Available online at www.sciencedirect.com

ScienceDirect

Procedia Economics and Finance 8 (2014) 300 – 305

Procedia Economics and Finance

www.elsevier.com/locate/procedia

1st International Conference 'Economic Scientific Research - Theoretical, Empirical and Practical Approaches', ESPERA 2013

Scenario for implementation of renewable energy sources in Romania

Dorel Dusmanescu[a]*, Jean Andrei[a], Jonel Subic[b]

[a] *Petroleum and Gas University of Ploiesti, 39 Bucuresti Blvd., Ploiesti 100680, Romania*
[b] *Institute of Agricultural Economics, 11060 Belgrade, Volgina Str. 15, p.o.b. 93, Serbia*

Abstract

Renewable energy sources represent an alternative to fossil fuels like coal, oil and gases. The pollution generated burning fossil fuels for industrial development and the limited character of energetic fossil resources imposes the necessity to replace them with other sources of energy. The renewable energy sources have some specific characteristics that involve a process of implementation adapted to the region particularities. The paper present a scenario for implementing the renewable energy sources into the Romanian economy, taking account to the specific socio-economic aspects of Romanian society. The target of this scenario is 2020 when Romania needs to ensure 24% of gross energy consumption from renewable sources.

Keywords: renewable energy, wind energy, solar energy, biomass, biodiesel, bioethanol;

1. Introduction

As a full member of European Union, Romania has committed to fulfill all the provisions of European Commission and to reduce the CO_2 amount that is emitted into the atmosphere with 20% by 2020. Therefore, Romania needs to ensure from renewable energy sources 24% of the gross energy consumption.

* Corresponding author. Tel.: +40740237254;
*E-mail address:*zlin50@yahoo.com

doi:10.1016/S2212-5671(14)00094-X

Compared to 1990, the economy of Romania had become much cleaner due to the fact that many enterprises which used to generate an intense pollution through the medium of their activity (steel industry, thermal power plants, chemical and petrochemical companies) have reduced their production after 1990, as most of them were eventually closed. As for the ones that remained in operation, they were required, after the adoption of the European environmental legislation, to renew the production technologies in order to be within the admitted limits concerning the emissions of pollutants. In this context, Romania had to fulfill all the EU recommendations. As (Zamfir, 2011; Maghear, 2011) argues, Romania should not only follow the European experiences but also to make steps forward in order to achieve energy potential of renewable energies in the context of sustainable development.

On the other hand, closing or reducing the production of polluting enterprises has led to the significant reduction of energy consumption. The effects of this action may reflect both upstream and downstream of energy production system. Labor resources mobilized in this sector have relatively significant percentages in the employed labor force. In this sense, the reduction of activity in the sector will have as direct and immediate effect a reduction of financial resources mobilized by labor taxation in the national budget.

The closure of a large number of businesses, particularly in the metallurgy and machine building branch, which are using a great amount of energy, also had horizontal effects, which resulted in a drastic reduction of the production and even in the closure of other businesses that provided these producers with raw materials and energy.

The result of this evolution was the increase of the number of the unemployed, which caused negative effects on the country's budget, which now has to ensure the payment of an increased number of unemployment benefits along with considerable sums for paying the compensatory salaries that were granted in various sectors of activity.

In the energy sector, the reduction of the energy consumption has led to the closure of coal power plants, which led to important social effects, especially because horizontal effects had led to the closure or the transition into conservational state of a number of coal mines, which caused important social problems in the concerned areas (e.g. Petrosani county, etc.).

In addition to the measures of reduction the emission of pollutants, by retrofitting or closing heavily polluting enterprises, Romania has committed itself to implement the renewable energy sources, which are to provide part of the energy consumption that the country has. Implementation of these energy sources can have both positive and negative effects on the economy and environment in Romania.

In order to make a comparison between countries with different economic development levels, we used as an indicator the gross consumption per capita (fig. 1). The gross inland consumption of primary energy reflects the amount of energy that is required to satisfy the domestic consumption within the limits of the national territory.

As shown below, the internal consumption per capita average is of 1.8 toe/capita for Romania, while for other developed economies in Europe, this value is between 3.5 to 4 toe/capita. The main future of the renewable energy production, expressed in thousands of tons of equivalent oil is presented in the table below.

Table 1. Production of energy from renewable sources in Romania, 2002-2011

-Thousand toe-

ENERGY TYPE	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Biomass	2351	2844	3160	3229	3235	3325	3832	3915	3949	3618
Geothermal	17	18	13	18	18	20	25	24	23	24
Micro hydro	1380	1140	1420	1737	1578	1373	1479	1336	1710	1266
Wind	0	0	0	0	0	0	0	1	26	120
Solar	0	0	0	0	0	0	0	0	0	0
TOTAL [thousand toe]	3748	4002	4593	4984	4832	4718	5536	5276	5708	5028

Source: EUROSTAT (2013)

To perform an analysis of the evolution of the need of energy that made of renewable sources, we have chosen as a landmark three European countries with the most developed economies: France, Germany and Great Britain.

Gross consumption per capita in Romania in 2011 is of about 1.79 toe/capita, and the average consumption of the three countries we chose as benchmarks (France, Germany and the U.K) is of 3.68 toe/capita. The evolution of this indicator in case of Romania until 2050 is presented in fig.1.

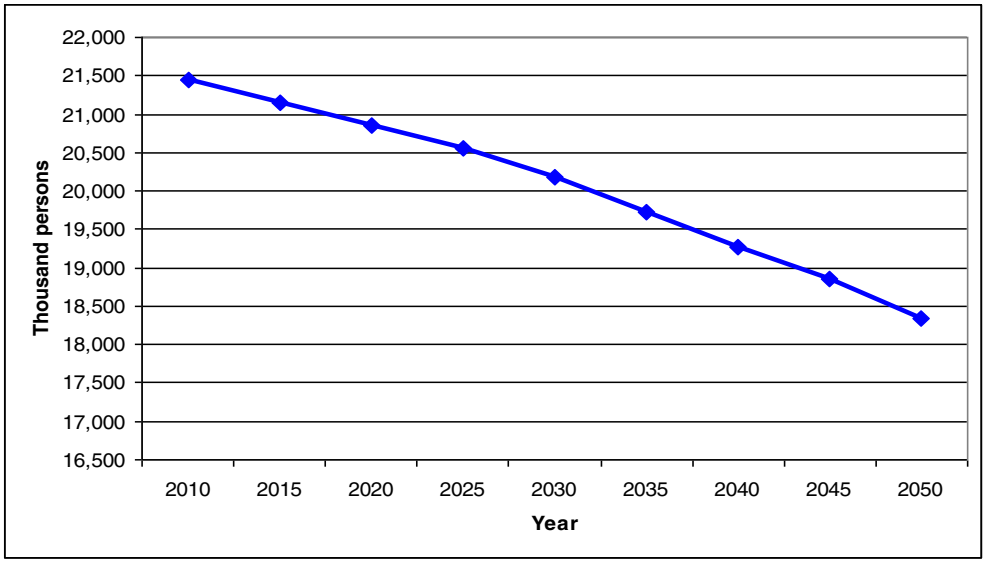

Fig. 1. Evolution of Romanian population in perspective of year 2050
Source: authors based on Eurostat (2013)

The theoretical potential which Romania has for all sources of renewable energy, analyzed in (Dusmanescu, 2013) is shown in Table 2.

Table 2. Technical theoretical potential of Romanian for renewable energy sources

Current no.	Renewable energy sources	Technical potential [GWh]	Technical potential [thousand toe]
1	Wind	409.731	35.231
2	Solar thermal	14.932	1.284
3	Solar photovoltaic	161.929	13.923
4	Biodiesel	6.084	523
5	Bioethanol	45.461	3.909
6	Solid fuel	71.966	6.188
7	Micro hydro	14.724	1.266
8	Geothermal	279	24
TOTAL		710.103	61.058

Source: based on (Dusmanescu, 2013)

This potential is a theoretical one, in the evaluation of which we tried to take into account all the restrictions that may arise in the implementation and exploitation of unconventional energy sources that have been analyzed.

As it is noted in some specialized studies (Voivontas et al.,1998; Martinot, 2007), in fact, due to the huge costs of investment, this potential will not be achievable in the near future. In the following, there is a scenario that will be analyzed in order to highlight the possible progress of the energy production that is made of unconventional sources by 2020.

2. Scenario Analysis - until 2020 projection

Although in the literature can meet some studies in which are approached potential analysis (Logan et al.1994; Haas et al.,2006; Dunlop et al., 2003, Lopez et al.,2012), the initial assumptions which are used in this scenario are the following:

- The population of Romania evolved as shown in Fig.1, which was made based on the EUROSTAT estimates, reaching a total of 20.86 million persons in 2020;
- Gross energy consumption per capita has remained the same since 2011, meaning 1.69 toe / per capita;
- Production of renewable energy increases until it reaches the level of 24% of the gross domestic energy consumption, in the year 2020.
- Gross energy consumption, corresponding to 2020 will be 35.253,4 thousands toe, and the amount of energy needs from renewable sources will be 8.461 thousands toe (24%).

Since gross energy consumption per capita remains constant, we consider that the consumption of the sources of energy remains constant. It means that the energy dependence that Romania has for every type of source of energy remains constant, and, implicitly, the deficit for these kinds of energy.

The suggested solution for to achievement of the objective of 24% in the indicated condition is presented in the following table as a mix of energy sources, which is to ensure the quantity of energy that is required, of 8461 thousands toe.

Table 3. Proposed energetic mix to ensure the necessary potential for 2020

Nr.	Renewable energy source	Potential [GWh.]	Potential [thousand toe]
1	Wind energy (7 % from tehnical potential estimated)	29.075	2.500
2	Solar thermic (5 % from tehnical potential estimated)	750	65
3	Solar photovoltaic (5 % from tehnical potential estimated)	8.200	705
4	Biodiesel (10 % from tehnical potential estimated)	600	55
5	Bio-ethanol (10 % from tehnical potential estimated)	4600	395
6	Solid fuel (56 % from tehnical potential estimated)	40.705	3.500
7	Geothermal (potential of source at the level of 2011)	279	24
8	Micro hydro (potential of source at the level of 2011)	14.724	1.266
TOTAL		98.933	8.510

Source: author`s own computations

In determining the energy mix we have considered the following:

- The high level of investment in renewable energy technologies would not allow the maximum level of Romania's potential in this domain until 2020. Therefore a choice has to be made concerning the most likely implementation for the concerned time horizon.
- I have considered the value of the potential to be constant for the geothermal energy and for the micro-hydro-electrical one; due to the lack of the needed technical and economical information, I could not make any estimations of the potential for the geothermal energy. As for the micro hydro I preferred not to take into consideration this source for future developments, because of the negative effects which it has on the environment.
- Wind technology has reached a maturity period, in which the specific costs began to lower, which makes possible the achievement of the level that is provided in the table 3, through the medium of the installation of powerful turbine, of 5, 8 or even 10 MW installed capacity at peak.
- The thermal solar potential can also be reached, especially if those technologies are being advertised for institutions that have a high consumption of warm water and heat (hospitals, hotels, greenhouses, industrial halls etc.), because these installations ‘ yield makes the exploitation of solar batteries that processes a great volume of fluid rentable;

- For the PV solar potential I provided the achievement of only 5% of the technical potential, due to the high costs of the investments. The PV technology is still under a development process, so that the great capacity investments are not economically justified for the analyzed horizon of time.
- For biodiesel and for bioethanol I provided the achievement of approx. 10% from estimated potential, because of the technical and economic problems which raises the application of these technologies. Although it is still evolving, still cannot estimate an expansion of production capacity by 2020 at a higher level than that required.
- For solid fuel, I have estimated higher percentage of 56% from the technical potential, because small plants for processing wood waste into lighters and pellets began to develop, along with the extension of their marketing and of the stoves or heating installations that are designed to function with this fuel. I considered that this activity has to be extended in energy willow plantation, not only in order to reduce Romania's dependence to solid fuel, but also to eliminate an important pollution source (sawdust and unprocessed wood waste).

As you can see above, in order to develop the energy production from renewable resources, I considered being most possible the wind and solar energy, meaning fuel that is made of wooden material, for thermal energy.

The production of biofuels (biodiesel and bioethanol) implies technological problems not only for the making of products that correspond to the European norms, but also for the adaptation of the vehicle's' motors to functioning with this type of fuel. This are problems which take time for finding a solvation to, so that , at the level of the analyzed time horizon, a greater production of biofuels cannot be estimated,

Another unconventional source of energy that I have not analyzed is the one that deals with the processing of industrial and household wastes. It is true that today, plenty of technological solutions for their processing exist, but when it comes to industrial processing, the energy consumption that is required for the processing of the waste along with the costs that are implicated do not ensure the generation of a high quantity of energy which could be available to consumers. We must not forget that these installations involve the transportation and the maneuvering of the wastes, along the environmental problems that may arise during this activity. The insurance of a clean processing, without affecting the environment can lead to a raise of the costs and of the energy consumption; therefore I have considered that this activity has a role of a great importance for the elimination of the waste from the environment and for the reduction of the pollution (we should keep in mind that there are technologies that process rubber and plastic masses wastes, which decompose in a long period of time) and less as a source of energy (electrical or terminal).

3. Conclusions

The achievement of a percentage of 24% of gross energy that is made of renewable resources involve important transformations not only in the structure of the energetic sector, but also in the technology that is used in the consumption habits of the society.

In giving possible solutions for the scenery that we presented, we must take into account the following aspects:

- The tendency that is expressed nowadays for building houses and public or industrial spaces with "zero „ energetic loss will continue and generalize, especially due to the technical progress.
- The technological development will lead to the production of a higher and higher number of "smart „electronics and appliances from an energetic point of view, meaning devices that will adapt their functioning in order to save energy.
- The technological progress can bring into the attention of the consumers other energy sources as well;
- The efficiency of the fossil fuels usage will grow due to the progress of the techniques; as a result the consumption rhythm will be reduced, leading to the extension of their life duration.

As possible solutions for the achievement of the analyzed objective, the following are being mentioned:

- The development of wind farms in conditions of maximum efficiency, by installing great-capacity production turbines. This allows the obtaining of a great quantity of energy without the necessity of occupying great surfaces with wind turbines.
- The gradual expansion of solar farms, along with the endowment of all the buildings with PV solar and/or thermal installations.
- The raise of the usage level of electric energy that is used for heating dwellings and for the preparation of food and of warm water.

- The transition to the usage on a large scale of the electrically-operated vehicles, not only for the passenger transport but also for merchandise transport.
- The introduction of high-speed trains, which would respond as efficiently as possible to the requests of the passenger and merchandise transport, especially on long distances.
- The introduction of bio fuels in aerial transport

References

Chapman J., Gross R., *Technical and economic potential of renewable energy generating technologies: Potentials and cost reductions to 2020*, http://webarchive.nationalarchives.gov.uk/+/http://www.cabinetoffice.gov.uk/upload/assets/ www.cabinetoffice.gov.uk/strategy/piuh.pdf

Dunlop, E. D., Šúri, M., Huld, T. A. (2003), *Photovoltaic Potential Assessment to Support Renewable Energies Growth in 10 EU Candidate Countries*, In Gottschalg, R.. (ed.) Proceedings of the Conference C79 of the Solar Energy Society CREST "Photovoltaic Science, Applications and Technology", Loughborough University (UK) 3.-4.4.2003, pp. 1007-1016

Dusmanescu D.2013. *Technical and Economical Aspects of the Promotion of Energy from Unconventional Sources*, Doctoral Thesis, National Institute of Economic Researchs „COSTIN C. KIRIȚESCU", București, 2013

Haas Michael J., Andrew J. McAloon, Winnie C. Yee, Thomas A. Foglia, *A process model to estimate biodiesel production costs*, Bioresource Technology 97 (2006) 671–678,

Kenneth L. J. 2006. *Computationally Intensive Analyses in Economics*, The Handbook of Computational Economics, vol. II, 2006, Elsevier

Lopez Anthony, Roberts Billy, Heimiller Donna, Nate Blair, and Gian Porro, U.S. *Renewable Energy Technical Potentials: A GIS-Based Analysis*, http://www.nrel.gov/docs/fy12osti/51946.pdfpag. 881-893

Logan D., Neil C., and Taylor A., *Modeling Renewable Energy Resources in Integrated Resource Planning*, National Renewable Energy Laboratory, http://www.nrel.gov/docs/legosti/old/6436.pdf

Maghear D.2011. *Romania's energy potential of renewable energies in the context of sustainable development*, Annals of Faculty of Economics, 1(2):176-180

Martinot E., Carmen D., Weiliang L., Chai Q.2007. *Renewable Energy Futures: Targets, Scenarios, and Pathways*, Annual Review of Environment and Resources Vol. 32: 205-239, first published online as a Review in Advance on August 23, 2007 DOI: 10.1146/annurev.energy.32.080106.133554

Voivontas D., Assimacopoulos D., Mourelatos A., *Evaluation of renewable energy potential using a GIS Decision Support System*, Renewable Energy, Vol. 13, No. 3, pp. 333 344, 1998

Zamfir A.I. 2011 *Management of renewable energy and regional development: European experiences and steps forward*, Theoretical and Empirical Researches in Urban Management, Volume 6, Issue 3 / August 2011

EUROSTAT (2013)