% is commercial biomass and the share of 70% represents the contribution of the biomass harvested by the owners from the private forests and gardens and of the agriculture waste resulted in the rural households.

Great amounts of wastes are obtained at the cutting areas. According to the thickness of the wastes, wood materials are used for firewood, for production of plates from wood fibers, for production of plates from wood particles and for production of cellulose pulp and paper. Up to now there is not a real production of pellets and briquettes.

According to the strategy of the Autonomous Forest Company “Romsilva” the annual harvest of standing timber may reach 18 million m³ by the year 2020; the largest part is allocated for the domestic wood and paper industry. The quantities of wood and wood wastes used as fuel are expected to remain approximately constant until the 2020.

Humidity of wood varies in large range, related to the moment of cutting, the sort of wood, to the climate change, to the regions etc. So the humidity of branches having diameters of 10-40 mm varies between 73-86% for beech and 70 – 96% for fir-tree.

The calorific value of different sorts of wood wastes biomass varies in the limits of 4-7 MJ/kg.

Regarding the crop production structure, area under grain cereals has the highest share (66%). The rest of surfaces are under fodder crops (14%) and technical (industrial) crops (13%). Taken together, these groups account for 93% of the entire cultivated area. This reflects the poor diversification of agricultural crops, requiring measures for the enlargement of agricultural crops, especially of those incorporating a high rate of technicality.

The productions and the energy potential of some main agriculture products in 1999 year and the average calorific value of some vegetal agriculture wastes are presented in the tables 5-2 and 5-3.

Table 5-2. Productions and the energy potential of some main agriculture products in 1999 (Balkan OPET)

Agriculture Product	Areas under crops (10³ ha)	Average Grain Yield (kg/ha)	Energy Potential (GJ)
Wheat and rye	415.5	2776	3 010 447

Maize	3013.4	3627	87 436 800
Sunflower	1043	1243	8 815 855
Tobacco	10.9	1349	105 870
Fruit trees			805 900
Wine twigs			3 768 240

Table 5-3. Average calorific value of some vegetal agriculture wastes (Balkan OPET)

Indicator	Type of vegetal agricultural wastes				
	Corn stalks	Sunflower stalks	Vine-twigs	Apple branches	Tobacco stalks
Calorific value, MJ/kg	16.5 at 9% humidity	15.7 at 9% humidity	16.5 at 7% humidity	15.2 at 7% humidity	16.4 at 7% humidity

Taking into consideration all vegetal agricultural wastes in Romania, the estimated overall energy potential of these wastes was 100 210 752 GJ in 1999.

Great amounts of small-sized wood are obtained in wood industry. But utilization of this wood for energy purposes is insufficient due to difficulties related to gathering, processing and transportation. Actual studies show that these wood wastes are economically viable resources and must to encourage the activities, which assure production of pellets and briquettes taking into consideration an environmental benefit.

In the table 5-4 there are presented the most important biomass resource types in Romania.

Table 5-4. Romania Biomass Resource Data (FAO 2002a, FAO 2002b).

Biomass resource type	Total production	Production density
Primary crop production, tonne	(avg. 1999-2001, tonne)	(tonne /1000 Ha)
Total primary crops (rank among COO)	53,291,420 (6)	2,314 (10)
Top 10 primary crops		
Alfalfa for Forage & Silage	7,846,000	341
Maize	7,777,600	338
Leguminous (misc), Forage & Silage	6,316,667	274
Wheat	5,364,014	233
Grasses (misc), Forage & Silage	4,678,167	203
Potatoes	3,742,300	162
Mixed Grasses, Legumes	2,949,367	128
Clover for Forage & Silage	2,704,367	117
Vegetables and Roots, Fodder	1,244,867	54
Grapes	1,170,786	51
Animal units, number	(number)	(number / 1000 Ha)
Cattle	3,097,000	134
Poultry	69,312,000	3,009
Pigs	6,521,000	283
Equivalent animal units	6,398,520	278
Forest products, cubic meters	(avg 1999-2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	3,152,600	137
Wood residues	343,500	15

Identification of Areas/Projects with High Potential for Biomass Energy

There are good opportunities for biomass development in Romania.

Biomass applications for biomass can be grouped into the following main market segments:

- substitution of part of the fossil fuels in existing district heating schemes (wood chips)
- enhanced uses of biomass as industrial fuels (wood chips and logs as industrial fuel for steam or hot water boilers) instead of oil
- improved uses of biomass for new district heating schemes for small towns and villages near the resources, in the countryside, where the population has no access to central co-generation or gas supply
- uses of straw and other agricultural by-products in appropriate biomass boilers for heat supply of farms and small villages (in the medium term)

The top priority is the use of biomass for thermal applications, substituting oil. Assuming an available biomass energy supply, district heating systems represent the most immediate and low-cost biomass application in Romania especially CHP plants, industrial co-generation and co-firing.

The most promising regions for the agricultural waste utilization could be the South Plain, especially the counties Braila, Ialomita, Calarasi, Giurgiu, Teleorman and the West Plain, especially the counties of Arad and Timisoara. In these counties the agricultural production is high, there are no own sources of fuel for heating and cooking.

In the Carpathians Mountains and Subcarpathians area where firewood and wood waste are available, there are opportunities to develop district-heating plants. The size of boilers for the district heating in the identified projects range from about 1 MW_{th} to 6 MW_{th}.(1996 RES Strategy)

The expected development of the wood industries will encourage the rehabilitation of the existing boilers from the existing autoproducers thermal plants which account about 550 steam boilers, or the construction of the new ones. The existing autoproducers thermal plants account about 550 steam boilers. (Balkan OPET)

Barriers/Incentives for Biomass Energy

At present there are no specific incentives for the implementation of biomass projects in Romania. There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed to be implemented by the NAER, is estimated to be promoted.

The RES development would be encouraged by the entering into force of the Law no 73/2000 of Funds for Environment (modified and completed by Law no 293/2002) in June 2002, which stipulates the penalties for polluters.

Among the policy for biomass utilisation should be support of agricultural incomes

Specific barriers to the implementation of biomass projects in Romania include:

- lack of incentive policy (subsidies, taxes exemption)
-

- lack of specific legislation
- lack of funds

Table 5-5. Romania Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	1.4 MW _{th} in DH plant 5 MW _{th} and 0.2 MW _e in CHP plant 578 MW _{th} in 176 sawmills fuelled plants 658 MW _{th} in 140 biomass fuelled plants in other industries 1242.4 MW _{th} and 0.2 MW _e Total
Projects under construction	0 MW Total
Supporting regulations?	No at present. There will be some incentives beginning with the end of 2002 year when the Directive 77, proposed to be implemented, is estimated to be promoted.
Industry association?	No. Big producers with various activities in wood field are Cozia Forest SA (Valcea county), Diana Forest SA (Bacau county), Dormafor SA (Suceava county), Elar SA (Arges county), Sargetia Forest SA (Hunedoara county). For biofuels transport – Euro Forest SA (Vrancea county). Small enterprises which produce seasonally and exports briquettes are located at Baia Mare and Brasov cities.
Biomass energy resource potential	
Level of information available	Good
Relative biomass potential (total / density)	
Country-level biomass investigations available?	Yes. The most important is the Strategy on Renewable Energy Sources in Romania, established in 1996 year under a project financed by European Commission – Directorate-General External Economic Relations (DG I/L3 PHARE) which analyzed the current status of all RES in Romania (solar, wind, geothermal, biomass, hydro), the estimated potential and set out the general outline of the RES development till 2010 year.
Estimated potential	168 TJ/y, gross (theoretical) potential 118 TJ/y, technical potential The evolution of the economic potential must be correlated with the fossil fuels prices
Target established?	Only general target
High density biomass areas	Carpathians Subcarpathians South Plain
Identification of areas/projects with high potential for biomass energy	
Recommended strategic assessments	-
Identified areas/projects	Replacement of about 550 steam boilers in range 1-5 MW _{th} in industrial sector District Heating plants in range 1 -6 MW _{th} in Carpathians and Subcarpathians area, from which: <ul style="list-style-type: none"> - 7.2 MW_{th} in Thermal Plants wood wastes, supplying 18 localities in Suceava county, as part of a greater project named “Suceava-Utilities and Environment at European Standards” - 5 MW_{th} in 3 Thermal Plants on wood wastes in Covasna town, Covasna county - 5 MW_{th} in Thermal Plants on wood wastes in Odorheiu Secuiesc town, Harghita county
Incentives/barriers for biomass energy	
Significant incentives	The new Law of funds for environment which entered into force in June 2002, which stipulates penalties for polluters would

Significant barriers	encourage biomass utilization Lack of incentive policy (subsidies, taxes exemption) Lack of specific legislation Lack of funds
Overall Prospects	Good. There are good opportunities for biomass development in Romania. The top priority is the use of biomass for thermal applications, substituting oil. Assuming an available biomass energy supply, district heating systems represent the most immediate and low-cost biomass application in Romania especially CHP plants, industrial co-generation and co-firing.

1.1.4 Hydroelectric Resources

Current Status of Hydroelectric Energy

In Romania there are 362 Hydroelectric Power Plants (HPP) with an overall installed capacity of 6120 MW, which means 27.9% of the overall installed capacity of the Romanian power system (21905 MW).

The structure of these HPPs are the following:

- 95% of them are owned by SC HIDROELECTRICA SA and have an installed capacity of 5899.3 MW
- 2.5% are owned by SC ELECTRICA SA and have an installed capacity of 156 MW
- 1.9% are owned by SC TERMOELCTRICA SA and have installed capacity of 117.6 MW
- 0.6% other producers

Out of these 362 hydroelectric power plants there are:

- 317 HPPs with capacities between 0 and 30 MW, totalizing 1069 MW installed
- 32 HPPs with capacities between 30 and 100 MW, totalizing 1529 MW installed
- 13 HPPs with capacities over 100MW, totalizing 3552 MW installed (The Annual Statistic Book of Romania for 2001)

In 2000, the total energy produced by the hydro sector was 14778 GWh, representing 28.5% of the total energy produced in Romania.

In 1998 and 1999, due to the good hydraulicity (rainy years) the hydro sector produced 35.3% and 36.1% from the overall energy production of the country.

The most important Hydroelectric Power Plant of Romania is Portile de Fier 1, on Danube river, and it is also the biggest hydroelectric power plant in Europe. It has an installed capacity of 1050 MW (the Romanian part, only) and it is planed to reach 1167 MW at the end of 2005.

The other Hydroelectric Power Plants of the country are located on the following rivers: Olt, Lotru, Bistrita, Someș, Dragan, Argeș, Dambovită, Raul Targului, Sebeș, Raul Mare, Cerna, Bistra, Buzău, Motru, Danube.

The most important local manufacturer which has the capability to build any kind of hydroelectric equipment, is the Metalurgical Factory from Resita.

Hydro Energy Resource Potential

In Romania, the most important water basins are: Olt, Lotru, Bistrita, Somes, Dragan, Arges, Dambovita, Raul Targului, Sebes, Raul Mare, Cerna, Bistra, Buzau, Motru, Danube.

The hydroelectric potential of Romania, according to the latest reevaluations is (Energetica Reviews 1995-2001, Electricity Supply in Romania 1996):

- theoretical potential = 70000 GWh/year, out of which:
 - the potential of the rivers inside the country, 51600 GWh/year
 - the potential of the Romanian part of the Danube, 18400 GWh/year
- technical potential: 34500 GWh/year and an installed capacity of 11370 MW, out of which:
 - the Romanian part of the Danube: 11560 GWh/year and 2620 MW installed
 - the micro-potential (HPP with capacities under 0.63 MW/plant): 2940 GWh/year and 757 MW installed
- economic potential: 27000 GWh/year and 9120 MW installed.
- exploitable potential (which is in accordance with the requirements of UCTE and takes into consideration legal and environment restrictions): from 24000 to 26000 GWh/year and from 7000 to 8200 MW installed.

At the end of 2000, 67.1% of the economic potential for energy and 54.7% of economic potential for power was exploited.

Identification of Areas/Projects with High Potential for Hydro Energy

There are very good opportunities for hydro development in Romania.

At the end of 1989, there were several Hydroelectric Power Plants under construction with a total capacity of 1300 MW.

After 1990, due to the lack of funds, the projects were reevaluated and 47 of them, which proved to be the most efficient, were approved to be achieved. All of them were started and 24 of them are in execution stages below 50%. The most of them are located in the western part of Romania. They are (Strategy of Ministry of Industry and Resources for SC HIDROELECTRICA SA, 2001):

- 36 Hydroelectric Power Plants with installed capacities bellow 30 MW, totalizing 296.4 MW, for example: HPP Beretea (16.2 MW), HPP Strei (16.8 MW), HPP Calan (7.8 MW), HPP Bacia (11.7 MW), HPP Simeria (11.5 MW) – all of them in Hunedoara county
- 10 Hydroelectric Power Plants with installed capacities under 30 MW and a totalizing 296.4 MW, for example: HPP Surduc (31.2 MW), HPP Raul Alb (36 MW), HPP Movileni (37 MW), HPP Valea Zadului (35 MW)
- 1 Hydroelectric Power Plant with an installed capacity over 100 MW, HPP Nehoiasu 2 (155 MW).

The projects implementation depends on the funds attracted.

Out of the other projects, that weren't selected for investments in the near future and which summing 400 MW installed, some were closed but some got in mothballing, waiting for funds.

Barriers/Incentives for Hydro Energy

At present there are no specific incentives for the implementation of hydro projects in Romania. There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed to be implemented by the NAER, is estimated to be promoted.

The RES development would be encouraged by the entering into force of the Law no 73/2000 of Funds for Environment (modified and completed by Law no 293/2002) in June 2002, which stipulates the penalties for polluters.

The most important specific barrier to the development of hydro projects in Romania is the lack of funds.

Table 5-1. Romania Hydro Energy Profile.

Current status of small to medium hydro	
Installed capacity (small<30 MW)	317 HPP, 1069 MW installed
Installed capacity (medium 30-100 MW)	32 HPP, 1529 MW installed
Projects under construction (small<30 MW)	296.4 MW in 36 HPPs (the same identified as projects with high potential)
Projects under construction (medium 30-100 MW)	448.6 MW in 10 HPPs (the same identified as projects with high potential)
Supporting regulations?	No at present. There will be some incentives beginning with the end of 2002 year when the Directive 77, proposed to be implemented, is estimated to be promoted.
Industry association?	No. The Metalurgical Factory from Resita can manufacture any kind of hydro equipments.
Hydro energy resource potential	
Level of information available	Very good
Country-level hydro atlas available?	Only a map, available at SC HIDROELECTRICA SA
Estimated potential	70000 GWh/year theoretical potential 34500 GWh/year, 11370 MW technical potential 27000 GWh/year, 9120 MW economic potential
Target established?	900 MW
Identification of areas/projects with high potential for hydro energy	
Recommended strategic assessments	No
Identified areas/projects	
- with capacities between 0 and 30 MW	- HPP Beretea (16.2 MW), HPP Robesti (28.5 MW), HPP Strei (16.8 MW), HPP Calan (7.8 MW), HPP Bacia (11.7 MW), HPP Simeria (11.5 MW) and other 30 hydroelectric power plants with a total capacity of 203.9 MW
- with capacities between 30 and 100 MW	- HPP Surduc (31.2 MW), HPP Raul Alb (36 MW), HPP Movileni (37 MW), HPP Valea Zadului (35 MW) and other 6 hydroelectric power plants with a total capacity of 309.4 MW
Incentives/barriers for hydro energy	
Significant incentives	Not at present. There will be some incentives beginning with the end of 2002 year when the Directive 77 , proposed by the NAER, is estimated to be promoted
Significant barriers	Lack of funds.
Overall Prospects	Very good. In Romania there are very good opportunities for

1.1.5 Other Resources

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1.1.6 Contact Information

Contacts made in the preparation of this assessment are gratefully thanked for their contribution to this report. Contacts include:

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1.1.7 References

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Geothermal Resources in Eastern Europe

