**PROJECT TITLE:** TECHNOLOGY FOR ENERGY-GENERATINGONSITE INDUSTRIAL WASTEWATER TREATMENT

**I. PROJECT STATEMENT**

In Minnesota the food- and beverage-processing industry, including dairies, malting plants, potato processing facilities, and breweries, is vibrant and provides economic opportunities in **both urban and greater Minnesota communities**. **These industries are water intensive and many do not treat their wastewater onsite**. Instead, they discharge their untreated wastewater, typically 20-100 times “stronger” or more concentrated than municipal wastewater, to a centralized municipal treatment plant. As a result:

* The industry is required to pay fees to the municipality to discharge the water to the municipal treatment plant, and
* The municipality has to expend energy to treat the (much stronger, more challenging, and potentially disruptive) industrial wastewater.

Our goal is to expand previous LCCMR-funded research to enable widespread onsite industrial wastewater treatment that turns pollutants into hydrogen and methane fuels and provides benefits to municipalities in the form of more predictable and easier wastewater treatment and lowered treatment costs.

**A previous successful LCCMR project formed the basis for this research**, resulting in the development of first-generation technology that we have since improved upon. This new technology

* Is designed to be installed onsite at food- and beverage-processing industry facilities,
* Consists of two reactor stages, one to turn pollutants into hydrogen and a second to clean the water further and turn remaining pollutants into methane,
* Treats the wastewater using bacteria that are encased (or encapsulated) in non-toxic gel-like beads,
* Easily retains the beads within the reactor and protects the bacteria within the beads,
* Turns pollutants in the wastewater into hydrogen and methane by allowing the encapsulated bacteria to “eat” the pollutants in the wastewater much as we eat food, “exhaling” hydrogen and methane. The hydrogen and methane are used directly onsite as fuels for energy generation.

In addition, this new technology improves upon other onsite treatment options by being very compact, and therefore less expensive to install, and by not only creating energy from pollutants in the waste, but requiring much less energy to operate when compared to competing technologies.

After onsite treatment of this very concentrated industrial wastewater, the treated wastewater is then discharged to the municipal wastewater treatment plant. Because the industrial waste is pre-treated, it should not disrupt their operation and will be much easier for the municipality to manage and further treat, requiring less energy and cost to do so. All of this should result in water quality and quantity benefits.

Unfortunately, although we have demonstrated successful deployment of the technology with real wastewater, in its current form, this technology is not easily scaled up and each new application (*e.g*., breweries vs. dairies) requires customization in terms of the bacteria within the beads, the type of beads made, their size, and their number. All of this increases the cost of the technology and limits its use. The proposed research would advance this technology to the point of being “off the shelf.” We will create an adaptable bacterial community that can be encapsulated in beads and used with a wide variety of wastewaters from the food- and beverage-processing industry. We will determine the optimal bead material to allow for bacterial growth within the beads. We will test the system at a pilot scale with multiple wastewaters. We will perform system optimization to decrease energy use (pumping, etc.) and maximize energy production.

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **ACTIVITY 1:** Develop an adaptable bacterial community and refine the encapsulating chemistry to enable reliable treatment of a range of industrial wastewaters  **Description:**A mixed bacterial community will be developed and tested that will grow within the encapsulation matrix (beads) and consume the wide variety of compounds in different wastewater streams. The encapsulation matrix will be optimized to protect the bacteria inside, provide space for them to grow, and enable the bacteria within the encapsulation matrix to access the variety of wastes that need to be consumed. The robustness of the treatment will be tested with a variety of wastewaters from food- and beverage-processing industries.  **ENRTF BUDGET: $179,070** | |  | |
| **Outcome** | **Completion Date** | |
| *1. Understand how a mixed hydrogen-producing community develops and grows when treating a variety of wastewaters* | *01/31/22* | |
| *2. Understand how a mixed methane-producing community develops and grows when treating a variety of wastewaters* | *06/31/22* | |
| *3. Demonstration of the two-stage hydrogen- and methane-producing technology with a range of wastewaters in the laboratory* | *10/31/22* | |

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| **ACTIVITY 2:** Pilot scale testing and design optimization of the wastewater treatment system.  **Description:**Using the microbial communities developed in Activity 1, the technology will be tested at the pilot scale at various industries (potato processing, candy manufacturing, brewery). A full evaluation of the design and operation of the system will be used to determine how to best maximize hydrogen and methane production while minimizing energy and equipment costs (e.g., pumping, gas collection).  **ENRTF BUDGET: $295,869** | |  |
| **Outcome** | **Completion Date** |
| *1. Scale up and demonstration of the technology at a pilot scale at multiple industries* | *01/31/23* |
| *2. Optimization of system design and energy efficiency* | *6/30/23* |

**III. PROJECT PARTNERS AND COLLABORATORS:**

Our primary project partners are Minnesota Department of Employment and Economic Development (DEED) and Metropolitan Council Environmental Services (MCES). Our team has been assembled to include expertise from the University of Minnesota in water treatment and energy generation (Novak and Arnold-Civil, Environmental, and Geo- Engineering; Wright-Mechanical Engineering). We have been working as a team to bring this novel technology to fruition.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

We have been pursuing National-scale funding for the project and will continue to do so. The project is currently being tested at a small pilot-scale at the Fulton Brewery. We have worked with a team at the Carlson School of Management to determine realistic value propositions for the technology. If a truly robust system can be developed and tested, communication efforts through MN DEED, MCES, and trade organizations will be used to further our implementation activities. We will work with the Venture Center at the University of Minnesota on additional implementation efforts.