DEVELOPMENT ASSISTANCE PROJECT

Partner country (project site): Official name of the State in English and name of the city or region if relevant **Chisinau, Republic of Moldova**	**Application number:** Allocated by the MFA -
Project title: **Autonomous integrated irrigation systems based on wind turbines, small hydro and photovoltaic installations**	
Estimated start date: Month / year: **11/2015**	**Estimated end date:** Month / year: **10/2017**
Estimated total project budget: **166066 Eur**	**Co-financing total: 87116 Eur** including contribution by other donor(s)
Amount requested from the MFA: **1618475 MDL/78950 Euro**	**Contribution from other institution or other donor(s)** obligatory for trilateral projects

1. Relevance of the Action

Development problem:

Global food security is endangered by rapid population growth and consequently increasing demand. As result, world market food prices are continuously increasing. Climate change is manifested by increased severity and climate variability and this phenomenon is not a regional, but rather global. It is clear that sustainable agriculture development is closely related to irrigation and fertilization of the agricultural land. Only an optimal combination of energy and water resources used for irrigation, mineral fertilization and organic soil of the Republic of Moldova will ensure a continued growth in agricultural production and food security. Also, this will help to decrease soil degradation and climatic vagaries dependence of agricultural production.

The climatic conditions of the Republic of Moldova impose that the optimal water amount needed during the active growing season for most crops consists of 300-700 mm. According to long-term weather observations for the above metioned period, the average amount of rainfall is from 235 mm in the south up to 330 mm in the northern region. Natural moisture is insufficient to achieve the expected amount for fruits, or especially for vegetables, even in years with above average climatic characteristics. Often, the Republic of Moldova, Romania and Ukraine are subjects to long-term droughts.

After 1991, there were implemented the key agriculture reforms characterized primarily by restructuring large agricultural units, decentralization of agricultural production, land privatization, formation of new economic relations based on market economy. The changes that took place in agriculture and power supply sector influenced negatively in particular the existing irrigation systems. The main causes that contributed to the aggravation of irrigation systems status are:

- sudden increase in electricity and fuel prices;
- reduced water demand from new landowners;
- parcelisation of the land made impossible the efficient use of pumping stations, water supply systems and irrigation facilities, designed, developed and built to irrigate large areas;
- small or even negative economic efficiency of irrigation systems placed at great heights with respect to water sources;
- bad management of involved companies and local authorities led to dissasemblyof watering plants, removing and selling non-ferrous metal pipes;
- technical obsolescence of irrigation equipment and facilities. In the last 10 years there were not purchased any new equipment;
- lack of state subsidies for the electricity purchase.

Considering the above, the Government of RM adopted Decision no. 256 of 17 April 2001 "On the rehabilitation of irrigation systems" According to this decision it is expected to achieve the following objectives: rehabilitation of large irrigation on 124,300 ha (40% of the irrigable area), 1991 irrigation systems will be equipped with mobile irrigation equipment with high productivity, low energy and water consumption; small irrigation implemented on 36,000 ha (small irrigation is executed on areas from 1 ha to 100 ha). As water supply sources there will be used 3000 water reservoirs, of which the most important are 411 lakes, Dniester Prut and Raut rivers. Also, small irrigation will be done with mobile

units, preferances given to modern and efficient methods including drip, sprinkler and aerosols irrigations, with the use of renewable energy as power supply. In order to minimize the negative effects on both humans and environment there will be developed and implemented the irrigation schedule techniques based on soil, crop and weather conditions monitorisation. The existing technologies and methods range from water balance or control registers up to sophisticated sensor-based systems. There is a need for an automated from the point of view of quality for watering (e.g.. Dropwise) co-cultivation and fertilization (for a drip irrigation fertilizer is brought to the root of the plant).

Target groups, beneficiaries and other key stakeholders:
The interested parties in the project are irrigable gardening land owners, located nearby rivers (using irrigation systems integrated with small hydro kinetic energy conversion of water) or reservoirs (integrated irrigation systems using wind turbines or photovoltaic installations). Wind turbines also can be integrated into irrigation systems that will use groundwater.
Form the point of view of economic and social development, the project implementation in the envisaged regions, will serve as a good practice, testing grounds and sharing experience for usage of renewable energy sources in irrigation applications for other possible stakeholders.

Specific problems to be addressed by the action:
Basic issues that will be solved in the project are: the argumentation of energy needs of an irrigation system during the growing season; calculation necessary parameters of wind, hydro and solar energy conversion systems; development of drip or sprinklers irrigation systems integrated with wind turbines, small hydro and photovoltaic installations; development of an automated interactive system for monitorisation and optimization of the water, nutrients and pesticides flow control, that is a useful tool that allows small and medium farmers to set up and master the irrigation, fertilization and plant protection product applications.

Relevance of the proposal to identified problems:
Dropwise or sprinkler irrigation systems integrated with wind turbines, small hydro and photovoltaic installations and automated control system for monitorisation and optimization software for automatic linking process of the factors related to soil, water, fertilizers and plant protection treatments, will help to reduce the cost of necessary irrigation (especially for long-distance networks to irrigable land) and partly to reduce the environment pollution.

Relevance of the proposal to the objectives and priorities of the Call for proposals:
The drastic reduction of irrigated land in the last 20 years in Republic Moldova can be explained mainly by electricity price increase, since 95 % of the power demand is either imported or produced from imported fossil fuels. The objectives of the project will reduce energy dependence on imported energy sources in Republic Moldova.

Relevance of the proposal to the objectives and priorities of the donor co-financing the action:
Only in case of trilateral projects

2. Description of the Action and its Effectiveness

Analysis of project strategy - description of the proposed action including background information where relevant

Goal (development objective):	**Key indicators:**
Creating systems for drip or sprinkler irrigation systems integrated with energy conversion systems (wind, hydro and solar photovoltaic) and computerized intelligent and interactive control by managing simultaneously irrigation, fertilization and phytosanitary treatments application processes. This will reduce long-term energy dependency of irrigation systems users, reducing the cost of agricultural production and consequently contributing to the achievement by Republic Moldova the 20% green energy goal by year 2020. Team experience gained over the last 15 years will be crucial for the success of the proposed project. Multidisciplinary and multi-criteria analysis of the integration of wind turbines, micro hydro power plants and photovoltaic installations with irrigation systems will allow power supply autonomy, operational optimization and efficient design of irrigation systems. Using wind,	Mostly based on national statistic data (e.g. MDG[1] indicators)

[1] Millenium Development Goals (UN doc)

hydro and solar energy resources will reduce the poverty of rural population by supporting rural producers of agricultural products and ensuring new jobs.	
Outcomes (project purpose): The transition to renewable energy sources (wind, hydro, solar) will reduce the needs for imported fossil fuels and power suplies. Also, it will reduce the costs of the power supply used to irrigate farmlands. Together with the implementation of automation, computerization and monitorisation of agricultural processes will provide effective support for enhancement tof the competitiveness of the agricultural anf food producing sectors in Republic Moldova.	**Key indicators:** Should reflect the change that project itself is expected to bring about (and measure)

Project strategy:

Traditionally irrigation systems are supplied with electricity from centralized networks. In some cases the electrical networks are at long distances from national electric grid. The project strategy consists in replacing traditional power sources needed in irrigation systems with those based on non-traditional sources such as wind, hydro and solar energy conversion systems. As high-level objectives of the project there are integration of irrigation systems with renewable energies, that will provide a triple effect: economically - providing relatively cheap energy; ecological aspect - helps to reduce pollution and indirectly increase organic food production; politically – EU and Republic of Moldova commitment in achieving desired level of 20% green energy in total power needs by 2020.

In order to achieve the set out purposes, the project planned activities are divided into the following steps:

1. Estimate the annual energy needs (seasonal) for a drip or sprinkler irrigation system and calculate the available energy potential.
2. Design and develope the following:
- Design a drip irrigation system integrated with a wind turbine and a photovoltaic installation;
- Design a sprinkler irrigation integrated with a small hydro kinetic energy conversion installation;
- Design a drip or sprinkler irrigation systrem integrated with a photovoltaic installation;
- Design an automated control system for monitorisation and optimization of irrigation processes, applications of nutrients and pesticides, climate data acquisition units, unit information processing and automatic driving unit.
- Design and develope a software for all units as a practical and effective tool for automatically correlating the factors related to soil, water, fertilizers and plant protection treatments.

3. Manufacture:

- Manufacture and complete the standardized nodes for drip irrigation system integrated in an experimental prototype system with a wind turbine and a photovoltaic installation;
- Manufacture the experimental prototype sprinkler irrigation system integrated with a photovoltaic installation.
- Manufacture the experimental automated prototype system for controling the monitorisation and optimization of irrigation, application of nutrients and pesticides processes, data acquisition units, unit information processing and automatic control unit.

4. Testing of the manufactured experimental autonomous irrigation systems prototypes in real conditions in selected households (partners) in Criuleni and Ungheni regions.
5. Elaborate the recommendations concerning the serial manufacturing of the developed autonomous irrigation systems.
6. Elaborate the recommendations for large-scale implementation of developed autonomous irrigation systems.
7. Dissemination of results.

Specification of the target groups:

The basic target groups are both large farming companies and small farmers, trained in particular in the vegetables and fruits cultivation. For hydro conversdion systems agricultural areas located near Nistru, Prut and Raut River rivers are recommended. Elsewhere, it is recommended to implement the irrigation systems integrated with wind turbines or photovoltaic installations. The solar conversion installations are recommended especially for small irrigation. Testing the irrigation systems integrated with wind turbine and photovoltaic installations will be carried out with the support of the district and agricultural land owners from Criuleni and Ungheni (Floreni).

Other key stakeholders:
At the local level - local authorities will be interested in implementing autonomous irrigation system integrated with wind turbines, micro hydro power plants and photovoltaic installations. At the national level - the project will contribute to increased agricultural production and its quality, to achieve the goal of 20% clean energy by 2020.

3. Efficiency of the Action

Outputs:	**Key indicators:**
In the short term project will provide: increased productivity of irrigated land; energy independence; reducing pollution; indirect contribution to increase organic food production and automation, computerization and monitoring of agricultural processes will provide effective support to enhance the technical and economic competitiveness of small and medium farms agribusiness sector.	Quantitative and qualitative data that measure extent / amount, time and quality of "products"

Proposed activity clusters:
Groups of the proposed activities:
To produce the required short-term outcomes were determined five main groups of activities and specific actions to be taken.

GA1. Management activities, coordination and communication - the duration of the project.

GA2. Estimate the annual energy needs (seasonal) of a drip irrigation system and sprinkler and calculating energy potential (months 1-3):

2.1. Estimate the annual energy needs (seasonal) of a drip irrigation system and sprinklers (v, Floreni, Ungheni; Criuleni);

2.2. Calculating the wind an solar energy potential (v. Floreni, distr. Ungheni), and the solar energy potential (distr. Criuleni);

GA3. The design of autonomous drip and sprinkler irrigation systems integrated with wind turbine and photovoltaic (months 3-12, Technical University of Moldova):

3.1. Design of drip irrigation integrated with wind turbine and photovoltaic installation.

3.2. Design of sprinkler irrigation integrated with photovoltaic installation.

3.3. Design of automated control system for monitoring and optimization to ensure irrigation processes, application of nutrients and pesticides, climate data acquisition units, unit information processing and automatic driving unit.

3.4. Design and development of software for all units as a practical and effective tool for automatically correlating factors related to soil, water, fertilizers and plant protection treatments.

GA4. Production and completion of standardized components pilot prototyping drip and sprinkler irrigation system integrated with wind turbine, micro hydropower and photovoltaic (9-17 months, Chisinau, Technical University of Moldova, mechanical enterprises):

4.1. Production and completion of standardized components for prototype pilot drip irrigation system integrated with wind turbine and photovoltaic installation;

4.2. Production and completion of standardized components of the prototype pilot sprinklers irrigation system integrated with photovoltaic instalation.

4.3. The manufacturing of the experimental prototype automated control system for process monitoring and optimization to ensure irrigation, application of nutrients and pesticides, data acquisition units, unit information processing and automatic driving unit.

GA5. Test manufactured autonomous irrigation system prototypes in real conditions (18-23 months):

5.1. Test prototype drip irrigation system integrated with wind turbine and photovoltaic installation (v. Floreni, distr. Ungheni);

5.2. Test prototype drip irrigation system integrated with photovoltaic installation (Criuleni);

GA6. Elaboration of recommendations (months 23-24)

6.1. Elaboration of recommendations for serial production of developed autonomous irrigation systems.

6.2. Preparation of recommendations on the implementation of developed autonomous large-scale irrigation systems.

GA7. Dissemination of results (3-24 months).

7.1. Publishing scientific results in international journals and booklets;

7.2. Presentation of scientific results in national and international exhibitions;

7.3. Organizing workshops for potential private decision makers in local authorities in rural areas etc.;

7.4. Training specialists in the development of systems for converting energy from renewable sources (Cycle I, Cycle II Cycle III according to the Bologna Process);
7.5. Develop, publish and disseminate information materials on the installation and maintenance of irrigation systems integrated with wind turbines and solar installations.
7.6. Promoting the the results of the radio and TV, the print media.

Estimated total budget of the action (and cost-sharing scheme, if applicable):

Amount required from the MFA:	% MFA: 47.5%
Contribution by other donor(s):	% other donor:
Contribution by local partners:	% partners: 31.5%
Contribution by applicant:	% applicant: 21.0%

4. Feasibility and Sustainability of the Action

Risks analysis and contingency plans:

Political risks. Testing and subsequent use of micro hydropower plants will require their installation on r. Prut and Dniester rivers and will require coordination actions between border services of neigbouring contries. The change of political course of the Republic could affect the project. Environmental risks. Are practically excluded since the power supply used for irrigation systems will be wind energy conversion systems, hydraulic (water kinetic energy without building dams) and solar energy.

Economic risk. During the Project implementation it is not predicted any economic risk. In the long term it can be one of the following. First, the lack of information and knowledge from possible users, which can be reduced by a wide dissemination of the results in various forms. Second, it could be the lack of funds for project implementation. Development of autonomous irrigation systems integrated with wind turbines, micro hydro power plants and photovoltaic installations with automatic orientation to the sun, which has high level of efficiency and remains low cost, can drive external financing.

Physical risks. Climatic conditions can affect the installation and testing of autonomous systems of irrigation. For example, the micro-hydropower plant may be impaired by a strong flood. Running a strong foundation and installation of infrastructure protection will reduce this risk. Impossibility of performance tests during proposed periods. Being short term these risks will be eliminated by modifying the work plan and the terms of activities realization.

Legal risks. Legislative and policy changes in national and local authorities could compromise a part of the Project. Reducing the influence of these risks can be achieved by reducing the liability for such changes by monitoring and limiting such changes that may have an effect on the project.

Technical risks: Lack of technical equipment needed for the project specified in the contract signed for the analysis and evaluation of services and / or lack of proper maintenance. Reducing the influence of risk: better organization of tenders. Incorrect execution of the steps in the project by the applicant and the partners. Ways to limit the risks: periodic sweeps of progress in implementing the contract research services.

Human risks: lack of cooperation with local staff. Limitation: restoration contract workload distribution among other partners. Operating errors that lead to increased cost of the project objectives. Limitation: continuous monitoring of each action based on verifiable indicators.

Financial risks:

- Failure to provide necessary funding timeline activities. Consequences: breach contract terms. Limitation: contact with the Managing Authority.

Rising prices of equipment, utilities and supplies. Effect: increase of total project costs. Limitation: reallocation of financial resources required.

Overcoming the costs allocated to the project stages to the applicant and partners. Consequences: Changes in the project budget. Limitation: periodic financial control documents.

Assumptions:
Project will succeed because it fits perfectly into European development strategy 2020 Energy Strategy of the Republic of Moldova which provides increased energy production "green" up to 20% of total consumption by 2020, Environmental Strategy 2023, which provides for reduction pollutants and greenhouse gases in the National Development Strategy of the Republic of Moldova 2012-2020 (energy efficiency) in Case no. 282 on the approval of the National Strategy for Sustainable Development of the agroindustrial complex of the Republic of Moldova (2008-2015) as "profitable expansion of irrigation".

Sustainability:
Due to the advantages mentioned above, the project will attract a large number of users wishing to implemet the results, leading to long-term sustainability. Financial applications developed within the project will be supported by the beneficiaries of installed systems: staff training costs are supported by the project; operating and maintenance costs (costs that will not be too high) will be borne by local communities; For this purpose, there are obtained approvals from local authorities associated with the project. Financial sustainability is of great interest to extend applications in as many places as possible. It will be the task of local authorities, which will have to allocate additional funds and / or organize fundraising. It can be appreciated that the interest in such shares exceed the risks (discussed above) and will be necessary more actions in this regard made with the support of regional and government policies.

5. Organisation and Performance

Applicant (name, address, contacts):
Technical University of Moldova:
- Department "Machine Design Basics." - Tel. / Fax. 509939. 022 E-mail: dulgheru@mail.utm.md, valeriudulgheru@yahoo.com;
- Department of Information Technology, Space Technology Centre, Tel: 022 235239. / Fax. 022 235441, E-mail: nsecrieru@mail.utm.md; nsecrieru@gmail.com

Local partner for project implementation, if applicable (name, address, contacts):

1. Ministry of Agriculture and Food Industry, Directorate "*Policies and Regulations production quality plant products".* Mihai Suvac, tel. 022 21 15 75, email: mihai.suvac@maia.gov.md;
2. Agricultural enterprise "*Fortina-Lapis"*, v. Floreni, distr. Ungheni. Tel: +373 273 297 14. E-Mail: lescons@yahoo.com
3. Agricultural enterprise "*Triden"* LLC, v. Criuleni, str. Aug. 31, 1989. Tel.: +373 248 74 290. E-mail: agriest.com@gmail.com.

Fields of operation and previous experience in the given sector or region:
One of the basic scientific directions of the Departments is to develop renewable energy conversion systems. In this area the Department was founded specialization Master (Cycle II according to the Bologna Process) "Systems Engineering Renewable Energy Conversion". In order to improve scientific research in the field was created Centre for Development of Renewable Energy Conversion Systems, which includes: a laboratory modeling and simulation of wind rotors and hydraulic stations equipped with advanced graphics and software simulation of the interaction of the fluid with the blade ANSYS; a research laboratory aero / hydrodynamic features a wind tunnel for aero profiles breath / hydrodynamics; a Laboratory Technologies manufacturing composite blades; two polygons testing of wind energy conversion systems and solar design and development department of information systems, laboratory for hardware and software design of intelligent micro control systems. Scientific research conducted during 2007-2014 in 7 research projects in three state programs and four international projects in research programs CRDF (USA), SCOPES (Switzerland) SEE Transnational Cooperation and BSEC HDF resulted in: development, manufacture and testing of 10 wind turbines with an output of 10 kW each; industrial prototypes of two micro hydro power plants; two sizes of photovoltaic systems with automatic orientation to the sun, controlled and monitored remotely.

Roles and responsibilities of applicant and the partner(s):

Roles and responsibilities of the applicant and their partner:

Technical University of Moldova, departments "Machinery Design Basics", "Information Technology", "Space Technologies Center" will: estimate the annual energy needs (seasonal) a drip irrigation system and sprinkler and calculating energy potential; conceptual development, design, manufacture and testing of autonomous systems of drip irrigation and sprinkler integrated wind turbine, micro hydropower and photovoltaic installation with automatic orientation to the sun; experimental prototype development and manufacture of automatic control system for monitoring and optimization to ensure irrigation processes, application of nutrients and pesticides, data acquisition units, unit information processing and automatic driving unit; developing recommendations for making the number of autonomous systems developed irrigation and widespread implementation; dissemination of results.

Agricultural enterprise "*Fortina-Lapis"*, v. Floreni, distr. Ungheni - implementation of autonomous irrigation system integrated with wind turbine and photovoltaic installations.

Agricultural enterprise "*Fortina-Lapis"*, v. Floreni, distr. Ungheni - implementation of autonomous irrigation system integrated with wind turbine and photovoltaic installations.

Agricultural enterprise "*Triden"* LLC, v. Criuleni - implementation of autonomous irrigation system integrated with photovoltaic installations.