SuperValu€

Energy and elements recovery from wet organic waste streams

Wet residue characteristics

Four wet organic residue streams have been chosen to work with during the project:

- fruit and vegetables waste produced during the wholesale packaging and distribution processs, obtained from the partner Fresh World;
- manure from a cow farm;
- sewage sludge from a municipal waste water treatment installation;
- cheese whey from dairy processing.

The utilization of these residues is problematic and also associated with additional costs for the company, e.g. the utilization of 1 913 tons of fruit & vegetable waste causes a financial burden of 300+ kPLN (ca. 75 kEUR) on annual basis (data: Fresh World, 2017). The data about other streams will become available during the case studies to be preformed in the last phase of the project.

The samples of the studied organic streams are shown in Fig. 1, and the main composition data is shown in Fig. 2.

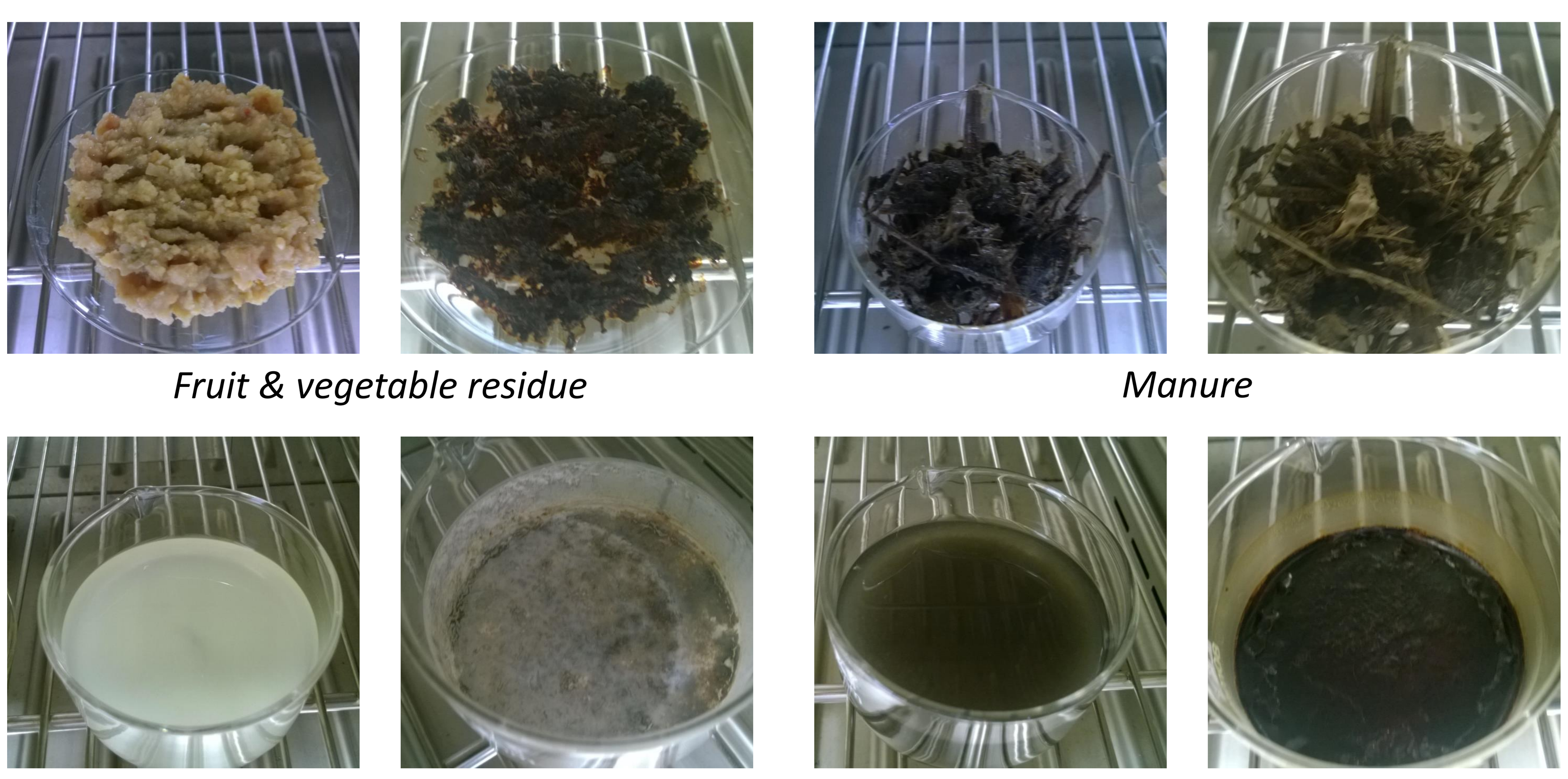


Fig. 1: Pictures of four organic residue samples analysed in the SuperValue project: as received (left) and after drying (right)

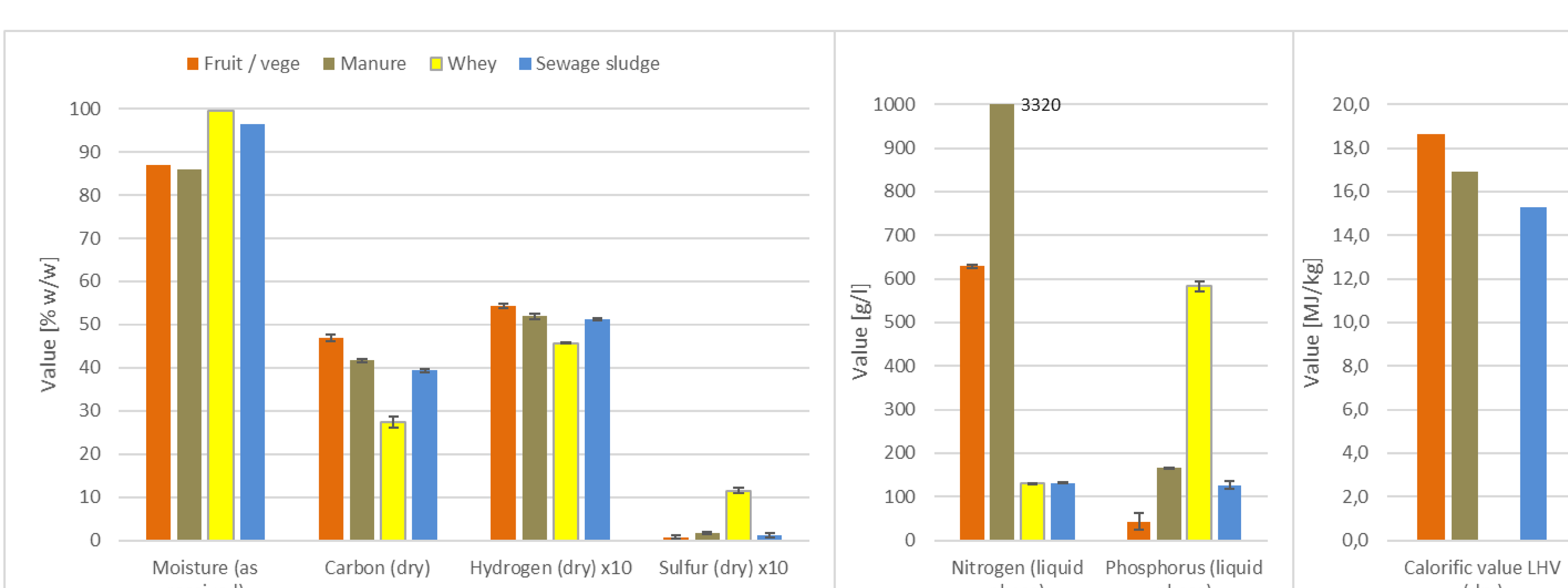


Fig. 2: Analysis results indicating the main composition parameters of the streams

Energy potential and SuperCritical Water Gasification (SCWG) technology

From the already available data an energy potential can be calculated, with in the case of Fresh World equals 4.7 TJ (1.3 GWh) of energy per year, in terms of the LHV value of the organic waste. A rough and initial assumption that 25% of this energy could be converted to electricity shows a significant reduction in the company's peak demand for electrical energy, see Fig. 3.

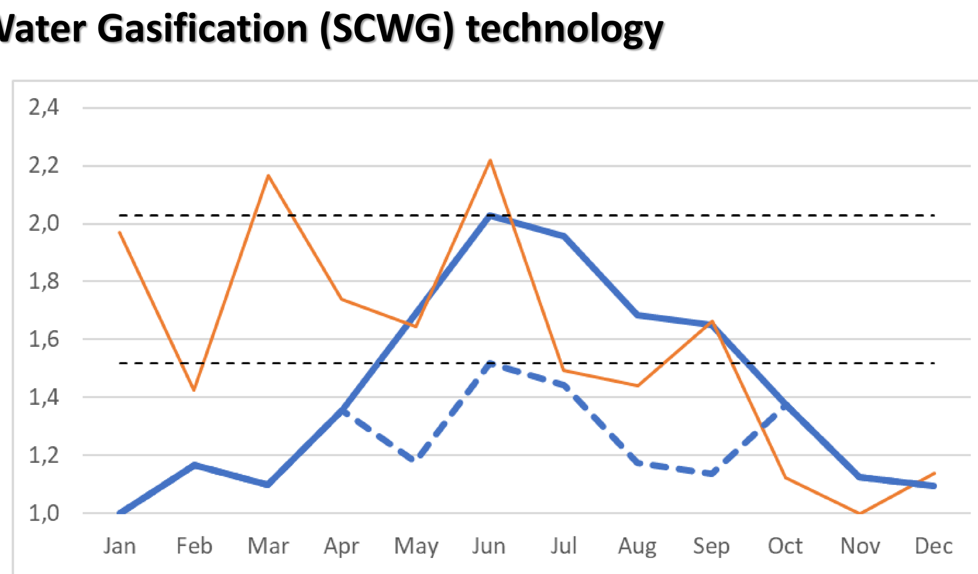


Fig. 3: Organic waste availability and energy consumption (both normalized to the month where the minimum occurs).

The project focuses on organic waste streams with high (>80% w/w) moisture content. Drying of such streams under the most circumstances is not economically viable. However, water brought to supercritical conditions (P > 221 bar, T > 374°C, see Fig. 4) starts to behave as an excellent **solvent for organics**, while the salts normally present in the solution precipitate.

Decision tool

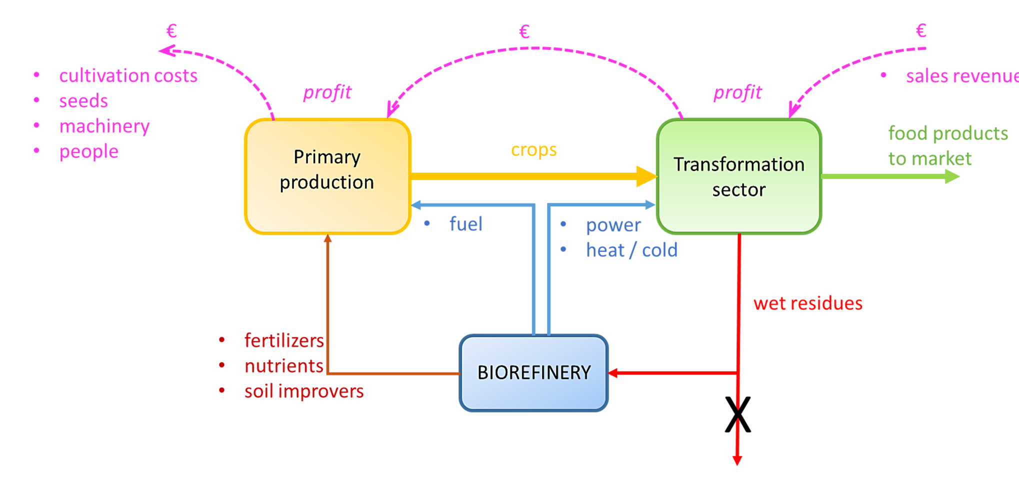
A decision tool is being implemented in a spread sheet form. This decision tool will be used in the case studies to evaluate which energy recovery technology is optimal from the economic point of view for the owner to invest in. The following energy recovery options are taken into account in the project:

- gas combustion in a boiler and the production of cold by means of an absorption chiller;
- gas combustion in a gas engine – combined heat and power;
- synthesis of liquid energy carriers

About the SuperValue project

Partners: RIC Pro-Akademia (PL), TU Delft (NL), Fresh World Int. Sp. z o.o. (PL)
Call: 2nd FACCE SURPLUS call - small-scale biorefineries (ERA-NET cofund)
Budget: 357 kEur
Duration: 1st July 2018 – 30th June 2020 (24 months)

Philosophy and Aims

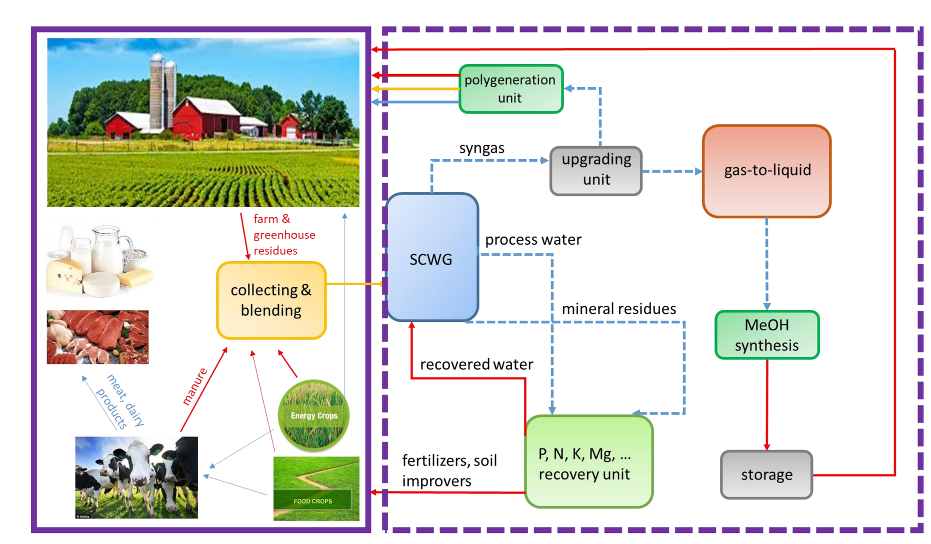


A new business plan:

1. To maximize the shared profits
2. To minimize the environmental pollution
3. To utilize green energy sources

Tasks

WP1: SuperCritical Water Gasification process optimization (TUD)
WP2: Recovery of the minerals from SCWG effluent (RIC)
WP3: Gas valorization options (RIC)
WP4: Case studies & LCA (FRESH, RIC, TUD)



Water at supercritical conditions

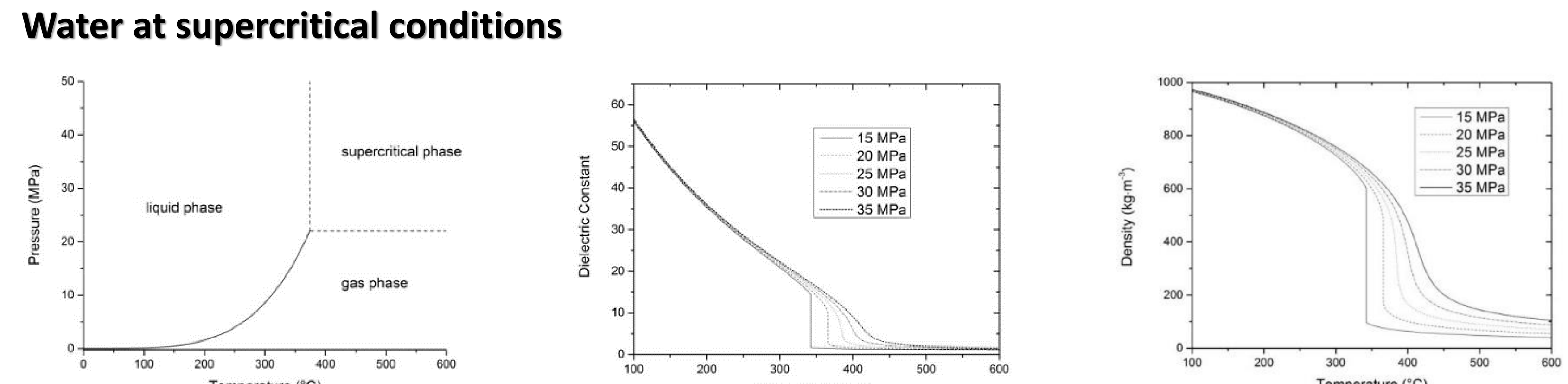


Fig. 4: Phase diagram and physical properties of water. Reprinted from (M. Uematsu, E.U. Frank, J. Phys. Chem. Ref. Data. 9 (1980) 1291–1306)

Recovery of nutrients using a Microbial Fuel Cell (MFC) system

Involvement of a MFC-based concept for up-concentration of resources (especially N & P) bridges the gap between the reusing the process water and the recovery of said resources as a refined product. The experiments are being performed in a two-chamber MFC device equipped with cation exchange membrane (CEM) fed with the SCWG filtrates enriched with organic carbon source (acetate). Such system should permit to transfer cations from anodic to cathodic chamber, as shown in Fig. 5.

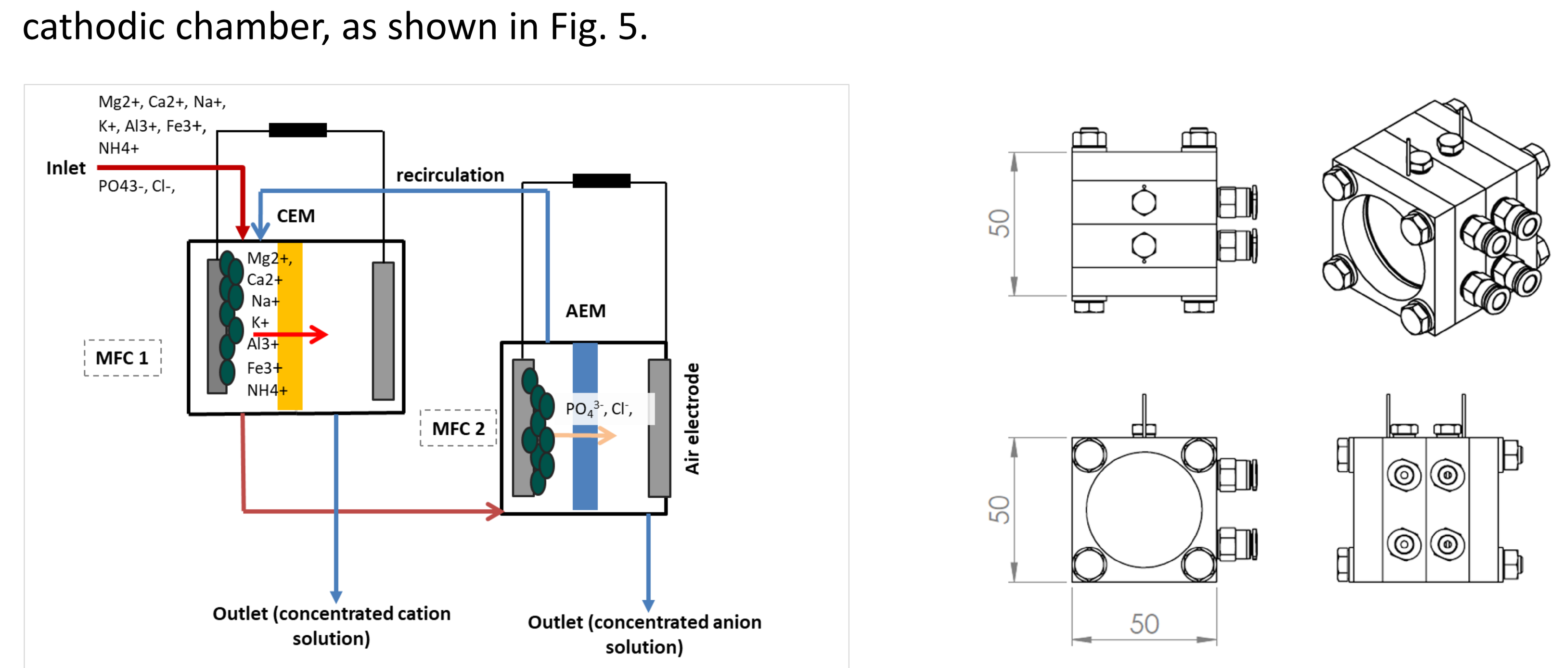


Fig. 5: The schematic of a dual MFC system (left) and the drawings of the test setup (right)

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