THE CAPACITY OF BIOLIQUIDS EXTRACTED FROM OIL-RICH-PLANTS TO BE RENEWABLE ENERGY SOURCES IN ROMANIA

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Abstract - The paper promotes bioliquids from indigenous oil-rich plants as renewable energy sources. In the first part the paper analyzes the national and European perspectives to develop renewable energy sources according to the National Strategy for 2016 -2030 with the prospect of 2050, as per European directives. The second part presents the point of view of the Directive 2009/28/EC on bioliquids and the possibility to use bioliquids from oil-rich plants for energy generation in order to reduce pollutant emissions. The third part of this paper presents the results of laboratory analyses concerning the energy characteristics of bioliquids from indigenous oil-rich plants. The conclusions of part four point out that bioliquids from oil-rich plants have the potential to be a solution for EU's renewable energy and the climate change objectives.

Keywords: bioliquids,oil-rich plants,renewable energy sources.

1. THE NATIONAL AND EUROPEAN PERSPECTIVE TO DEVELOP RENEWABLE ENERGY SOURCES (RES) IN ROMANIA

The Climate - Energy package includes the EU objectives relating to the greenhouse gas emission reduction and promotion of renewable energy sources (RES) within a legislative framework establishing the targets by 2020, the well-known 20/20/20. The Directive made it mandatory for each Member State to draw up a National Renewable Energy Action Plan.

Targets EU 2020 are:

- Reduction of the greenhouse gas emissions: 20% EU and Romania 20%;
- Increase in energy efficiency: 20% EU, Romania 19%;
- Share of RES in energy consumption: 20% EU and Romania 24%.

The degree of realization in these national RES targets is:

- National RES share in national gross electricity consumption: 2010-2014 was 33%, 2015 increased at 35%;
- Achieved levels: 2010-31%, 2011-32%, 2012-34%, 2013-40%, 2014-44% and 2015-44%.

At the end of 2015, Romania exceeded the established target by 2020 (24%), achieving 26.27% at national level.

According to data provided by ANRE, in 2015 there are 698 RES producers in Romania, distributed as follows: wind-70, hydro-89, PV -514 and biomass-25 producers.

The evolution of biomass producers in Romania: 2009-1, 2010-3, 2011-4, 2012-7, 2013-14, 2014-19 and 2015-25 producers.

Biomass has not developed at the same pace as the other RES technologies, although it represents the main potential for Romania. At the end of 2015 Romania had only 107 MW from biomass production.

The dynamics of the production capacities on biomass in Romania records: 2011-25 MW , 2012-43 MW , 2013-66 MW, 2014-100 MW and 2015-107 MW.

The National Strategy for 2016 -2030, with the prospect of 2050, respects Romania's national and international commitments in the energy sector**.**Romania's energy strategy is built upon five main objectives based on mathematical modeling, using data comparable to those European to design the future Romanian energy system on three main development scenarios (minimum / maximum /average) of energy consumption for 2030.

The final energy consumption will increase slightly, remaining between 20 and 23 million tones of oil equivalent (toe). The Ministry of Energy's projections indicate a substantial advance in the electricity production over the next 15 years, from 61.06 MWh in 2015 to 72.77 MWh in 2030. This will be even while the installed capacity would rise by only 12% (from 21,14 GW, to 23,68GW). Only after modernizing the energy system of governance the other goals may be pursued: energy security, clean energy, competitive markets, in order to reach the core objective: to reduce energy poverty and to protect vulnerable consumers.

The energy mix will remain balanced between 2015 and 2030:

- Water - from 25% to 26%
- Nuclear - from 17% to 16%
- Wind - from 8% to 22%
- Solar – from 2% to 6%
- Coal - from 34% to 5%
- Natural gas – from 12% to 21%
- Biomass – from 1% to 3%.

This small proportion of biomass is due to the

investment costs and fuel costs, higher than other RES technologies; for biomass is difficult to compete with other RES producers and this difficulty can be eliminated by a support scheme.

The preliminary findings of the quantitative modeling shows that the share of RES could even decline in 2030 compared to 2015, in the absence of a new support scheme.

In the most optimistic scenario, the share of renewables in the electricity mix could exceed 80%, by 2050.

At present, the total annual production of energy from renewable sources is about 6550 ktoe and the unused technical potential is approximately 8000 ktoe with the following shares: biomass and biogas – 47%, solar energy – 19%, wind energy – 19%, hydro – 14%, geothermal – 2%.

The more and more serious commitments to attain the targets set for the greenhouse gas emissions reduction at the European and international level through increasingly strict decarbonization policies have set substantial constraints on the energy mix components and on producing and consuming energy technologies.

The Energy Strategy offers a sustainable development vision of the country including Romania's evolution towards the role of regional hub forproduction, storage and tradingof energy;diversification of energy sources and services; development of energy infrastructure at the same time with the introduction of innovative technologies.

From the economic point of view the local renewable energy sources combined with the encouragement of the local industry may lead to the valorization of the agricultural biomass resources even in the case of rather modest support schemes. In order to achieve this, policies encouraging local producers and local capital are required.

The European Union is the world leader in renewable energy sources (RES). Through the Directive 2009/28/EC, EU adopted the most advanced sustainability scheme, with sustainability criteria for bioliquids and biofuels.

The Directive stipulates that energy from biofuels and bioliquids should reduce greenhouse gas emissions by at least 35% and that the share of renewables should increase to 50% from January 1, 2017.

In Romania the provisions of Directive 2009/28/EC have been translated into the Law 139/2010 and HG 935/2011 establishing the system for the promotion of renewable energy sources.

At present the EC is working on a complete redefinition of its energy policies, re-establishing the priorities in the energy sector. Thus, biomass and biogas get on the first place from the perspective of renewable energy sources (RES) development.

Romania, as an EU MS, needs to fulfill its commitments at the EU level and ensure the sustainable development of agriculture. Establishing the optimal production ratio between agricultural and energy plants and the food and energy quotas are solutions based on social, economic and environment sustainability principle.

In Romania, valorization of RES potential aims at increasing security of energy supply by diversifying the sources and diminishing the share of imports of traditional resources leading to the sustainable development of the energy sector and environmental protection.

Romania has set a national target for 2020 of 24% of renewable energy in the gross final consumption of electricity, target that has been already achieved, but which must be conserved until the year of reference.

The best solution to balance the preservation of the renewable energy industry and this target is the adoption, on 30-th March 2017, of OUG 24/2017 for the amending and supplementing Law 220/2008.

The main amendments are:

- removing the validity period of only 12 months for the green certificates. Basically, these will be valid for the entire period of operation of the support scheme, respectively until 2032.In this way, there will be avoided the situations met in recent years, in which a large number of green certificates could not have been exploited by the producers;
- the mandatory purchase quota for the electricity suppliers will be replaced with a new mechanism, i.e. the static green certificates amount, which will be reviewed every two years by ANRE,for creating a balance between consumers and producers;
- creation of anonymous platforms for trading renewable energy sources and green certificates on centralized trading electricity markets so that both large and small producers and suppliers be able tofind their place within the market;
- the green certificates will gain value when traded and not at the moment of issue as before, which will remove some of the pressure on the cash flows of the operators in the field. The renewable energy producers will pay the profit tax only at the time of the green certificates trading, and not when they register them in their accounts, as per the old legislation.This impediment led to insolvency and bankruptcy cases among the renewable energy producers.

2.THE POSSIBILITY OF USING BIOLIQUIDS AS RENEWABLE ENERGY SOURCES

Crude vegetable oils are considered bioliquids, under the Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources. According to Article 2, the following definitions also apply:

-'biomass' means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste;

-'bioliquids' means liquid fuel for energy purposes other than for transport, including electricity and heating and

cooling, produced from biomass;
-'biofuels' means liquid or gaseous fuel for transport produced from biomass.

Bioliquids from oil-rich plants can be used for clean alternative energy generation. As vegetal biomass from agriculture, oil-rich plants produce oilseeds whose oil content ranges from 20 to 60 %. In order to utilize oil-rich plants for energy generation, we are interested in crude vegetable oils obtained through pressing without any chemical modifications, unrefined and unesterified.

In Romania biomass has got the greatest potential among the renewable energy sources (65%), according to the data in Figure 1 followed by: 17% wind energy, 12% solar energy, 4% micro hydropower and 2% geothermal energy.

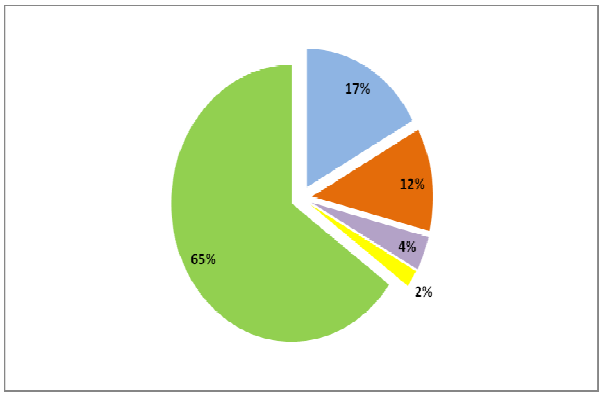

Fig. 1 - The Rewenable Energy Sources in Romania

The energy potential of biomass in our country has been evaluated at about 7, 594, 000 toe/year, representing about 19% of the total primary resource consumption.

At present, the installed biomass capacity in Romania totals 107 MW, much less than the wind farms (2,800 MW) and photovoltaic systems (1,500 MW), although indigenous biomass has a great potential.

The latest data on the structure of the biomass potential are provided by the Ministry of Agriculture and Rural Development (MADR) and are presented in Figure 2. The national potential of biomass is made up of: 63.2% vegetal biomass, 15.5% forestry biomass, 7.7% biogas, 7.2% urban waste and 6.4% wood waste. This figure points out that vegetal biomass from agriculture has got the greatest share at the national level.

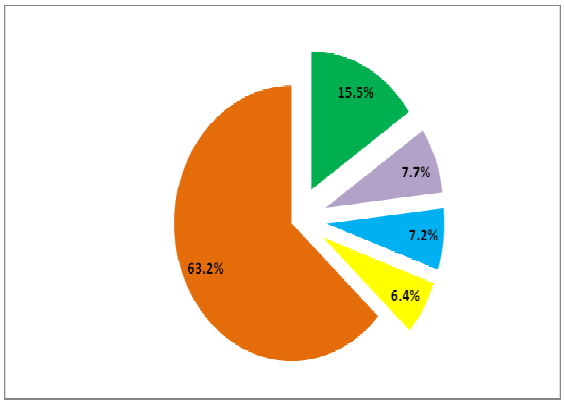

Fig. 2 - The Romanian Resources of Biomass

Agriculture represents one of the main branches of Romania's economy contributing about 5-6% of the GDP in comparison with the other EU Member States where the average percentage is only of 1.7% of the GDP.

Traditionally, Romania is an important oil-rich plant producer, these plants being cultivated on increasingly greater areas each year.

The most representative indigenous oil-rich crops are: sunflower, rape and soybean.

The indigenous oil-rich plants have the following net advantages:

- They can be used in more than one way (food, energy and transport)
- They increase national security and independence (energy and food)
- Potential of intensive cultivation
- Profitable valorization prospects.

Besides ensuring diversification of renewable energy sources, bioliquids from indigenous oil-rich plants are a key sustainable future element contributing to the security of energy supply and energy independence of the country.

The oil-rich indigenous plant species that have the greatest RES potential have been identified and selected. They include sunflower, rape, and soybean. Due to the predominantly decentralized nature of the selected indigenous plants the bioliquid supply is less vulnerable in comparison with the supply of hydrocarbons for the energy system.

The advantages of utilizing indigenous oil-rich plants to produce bioliquids for energy purposes are the following:

- They have a great regeneration potential and are environmentally friendly
- Grow quickly and the costs of their cultivation are low
- Have high yield potential (t/ha)
- Can be also cultivated on plots of land that are not utilized, redeveloped/rehabilitated
- The works are entirely mechanized
- The existing infrastructure is used for the cultivation, extraction, and transport and energy production
- They may yield considerable profit.

3THE ENERGY CHARACTERISTICS OF BIOLIQUIDS RESULTING FROM LABORATORY ANALYSES

The chemical and energy characteristics of bioliquids from oil-rich plants were determined in the INCDE-ICEMENERG's accredited Laboratory.

Crude vegetable oils are chemically unchanged (unrefined, unesterified), but filtered (mechanically); they can be obtained from the seeds of oil-rich plants through the cold- pressing process. Three types of bioliquids with potentially stable energy utilization were tested in laboratory in order to determine their characteristics: sun-flower, rape and soy oils.

The chemical composition and specific features of these vegetable oils give their energy potential; they have

properties similar to fossil fuels in liquid form. Their properties have a great influence on their burning in the boiler, wear of metal parts, transport, storage and handling.

The chemical composition and main characteristics of bioliquidsextracted from oil-rich plants have been determined by means of the following chemical lab tests: elemental analysis and technical analysis. The elemental analysis has indicated the content of C, H, N, O, S in these oils. The technical analysis indicates the presence of water and ash in them. The following have also been determined: density, viscosity, surface tension, auto-ignition temperature, coke index, calorific value, etc. Crude oils from oil-rich plants have properties similar to those of the fossil fuels in liquid form.

The results show that, in comparison with traditional liquid fuel, bioliquids from oil-rich plants (except soy) are in general characterized by higher viscosity, as in figure 3:

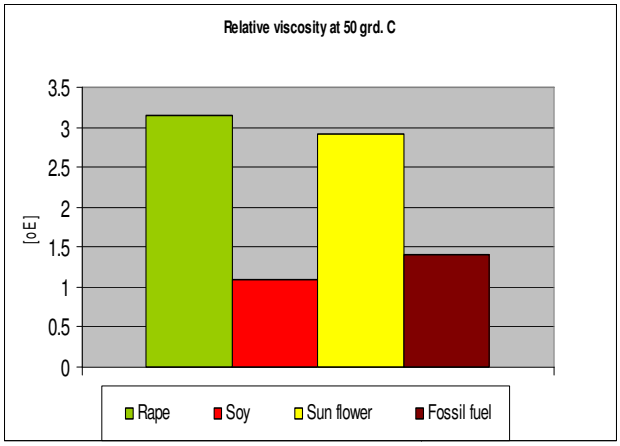

Fig. 3 - Relative Viscosity at 50^{0}C of Bioliquids versus Liquid Fossil Fuel

In INCDE-ICEMENERG's laboratory there has been determined that the calorific values of bioliquids from oil-rich plants are close to those of traditional fuels in liquid form (figure 4).

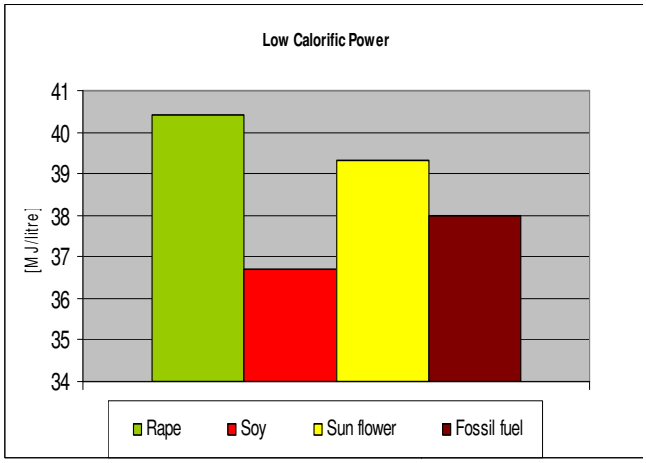

Fig. 4 - Low Calorific Power of Bioliquids and Liquid Fossil Fuel

Laboratory results indicate a higher ignition point of bioliquids extracted from oil-rich plants, in comparison with the liquid fossil fuels (figure 5). A higher ignition point is favorable for safer transport and handling.

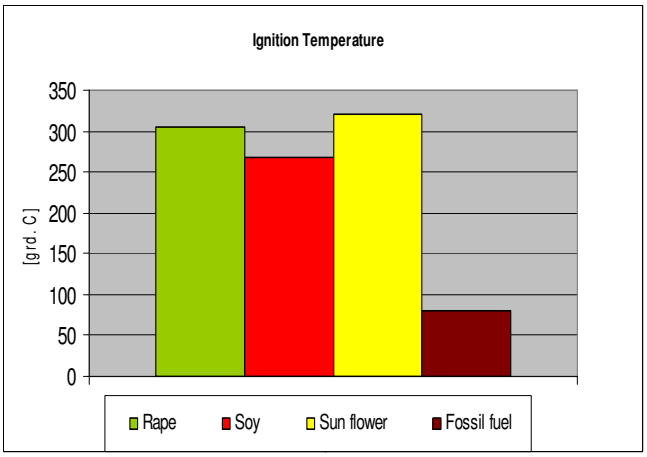

Fig. 5 - Ignition Temperature of Bioliquids versus Liquid Fossil Fuel

The surface tension (figure 6) is an important characteristic, necessary to take in consideration, in order to have a good atomization and to appreciate the influence over burners.

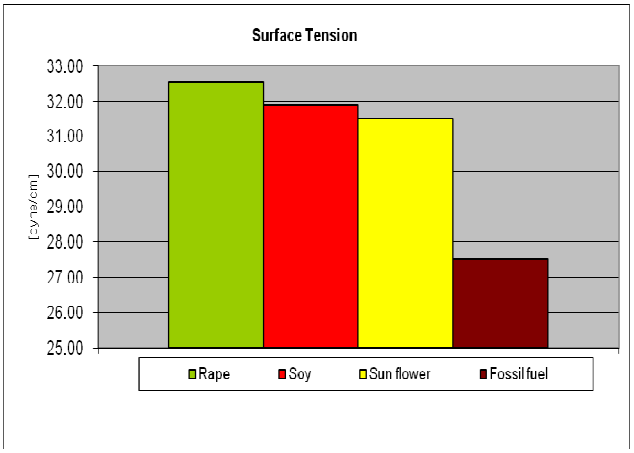

Fig. 6 – Surface Tension of Bioliquids and Liquid Fossil Fuel

The results show that, in comparison with fossil fuels, the three kinds of bioliquids from oil-rich plants have no major differences of density and other characteristics.

A remarkable property of these bioliquids is its low Nitrogen and Sulfur content, that drastically reduces NOx and SOx emissions.

Others properties refer to the content of water, phosphorous and ash, carbon residue, contamination, oxidation. A high contamination can block filters and atomization systems that impose filtering measures. A water- vegetable oil emulsion, despite a difficult stability, can be favorable for burning.

In comparison with traditional liquid fuel, bioliquids from oil-rich plants have a lower water content, phosphorous, ash and carbon residue, which are favorable in order to reduce pollutant emissions.
This chemical composition of bioliquids extracted from oil-rich plants gives their energy potential; they have similar properties as the liquid fossil fuels. This conclusion is supported by experimental investigations in INCDE-ICEMENERG's laboratory.

4. CONCLUSIONS

Bioliquids extracted from oil-rich plants can be used for heating, in cogeneration and other applications, substituting traditional fuel. They are promoted by the EU Directives as renewable energy sources (RES).

The paper focuses upon the possibility to use bioliquids for stationary applications, both industrial and household. Generation of electricity and heat from crude vegetable oil through combustion enlarges their field of application adding to transport as until now.

The feasibility of bioliquids utilization is based on the Romanian agricultural potential that could sustain an industrial bioliquids' production.

The first investigations and experiments concerning energy properties of some bioliquids from indigenous oil-rich plants have demonstrated the possibility of their utilization for heating systems and electricity generation.

The most important oil-rich plants in our country that have also got a great agricultural potential are: sun-flower, rape and soy. The evolution of the agriculture crops with oil-rich plants in Romania is increasing. The climate of our country and soil quality is favorable to obtain higher crops. Thus, the use of oil-rich plants in energy purposes can develop especially by extending suitable crops and reserving 10-12% lands of our country allowing a production of oil-rich plants (including food, transport and energy purposes).

For assessing the actual potential of the oil-rich plants in Romania an analysis from the European and international perspective, pointing out the important positions our country holds at the world economy level as concerns the oil-rich plants and vegetable oils, is required.

At the international level Romania is the 15th largest producer of sunflower oil, the 27th producer of rapeseed oil and the 68th producer of soybean oil.

As regards the potential of oilseed production, Romania holds top positions in the EU relating to sunflower seed (1st place), rapeseed (2nd place) and soybean (6th place).

The production of oils from oil-seed plants for use as bioliquids is theoretically limited only by the agricultural capacity of a given economy. Romania is the net exporter of oilseeds, occupying the 8th place in the world after USA, Brazil, Canada, Argentina, Paraguay, France and Ukraine. At the EU level, Romania is the second great exporter of oilseeds.

Concerning our country's potential to export oilseeds:

- relating to sunflower, Romania exports amount to 18.8 % of the global sunflower exports; together with Bulgaria and France it ensures about 50 % of the world's export offer.
- relating to rapeseeds, Romania holds the 7th place in the world's top exporters; the share of the first three great exporters in the world is of 60 % of total world exports, Romania's share being of 3.6 %.
- as concerns the global soybean exports, the share of the first two top exporters (USA, Brazil) is of 75 % of the soybean exports; Romania holds a more modest place with a share of only 0.08 %.

Considering the exports structure, Romania is the greatest world exporter of sunflower seeds. The share of sunflower surpasses 60 % of the total exports value of oilseeds, rapeseeds and soybeans having 3.42 % and 3.4 % shares, respectively. Romania is the 7th great world rapeseed exporter, and the 13th great soybean exporter, and, at the level of the EU it is among the first 5 countries considering the value of the rapeseeds and soybean exports.

Traditionally, Romania is an important oil-rich plant producer, its indigenous oil-seed plants being cultivated on increasingly greater areas each year. Using Romanian most representative oil-reach crops (sunflower, rape and soybean), without the need for exotic and environmentally damaging oil crop imports,we have the advantages to develop our agriculture and energy industry, to increase national security and independenceconcerning energy and food.
The use of bioliquids for energy generation is becoming increasingly important today as our supply of fossil fuels diminish by the second. Bioliquids are generally cheaper than conventional fossil fuels but supply almost as much energy. Unlike fossil fuels, bioliquids can be mass-produced and will never run out as long as we continue to grow their constituent oil-rich plants. Most importantly, they help reduce the amount of pollutants and greenhouse gases commonly released by conventional fuels.

The high potential of bioliquids from oil-rich plants to become RES is given both by the great agricultural potential of Romania, and the chemical characteristics of these bioliquids. Thus, it is necessary to take into consideration the laboratory analysis of INCDE-ICEMENERG, in order to appreciate the energy potential of bioliquids obtained from oil-rich plants.

In comparison with the fossil liquid fuel, bioliquids are characterized by slightly higher viscosity, high ignition point, very low sulfur content, and a comparable heat value. These typical features ensure the ecological and economical performances of combustion, without major modifications of the burning installations in our existing power plants. Oil-rich plants, being agricultural biomass, are carbon- neutral, in the sense that the carbon released during combustion can be taken up by growing plants.

Production and processing of bioliquids have low costs and low energy consumption. The good energy balance combined with a good CO_2 balance recommends bioliquids as an economical and ecological solution for energy generation. This is a way to develop a renewable energy source in order to ensure the energy supply

security and to reduce greenhouse gas emissions. In addition, this way could have a positive impact on economics and employment for rural communities.

As a result of this research, the technical recommendations may help the implementation of the measures necessary for promoting bioliquids extracted from oil-rich plants as renewable energy sources, according to EU's Directives.

Bioliquids from oil-rich plants can play an important ecological role in the growing efforts to solve energy and climate change crises.

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