PROJECT PARTICIPANTS:

WASHINGTON STATE UNIVERSITY (WSU), ***BIRGITTE K. AHRING,*** *Ph.D.* (Principal Investigator)

PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL), ***STEPHEN J. CALLISTER,*** *Ph.D*.

WASHINGTON STATE UNIVERSITY (WSU), ***AARON T. WRIGHT,*** *Ph.D*.

CLEAN-VANTAGE LLC, ***RICHARD GARRISON****, PE*

Most biogas plants in the US does not take full advantage of their clean energy generation potential, this problem is mainly due to the high cost of biogas refining technology. We have recently developed an economic process to transform the CO_2 contained in raw biogas into more CH_4 to produce pipe-line quality renewable natural gas (RNG). In this project, we are going to perform laboratory and pilot-scale studies to test a novel approach for early-detection of metabolic stress affecting the longevity of our production strain.

The proposed technology uses a methanogenic archaeon as biocatalyst. This microbe, isolated in Dr. Ahring's laboratory, has displayed an outstanding capacity to capture the CO_2 in raw biogas (approx. 60% CH_4 and 40% CO_2) and transform it into more CH_4 with a 0.99 CO_2 conversion efficiency. The final product (approx. 99% CH_4) satisfies the RNG standard heating value, therefore it can be distributed in the natural gas grids to replace fossil natural gas in almost any industrial and domestic energetic demand including heat and electricity generation as well as being used as vehicular fuel. The main objective of this project is to extend the longevity of our Biogas-to-RNG technology. To achieve this, we will synthesize a set of activity-based probes, molecular sensors that emit a signal when certain proteins are unusually more present in a reactor, we will design these probes to early-detect biomarkers that indicate stress responses in our production strain. Observation of these activity-based probes will enable us to counteract any perturbation before productivity is affected, ultimately prolonging the reactor life-time. Effective engineering pathways and process engineering strategies to maximize the duration of RNG productivity in the bioreactor will be developed. Later on, we will demonstrate extended operation of a pilot-scale Biogas-to-RNG system with high CO_2 conversion efficiency, this demonstration will last 6 months.

Natural gas is expected to become the main primary energy source in the US by 2030. Unfortunately, the natural gas sector completely depends on fossil-crude and, together with the transportation sector, produces more than 40% of the total national greenhouse emissions. The success of this project will develop a truly sustainable technology ultimately able to provide almost any biogas facility with the capacity of RNG export into natural gas grids. A broader impact of this project is the acceleration in the decarbonization of the natural gas and vehicular sectors.