UNIVERSITY OF
PATRAS
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

*Greece – China Call for Proposals for Joint RT&D Projects* launched under the auspices of the Ministry of Science and Technology (MOST) of the People's Republic of China and the Ministry of Education, Research and Religious Affairs/ General Secretariat of Research and Technology (GSRT) of the Hellenic Republic.

*Greek side: Funded under European Regional Development Fund (ERDF) and National Resources (GSRT)*



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| **Project title:** | **Integrated management and exploitation of multi-dispersed agricultural residues – application to energy production** |
| **Acronym and project number, Start & Duration** | **SYNAGRON** 81049<br>Start: 14/10/2019, Duration: 3 years |
| **Partners from Greece:** | 1. University of Patras, Dept of Environmental Engineering (Coordinator) & Dept of Chemical Engineering<br>2. University of Western Macedonia, Chemical Engineering Dept<br>3. SIRMET S.A. |
| **Partners from China:** | 1. Beijing University of Chemical Technology, BUCT<br>2. Beijing United Pioneer Environmental Engineering Co., Ltd<br>3. Nanjing Benran Environmental Technology Co., Ltd |
| **Other Collaborating Organizations:** | Khalifa University of Science and Technology, KUST, United Arab Emirates |
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| **Deliverable D1.1a:** | **Report on the most promising agricultural residues in Greece** |
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**Patras, 10/7/2020**

# EXECUTIVE SUMMARY

It is widely accepted by most of the scientific community, that the last decades the observable high- speed increase in anthropogenic greenhouse gas concentrations has cause changes in global climate. Also, the future availability of the non- renewable fuels has given rise to significant public apprehension. Renewable energy sources (RES) are exploitable energy forms that rise from diverse physical processes. The most promising among the renewable energy sources is biomass energy potential. Agricultural biomass refers to the agricultural residues which remain in the fields after harvesting along with the tree pruning. The most plentiful and renewable resources on the planet are the agro-industrial residues. Greece is an agricultural country and significant percentage of its biomass consists of agricultural and animal waste. The residents of Greece have the opportunity to exploit almost any kind of renewable energy forms. This owns to the diverse topography of the country and temperate climate, to the agricultural and animal breeding culture and to the windy and shiny climate. In Greece only a small percentage of biomass is used to cover electrical energy needs. Huge amounts of agricultural residues and animal manures are being deposed uncontrollably in the environment or in landfills, while farmers most of the times proceed to the burning of the residual biomass in the field.

Residual biomass could arise from the agricultural sector in the form of crop residues and of animal waste. In this report, literature review has been fulfilled on primary agricultural waste that includes crop residues that are left on fields, on secondary agricultural waste that includes liquid and solid waste from agricultural treatment plants and on animal manures. Based on the literature review, the residues were divided into three categories:

1. **Agricultural residues**
2. **Animal manure**
3. **Agro- industrial residues**

In the chapter of agricultural residues, were descripted the production and the harvested area of the main crops in Greece, as well as the production and the physicochemical characteristics of the residues from these crops. Specifically, the main crops include wheat for crop, edible legumes, industrial plants, potatoes, vegetables and tree plantations. In the category of wheat for crop the most abundant residues are those of maize. In edible legumes, the crop that stands out is that of beans, except from the year 2016 that chickpeas prevail. In terms of industrial crops, the largest amount of residues is presented by cotton. Lastly, the tree plantations with the biggest quantity of pruning are those of olives and is followed by citrus. The largest amount of agricultural residues is produced at the regions of Thessaly, Macedonia, Peloponnese and Crete Island. According to the physicochemical characteristics of each residue, especially the moisture percentage and C/N ratio, conclusions can be drawn as to which residues are biodegradable and which is the appropriate method of treating them. For low moisture content and high C:N ratio thermochemical treatment of biomass is suitable and on the other hand biochemical treatment is suitable. The residues of wheat for crop, edible legumes and trees could be classified as non-biodegradable and suitable for thermochemical treatment, in contrast with the residues of tobacco, sugar beet, potatoes

and vegetables which could be classified as biodegradable and suitable for biochemical treatment. Also, from the physicochemical characteristics of each residue was extracted the estimated energy of each crop. From all the categories olive prunings present the biggest estimated energy and is followed by citrus prunings.

Chapter 2.2. refers to the animal waste and particularly to the produced manure. In Greece, animals produce significant amount of manure due to the high animal breeding activity. Most of the manure is produced from pigs, cattle, poultry and sheep/goats and the largest amount is presented by sheep and goats. The exploitation of these wastes, that used to do the farm owners, was to sell them as fertilizer or simply spread onto agricultural and/or arable land. Livestock manure is the kind of waste suitable for biochemical treatment due to its high moisture percentage (above 70%) and its low C/N ratio (below 30). From the physicochemical characteristics of the manure was calculated the estimated energy with sheep and goat manure present the biggest estimated energy.

Lastly, mention made on the secondary agricultural waste and specifically the liquid and solid waste from agricultural treatment plants. These materials can be used to yield a major of valuable added products such as fuels. The quantities of these waste as well as their characteristics were described in the chapter 2.3. The agricultural industries, for which the wastes were reported, were of orange, peach, beer, cheese, cotton, flour, olive, potato, rice, sugar, sunflower, tobacco, tomato and of wine. These industries produce vast amounts of liquid and solid wastes. The most abundant agro- industrial residues are those of olive mills and these residues are followed by the agro- industrial residues of breweries, of sugar industry, of cheese industry, of tomato processing industry and of wineries. Some of these wastes could be used/ or are used for animal feeding (e.g. sugar beet pulp, citrus pulp). Industrial wastewaters are suitable for biochemical treatment as they contain high percentage of moisture (wastewater from orange production, liquid waste from sunflower oil production, tomato processing wastewater, liquid waste from refining facilities, wine lees, olive mill wastewater and potato wastewater).