

EXPLOITATION OF RENEWABLE ENERGY SOURCES IN THE ROMANIAN ENERGY STRATEGY CONTEXT

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Abstract: *This paper conducts an analysis based on the current market situation of energy in the framework of liberalization and the need for providing energy security, in compliance with national and international standards for environmental protection. There are presented, by category, the types of renewable energy sources and their present situation in Romania. Also, are presented the particularities of renewable energy use in the low power electricity production and their integration in distribution networks.*

Keywords: *renewable energy, wind energy, solar energy*

Regardless of the period in history or geographical area the energy has been a major issue, as the primary factor in the development of human society. Both of economically and socially we can only speak about sustainable development in close correlation with the development of the energy sector. More specifically, the evolution of the economy and society is determined by how it will achieve accessibility and availability of energy. For this reason, it was looked for solutions over time to ensure energy requirements for the society needs and economic growth.

Long term assurance of energy demand, in various forms of use, at affordable prices for all consumers, is an important component of sustainable development. In addition, attention should be paid to the risks involved in the production, conversion and energy transport, especially how it is accepted by society in terms of environmental impact and resulted waste management.

Among the organizations that are working in this field, globally, stands out the World Energy Council - WEC founded in 1924, Romania being a member in the same year, and the International Energy Agency - IEA founded in 1974. They have the main goals as energy security, environmental protection and economic development. Finding the solutions for achieving these goals is a problem to be solved as soon as possible, especially in the context of developments in recent years.

When establishing solutions on energy security, should be taken into account the current trends, namely [12]:

- Displacement of energy demand curve to Africa, Asia, Middle East and Latin America;
- Urgent need to reduce greenhouse gas emissions;
- Compliance with national regulations, European (where applicable) regarding policies and global air pollution;

- Use of renewable energy with minimal or zero CO₂ emissions and the rapid development of related technologies.

Neither, the primary energy market developments, in recent years, should not be neglected. The various social and political events occurring in the main areas of energy resources have led to serious tensions and disturbances and generated great price volatility. The main problems that characterize the various primary energy markets are [5]:

- Imbalance in supply / demand worldwide which has led the price volatility;
- The price volatility is a risk factor for large energy producers in competition;
- Lack of investment in infrastructure both within the oil and gas market;
- Lack of concern in finding substitutes for fossil fuels for use in the transportation sector;
- Inadequate allocation of funds in the research and technological development for expected renewable energy sources.
- Political instability which causes uncertainties for investment in the energy sector;
- The conflicts between countries that are supplying the main primary energy source and transit countries and / or those who purchase, which causes interference or disruption of long-term energy supply;
- Lack of society confidence in nuclear power as a viable solution to reducing pollution due to installations and management security and waste storage.

Regardless of the estimates, found in studies of recent years, regarding at: fossil fuels, evolution of energy price and the future of the planet's climate, consumer expectations, regarding at the energy required, remain unchanged. Wherever they are on the globe: the price should be competitive and energy should be clean, safe and available for all.

The electricity infrastructure is a strategic component of the XXI century society, whose importance increases considerably every day. According to WEC forecasts, it is estimated that the corresponding global energy mix by 2050 will consist of at least eight energy sources (coal, oil, gas, nuclear fuel, hydro, biomass, wind and solar radiation), but none of them did not cover more 30% of the market [1]. The electricity makes this diverse portfolio to be possible, while respecting the global energy and environmental policies. The market share of electricity is growing and is

expected a 40% value in 2020 for countries in Organization for Economic Co-operation and Development - OECD, according to the IEA. All this is due to the intelligent and efficient processes and technologies that are already introduced or will be implemented in industry, domestic use and transport. By 2007-2030 period, the electricity demand is expected to increase by 76%, meaning the installation of 4,800 GW [6]. Figure 1 shows the distribution of fuel energy estimation during 2008-2030 period.

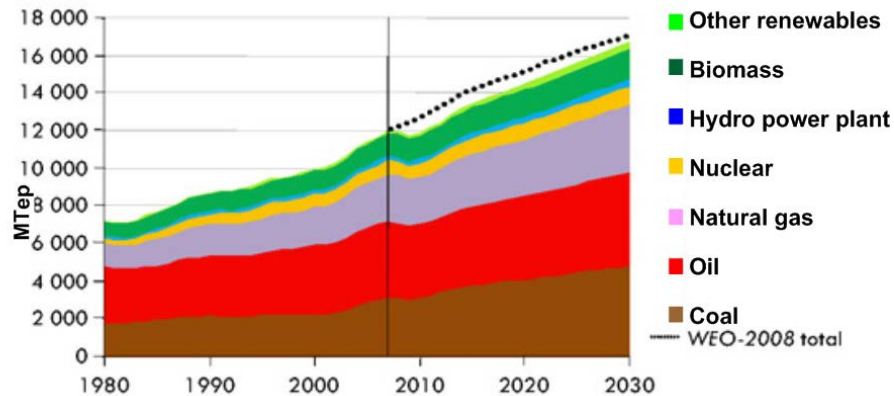


Fig. 1. Estimation of fuel energy distribution during 2008-2030

Taking into consideration all the requirements from consumers, analyzing the trends for estimated energy in the coming years (especially electricity) and aligning itself to local and global environmental policies, the energy market has entered into an extensive process reorganization by encouraging the competition, both wholesale sector and retail market. Creating a single electricity market involves the transformation of the electricity transmission and distribution networks classics in a unified network and interactive power supply – Smart Grid, having as main function the production, supply-demand brokerage and sale of electricity. All this increases the competitiveness and service quality, safety and reliability,

In this new context, energy security and further development of society, requires follow two directions:

- the increase of the efficient use of fossil fuels (coal remains under the main fuel);
- the widespread use of energy from renewable sources.

The widespread use of renewable energy sources increases the level of energy security for both, the present and especially the future. Although is not a new concept, the explosion of renewable sources integration in electricity started with ninth decade of the last century and continuing the upward trend today.

Using these sources together with energy efficiency measures and rational use of energy, it can provide to consumers the same energy

services that fossil fuels offer today's: heating and cooling (by systems using solar energy, biomass, geothermal energy), fuel (biofuel - bioethanol, biodiesel) products, chemicals (biofuels can replace a wide range of products in this field, currently obtained from petroleum or gas), electricity [2].

Providing electricity demand is the main service for using the renewables. Electricity production from renewable sources is performed both as centralized ("classic power") and by low power units (of the order of tens of MW and MW), spread on the ground. Centralized electricity production (plants with installed capacity by tens and hundreds of MW) is characteristic for hydropower plant, wind farms (both offshore and continental), geothermal power plants and power plants using biomass. The main issues to be considered are the impact of integration in transport networks.

The production of electricity by small power units, is called - Distributed Generation – DG, and has a great spread in the world. The major advantage of this concept it represented by the use of electric power generation technologies close to the place of consumption, thus reducing a significant percentage of the total cost of electricity (about 30%) by minimizing transmission and distribution losses and lowering costs on the steps [10].

Romania's energy strategy in the renewable energy sector

A classification of renewable energy sources can be made according to the type of primary energy use: solar energy; wind; hydropower; biomass

and biogas; geothermal energy; gas resulting from the fermentation of waste (landfill gas); wave energy; marine current energy; tidal energy.

Over the past years there was an explosion in the world on the use of DG and this was largely due to renewable energy sources. Globally, the largest energy use are the first four type, mentioned above, the weight of other are smaller but growing.

Geothermal energy comes from the energy stored in warehouses and underground hydro reservoirs. Worldwide, this energy is used both for electricity generation and thermal power plants of this type are present in over 20 countries. The installed capacity worldwide is 10 GW, annual output is over 60 TWh [3].

The biogas and waste fermentation gas produced from plant debris and / or animals or residue can be used to produce heat or electricity. [14]

The wave energy is closely related to wind energy potential of renewable electricity being determined by the frequency and intensity of the winds that move the water's surface layer of the World Ocean. The first farm generating electricity using wave energy was inaugurated in 2008 in Portugal, with an installed capacity of 2.25 MW [8].

Sea currents energy results from horizontal movements of large masses of water under the influence of wind, differences in density, temperature and salinity between two points. So far, technologies are developing, and all facilities are under the project. A prototype mini plant of this type is made in the UK and has an installed capacity of 330 kW [14].

Tidal energy is determined by the attraction, exercised by Sun and Moon, on the water seas and oceans. Economical tide recovery is possible only where the difference in level between ebb and flow exceeds 8 m, a phenomenon often encountered in bays and straits. Plant with the highest installed capacity is in South Korea (254 MW), followed by the first plant built using this energy in France in 1966 (240 MW) [9.14]

Analyzing particularities of each renewable energy for electric power production, new environmental policies (both global, regional and state level) and energy market developments, can easily extract both advantages and disadvantages.

A great advantage of renewable energy is the zero or almost zero contribution to the expansion of greenhouse gas emissions and environmental pollution. This is very important especially during the last few years, given that environmental policies and regulations were tightened and targets set by various international bodies are very difficult (if not impossible) to achieve without considering renewable energy sources

Another major advantage is the "insensitivity" to the price of fossil fuels. Regardless of economic

crises, political or military, the price of energy from renewable energy sources remains the same. This leads to decrease operating cost of renewable energy and reduce operating risks.

Technological progress is another big advantage. The technologies used have a greater efficiency and higher yield. Furthermore, with the evolution of technology, the price is falling, so technologies are accessible on different markets, even in developing countries.

In terms of disadvantages, the specific requirements for the location of installations depending on the technology and energy used, is one of them. Poor predictability characteristic of power generated (especially wind) and availability of renewable energy (sun, wind, water) imparts a slightly negative influence on the feasibility of renewable energy systems. The unpredictability of renewable energy involves higher costs for balancing the electricity system and maintaining reserve power source in the event of extinction (even for a short time) [4].

Costs are often the main element that can tilt the balance of advantages and disadvantages. Even though, the costs involved in implementing these technologies are higher, however, in the long term, renewable energy sources provide benefits on several levels (economic, technical, environmental protection, etc.).

The economic feasibility of distributed renewable energy depends on many things. Investments are important as well fossil fuel price and the market price for electricity. Network connection costs (for obtaining the effective connectivity) have significant importance in calculating the total cost, particularly for renewable DG [4]

The income from DG and renewable energy sources is dependent on sold electricity (and heat for cogeneration). In addition, the benefits can be the network services cost (balancing delaying investments in the network, reducing network losses) or environmental subsidies and taxes. These subsidies and taxes are generally designed to stimulate the production of clean electricity. Examples are green certificates or charges "feed-in" for electricity produced from renewable energy tax reductions for investments in CHP and renewable energy, CO₂ taxes and carbon credits [16].

According to [11] the use of renewable energy is based on three important premises (the 3 A - "accessibility, availability, acceptability"):

- Accessibility - ensuring access to affordable energy for all social categories;
- Availability - long-term continuity of supply and quality services in the short term, any interruption in supply, be it short can cause negative consequences for the activities;

• Acceptability - the integration of social and environmental protection (local pollution, regional and global).
 Romania has a wide range of primary energy sources: oil, natural gas, coal and uranium, as well as an important renewable resource potential. According to studies, the energy potential of renewable energy in Romania, is shown in Table 1.

In recent years, the imports of primary energy resources have continuously increased, representing about one third of all primary energy resources. Moreover, forecasts for the coming period are not very optimistic. It is expected that, dependence on imports of primary energy resources, by 2015, will reach about 50% of the total with an increase of 3% per year.

Table 1. National energetic potential of renewable energy sources

Renewable energy sources	The annual energy potential	Application
Biomass	318 x 10 ⁶ GJ	<i>thermal energy</i>
Wind energy	23.000 GWh	<i>thermal energy</i>
Geothermal energy	7 x 10 ⁶ GJ	<i>thermal energy</i>
Hydropower	40.000 GWh	<i>thermal energy</i>
in which: <10 MW	6.000 GWh	
Solar energy:	60 x 10 ⁶ GJ	<i>thermal energy</i>
• thermal	1.200 GWh	
• photovoltaic		

This leads to promoting the use of renewable energy sources as one of the priorities of the current energy policy, as it is shown by the *Strategy for the of renewable energy sources*, this representing a feasible and accessible solution for medium and long term.

Accelerating the exploitation of renewable energy sources in Romania, is justified by the benefits they confer:

- increasing the security of energy supply;
- promoting regional development;
- ensuring environmental protection rules;
- reducing emissions of greenhouse gases.

The main normative document that defines Romanian energy policy is HG1535 / 2003, who presents both the overall objectives of the strategy on promoting renewable energy sources and specific objectives, distinctly presented for each type of source.

The main overall objectives are:

- integration of renewable energy into Romanian Power System network;
- reducing technical and psychosocial barriers in using the renewable energy, simultaneously with the identification of cost and economic efficiency;
- promoting private investments and create conditions for facilitating the access of foreign capital on renewable energy market;
- ensuring independence of the energy consumption of the national economy;

- ensure, where appropriate, the energy supply for isolated communities by harnessing the potential of local renewable energy sources;

- creating conditions for Romanian participation in the European market of "green certificates" for energy produced from renewable energy sources.

Among the specific objectives, the most important aims:

- **biomass** - could cover approx. 70% of Romania's commitments relating to the share of renewables in total energy consumption.

- **wind power** - scientific studies have identified a potential of about 14,000 MW installed capacity, which could provide 23,000 GWh/year. In the Black Sea continental shelf ("off-shore"), the undertaken studies reveal a wind potential of approx. 2000 MW, considered feasible for the long term (> 20 years);

- **geothermal energy** – the objectives for efficient recovery program in Romania are:

- preparation of feasibility and consulting studies with implementation solutions for assimilation of technologies and equipment;
- dissemination and exploitation of data and information, related to the current implementation programs;
- developing a legal framework of rules and regulations for the exploitation of geothermal resources in conditions of high economic efficiency.

- **hydropower** - study on the Romanian hydropower potential confers opportunities for achieving a 780 units (with a maximum installed capacity of 10 MW / unit) with a total capacity of 2150 MW, which could provide 6000 GWh/year. For the long term, it is estimated that the total installed capacity in new hydro units will be approx. 840 MW, of which 240 MW in low power;
- **solar energy** - will be created solar energy systems, photovoltaic and / or solar-

thermal, with or without connection to the power grid. Solar thermal applications will be performed with collectors (including ancillary components), which will total an area of approx. 150000 m². In photovoltaic applications it has been identified several types of projects:

Table 2 The share of renewable energy in total consumption of primary resources in Romania

Renewable Energy Sources	2000 [thousands oftep]	2010 [thousands oftep]	2015 [thousands oftep]
Solar energy:	–	7,50	17,00
• solar thermal	–	7,34	16,00
• solar-electric	–	0,16	1,00
wind energy	–	27,00	86,10
Hydropower:	1.272	1.565,20	1.608,20
• large hydro power	1.185	1.470,60	1.470,60
• Small hydro power	87	94,60	137,60
Energy from biomass:	2 772	3.347,30	3.802,00
• biomass-thermal	2 772	3.249,80	3.487,80
• biomass-electric	–	97,50	314,20
Geothermal energy	–	17,50	23,90
Total (including large hydro) [toe]	4.044	4.946,00	5.537,20
Share of renewable energy in the total consumption of primary energy resources [%]	10,01	11,00	11,20

▪ autonomous photovoltaic systems for rural electrification, with applications in: Apuseni Mountains, Northern Moldavia, Danube Delta, etc.

▪ photovoltaic systems connected to the distribution network: mini solar-photovoltaic plants with installed capacity of several hundred of kW to 1 MW in the Black Sea coast and 1-5 kW photovoltaic systems connected to the network in cities, seaside, etc. The main values of the targets, set by the proposed strategy are:

- 2003-2010: new capacities for energy production from renewable sources, totaling 441,5 MW (electricity) with investments totaling 887,5 million euro;
- 2011-2015: the total installed power of 789 MW (electricity) using a 1153 million investment.

This will cause a reduction in import of primary energy resources with an equivalent of 19.650 GWh (electricity) (weight 11%) and for 2015 is projected 23.367 GWh (11.2% share).

Share values are shown in Table 2, compared to each renewable energy source.

Supporting investment projects and identification of funding sources in the field of renewable energy will be achieved through: initiating legislative action and establishing direct institutional cooperation between central and local

executive authorities; attracting direct funds, including the mechanisms applied in the Kyoto protocol; supporting projects implementation in the field of waste management and capitalization (biogas production, wood waste utilization for thermal energy, waste incineration with heat recovery, etc.); harnessing the potential power of the interior rivers by building small hydropower plants (max. 10 MW).

With the accession of Romania in the European Union some targets have been set for the alignment to joint efforts of Member States in promoting and using renewable energy E. Thus, the European Directive 77/2001 / EC was transposed to Romania by Government Decision no. 443 of 2003 [HG443 / 2003] as follows: national target of 33% of electricity produced from renewable energy sources, for 2010; deadlines and responsibilities for ministry and competent authorities; mandatory introduction of support schemes of electricity produced from renewable energy sources, compatible with the market mechanisms.

Moreover, with the adoption of law 220/2008 was established the promotion system for the production of energy from renewable energy sources. It uses mandatory quota system combined with green certificates trading system or fixed price.

In March 2009, in Romania a total of 24 producers, using CV, signed the Registry of Evidence Annual Producers energy - renewable energy: 12 using wind power and 12 hydro. For them, Transelectrica issued in the same month,

20,084 green certificates, of which 1.213 for wind energy. Compared with the values recorded in the same period of the last four years, there is an increase of 17 times for wind and 32.6 times for hydropower [4].

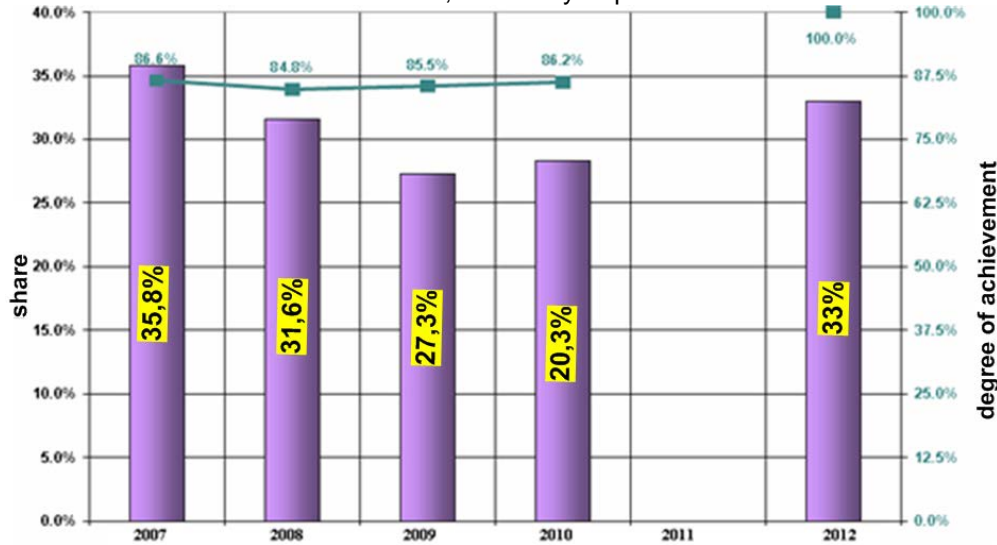


Fig. 2 Rate of achievement for the national target - renewable energy sources [4]

In late 2010, the installed capacity in hydropower (high power and installed capacity exceeding 10 MW) was 6422 MW and wind farms totaling approximately 11 MW. According to [15], there is an increase in the share of energy - renewable energy sources, the value of 121 GWh, of which 11 GWh coming from wind energy. Compared to 2007, electricity from wind power increased by

36%. In these circumstances, the national target of 33% for 2012 for the share of energy - renewable energy sources in gross national electricity consumption was achieved more than 86% (Fig. 2).

CONCLUSIONS

Although at present, the share of production units in the system using renewable energy sources (excluding hydro) is small investor interest is high, especially on the wind. Areas are Banat, Dobrogea and Moldova, due to significant wind potential. The network connection requests totaling nearly 17,000 MW of power, of which 2,700 MW have already received the technical connection. There are also signed contracts with different companies ready to connect to the network, with a power of 680 MW. There are discussions for wind parks in the next period, with significant powers: approx. 3,000 MW in Dobrogea, 1,500 MW in Moldova, 600 MW in the Danube valley.

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