WATERWORKS 2017 RDI FUNDED PROJECTS BOOKLET

Title of the project: RECOWATDIG

Acronym and LOGO:
RECOWATDIG

Representative image of the project:

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Project website:
http://recowatdig.pwr.edu.pl/

Abstract:
Project proposes innovative, transdisciplinary approach, by enabling an access to the potential water resources, currently neglected, i.e. water evaporated during drying of high moisture solid fermentation products. Moreover, project is aiming to achieve high synergy by integrating the water recovery with improved heat balance of the drying process and additional utilization of the latent heat, that could be recovered during the water condensation. Furthermore, project proposes to apply the hydrothermal carbonization (HTC), thus bringing the potential for synergy, due to positive effects in terms of dewaterability and sanitization.
The main goals of project : development of technology

Keywords: (In relation with Water JPI SRIA)
Water recovery, membrane purification, fitration

Open keywords:
Recovery of water from digestate , purification of waste water, hydrothermal carbonization of digestate

Project structure (WPs description):

WP 1	**Project Management**	WP is intended to integrate all management, communication and compulsory reporting tasks of this project, described in details in paragraphs 3.2, 3.3 and 3.4 of this document. • WP Leader: WUST; Involved Partners: all

WP 2	**Hybrid membrane purification of the recovered water for the agricultural use**	The aim of this WP is to determine a set of parameters for the membrane purification system necessary to achieve satisfactory quality of the water after each of the purification stages, thus enabling its subsequent use in the agriculture. Works will start with the preparations of laboratory setups, e.g. for conducting membrane pressure filtration processes using polymer and ceramic membranes, forward osmosis process or a setup for carrying the adsorption process, using hydrochars and magnetic biochars, located at WUST and KTH as well as purchases of the necessary consumables in order to ensure accomplishing all the goals in a timely manner. ZGO will provide the water samples in order to determine a reference case scenario ("business as usual"). Samples of permeates as well as samples of liquids from dewatering performed within the scope of WP3 and drying performed within the scope of WP4, will be tested by WUST. • WP Leader: WUST; Involved Partners: KTH, UT, ZGO.
WP 3	**Improvement of the dewatering properties of the digestate and its sanitization via HTC**	Activities performed within this WP will serve the purpose of the determination of the parameters of HTC that will allow to maximize the mechanical dewatering capability of the treated digestate. Works will start with the preparations of the laboratory scale HTC and mechanical dewatering rigs at UT and WUST and purchases of the necessary consumables in order to ensure accomplishing all the goals in a timely manner. Most of the tests shall be performed at UT and results of testing of the obtained samples will allow to narrow down the amount of tests on a bigger rig, located at WUST. ZGO will provide necessary samples of the digestate. • WP Leader: UT; Involved Partners: WUST, ZGO, KTH
WP4	**Sustainable recovery of water from low temperature drying of hydrochars, using condensing heat exchanger**	The goal of this WP is to optimize drying parameters of mechanically dewatered hydrochars in order to: ✓ Maximize recovery of the water during condensing. ✓ Achieving the lowest possible energy consumption for drying. Works will start with the preparations of the drying rigs at WUST and purchases of the necessary consumables in order to ensure accomplishing all the goals in a timely manner. ZGO will provide the digestate samples in order to determine a reference case scenario (drying of digestate without HTC). Rest of the samples will be delivered after the tests performed within the scope of work of WP3. • WP Leader: WUST; Involved Partners: ZGO, UT, KTH

WP 5	**Determination of the physical, structural and chemical properties of hydrochars produced from digestate**	Physical, structural and chemical properties of the hydrochars, produced from digestate during WP3 and dried during WP4, will be determined within the scope of this WP. Among these properties one can distinguish: o Presence of functional groups o Porosity and pore size and volume distribution o Magnetic properties the hydrochars Determined properties will be used as a starting point for the subsequent modelling. ZGO will provide the water samples in order to determine a reference case scenario (“business as usual”). • WP Leader: AGH; Involved Partners: KTH, WUST, UT, ZGO
WP 6	**Use of by- products from water recovery and purification stages**	Activities performed during this WP will serve the purpose of assessment of different utilization routes for by-products of water recovery and purification stages. Some of the utilization routes will serve the purpose of the installation itself, whereas others will lead to turning residues into marketable products, potentially leading to improvements in the economic performance of the installation or some gains from the environmental point of view. Important activity of production of magnetic hydrochars will serve all the purposes, mentioned above. Activities will involve: (1) Production of magnetic hydrochars (used in WP2); (2) Determination of the improvement of the gas yield of the anaerobic digestion process using HTC liquid reject stream and hydrochars; (3)Assessment of the potential use of surplus hydrochar as a soil amendment (marketable product); (4) Determination of the fuel properties of hydrochars and the level of consumption ensuring self-sustainability of the whole installation. A suite of experiments will be performed using research infrastructure and analytical equipment located at KTH, WUST and AGH. ZGO will provide necessary information about their anaerobic digestion process. • WP Leader: KTH; Involved Partners: AGH, UT, WUST, ZGO
WP 7	**Model of the proposed installation for recovery of clean water from the digestate, techno-economic and sustainability assessment**	Developing of the model of the proposed installation will be crucial in terms of assessing: Mass, energy and exergy balance of the proposed installation; Sustainability of the proposed installation; Economic feasibility of the concept; Reaping the benefits of a “smart grid ready” status, through accumulation of purified water. Results from the modelling stage will be crucial in the subsequent technical design stage. Academic partners will supply the results of their respective tests, whereas industrial partners will play an advisory role in terms of the techno-economical modelling. • WP Leader: KTH; Involved Partners: all partners

WP 8	**Technical design of a containerized installation for drying, condensation and purification of water from a digestate**	Technical design will be developed, based on the results from previous Work Packages: Achieving optimum CAPEX of the proposed installation by: Sizing of all the elements for fitting into containers (modules); Determination of the deployment and connections between each of the modules allowing to fit them into the specific floor plan; Optimization of the erection time of the installation, by finding the optimum deployment (minimalization of the man-hours on site). Guidance from industrial partners as well as data supplied by WUST and models made by KTH will be used to complete the technical design. WP Leader: HoSt; Involved Partners: UT, ZGO, WUST, KTH
WP 9	**Disseminatio n and exploitation of results**	This Work Package will be dedicated to the dissemination and exploitation of the results obtained through work performed in other WP's. The goal of this WP is raising awareness of the project results among: Academic community; Potential users of the technology; Authorities on various levels, with special emphasis on the authorities of the regions with scarce water resources and severe competition between the use of existing reservoirs for agriculture and consumption by the population; NGO's and aid organization focused on the development of the areas with scarce water resources and severe competition between the use of existing reservoirs for agriculture and consumption by the population. An exploitation plan will be submitted, as outlined in section 2.3. Preparation of the project website also falls within the scope of this WP. • WP Leader: WUST; Involved Partners: all

Outcomes and expected impact:

- Containerised (transportable) system for the purification of the water from digestate, utilizing drying and condensation, that will allow quick and efficient deployment and integration with an existing infrastructure, thus achieving CAPEX at a competitive level, by reducing the required assembly time.
- Modular technology designed as a PnP solution, allowing straightforward integration with an existing infrastructure of the plant, with a possibility of further integration of modules, achieving their commercial readiness (HTC).
- Cost efficient purification of water, which will involve optimization of OPEX by utilization of membranes requiring lower pressure (in comparison with state-of-the-art solutions) and utilization of a part of the hydrochar stream and magnetic hydrochar for filter columns.
- The unique solution to make the hydrochar as magnetic biochar for waste water application, with a high potential for patentability, will be developed by KTH basing on KTH's exiting knowledge and facilities.
- Zero waste and zero liquid discharge technology, thanks to recirculation of the reject liquid back to the anaerobic digestion and turning solids into a sellable product (soil amendment, magnetic hydrochar - sorbent).

List of deliverables expected:	
D2.1Physico-chemical properties of liquid fraction from HTC of the digestate D2.2Multistage purification of liquid fraction from HTC of the digestate: optimal configuration and parameters of MF, UF, NF and FO membranes D2.3 Multistage purification the post-condensation water after drying of the solid digestate fraction: optimal configuration and parameters of NF membranes. D2.4The use of advanced carbon materials (hydrochars, magnetic hydrochars, nanotubes) for purification of water recovered from the digestate D3.1Optimization of HTC process for maximum dewatering of the hydrochars produced from the digestate D4.1Drying and vapour condensation: comparison of results for two variants of dryer and optimization of drying of hydrothermally carbonized digestate for maximum water recovery from condensation. D5.1Physical, structural and chemical properties of HTC treated and dried hydrochars D5.2Physical, structural and chemical properties of magnetic hydrochars D6.1The use of post-HTC reject liquid reject and hydrochar in the anaerobic digestion D6.2Hydrothermally treated digestate as a fuel for pyrolysis, gasification and combustion D6.3Optimized production of the magnetic hydrochars. D7.1Detailed mass, energy and exergy balance of the installation for water recovery from hydrothermally treated digestate D7.2Techno-economic, environmental and sustainability assessment of the installation for water recovery from hydrothermally treated digestate D8.1Technical design of the containerised installation for water recovery from hydrothermally treated digestate: retrofitting possibilities and economic feasibility (internal report – not for publication due to possible IP restrictions) D8.2Retrofitting possibilities and economic feasibility of the installation for water recovery from hydrothermally treated digestate (executive summary of D8.1, without information that cannot be disclosed - publishable) D9.1 Dissemination activities report	
Contact person(s) for Communication activities (name and e-mail)	
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Expected research results to communicate and disseminate (in very general terms)	**Target groups for communication and dissemination activities:**

1. Conference publications	Conference participants: scientists, engineers, business representatives, decision makers, NGOs
2. Open Access publications in Scientific Journals	Scientists, engineers, business representatives, decision makers, NGOs, activists and interested citizens. *note: Open Access enables free and uninterrupted access to the article*
3. Publications in Scientific Journals	Scientists, engineers, business representatives, decision makers, NGOs, activists and interested citizens. *note: Articles in subscription based scientific journals typically have embargo period of 12 months. During this time articles are behind a paywall and are freely available only for members of institutions that paid for subscription. After the embargo period articles can be made available by putting in a repository (see point 4 and 5).*
4. Research Gate	Research gate is a social media for Scientists that also can serve as a repository after the embargo period.
5. Repositories	Repositories enable dissemination after the embargo period. Repositories such as Figshare and Research Gate will be used.
6. Social media	Business, professionals working in the field, NGOs, activists and general public.
Experiments / Case studies (if any): location, type of experiments:	The Netherlands: Experiments on hydrothermal carbonization of digestate, its dewatering and energy properties (potential use as fast pyrolysis feedstock). Poland: Experiments on the composition of HTC effluent, after hydrothermal carbonization, as well as its subsequent purification using ultra, micro and nano-filtration membranes as well as other novel purification techniques. Determination of chemical, structural, physical and energetic properties of hydrochars. Sweden: Experiments on magnetization and pyrolysis of hydrochars.
Water Policy context / project contribution to policies (National, European, International – UN SDGs):	International

Funder of the project: Institutions: Country	National Centre for Research and Development: Poland Nederlandse Organisatie Voor Wetenschappelijk Onderzoek: the Netherland Swedish Research Council Formas: Sweden
Photo of the Research Team, if available:	

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*Compiled by*_____ *Date,*