DEVELOPMENT OF BIOENERGY IN MOLDOVA

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Abstract. This article summarizes practices of the Republic of Moldova in the area of bioenergy development and usage of biomass for energy engineering purposes. Information is provided on the developments in the bioenergy area, on organization and results of the development of new technologies as well as on the projects already implemented.

Key words: Republic of Moldova, bioenergy, biomass, renewable energy sources, technologies, projects.

DEZVOLTAREA BIOENERGETICII ÎN MOLDOVA

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Rezumat. Este generalizată practica Republicii Moldova privind dezvoltarea bioenergiei, domeniului utilizării biomasei în scopuri energetice. Este dată informaţia despre elaborările, organizarea şi dezvoltarea noilor tehnologii şi proiecte realizate în domeniul bioenergiei.

Cuvinte cheie: Republica Moldova, bioenergie, biomasă, surse regenerabile de energie, tehnologii, proiecte.

РАЗВИТИЕ БИОЭНЕРГЕТИКИ В МОЛДОВЕ

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Аннотация. В работе обобщена практика Республики Молдова в части развития биоэнергии, области использования биомассы в энергетических целях. Приведена информация о разработках в области биоэнергии, организации и результатах по развитию новых технологий, а также реализованных проектах.

Ключевые слова: Республика Молдова, биоэнергия, биомасса, возобновляемые источники энергии, технологии, проекты.

Introduction

Bioenergy comprises the energy and the fuel obtained through harnessing biomass. At this point, biomass means biodegradable fraction of products, wastes and residues in agriculture and forestry or in contiguous industrial sectors, including materials of plant and animal origin as well as industrial and communal wastes.

Biomass is a continuously renewed energy source, and production of energy from biomass has little deleterious effects on the environment. Also, biomass is the internal domestic energy source in the Republic of Moldova, therefore production of such energy reduces consumption of imported energy carriers.

Overall area of agricultural resources of Moldova is 3.385 mln. hectares, where 1.952 mln. ha – agricultural lands including, 242 th. ha – areas of perennial plantations, 335 th. ha – meadows (hayfields) and 1375 th. ha - pastures. Woodlands occupy 433 th. ha. The black soils cover almost 80% of the country's territory (2.5 mln. ha). These geographical and natural conditions create positive prerequisites for the development and generation of energy on the basis of biomass.

1. Assimilation of renewable energy sources in Moldova

1.1. Potential of the main renewable energy sources

In the energy balance of Moldova (without Transnistria) in 2007, total consumption of energy resources amounted to 2361.8 ktoe (3374 ktce), of which only 66.5 ktoe (or 95 ktce) consist of local resources that are renewable due to their origin: 2.8 ktoe or 4 ktce have been

generated by the Costeşti hydropower plant as electric power and 63 ktoe or 91 ktce – as fuel wood and wooden agricultural waste. At the same time, climatic conditions together with technical-and-economic possibilities enable large-scale utilization of solar energy, biomass of diverse kinds and organic waste, wind and hydraulic energy whose potential is represented in Table 2. The potential of major kinds of renewable energy sources (RES) is estimated at 2700 ktoe or 4100 ktce, that is 1.2 times more than the overall total consumption of energy resources in 2007.

Table 2: Available technical potential of the main RES[1] types.

RES	Technical potential, mln. toe
Solar energy	1.2 (1.8)
Wind energy	0.7 (1.0)
Biomass (agriculture. waste, fuel wood, waste from wood processing, husks of grapes, biogas, biofuel)	0.5 (0.8)
Hydroenergy	0.3 (0.5)
Total RES potential	2.7 (4.1)

1.2 Growth prospects for the share of bioenergy in the structure of energy sources

Achieving the main goal of the Energy strategy of the Republic of Moldova - to ensure by 2010 that 6% of the total energy consumption would be from the RES - assumes broad involvement into the economic cycle of the main types of RES - solar, wind, biomass and hydraulic energy. As long as the methods, technologies and equipment for converting the RES to the heat, mechanical or electric energy that Moldova has at its disposal at the present moment, are of various degrees of maturity, technical perfection and commercial competitiveness in the country's domestic market, also taking into account traditional usage of biomass for fuel in the agricultural sector, it can be projected that in the 10 years to follow a large proportion of biomass and hydroenergy shall persist in the volume of energy obtained from the RES. Simultaneously, thanks to technological progress and new technologies prerequisites will be created for putting to use solar, wind and geothermal energy as well as low potential sources of heat[2], biogas and energy cultures.

In 2010, total consumption of primary energy resources estimated on the basis of socio-economic development of the Republic of Moldova and of the projected reductions in proportional usage of energy by 2% - 3% per annum, will amount to 2.7 - 3.3 mln. toe (or 4.0 - 5.0 mln. tce), of which RES will make up 167 - 210 ktoe (or 240 - 300 ktce), i.e. 2.5 - 3.1 times more than in 2007.

Taking into account the current structure of RES consumption and the experience of European countries, the following proportional distribution of various RES in the amount of energy generated from the RES by 2010 is anticipated:

- ***S*** biomass - (fuel wood and wood waste, biogas and biofuel) - 70%;
- ***S*** hydro (large and small hydropower plants) - 14%;
- ***S*** solar heat energy - 10%;
- ***S*** wind - 3%;
- ***S*** solar photoelectric - 0.1%;
- ***S*** other types of energy - 3%.

Utilization of biomass of energy cultures, agricultural, municipal, forest wastes, raw materials for the production of liquid and solid biofuel is viewed as the preferred way for

[1] Technical potential of these resources has been determined for the possibility to use 0.1 per cent of thecountry's territory for deployment of solar collectors and photoconverting modules (PV), 0.03 per cent of the country's territory in valleys and open lowlands for mounting wind installations at the height of 50-70 m above the land surface, 25 per cent of the yearly amount of 2.5 mln. tons of agricultural waste as well as kinetic energy of rivers Dnestr, Prut and Reut by installing flow-type micro hydropower generators without dambs.

[2] Utilization of the warmth of the earth, water or air by using heat pumps in order to increase the temperature of heat-transport agent.

reducing country's dependence on the imports of energy resources.In Moldova, utilization of green mass as energy resource is a rather topical issue. At the Institute of Ecology and Geografy of the Academy of Sciences of Moldova, evaluation of the energy potential of various green cultures has been performed. 25 varieties of annual and perennial plants (herbaceous plants, shrubs and trees)[3] which can be grown on considerable areas in the Republic of Moldova and shall make it possible to produce biomass of industrial magnitude for obtaining biofuel. Evaluations have been performed concerning energy potential of these varieties of cultures, the amounts of biofuel yield from processing of biomass and the amounts of carbon dioxide released in burning thereof.

Table 3*:* The yield, the sugar (or starch) content and the efficiency of bioethanol for crops with energy potential.

Plant species	Sugar (or starch) content, %	Yield, t/ha*	Efficiency by ethanol, l/ha	Energy potential by	CO_2 emissions, kt/ha
Potato (*Solanum tuberosum*)	17.8	32.4	36	7961	7.06
Sweet potato (*Ipomoea*	25.0	12.0	24	5173	4.59
Root chicory (*Cichorium*	16.0	35.0	32	7001	6.21
Wheat (*Triticum aestivum*)	62.0	7.2	28	6152	5.46
Barley (*Hordeum vulgare*)	58.0	5.8	21	4634	4.11
Maize (*Zea mays*)	65.0	6.9 (	28	6195	5.49
Rye (*Secale cereale)*	62.0	7.2	28	6152	5.46
Fodder beet (*Beta vulgaris var.rapacea*)	8.2	98.5	4923	106128	9.418
Sugar beet (*Beta vulgaris* var. *altissima*)	16.0	57.4 (50)	5600	120723	10.713
Sweet sorghum (*Sorgum*	10.0	90.0	54	1164	10.3
Topinambur (*Helianthus tuberosus*)	15.0	30.0	2610	562653	4.993
Triticale (*Triticosecale*)	62.0	7.2	28	6152	5.46
Switchgrass (*Panicum*	60.0	20	36	7760	6.88

2. Targeted activities in the area of bioenergy in the Republic of Moldova

2.1 Bioethanol

At present, the most feasibly applicable and cost-effective in Moldova is fuel ethanol or "bioethanol" derived from ethyl alcohol.

It is planned to produce bioethanol from sweet sorghum as well as from other kinds of agricultural products – various cereals and maize.

The following projects for production and usage of bioethanol are the preferred ones:

- creation of a centre for industrial production of bioethanol in Kagulsky district;
- deriving ethanol by processing grain, maize and sweet sorghum;
- equipment for sweet sorghum juice fermentation;
- facility for electrodynamic rectification of ethanol;

[3] **High sugar/starch content plants** - potatoes (*solanum tuberosum*), earth apple (*helianthus tuberosus*), wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), oats (*Avena sativa*), rye (*Secale cereale*), Triticale (*Triticosecale*), maize (*Zea mays*), switchgrass (*Panicum virgatum*), sweet sorghum (*Sorghum bicolor*), sugar beet (*Beta vulgaris*), root chicory (*Cichorium intybus)* – for alcohol production; **Oleaginous plants** - microalgae (*Algae*), hemp (*Cannabis sativa*), sunflower (*Helianthus annuus*), rape (*Brassica napus*), soybean (*Glycine măx*), quinoa (*Chenopodium quinoa*), amaranth (*Amaranthus spp*), aquatic life (micro-alga) – for vegetal oil production; **Plants for solid fuel production** - arundo donax (*Arundo donax*), common reed (*Phragmites communis*), reed canarygrass (*Phalaris arundinacea*), perennial ryegrass (*Lolium perenne*), poplar (*Popolus spp.*), willow (*Salix spp.*), black locust (*Robinia pseudoacacia*), vine, fruit trees (*Vitis vinifera; Arborea* and other plants; biomass used as fuel in the core.

- equipment for extraction of juice from sweet sorghum;
- machines for sweet sorghum harvesting;
- technology and equipment for preparing stable mixtures of ethanol with gasoline;
- factories for production of bioethanol from grains and maize.

2.2 Biodiesel

Production of biodiesel fuel is one of possible solutions to provide agricultural industry with fuels and lubricants (F&L). Under the existing production structure in agriculture about 30% of incomes from plough lands of the Republic of Moldova is used to cover the costs of procuring F&L. Alternatively to purchasing F&L, 30% of plough lands could be used to produce own biodiesel. Rape (coleseed) is the most appropriate energy culture for this purpose.

Advantages of rape:

- fits well into Moldova crop rotation;
- is a winter crop of solid planting (uses autumn, winter and spring moisture);
- early-ripe culture;
- yielding capacity comparable to that of wheat;
- high yield of oil (like that of sunflower). Drawbacks:
- high percentage of losses in harvesting;
- non-simultaneous ripening.

In 2006, the German Bio-Company-Raps put into operation the plant producing coleseed oil to be used in biodiesel industry. The factory is situated in the north of the country in the Lipkan village of the Brichen district. It has been opened by the Moldavian-German joint venture Bio-Company-Raps. The German partner has invested 5 mln euros into the JV. The company is planning to make considerable investments into coleseed cultivation including improving quality of cultivars species, mechanizing the process of harvesting of this culture.

At present, the plant is processing 50 tons of raw materials per day. Coleseed grown in Moldova is used to produce the oil. It is planned that in parallel to expanding the areas under coleseed production capacities of the plant will be also increased. It is envisaged that the plant shall process at least 300 tons of coleseed per day, and 70 additional jobs will be created.

The Government of Moldova supports implementation of such projects aimed at bettering the situation in agriculture based on processing domestic starting materials, producing and selling finished products, opening new jobs.

At the exhibition Moldenergo held in the International Exhibition Center Moldexpo on 11-14 March 2008 ‘Mercedes-Benz TIR-diesel’ was demonstrated using phytodiesel type of biofuel produced in Moldova by the Moldovan-German joint venture Bio-Company-Raps.

The problem to be resolved in order to advance the biodiesel into the market of Moldova as an alternative fuel is to evaluate the internal and external markets both for the equipment and for the finished product – biodiesel.

2.3 Biogas

Biogas technologies in Moldova are aimed at resolving the four problems:

1. Environmental – elimination of waste;
2. Energy – obtaining fuel and energy;
3. Agrochemical – getting environmentally clean fertilizers and food products, enhancing soil fertility;
4. Social – improving working and household conditions, especially for rural residents.

Energy specificity of Moldova require creation of highly cost-efficient biogas technologies to be used in a broad-scale range: from individual peasant holding and private plot of land to large cattle-breeding farms, poultry factories and cities.

Among characteristic projects dealing with biogas production the following are worth mentioning:

- Projects for generating biogas at large cattle breeding farms and poultry factories.
- Project to produce electric power at the landfill for communal waste in the Tsyntseren village of the Anenyi-Noi district on the basis of landfill gas.
- Biogas projects in the wine-making industry of Moldova.

On the European grants in Moldova, two modern biogas stations have been built and put into operation together with co-generation installations at the Avicola poultry factory (Vadu-Lui-Vode) and at the stock raising complex in Kolonitsa near Kishinev but for various reasons they are practically not operated at the moment. In the first case this is due to changes in poultry raising technology, in the other - due to disestablishment of stock raising farm as result of privatization of cattle herd. Such instability of situation hinders resolution of institutional and technical problems of broad development of biogas technologies in the Republic.

Usage of wine industry waste

Sub-program «Pre-processing and use of wine industry waste and obtaining new products» [4]makes provisions of utilization of the winemaking byproducts, in particular of wine-alcohol dregs which if discharged can be environmentally hazardous. The dregs are viewed as energy raw materials for deriving biogas and can be used to generate electric power and heat.

Of 150 wineries, 32 have alcohol distilling facilities and produce environmentally deleterious highly concentrated effluents with the total amount of up to 5.0 mln. m^3/year with average CRO[5] up to 25000 mg C02/liter.

- Output of biogas from 1 kg of CRO is 0.5 m^3 with 70% methane gas content;
- Potential output of methane in biogas is about 43.0 mln. m^3/year, with the possibility for co-generation of 82 mln kW of electric power and 150 mln kW of heat;
- Incremental cost of a bioreactor is 300\$/m^3; with the average duration of its operation of 200 days per annum it would require construction of about 50 reactors of 200 m^3 volume for the overall cost of US\$ 3-4 mln or conditionally - 1.2 Lei/m^3 of produced methane.

Usage of solid communal wastes

Increased consumption in the past decades in Moldova has resulted in considerably increased generation of solid communal wastes (SCW). One of the main ways for SCW disposal in Moldova remains burial thereof in near-surface geological environment. Under the circumstances, the wastes are subjected to intense biochemical decomposition causing, in particular, generation of landfill gas containing micro components such as methane (CH4) and carbon dioxide (CO2).

In the world practice, the following ways of landfill gas utilization are known:

- Gas flaring ensuring elimination of unpleasant odors and reduction of fire hazardous SCW at the landfill, in this case energy potential of landfill gas is not used for economic purposes;
- Using landfill gas as fuel for gas engines in order to obtain electric power and heat;
- Direct burning of landfill gas for generation of heat;
- Raising methane content in landfill gas (enrichment) up to 94-95% with subsequent usage thereof in general purpose gas networks.

In 2006 working project was developed to generate electric power at the domestic wastes landfill in the Tsyntseren village of the Anenyi Noi district. Major purpose of the project is to capture and destroy maximum possible amounts of biogas thereby eliminating greenhouse effect caused by emissions of biogas into the atmosphere. The project envisaged construction of an electric power mini power plant of 1500 kW capacity.

[4] In the framework of Research Program 043.014P adopted by the Government of Moldova.

[5] Chemical requirement for oxygen = the amount of oxygen required for oxydizing an organic substance in a water sample or water reservoir.

In 2007 project construction started. This is a pilot project as long as until now no similar projects have been implemented in the Republic of Moldova. Already, the first start-up complex has been erected comprising, namely:

- Network of vertical gas drainage wells throughout the whole body of the landfill connected by a pipeline;
- Gas engine for generation of 320 kW of electric power;
- Combustion chamber for second firing of biogas that has not been used in electric power generation.

The main purpose of the first start-up complex is to capture and destroy maximum possible amounts of biogas thereby eliminating greenhouse effect caused by emissions of biogas into the atmosphere. Composition of biogas at the Tsyntseren SCW landfill is: methane (CH4) -61%, carbon dioxide (CO2) - 33.06%. Calorific capacity of biogas is 19.8 MJ/m^3.

From 25 September, 2008 the first start-up complex was put into operation.

Company «Biogas Inter» intends during minimum one year of work of the station to measure the real production output of the landfill leaving for itself the opportunity for the future to link up to major power grids and to increase electric power generation.

Application of biogas installation in small businesses

Making use of biogas installation (BGI) in large cattle breeding and poultry complexes first of all involves resolution of such environmental problems as:

- accumulation of large amounts of biomasses polluting the environment, safe processing thereof and getting starting materials for production of vitamins and quality fertilizers;
- problem of land fertility and others.

Everyday potential of biogas production using BGI depending on concrete amounts of production amounts to ranges between 0.5 to 1.0 m^3 per day. Gained energy can be used for water heating of production premises and an office; for cooking food and fuelling a diesel electric generator; using the processed mass as fertilizer.

Institute of Energy Industry of the Academy of Sciences of Moldova has proposed the process scheme of a comprehensive bioenergy installation for generation of electric power, hot water and gas by using manure, poultry dung and solid organic waste as starting materials. Suggested technical solution ensures practically 100% usage of the burned gas energy due to implemented feedback between the power plant and the bioreactor. The installation comprises a bioreactor of 0.26 m^3 volume, reservoir for biogas of 0.08 m^3, heating device, instruments for measuring and controlling output parameters, pressure attenuator. The installation can operate in two modes; mesophilic and thermophilic. This is a demonstration installation.

Russian producers are offering biogas installations (BGI) with the working volumes of bioreactor ranging from 2.5 to 20 m^3. The cost of these BGIs without gas burning equipment is 6.0 - 12.0 thousand euros. The manufacturers claim that the return-on-investment time for these installations is 1.1 - 2.2 years. However, in the conditions of Moldova the initial construction costs can be reduced several fold. For instance, in Moldova due to exclusive standards on the quality of wine material practically all the wineries undergo restructuring whereby huge numbers of steel tanks of 10 m^3 and greater volumes are released. These tank cisterns can be used as bioreactors (methane tanks) and gas holders.

Besides, at the end of the XX century in Moldova for a long time stage-by-stage electric power blackouts were practiced. This has led to the situation when small businesses and the private sector have accumulated a large number of gasoline and diesel-fuelled electric generators which can be used as gas burning devices.

Also, it should be takeninto account that production of biogas generates biosludge. Biosludge is used as fertilizer on the farmlands and when the substrate is fully processed in the reactor of the installation, the biosludge may be used as an addition to the feeds for pigs and poultry. After uncomplicated processing (filtration and drying) of biosludge it can be sold for

commercial purposes.

Constructed BGI is not very labour intensive in maintenance (2-3 man/hours a day). Such work can be performed by low-qualified operators. As the prices on energy sources of all kinds grow further, the importance of BGIs in small businesses shall become extremely important.

2.4 Solid types of biomass

Solid biomasses comprise residues from cleaning and trimming of gardens, vineyards, sanitary cleaning of forests, materials of vegetation origin (stems of maize, sunflower, tobacco, thatch), waste from timber processing, solid industrial and communal organic wastes.

Solid types of biomass primarily as fuel wood and timber waste are primarily used for heating of living premises and for cooking using various devices.

Various heating boilers with 75 - 80% efficiency, technologies for briquetting and processing of solid biomasses to be used as fuel in local boilers (heat plants) of 0.5 - 1.0 MW. It is deemed appropriate to use these boilers to provide heat supplies for institutions in rural areas.

In terms of using solid biomasses, the following projects seem preferable:

- equipment for briquetting of plant wastes;
- vats for burning plant wastes;
- manufacturing units for making granulated wood bars and devices for altering starting materials;
- enterprises for processing solid household waste.

3. Legislative acts and regulations

3.1. Law on renewable energy

The Law of the Republic of Moldova on renewable energy (N 160-XVI of 12.07.2007) sets forth objectives and principles of State policy in the area of renewable energy sources: enhancing energy security of State and reducing adverse environmental impacts of the energy sector by annually increasing the proportion of produced and used renewable energy and fuel. The objective of State policy in the area of renewable energy is to ensure by the year 2010 generation of energy from renewable sources in the amount of 6% and by the year 2020 - in the amount of 20% of the country's energy balance.

State policy in the area of renewable energy is based on the following principles:

a) competitive selection (tenders) and promotion of the most efficient programs;

b) guaranteed marketing of renewable energy by non-discriminative connection to centralized electric power and heat grids as well as by guaranteed marketing of renewable fuel via access to transportation and distribution networks;

c) promoting generation of electric power from renewable sources via compulsory procurements by the suppliers of preset quotas of electric power generated from the sources of concern;

d) providing economic and financial incentives for the process of assimilation of renewable energy sources.

The Government employs the tools and incentives for financial and economic support to generation and usage of renewable energy. For example, the legislation provides for tax and loan privileges for individuals and economic legal entities who are manufacturing or remodeling technical devices and appliances functioning on the basis of renewable energy sources.

3.2. Methodology for calculating, establishing and applying tariffs on electric power generated from renewable energy sources and biofuel

In order to arrange for investments into RES production projects, tariffs should cover return on investment for the producers as well as make possible certain rate of profit. On the other hand, these tariffs should allow for competitiveness of RES in the market.

The National Agency regulation in the energy sector of the Republic of Moldova (NARE) is entitled to approve tariffs on each type of renewable energy and fuel calculated by the producer on the basis of methodologies approved by the NARE. In accordance with the Law on renewable energy and with the National financial accounting standards (NAS) of the Republic of Moldova, the NARE approved the Methodology For Calculating, Establishing And Applying Tariffs On Electric Power Generated From Renewable Energy Sources And Biofuel.[6]

The methodology establishes:

a) structure and procedures for determining regulated incomes and expenditures;

b) procedures for calculation, approval and application of regulated tariffs;

c) procedures and arrangements for correcting tariffs for the period of validity of the methodology.

The methodology is targeted at for efficient and profitable performance of the enterprises that would enable them to recover financial investments into developing, upgrading and renovating production facilities. The methodology provides for the recovery of investments made into constructing, enlarging or upgrading installations, transportation-and-communication and distribution fuel and energy lines within the period of up to 15 years upon condition that the rate of cost efficiency would not exceed more than two-fold the respective cost-efficiency rate in the traditional energy sector.

The methodology is binding for all energy generating facilities if the generator's energy producing electric installations' capacity is not less than 10 kW and the electric power generated by them is pre-designated for the electric power market as well as foe all enterprises producing biofuel for the market of oil refinery products.

3.3. Law on Science-and-Technology Parks and Innovative Incubators

The Parliament of the Republic of Moldova on 21 June, 2007 passed the Law on Science-and-Technology Parks[7] and Innovative Incubators[8]. The Law is targeted at stimulating activities

in the area of innovation and technology transfer, transformation of the results of scientific research and innovations into new or improved products, services, processes.

In the framework of scientific-and-technological park, active are organizations operating in the area of science and innovations. Functioning period should not exceed 25 years for the scientific-and-technological park and 15 years for the innovative incubator. Economic entities, other legal entities and individuals taking part in respective projects are entitled to privileges in using human and material resources.

In the framework of science-and-technology park, the following purposes are brought

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[6] The methodology came into force on 27 February, 2009 and will be enforced for 15 years. The methodology was produced by a group of experts from the consulting company „SWECO International AB" (Sweden) and „Pierre Atwood" (USA) in the framework of the project for technical assistance rendered by the Swedish Agency for co-operation and international development.

[7] A Science-and-technology park is a pool of legal entities and individual persons grouped on the basis of an agreement of association. It comprises organizations operating in the area of science and innovations, other entities operating in the area of innovations and technology transfers, economic entities using achievements of science and innovations.

[8] An Innovative incubator is a pool of legal entities and individual persons on the basis of association agreement concluded between the administrator of the incubator, on the one side, and the residents of this incubator, on the other side and using achievements of science and innovations from one or more science-and-technology areasby means of activities in the area of innovations and technology transfer and involved in research aimed at rendering scientific support to the activities concerned.

into effect:

a) using research results and innovations in the internal and external markets;

b) market studies, preliminary feasibility studies of the research deliverables;

c) attracting new economic entities and investments towards research and education;

d) creating new jobs in developing, introducing and using new front-edge technologies, stimulating ingress of high-class professionals into research and technological development sphere;

e) orienting organizations in the area of science and innovations towards requirements of internal and external markets, encouraging their initiatives in mobilizing additional financial resources;

f) inducing economic entities of private sector to take active part in developing and using the results of research and innovations for creation of new commodities (services);

Administrator of the innovative incubator renders incubation services including:

a) offers at reduced prices or free of charge, services in property leases, consulting, assessment and promotion of intellectual property objects, marketing, financial accounting, information, juridical services as well as other services contributing to the performance of the residents of innovative incubator;

b) attracts investments;

c) seeks for, and provides opportunities for implementation of innovations facilitating contacts of residents with other private individuals and legal entities including small and medium-sized enterprises.

4. Implemented projects

4.1 Science-and-Technology park 'Academica'

In keeping with the Law On Science-And-Technology Parks And Innovative Incubators the science-and-technology park 'Academica' has been set up.

Science-and-technology park 'Academica' has 31 residents of whom 8 have projects in the area of bioenergy, in particular:

- L.t.d., „Biocombustibil" – production of electric power and biodiesel fuel from biomass;
- L.t.d., „Agromodvita" – production of fuel for diesel engines from water plants (algae);
- L.t.d., „Bioprodagro" – processing of corn into bioethanol and derivatives;
- L.t.d., „Întroducere" – production of alternative fuel for engines – bioethanol from sweet sorghum.

4.2 Innovative incubator

In keeping with the Law On Science-And-Technology Parks And Innovative Incubators innovative incubator „Inovatorul" has been set up. Innovative incubator „Inovatorul" was created on the proposal from science-and-technology cluster in the framework of Partnership Agreement between the Government and the Academy of Sciences of the Republic of Moldova.

The innovative incubator was established with the purpose to promote, encourage creation and develop innovative companies whose activities are based on front-edge technologies applied in various areas.

4.3 RES landfill

Based on accepted legislative acts, in Moldova a landfill of renewable energy sources was put into operation. One of the purposes for the landfill is to perform experimental study of innovative technological solutions and technologies elaborated in the Republic, in order to improve and promote those for practical usage. At the landfill they demonstrate the best foreign and domestic technologies and samples of machinery for transforming and using energy from renewable sources applicable for usage in Moldova. In real conditions they test

performance of devices, processes and comprehensive systems for transforming the energy potential of RES elaborated in Moldova. The landfill is used as testing ground to verify the efficiency of new engineering designs and technologies for transforming the energy of renewable sources.

Experimental-and-technological section of the RES landfill: bioenergy sector.

In the framework of the landfill there is a special experimental site dedicated to bioenergy. Technological equipment of the site comprises:

- Experimental demonstration unit for obtaining biodiesel (manufactured in Bulgaria)
- Experimental demonstration unit for ethanol dehydration (Institute of applied physics of the Moldova Academy of Sciences)
- Unit for briquetting of plant raw materials (complex – final drying, crushing, grinding, pressing, packaging).
- Boilers operating on solid biofuel (heating capacity up to 30 kW).
- Land plots for cultivation of energy cultures (sweet sorghum, rape, artichoke, poplar, etc.).
- Proportioning measure meter for preparing and dispensing the mixture of fuel and biofuel.

Scientific objectives pursued at the site comprise:

1. Experimental evaluation of the efficiency of the cycle of obtaining bioenergy in Moldova for various energy cultures.
2. Developing and efficiency testing of cost-reduction methods in the processing of starting materials used in making liquid fuel.
3. Experimental efficiency verification of new methods for preparation of raw materials used in producing bioethanol, biodiesel, solid biofuel from plant raw materials and wasre from plants cultivation.
4. Resolving problems in automating the process of direct combustion of solid biofuel.
5. Ecological aspects involved in the usage of solid biofuel and solid waste, for example identifying radioactive hazards of the products of biofuel combustion as well as concentrations of heavy metals in the ashes.

5. Barriers impeding assimilation of renewable energy sources.

Implemented projects involving renewable energy generation and usage entail inferences regarding a number of hindrances in the way of integrating bioenergy in the Republic of Moldova:

а) Hindrances of legislative, institutional and information nature:

- insufficient level of compliance with legislation on environmental protection;
- lacking financial resources for the implementation of fundamental principles of ecology and stable development;
- insufficient data on local and regional project developers, successes or failures, lack of project and consulting centers in this field;
- deficient information on contemporary technologies for tapping on the RES potential;
- formed belief of local high-level public officials that integration of RES is an exclusive competence of the Government;
- low skill level of engineers and technicians in the area of modern technologies for transforming various types of RES into electric power, heat, etc.;
- lacking syllabuses on the RES in the curricula of educational establishments;
- lacking comprehensive educational syllabuses on the RES and the personnel training programs for the area concerned.

б) Technical, technological and financial:

■ lack of locally manufactured equipment (with the exception of solar water heaters) required for transformation for various types of RES;

■ need for individual systems to accumulate heat or electric power which often result in considerably increased investments;

■ considerable initial investments required for construction of installations for transformation in the RES;

■ high interest rate on bank loans as well as long period of investments payoff;

■ need for considerable investments involved when small generators of electric power from the RES have to link-up to distribution grids.

Conclusion

• In the energy balance of Moldova for 2007, gross consumption of energy resources amounted to 3.37 mln tce. Natural, technological and economic conditions enable broad scale usage of biomass in various states as well as organic waste. By 2010, forecasted biomass should reach around 70% of the total amount of renewable energy sources utilized in Moldova, and the volume consumed should be 240 - 300 ktce (167-210 ktoe).

• Presently, the technologies for using biomass are at the inception stage of development. Many technologies already have promising perspectives for commercialization in the nearest future, especially in view of increasing cost of natural gas.

• To assimilate new technologies for biomass usage the Republic of Moldova needs technical assistance and transfer of technologies from industrialized countries.

• The process of bioenergy technologies implementation in the Republic of Moldova started with putting into operation of up-to-date boilers for incineration of wood and straw wastes. Other technologies for producing energy from biomass are of no less importance and they shall be priorities in the nearest future, however they still need to pass through demonstration stage for verification of their economic indicators' competitiveness. Priority projects would comprise biomass briquetting and usage in the household sector, introduction of biogas installations, production of biofuel based on rape oil, of ethanol on the basis of sweet sorghum cultivation, growing energy cultures (e.g., white willow) on nitrate polluted plots and on salined soils.

• Formation and evolution of competitive national bioenergy branch is demandable for sustainable development of Moldova economy. Stimulating interventions are required for the development of bioenergy in Moldova aimed at ensuring healthy competition and sustainable balance between production of food products, feeds, fuels and fertilizers.

• It is necessary to develop domestic production of equipment used in generating bioenergy. Experience of foreign producers and transfer of technologies play a key role here. Dissemination of information about local and regional project developers, successes or failures, organization of design and consulting centers in this field would contribute to the process of implementation of RES and in particular, of bioenergy. It is necessary to draw up comprehensive educational syllabuses on RES as well as cadre training curricula for this area.

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