Analysis of the biofilm life cycle on the electrodes of electrochemical bioreactor and evaluation of key parameters responsible for electromethanogenesis.

Pollution, global warming and energy resources are crucial issues for todays' modern society. Non-renewable fossil fuels diminish while world population continues to grow. Fossil fuels are finite, thus they will run out in the future. Moreover, burning fossil fuels raises serious environmental issues because it is directly linked to global pollution and warming as CO_2 is emitted. Therefore, in recent years, particular emphasis has been placed on the development of alternative renewable energy sources (e.g., wind, solar, biomass).
However, given the fluctuating and intermittent nature of these energy sources there is serious discrepancy between production and consumption affecting security and stability of the power grid. Supply and demand of electrical energy must be balanced. This has become a critical challenge for our society to develop innovative energy storage and transport solutions. Current storage systems present low energy density or limited storage potential. Therefore, new technologies must be developed to overcome these limitations. One of such potential solution is conversion of surplus of electrical energy into fuel in form of methane (biogas).

Wastewater (WW) in particular is now considered as a 'misplaced resource' from which valuable products and energy can be obtained. Due to their robustness, anaerobic digestion (AD) have become the preferred technology for recovering some of this energy in the form of biogas produced in the methane fermentation process.

Most often biogas contains only slightly more methane than carbon dioxide because there is not enough hydrogen available. It is not possible to obtain pure methane without additional source of hydrogen. This could be overcome using microbial electrolysis cell (MEC) which potentially might provide enough hydrogen from electrolysis to convert whole available carbon dioxide to methane. The hydrogen produced on the cathode of MEC is potentially ideal substrate for methanogens.

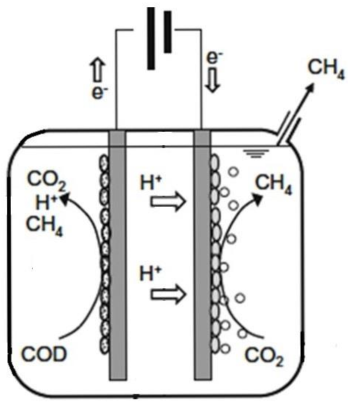

Fig. 1. Scheme of an anaerobic MEC reactor used in electromethanogenesis.

The major benefit of MEC could be the storage system which could allow energy surpluses to be stored for use during periods of peak demand in the form of highy methanized biogas as well as existing natural gas transport network.
Moreover if the gas produced in the MEC were not consumed locally, it could be injected into the natural gas grid and transported over long distances to a final use location which would reduce congestion in the electricity transportation grid by providing an interface between the gas and electricity grids.

That is why currently methane production in MEC is very interesting subject to study. This is very complex process where methanogenic microorganisms, together with electrochemically active microorganisms (EAM) and other species colonize electrodes forming biofilms which converting electricity into fuel**. Therefore the goal of our project is to determine the optimal conditions using a new materials for MEC reactor electrodes for the production of methane. For this purpose, we will study the growth phases, structure and population biofilms on electrodes in various cycles of its life, influence of various electric parameter, (EAM) and biological nanowires for the direct interspecies electron transfer. This will be the first step in creating efficient experimental platform dedicated to study conversion of electrical power into fuel (chemical energy in form of methane).**