**No-Waste – Utilization of Industrial By-products and Waste in Environmental Protection**

Environmental pollution is a global problem. Unsustainable production of goods, improper treatment of waste, emissions to air and water, and inadequate legislation cause growing problems to human beings and nature. The urgent need for reducing environmental load coming from industry, agriculture and communities demands for novel ways of thinking. The No-Waste project approached resolving this problem by developing environmentally sound and sustainable possibilities to utilize and valorize different wastes and emissions. The major aim was to create valuable new products and renewable energy to minimize the waste as well as emissions to air and water.

This Marie Curie IRSES (FP7) –funded No-Waste project collected together scientists from six (6) different countries: Finland, France, Germany, Morocco, Brazil and China aiming at resolving together environmental related problems. This ambitious aim and wide operational area required extensive collaboration, but also gave the partners possibilities to widen the collaboration beyond the specific tasks of the No-Waste. In total, the No-Waste project mobilized 60 researchers and management personnel and altogether 188 exchange months were completed during the course of four years.

The research tasks in the No-Waste project concentrated on the production of hydrogen and synthesis gas from waste, valorization of wastes from olive and argan production, production of valuable chemicals from CO2 and organic gases, utilization of coal mining methane emissions and development and product design related to the hydrothermal carbonization process. In achieving the goals of the No-Waste –project, catalysis and sustainability played the major roles. The achievements of the project were gained through intensive collaboration and by integration of the expertise, research efforts and infrastructure available in the partnering institutions.

As the major achievements of the No-Waste project, we could mention a few of the results. The development of different types of catalysts have been in very central role in the project, since by using the catalysts the environmental and economic impacts of most of the processes in general can be minimized. In addition, the catalysts are used in connection with the wide variety of processes of emission treatment and water purification. During the No-Waste project new catalytic materials were developed for dry reforming of methane, ethanol steam reforming, utilization of contaminated methanol, utilization of CO2, methane oxidation in lean and rich fuel conditions, and for production of hydrogen. In each case, high activity, selectivity and stability of the catalysts are required, and due to the conditions of use, the catalyst compositions need to be optimized to the specific application. Understanding the characteristics of the catalysts and the information how they perform leads us to the best results in catalyst development. Furthermore, the use of noble metals is often required in catalytic materials, which have an important impact on their costs. Replacing of noble metals by metal oxides and reducing the required amount of noble metal will lead to more economic catalytic materials. Significant achievements were gained during the No-Waste project in these aspects. The results of these achievements are and will be published in the scientific journals. Another major achievement has been reached in the utilization of organic waste material. The main process applied here was hydrothermal carbonization, which was used in the processing of sewage sludge, argan and olive residues, waste of polymer industry among the other applications. As the result, we were able to produce fertilizers and very efficient adsorbent materials that were tested in water treatment purposes. This result has a major impact on environment – with relatively facile processing, the organic waste can indeed be turned to a valuable product that has a contribution to the environmental protection. In the case of fertilizer use, the utilization of chemical fertilizers can be minimized and in the case of adsorbents, an important impact can be seen in water purification applications, construction of percolation fields etc.

In the beginning of No-Waste, we expected the project to have environmental, economic and societal impacts. The major impact was expected to arise related to the environment by contributing to emission reduction, by minimizing the waste, and by transferring the know-how, technologies and materials, as well as increasing the environmental awareness in the partnering countries. In this terms, the No-Waste project was successful. We managed to disseminate the information on environment to the general public especially via Moroccan TV and Brazilian radio The results of the project were achieved in collaboration, and in fact, many of the results would not otherwise been possible to be reached, due to the large availability of materials, research infrastructures, experimental facilities, industrial and other contacts, knowhow etc. were available for the consortium. From the economics point of view, we have introduced several interesting possibilities for the utilization of especially organic waste originating from different types of industry. Without forgetting the utilization of gaseous emissions and production of clean energy, the results will finally end up as positive economic impacts for the companies, especially SMEs. During No-Waste we have actively sought companies that would be interested in the project results and finally ended up with 23 industrial contacts from different countries. With at least five of these contacts the work has already agreed to be continued further and new projects are to be started. Integration of the knowhow and ideas during No-Waste resulted in new research openings in the partnering institutions. At the end of the project, nine (9) new projects have started and several are under evaluation. This has an economic impact on the research groups involved and later contribution to the environment can be forecasted. The societal impacts of the project are mainly connected to the improved knowhow and widened networks of the seconded researchers. The seconded staff has benefited also from the widening of their point-of-views about different aspects, also outside the research community. The results of the project have also societal impacts in terms of improvement of the living environment of the human beings, since the results are directly connected to the reduction of waste and having cleaner air and water. The project also improved the research ethics skills of the staff involved, since research integrity was taught and discussed during the joint seminars and meetings.

During the No-Waste several workshops and meetings were organized, of which the most marked ones were the Environnement symposium organized in Morocco in 2016 and ‘utilization of waste’ workshop organized in the same place in 2014. In addition to these events, the No-Waste researchers have actively participated in the international conferences (~50 presentations), scientific journals and delivered the results of the project in local scale (~100 contributions in total).

In general, we can assess that the collaboration during No-Waste was very successful and will continue further. The starting point of the collaboration was then, and continues to be, the mutual interest of the partners towards novel green chemistry approaches for decreasing of different environmental loads. At present, this work aiming at cleaner environment is still important and should be continued so that we can leave behind a clean and healthy living environment to the next generations.

More information on the No-Waste project and its results can be found from: [www.no-waste.net](http://www.no-waste.net) and <http://www.oulu.fi/pyolamen/no-waste>

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