Research Summary Sheet

Upgrading agro-waste management strategies on regional basis around an existing technology: the anaerobic digestion and connected emerging technologies

Context and Challenges

The aim of WP3 is to provide in depth knowledge on the improving of both conventional anaerobic digestion process and advanced anaerobic digestion technologies.

In particular, the activity carried out in this WP considered the upgrade of the whole technology chain: from biomass treatment, to enriched biogas treatment, to safe digestate use. On the upfront of AD technology, the portfolio of usable agrowaste and the efficiency of the agro-waste management were expanded through the use of applications like pre-treatments and conversion of recalcitrant ligno-cellulosic streams, then processes for the bioconversion of biomass into CH4, H2, volatile fatty acids and biopolymers were studied, and finally the proper management of nutrients present in digestate was studied.

Results and Applications

Specifically, the pre-treatment of straw and other fibrous biomasses in a monitored demonstration-scale wet explosion pre-treatment (AD BoosterTM, Denmark) integrated in the biogas process to perform pre- and post treatment of lignocellulosic biomass such as straw and manure fibres. During the operative period, the parameters were fixed to obtain maximum methane production of the biogas and converting a huge part of lignocellulosic matter into biogas. In Greece, enzymatic tests and chemical delignification of wheat straw with enzymatic hydrolysis for the production of biodegradable sugars have been also performed at lab and pilot scale levels. The anaerobic digestibility of the effluents produced was measured after the definition of the optimum conditions for the pre-treatment scheme and finally the effluents were fed to a pilot scale anaerobic digester to define the biogas production for increasing OLRs.

In line with the improvement of existing AD technologies, a pilot scale plant for the production of biohythane from waste and effluents generated by a wine-vinasses distillery was studied in Narbonne, France. Studies on biohythane optimization production were

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conducted both in mesophilic and thermophilic conditions: energy recovery was significant as it was the generation of methane and hydrogen.

A demonstrative scale plant treating agro-waste such as grass residues, liquid and solid manure for the production of VFA (Volatile Fatty acids) through acidogenic fermentation, and biohythane production was operated also in Isola della Scala, Verona, Italy. VFAs, which are good precursor molecules, could be used for the successive production of PHAs (Polyhydroxyalcanoates), which have a good potential in the bioplastic market. The production of the polymer was achieved in the same plant based on aerobic PHA accumulation from a microbial mixed culture by using an effluent rich in VFAs content coming from the fermentation process.

The bio-uprade of biogas to biomethane via bio-electro processes was also studied at (large) lab scale.

Eventually, an intelligent use of digestate was defined: a near-infra-red system allowed for the proper management of nutrients streams on fields. The presence of pathogens and hazardous molecules were also defined. In this way, it was possible to minimize the effect and risk of environmental impact and make feasible the reuse of digestate in terms of nutrients recycling.

Breakthroughs, benefits and added value

The work demonstrated that it is possible, both at pilot and demo scale, to use chemico-physical-biological pre- / post- treatments of ligneocellulosic substrate to increase the bio-conversion into biogas. Production of bio-hythane (H2+CH4) was achieved from manure, crops residues, winery waste. VFA was produced from manure and crops residues and converted into into PHA but impurities are present, and extraction/purification are difficult. The intelligent, safe and environmentally sound use of digestate on fields was defined.

Further information on NoAW project: http://noaw2020.eu

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