Motivation

There is a need for fertilizers in agriculture to ensure sufficient food production. These fertilizers are made from phosphorous (P) and ammonia (NH₃). P is limited and scarce and NH₃ comes from energy-intensive processes, such as the Haber-Bosch process.

Urine is a potential source of the previous nutrients. It contributes to 80% of the nitrogen (N) and 50% of the P load in conventional domestic wastewater. Its high N and P concentration compared to normal sewer water enables a more effective and energy efficient recovery.

Additionally, the nutrient load to the wastewater treatment plants is lowered and the water consumption reduced by the use of separation toilets or water free urinals.

Research goals

The process must be optimized and the material costs lowered in order to make it more economically attractive. For that reason, the research involves:

- Optimization of coulombic efficiency and current density of the anode; NH₃ and alkaline recovery of the cathode
- Investigation of conditions for crystallization and precipitation to increase P recovery (via struvite precipitation)
- Testing different configurations of cell stacks to decrease startup and operation problems and increase current density

Technological challenge

The aim is to develop, demonstrate and evaluate an innovative and energy-efficient bio-electrochemical system (BES) that allows for the recovery of valuable nutrients (P and NH₃) from urine while producing chemicals (NaOH, KOH) and, depending on the type of BES used, electricity or hydrogen (H₂) (Fig. 2 and 3).