New York University’s Micro Anaerobic Digester: 
A Renewable Energy Solution 
Fueled by Table Scraps

REV Campus Challenge Submission
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New York University is proposing to develop and operate a small scale urban waste-to-energy system on its New York City campus. This clean energy project, “NYU’s Micro Anaerobic Digester: A Renewable Energy Solution Fueled by Table Scraps” (NYUMicroAD) will capture and convert organic food waste generated primarily from the NYU’s dining halls into renewable electricity and biofertilizer.

The NYUMicroAD project will divert NYU’s organic waste, currently transported off-site by diesel fueled truck at considerable financial and environmental costs, into readily available and renewable energy on site. To our knowledge, the NYUMicroAD system is the first of its kind here in the U.S.

The renewable electricity generated will be directed into the University’s existing microgrid system. The NYUMicroAD project also calls for a series of newly installed on-site electric vehicle (EV) charging stations which will provide energy for the a newly purchased NYU EV fleet. In addition to the regular use of passenger vans by NYU’s Public Safety, Athletics and Facilities, these EVs would be used to collect and transport the organic waste to the digester system.

A secondary byproduct of the NYUMicroAD process, is a renewable, high-quality organic fertilizer. Following on-site digestion, the remaining liquids (digestate) and biosolids would be collected and utilized as nutrients for campus/community urban farms and landscaping.

NYU is a member in good standing of the REV Campus Challenge.
I. INNOVATION

HOW IS THE PROJECT INNOVATIVE AND UNIQUE? DESCRIBE HOW THE PROJECT IS CHANGING THE STATUS QUO.

Many colleges and universities in New York State and nationwide have implemented food waste collection programs for composting. However, our research has shown that an on-site micro anaerobic digester (defined as a unit being able to process 500-5,500 pounds of organic material per day) has not been demonstrated in a dense, urban environment, with a sensitive surrounding community.

NYU’s project, “NYU’s Anaerobic Digester: A Renewable Energy Solution Fueled by Table Scraps” (NYU MicroAD) will demonstrate an innovative solution for bio-waste disposal, turning organic waste into energy and organic compost, extracting additional value from food scraps.

The successful implementation of NYUMicroAD will demonstrate the feasibility for replication at other campuses across NYS and the U.S.—as well as at an array of public and private waste-generating institutions. A successful implementation of this system would eliminate the need for organic waste to be trucked to distant landfills or composting sites.

The current waste stream for discarded organic materials (pre and post-consumer food waste) is at best an organized organics collection program, where the material is diverted to compost or renewal energy, and worst, where the material is co-mingled and diverted to a landfill.

Both of these activities has a cost for disposal with little or no economic return to the initial producer of the organic waste. Both activities contribute to greenhouse gas emissions—inherent in the processes of trucking the material off-site and the inevitable unchecked off-gassing of the decomposing organics. As an environmentally sustainable alternative, NYUMicroAD transforms this organic waste into a source of revenue-generating renewable energy and liquid fertilizer.

Now, instead of continuously adding to the overall environmental degradation, NYU, the generators of the organic waste, will now be a leading solution to GHG mitigation within the confines of its own environment, a completely unique position in the field of food waste diversion in an urban environment.

NYUMicroAD will enable greater student involvement and engagement—over more common on-campus clean energy projects - e.g. building efficiency, rooftop solar, etc. Campus-wide behavioral and operational changes will require designed studies, review of methodologies and active evidence-based implementation strategies designed by students and faculty. The collection
and processing of food waste is ripe for multiple pedagogical tie-ins, as our contributing academic sponsors point out in their letters of support.

The societal value and impact on climate change mitigation is derived from the combination of two key elements:

1. A paradigm shift in our thinking and understanding that organic waste is a resource with inherent energy and nutrient value that can and should be captured.
2. An evolution of the waste stream management supply chain that “removes the truck.”

**PROJECT DESIGN**

Anaerobic Digester technology is an established technology functioning across NYS and the U.S. What makes NYUMicroAD unique is that the project team plans to situate the operation in the dense urban environment that is NYC.

The NYUMicroAD system produces two outputs: renewable energy in the form of biogas turned into electricity and thermal energy; and a rich liquid organic fertilizer. Each of these output products deliver a significant and immediate reduction in GHG emissions.

A combined heat and power unit (CHP) converts the biogas into electricity, which is fed into our NYU CoGen microgrid. The resulting electrical generation will be used to power a newly implemented electric vehicle (EV) fleet for the university. The thermal energy generated will be used for heat and hot water generation within the immediate surroundings, ensuring the NYUMicroAD’s energy self-sufficiency.

The second output, a rich liquid organic fertilizer is commonly called a “bio-fertilizer,” and is a proven significant GHG reduction substitute for chemical fertilizers. The use of the bio-fertilizer by our NYU Farm and NYU Landscaping is also in line with our Climate Action Plan (NYU-CAP) for reducing and mitigating reliance on fossil fuels.

**BUSINESS MODEL**

Currently, NYU pays our carting company 175.3 dollars per ton to remove food scraps and take the organic material 230 miles upstate to a farm for composting. NYUMicroAD will eliminate the cost of the carting, a savings of $31,500 dollars per year.

- **Electricity**—NYUMicroAD’s projected electrical output is 51,210 kWh per annum (@90% efficiency). At $0.15/kW this translates into a revenue of $7,682
- **Thermal heat** projected output in MMBtu per annum is 134.045. At $40.635/MMBtu this translates into a revenue of $5,447
- **Bio-fertilizer** projected output per annum is 159 cubic yards. At $11/cu.yd. this translates into a revenue of $1,749

NYUMicroAD is projected to generate $14,878 per annum, avoid $31,500 in tipping fees and reduce GHG output by 565.05 metric tons of CO2e per annum.
INNOVATIVE PARTNERSHIPS

Bringing NYUMicroAD online allows several shelved initiatives to be started:

1. EV conversion of the NYU Public Safety Fleet in partnership with Zenith Vehicles, a NYS approved vendor;
2. Upgrades to the CoGen microgrid to allow for EV charging station installation;
3. EV charging station access for the wider NYU community, making available parking spaces with EV charging capacity which will encourage the adoption of EV vehicle purchases by the NYU community;
4. Partnering with CarCharging a nationwide public EV charging services, whose business model is designed to accelerate the adoption of public EV charging.

CURRICULUM INTEGRATION

The NYUMicroAD project data can be incorporated into student coursework through research and classroom activities in a trans-disciplinary fashion across a wide range of subject areas including: engineering, biology, chemistry, cultural anthropology, nutrition, urban studies/policy, economics, real estate, and environmental studies, to name a few.

The NYUMicroAD project provides an opportunity for faculty to integrate this innovative system on campus into their curricula. The system’s mechanics and its relative outputs, provide unique and wide-ranging pedagogical possibilities—from theoretical analyses of waste systems, to investigation and studies on the microbial signature of the digestate.

One of the overarching goals of NYUMicroAD is to provide real-time data to faculty and students allowing our campus to act as a living lab. Data might include:

- pre-consumer and post-consumer organic waste counts;
- organic waste ingested;
- composition of food waste;
- electricity produced;
- GHG reductions;
- EV statistical data—miles driven, GHG saved, etc;
- EV charging station statistics

Internship possibilities include training as a tour guide for the planned tours of the NYUMicroAD which would be instituted on a regularly scheduled basis. The tours, highly informational in nature, might include information on the history of NYU’s waste stream management, energy use and GHG reductions, construction and operation of anaerobic digesters, and the electric vehicle charging system.

The tours, run by students, would be an opportunity for community members (NYU and non-NYU) to learn about NYU’s commitment to sustainable operations, the latest developments in waste stream management, and the
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possibilities for alternative clean energy production from organic waste.

In addition, the bio-fertilizers would be used by both the NYU Urban Farm Lab—a living lab created by the Department of Nutrition and NYU Sustainable Landscaping for its organic grounds maintenance.

The NYUMicroAD could be used as a model for resiliency because of its ability to produce electricity that would be incorporated into the NYU CoGen grid in the event of a natural or man-made disaster power failure, or provide energy to the electric vehicles if there is a diesel fuel crisis. Studies in resiliency span many different disciplines, not just science and engineering.

Personal tour guides, interactive displays, and access to the site itself would encourage maximum interest and engagement with the subject, bringing together students, faculty, staff, and members of the greater NYC community.

WHAT PROBLEM(S) DOES THE PROJECT AIM TO SOLVE? HOW HAVE OTHER APPROACHES ATTEMPTED TO SOLVE THESE PROBLEMS AND WHY IS THIS APPROACH BETTER?

The topic of waste management represents environmental, economic and public health costs and issues. The economic costs are represented by the collection, hauling, and disposal of the waste in landfills or at distant compost sites. Environmental and climate costs are associated with the use of heavy duty diesel trucks to transport this material to processing facilities. Furthermore, as organics break down, they release methane, a short-lived climate pollutant 28-36 times more potent than carbon dioxide. These costs are most significant in urban settings, especially in NYC. With the introduction of the NYUMicroAD, the costs (both financially and environmentally) associated with traditional waste management practices are eliminated.

The disposal of waste, both organic and inorganic, has long vexed policy makers. For organic waste, composting seems to be the answer. However, we know that composting is no panacea. NYU has struggled to make it successful, as has NYC, and they are certainly not alone. So while the topic of anaerobic digestion is on the agenda of state and municipal agencies, to date the use of anaerobic digestion has been limited to large centralized installations that require multiple partners and millions of dollars.

The invention of the NYUMicroAD opens the door to a whole new world of users and applications throughout the country. A successful use of a Micro AD in a large, dense urban setting would be ground-breaking.
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II. TEAM MEMBERS

FACULTY

Kurt Becker, PhD
Vice Dean for Research, Innovation and Entrepreneurship
Tandon School of Engineering
Letter of support on page 20

Kenneth Birnbaum, PhD
Associate Professor of Biology
Director of the Cellular Analysis Core, Department of Biology
Letter of support on pages 22-23

Kurt brings expertise in the field of anaerobic digestion, and, in his current role as Vice Dean for Research, Innovation and Entrepreneurship at the NYU Tandon School of Engineering, is charged to identify innovative projects relating to clean energy from across NYU working with faculty and students to help assess the commercialization potential. He was also instrumental in identifying many ways that students could learn from this project in an experiential way, both in the sciences and the environmental studies arenas.

As an esteemed faculty member of the Center for Genomics and System Biology in the Department of Biology at NYU, Ken was key in identifying the value of the NYU Micro AD as a living laboratory. This project would be an excellent opportunity to extend the classroom experience by placing students with an interest in microbial engineering into a position to study anaerobic digestion, with implementation of the technology that is the first of its kind in North America. Ken also suggested several research ideas for graduate and post-graduate NYU students.

STUDENTS

Katie Dorph
NYU College of Arts & Science
Katie is an undergraduate student in NYU’s Biology program. She is currently a co-president of NYU’s Community Agriculture club. She has contributed to the project by investigating ways for the micro AD to be incorporated into the biology department, either through research or curriculum. Her connection with faculty members in Biology will strengthen the overall project.

John Farrell
Interactive Telecommunications Program

John is a Brooklyn-based designer and developer. He holds a Masters degree from NYU’s Interactive Telecommunications Program, where he is currently a Resident Research Fellow. He helped brainstorm proposal ideas and ways to utilize web, data visualizations and visual design to engage NYU community with the project. John will strengthen the overall project with his creative programming and design experience and connections with ITP program to develop curricula and a web presence.

Emily Fernandez
Rory Meyer College of Nursing
Emily is an undergraduate student in NYU’s Nursing program interested in sustainable development and global health. She participated in the working group to develop the idea and will strengthen the project by utilizing her experience as an ECO Rep to develop engagement strategies.

Sophie Golomb
NYU Steinhardt
Sophie is a graduate student in NYU’s Environmental Conservation Education program. She has extensive experience with community engagement and outreach. She worked on the development of the proposal idea and will strengthen the project by assisting in the development of tours and interactive displays.

Zachary Kessel
Gallatin School of Individualized Study
Zachary Kessel is an undergraduate student concentrating in computer science, technology and society. In his capacity as a student worker at the Office of Public Affairs, Zack assists press officers and content producers with everything from analyzing social media analytics to drafting press releases and producing videos. As an RA and student leader on campus, Zack brings his great expertise in student engagement to this project. Furthermore, Zack was responsible for formatting and compiling the REV Challenge Submission.
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Scott Klein
NYU College of Arts & Science
Scott is an undergraduate student in NYU’s Environmental Studies program. He has various experience educating fellow students in policy and system changes and collecting and analyzing empirical data. At NYU, he serves as the social chair and junior treasure for EarthMatters, the largest environmental club on campus. As a Freshman Scott will be part of the implementation team of this project. His strong interest in making NYU campus more sustainable through innovation and education will be utilized to strengthen the engagement element of this project with faculty and students.

Tessa Rosenberry
NYU College of Arts & Science
Tessa is an undergraduate student in NYU’s Environmental Studies program. She has experience in environmental education, communications and organizing students to act on climate change. Tessa was the primary organizer for recruiting students and faculty advisers to be part of the project team and updating the team throughout the proposal development. As the liaison between environmentally-minded clubs (under grad and grad) she will be a valuable member of the team to develop ways to connect the student body with this project.

Priyanandana Varma
Tandon School of Engineering
Priyanandana is an undergraduate student in NYU’s Industrial Engineering program. He has knowledge and experience in the working and basic functions of anaerobic digestion from an engineering perspective. He participated in the development of the project idea and will strengthen the team by connecting the engineering aspects of the project when creating engagement materials.

NYU LEADERSHIP

Dianne Anderson
Director of Sustainability, NYU
Dianne has been with NYU since 2007 and was the primary lead on reducing energy usage within campus buildings to lower NYU’s greenhouse gas emissions. She understands the infrastructure and logistical operations of the university. She was part of the proposal development team and will be a key team member leading its implementation. Her expertise in clean energy and waste management will strengthen the project.

Nicolas Gordon
Manager of Sustainability, NYU
Nicolas brings not just vast knowledge of life cycle analysis, carbon accounting, and sustainable innovations, but also has a discerning eye as a civil engineer and Masters of Science in Sustainability Management. He was a great proponent of the system early on, when others were skeptical, and took on the bulk of investigation into the feasibility of this system. He is the main contact with the vendor, asking all the right questions about the reality of creating a living lab for the faculty and students, the challenges of collecting food waste, and the possibility of using the biogas for electricity for the (new) fleet of electric vehicles.

Christopher James
Media Relations Specialist
University Relations and Public Affairs
As a media relations specialist in the Office of Public Affairs, Christopher brings over eighteen years of experience in public relations to this project. A press officer for NYU’s Office of Sustainability, Christopher will be responsible for publicizing and garnering press interest in the NYUMicroAD. Christopher himself is an avid supporter of environmental causes and brings this passion into his work.

Beth Morningstar
Assistant Vice President
Strategic Initiatives and Sustainability
Beth has been at NYU for a number of years in different capacities. For this project, she brings the advantage of being engaged with many different areas of the university, both administrative and the schools. In her various roles over the years, she has also gotten to know many senior level members in both the faculty and the staff. In her current role in the Office of Sustainability, she is building relationships with the student body. Beth has also worked with key members of the NYC community. She is someone that can make connections and can make things happen. In her role, Beth championed this proposal among the senior university administration.

Jennifer Pautz
Director of Government Affairs
University Relations and Public Affairs
In her position at the Office of Government Affairs & Civic Engagement, Jennifer is responsible for University interactions and compliance with local, state and federal government. Jennifer also works closely with the civic engagement professionals at NYU, and provided her unique perspective to this application.
SUPPORTING FACULTY AND STAFF

These members of the NYU Community showed great enthusiasm towards our proposal and have offered letters in support of the initiative.

David Alonso
Vice President, Construction Management & Strategic Services
Capital Projects and Facilities
Letter of support on page 19

As vice president of Facilities and Construction Management (FCM) at NYU, David Alonzo oversees a division at NYU comprised of construction, real estate development, facilities management and facilities operations. He is responsible for overseeing a 14M sq foot real estate portfolio—over 180 buildings in NYC—including office space, academic space, student residences, and faculty residences.

Alonzo’s construction group is responsible for over $250 million in projects per year. He oversees the combined efforts of the facilities and engineering groups, which provide high quality architectural, engineering, space-planning, interior design and project management for the whole of NYU.

A professional engineer by training, Alonzo’s expertise includes: BAS systems, energy management, HVAC performance, and control systems. For more than 16 years at NYU, Alonzo has taken special pride in ensuring the facilities he manages are fully functional, operational, and always ready to contribute to and enhance NYU’s institutional mission.

Amy Bentley, PhD
Professor, Food Studies
Nutrition and Food Studies
NYU Steinhardt
Letter of support on page 21

A historian with interests in the social, historical, and cultural contexts of food, Amy is co-founder of the Experimental Cuisine Collective, an interdisciplinary group of scientists, food studies scholars and chefs who study the intersection of science and food, co-founder of the NYU Urban Farm Lab, and also serves as a Faculty Fellow in Residence at Brittany Hall at NYU. She is Editor of Food, Culture, and Society: An International Journal of Multidisciplinary Research, and is a board member for the journals Food and Foodways and the Graduate Journal of Food Studies.

Jennifer Berg, PhD
Clinical Associate Professor
Director, Graduate Food Studies
NYU Steinhardt
Letter of support on page 21

Jennifer graduated from the Department of Nutrition, Food Studies and Public Health at New York University with a master’s degree in Food Service Management in 1996 and a Ph.D. in Food Studies in 2006. She has taught numerous courses in the Department since 1990 and now serves as the director for the Graduate Program in Food Studies and Food Management. Jennifer serves as the treasurer for the Association for the Study of Food and Society, an international organization dedicated to an interdisciplinary discourse on the role of food in culture and society and advisory board member for the American Institute of Wine and Food. She co-chairs Days of Taste, a yearly farm-to-table program for 2000 New York City public School students. She is a certified Greenmarket tour guide and tour market trainer for the New York City Council on the Environment.

Winslow Burleson, PhD
Associate Professor
Rory Meyers College of Nursing
Letter of support on pages 22-23

Professor Burleson is a social inventor with a transdisciplinary program of integrated research and education focused on health and educational technologies, informatics, design, simulation, and innovation. His laboratory and field based research advance human computer interaction, cyberlearning, creativity research, affective computing, intelligent environments (tutoring systems, smart homes, and “things that think”), and media arts.
III. PROJECT IMPACT

GREENHOUSE GAS EMISSIONS ARE REDUCED AND MITIGATED IN THE FOLLOWING WAYS:

- Production and utilization of renewable natural gas (biomethane)
- Production and utilization of electricity from organic waste
- Production and utilization of thermal energy from organic waste
- Production and utilization of bio fertilizer from organic waste
- Emission reductions associated with the elimination of collection and transportation of organic waste to landfills
- Emissions reductions associated with organics decomposition in landfills, the third largest anthropogenic source of methane in the US
- Emissions reductions associated to upgrading University fleet vehicles to Electric Vehicles.

THE NYUMicroAD PROJECT WILL REDUCE GREENHOUSE GAS EMISSIONS BY 565.05 METRIC TONS OF CO2e. THE BREAKDOWN OF THESE EMISSIONS IS DETAILED BELOW:

The emissions associated with the elimination of the collection and transportation of NYU’s organic waste was calculated using mileage of the existing route and the typical miles per gallon of a packer truck. The conversion to lbs CO2/gallon of diesel fuel burned was calculated using information provided by the U.S. Energy Information Administration.

Daily Round Trip
Total Mileage: 230 miles
Fuel Consumption: 3 mpg
Total Consumption: 115 gallons
Emissions: 22.38 lbs CO2/gallon of diesel fuel burned
Total Emissions: 2,573.7 lbs CO2

Annual Information
Number of Trips: 312
Total Mileage: 71,760 miles
Total Consumption: 35,880 gallons
Total Emissions: 802,994.4 lbs CO2

The food waste from the dining halls will now be collected by a modified EV pickup truck purchased and outfitted as part of this proposal. That vehicle will be charged with the electricity produced by the NYUMicroAD.

1 http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11
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NYU GHG emissions will be reduced further by the additional passenger vans that will be replaced by EV models powered by the electricity produced by the NYUMicroAD. The mileage used to calculate the emission reduction is based on NYU’s Public Safety data records. The fuel consumption is the average of the existing fleet operated by NYU’s Public Safety. The conversion to lbs CO₂/gallon of gasoline burned was calculated using information provided by the U.S. Energy Information Administration. The calculations below are shown for one vehicle but this proposal assumes three EV vans will be purchased.

The GHG emissions reductions have been calculated by taking the difference between the current practice of sending food waste to landfill and the GHG emissions of the NYUMicroAD system. On average 1 metric ton of food waste in a landfill releases methane into the atmosphere equivalent to 1 metric ton of CO₂e. NYU currently disposes approximately 180 tons of food waste per year, which represents 180 metric tons of CO₂e.

The GHG emissions the NYUMicroAD would generate have been calculated with assistance of the technology provider. The estimated biogas production on an annual basis is 27,000 cubic meters, given that 1 ton of input food waste produces 150 cubic meters of biogas. The total GHG emissions of the digester process are calculated as a function of the volume of biogas (Biogasmeter), the average methane content of the biogas (AVGCH4), the quantity of methane venting (CH4vent), the global warming potential of methane (GWPCH4), the density of methane (ρCH4), the biogas flare efficiency (BDE) and the biogas collection efficiency.

\[
GHG = \left[ (\text{Biogasmeter} \times \text{AVGCH4} \times (\rho_{CH4} \times (1/BCE – BDE) + CH4vent)) \right] \times \text{GWP}_{CH4}
\]

\[
GHG = \left[ (27,000 \times 0.6 \times 0.000674 \times (1/0.98 - 0.96) + 0) \right] \times 21
\]

\[
GHG = 13.85 \text{ metric tons of } CO₂e
\]

Therefore, the reduction of GHG emissions due to the avoidance of food waste in landfills is estimated in 166.15 metric tons of CO₂e annually.

OPPORTUNITIES FOR SIMILAR PROJECTS IN NYS

Residential colleges and universities, as a function of their existence and mission, are all producing organic food waste which needs to be collected and managed in some way. The NYUMicroAD project is geographically situated in the dense urban environment which is NYC, where space is at a premium. NYUMicroAD is being designed to maximize the available square footage, engineered to have the highest available outputs possible from the limited space. NYUMicroAD utilizes proven technology which can be implemented easily into any residential campus.

According to our research, in NYS, most colleges and universities generate small amounts of organic waste—less than 2.5 tons per day. Currently, there are no real viable options available for the management of these “micro” amounts of organic food wastes other than conventional transportation to off-site locations in landfills or commercial composting. The NYUMicroAD system

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2 http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11
3 Based on EPA’s Waste Reduction Model (WARM) https://www3.epa.gov/warm/Warm_Form.html
4 From Carbon Quantum GHG verification report for CCI. July 10, 2014
could be easily replicated in any entity generating a minimum of 500 pounds of organic food waste daily.

**ANTICIPATED LESSONS AND PRACTICES**

Site design, system location, logistics of organic food waste collection and transportation among other challenges will be gladly shared with our peers. We expect to learn a great deal about how the products of the NYUMicroAD are utilized, how waste collection can be streamlined, how the operational logistics of waste collection are handled, and the integration of on-site biogas to electricity with electric vehicle charging.

Reliance on partners both inside and outside the NYU community will provide both challenges and opportunities for learning and engagement. Our ongoing collaboration with the NYU and NYC community throughout all stages of the NYUMicroAD project is critical to the success of this project. We anticipate the takeaways and lessons learned will be useful when implementing other innovative ideas and technologies on the NYU campus.

**METRICS**

The project will be considered successful when NYU’s food waste is processed on site into clean energy. This clean energy will be fed into NYU’s microgrid to charge an electric vehicle fleet. The key milestones will be: site approval; permits obtained from the City; purchasing material; installation and connection of the NYUMicroAD; and EV charging stations. A key milestone will be the complete cycle of the digester with NYU’s food waste. The quantity of food waste collected, the amount of clean energy and bio-fertilizer produced, and charging duration of EV vehicles will be key metrics to illustrate success.

**RESILIENCY**

Resiliency is a critical part of NYU’s planning and construction. In 2008, NYU began constructing an upgrade to its 20+ year old cogeneration facilities at the Washington Square campus. This new plant (NYU CoGen), opened in 2010, providing 26 buildings with electric power and 40 buildings with heat, hot water, and seasonal cooling.

When the tidal surge caused by Superstorm Sandy flooded the 14th Street ConEd electric power plant in lower Manhattan, the resulting blackout in the lower half of Manhattan into nearly total darkness. NYU stood as a beacon - quite literally - because NYU CoGen continued to supply electricity, heat, and hot water to its campus building loop. Years of valuable research was saved; many lives, both in and out of the NYU community, were made more bearable because of the services NYU was able to offer.

The NYUMicroAD proposal follows along in lockstep with NYU’s commitment to resilience and sustainability. The electricity produced by NYUMicroAD will be fed into the NYU CoGen loop, and in times of need, would be used to power NYU buildings.

The NYUMicroAD project includes an EV fleet, another pillar of resiliency for
the University.

During the Hurricane Sandy aftermath, liquid transportation fuels were in short supply and difficult to find all throughout the NYC greater metropolitan area. NYU needed its fossil-fuel vehicle fleet to provide the logistics of delivering food, transporting personnel, providing medical services, and potential emergency response to residents in over 2000 apartments in NYU Faculty Housing, to the 12,000 students who live in NYU residence halls, and to several hundred elderly residents living in NYU-owned buildings and in the surrounding Greenwich Village community. The new EV fleet, powered by NYUMicroAD’s waste-to-energy system, would function uninterrupted in the event of another Sandy-style catastrophe.

**ECONOMIC DEVELOPMENT**

At the local, NYU-level, the NYUMicroAD will directly employ two additional newly created staff positions, and support the creation of dozens of paid internship opportunities for NYU students.

NYUMicroAD is designed and constructed with existing and replicable technology which is locally available from business right here in NYS. The use of local vendors and technology specialists, would create economic development as the NYUMicroAD system was replicated, deployed, and maintained at other entities such as hospitals and business complexes in urban areas across NYS. The economic ripple effect of new microgrid electrical production will increase the demand for skilled power maintenance and engineering personnel across NYS.

Additionally, statewide, in all levels of municipal, commercial, industrial, and institutional environments, waste management is a necessary expense. Each one of these sectors is struggling with the costs associated with waste disposal and are constantly searching for better ways to manage it. The NYUMicroAD system would transform a portion of their waste disposal stream—the organic waste—into products they could utilize or sell, thus producing a reliable annual revenue stream.

NYUMicroAd also provides a nutrient-rich liquid fertilizer as a secondary byproduct, which can be sold off or used locally by the campus. This has positive economic implications for any organic agriculture located locally or statewide.

The NYUMicroAD project also supports the continued development of the EV market in NYS. The project calls for a NYS electric charging station vendor to partner with NYUMicroAD. The EV charging infrastructure is a vital component of the NYUMicroAD project, and thus provides an opportunity for the overall EV industry to see growth statewide.

With the increase in EV charging stations available in municipalities, the natural follow-on for consumers will an increased demand of EV vehicles statewide. We see this as an opportunity for NYS on many levels, not the least of which would be the potential for producing efficient and affordable electric vehicles to meet consumer demand.
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IV. PROJECT VIABILITY

HOW DOES THE PROJECT SUPPORT DEPLOYMENT OF PROVEN CLEAN ENERGY TECHNOLOGIES OR CLEAN ENERGY PRINCIPLES?

This project is the deployment of a proven clean energy technology, which changes organic waste into energy (electricity) and natural fertilizer.

This project aims also to educate the NYU community and the larger NYC public about the value of organic material which, through our current means of disposal, is essentially wasted. The deployment of NYUMicroAD technology will be a model example for how food waste in an urban environment can be utilized, with the outputs going to support clean EV transportation and urban agriculture. The project will educate the average person about the value of a vast energy rich resource (organic waste) which is currently discarded at significant cost. The hope is this technology will change the way New Yorkers look at and treat food waste.

Recycling was once considered foreign and nearly impossible. We can see now that it is not. Organic waste needs be thought of in the same way. The implementation and deployment of the NYUMicroAD technology provides a foundation from which to build and develop the very same infrastructure and benefit that traditional recycling enjoys.

TO WHAT EXTENT WOULD THE AWARD ENABLE THE PROJECT OR ASPECTS OF THE PROJECT TO MOVE FORWARD THAT COULD NOT OTHERWISE PROCEED?

Winning the REV Campus Challenge would give NYUMicroAD, an exciting, viable, and innovative idea, the credibility it would need to engage and energize community support. The actual award of $1 million dollars would be used judiciously (please see budget proposal), but most importantly, this award would give a great deal of gravitas to a waste management system that is currently really not on anyone’s radar.

ANTICIPATED BARRIERS AND CHALLENGES

The biggest challenge that the project team will face will be the physical placement of the NYUMicroAD. NYU, with campuses downtown both in Manhattan and Brooklyn, is co-located vibrant residential communities. NYU’s neighbors take an active role in many aspects of NYU’s initiatives which may affect them. The team is faced with the challenges of space use issues as well as with the tackling the potential issues of aesthetics and smell in a dense urban environment.

The project team plans to overcome these challenges by robust engagement and close collaboration with all stakeholders both inside and outside of NYU. The team fully embraces the challenges as they truly believe in the environmental soundness of NYUMicroAD.

NYU currently uses gasoline and diesel fuel for its campus transportation fleet,
New York University's Micro Anaerobic Digester
A Renewable Energy Solution Fueled by Table Scraps

which includes passenger vans for Public Safety and Athletics, and cargo vans for NYU Mail Services and Facilities’ use. The conversion to EV vehicles made possible by the NYUMicroAD project will more than likely be positively embraced by the community both inside and outside of NYU.

The distribution of liquid biofertilizers will not be a challenge. The fertilizer can be shared with the NYU Urban Farm Lab, NYC community farms, and organic farms in New York State.

The team is sure that the excitement generated by winning the REV Campus Challenge Award, and the very real benefits of the NYUMicroAD, will win over the most ardent of naysayers from communities both inside and outside of NYU.

WORK COMPLETED TO DATE

Extensive study has been done in regard to the physical siting of the system. The project team hired R.G. Vanderweil Engineers, PC, to study the feasibility of siting the NYU MicroAD in an underground parking garage. Vanderweil determined that the (tentatively) proposed location would lend itself to easy connection to the four locations identified for connection to the Micro-Grid and existing vent lines.

The team has met several times with the contractors of this micro AD system, and there has been considerable time spent on electric vehicles and electric charging stations.

Extensive study has been done on the amount of organic waste produced in the dining halls.

The team has done much outreach and collaboration with faculty members and students across the university, seeking different ways to engage the community and looking for innovative ways that this project could be used as a living lab. This has been very successful to date. There is a tremendous amount of excitement and support for this system across the university.

Following the announcement of the REV Campus Challenge, NYU’s Office of Sustainability reached out to members of its Sustainability Task Force and environmentally focused student clubs to convene a working group to develop this innovative proposal. These meetings allowed the NYU community to voice its ideas in making our campus more sustainable by incorporating more clean energy into our system and connecting the project with educational elements. It was a collaborative process that also allowed students and faculty insight as to how university operations works.

The excitement, enthusiasm and commitment of so many students, faculty and staff from all different sectors of New York University is unparalleled. Winning the REV Campus Challenge would give the university a unique opportunity to collaborate in a whole new way on a project that has wide and far reaching benefits in so many different ways. The project team has never seen a proposal that has so captured the interests of every sector of the university, from facilities to the top researchers. It is a truly great opportunity.
V. BUDGET

THE BUDGET FOR THE NYUMicroAD IS ATTACHED AS PART OF THIS PROPOSAL. THERE ARE NO INDIRECT COSTS IN THIS PROJECT, OR IN THE BUDGET.
# New York University's Anaerobic Micro Digester

## A Renewable Energy Solution Fueled by Table Scraps

### PROJECT TIMELINE

<table>
<thead>
<tr>
<th>TASK</th>
<th>START DATE</th>
<th>DURATION</th>
<th>END DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Award Date</td>
<td>2-May-16</td>
<td>1</td>
<td>2-May-16</td>
</tr>
<tr>
<td>Community Engagement for Site Approval</td>
<td>3-May-16</td>
<td>180</td>
<td>3-Nov-16</td>
</tr>
<tr>
<td>Obtain Permits/Code Compliance</td>
<td>4-Nov-16</td>
<td>180</td>
<td>5-May-17</td>
</tr>
<tr>
<td>Purchase Micro Anaerobic Digester (20 wk lead time)</td>
<td>4-Dec-16</td>
<td>150</td>
<td>4-Apr-17</td>
</tr>
<tr>
<td>Purchase Electric Vehicle Infrastructure</td>
<td>4-Dec-16</td>
<td>150</td>
<td>4-Apr-17</td>
</tr>
<tr>
<td>Develop Curriculum Integration</td>
<td>1-Feb-17</td>
<td>180</td>
<td>1-Aug-17</td>
</tr>
<tr>
<td>Site Preparation</td>
<td>8-May-17</td>
<td>30</td>
<td>9-Jun-17</td>
</tr>
<tr>
<td>Operational/Logistical Changes to Existing Waste Management</td>
<td>8-Jun-17</td>
<td>30</td>
<td>12-Jul-17</td>
</tr>
<tr>
<td>Staff Training: Sustainability, Facilities and Custodial Services</td>
<td>12-Jun-17</td>
<td>120</td>
<td>12-Oct-17</td>
</tr>
<tr>
<td>Installation of Electric Vehicle Infrastructure</td>
<td>12-Jun-17</td>
<td>30</td>
<td>12-Jul-17</td>
</tr>
<tr>
<td>Micro AD Installation</td>
<td>12-Jun-17</td>
<td>60</td>
<td>12-Aug-17</td>
</tr>
<tr>
<td>Connection to NYU Micro Grid</td>
<td>12-Jul-17</td>
<td>60</td>
<td>13-Sep-17</td>
</tr>
<tr>
<td>Staff Training: Aramark in Dining Services</td>
<td>13-Aug-17</td>
<td>30</td>
<td>13-Sep-17</td>
</tr>
<tr>
<td>Pilot and Approval of Curriculum</td>
<td>23-Aug-17</td>
<td>120</td>
<td>23-Dec-17</td>
</tr>
<tr>
<td>Commissioning/Testing Period</td>
<td>13-Sep-17</td>
<td>30</td>
<td>13-Oct-17</td>
</tr>
</tbody>
</table>

*Timeline diagram visualizes the timeline from 2-May-16 to 23-Dec-17*
Dear Members of the REV Campus Challenge Selection Committee,

I want to offer my unqualified support to New York University's proposal for the development and operation of a waste to energy system on its New York City campus: "NYU’s Micro Anaerobic Digester: A Renewable Energy Solution Fueled by Table Scraps."

Anaerobic Digestion is a proven method for generating energy from organic waste streams such as food waste. From its fourteen dining facilities, New York University yields enough excess food to justify the effort and expense of pursuing this project.

The project team at New York University is proposing, with my approval and support, to turn the biogas created by the anaerobic digestion and turning it into electricity. This electricity will be directed into the university’s micro grid system which would be connected to a series of newly installed on site electric vehicle charging stations, for use by newly purchased electric vehicles.

The efficiency, cost savings, and emissions reduction of using food scraps right on our campus, without the need to transport them to an offsite composting site, is exciting. Also exciting is the production of bio-fertilizer which can be shared by NYU and NYC urban farmers alike. But converting our current fleet of diesel burning vans (used by Public Safety, Mail Services, Athletics, and Facilities) is, for me, the most compelling reason that this REV Campus Challenge grant be awarded to New York University.

I respectfully request your assistance in aiding the realization of this vision, and appreciate the opportunity to offer my firm support to this project.

Sincerely,

David Alonso

CC: Beth Morningstar
March 29, 2016

Dear Members of the REV Campus Challenge Selection Committee:

I want to offer my strong support for New York University’s proposal for the development and operation of a waste-to-energy system on its New York City campus (anaerobic digestion). While I am an expert in the experimental and theoretical study of electron-driven processes in plasmas, I also have served as the Associate Director of the Center for Environmental Systems at Stevens Institute of Technology from 2003 – 2007. In that role, I oversaw several projects dealing with anaerobic digestion. In my current role, I have – among other responsibilities – the charge to identify innovative projects relating to clean energy from across all of NYU and work with faculty and students to help assess their commercialization potential.

Anaerobic Digestion is a proven method for generating energy from biodegradable waste streams such as food waste. Through its fourteen dining facilities, NYU yields enough excess food to justify the effort and expense of pursuing an anaerobic digester. The very substance from which we would derive this green energy, food waste, is, in the best case, transported offsite to be composted, or at worst, placed in a landfill that contributes to the emission of greenhouse gases with no constraint. Our proposed initiative would effectively disrupt the waste cycle and create energy from excess.

In our project, we seek to engage researchers and scientists to collaborate in the creation of an innovative and effective solution to a complex challenge that requires the amalgamation of experts from diverse fields. An anaerobic digester in New York City, an urban, dense environment, is an undertaking that goes beyond the chemistry and the biological processes that make it possible.

This project will require the participation, collaboration, and engagement of not just the student body, but of faculty and staff as well, from stakeholders spanning engineering, design, cultural anthropology, nutrition and other fields. For example, the design and implementation of a process that encourages both food workers and students to correctly sort and then deposit their excess food is more complicated than it sounds, and could be part of a course on waste. Or an interface could be designed that could simultaneously analyze and measure each user’s deposit while building a profile of their nutritional habits.

The opportunities for experiential learning from an anaerobic digester are vast for interested students from undergraduates to PhDs. Working with faculty, students will be key participants in all aspects of the proposed project, including the design of extended research projects that would count toward their degrees.

I fully support this project, and hope that the REV Campus Challenge Selection Committee selects New York University for this "waste to energy" system on its New York City campus.

Sincerely,

Kurt H. Becker, PhD
Dear Members of the REV Campus Challenge Selection Committee:

It is our pleasure as Food Studies faculty to write a letter in support of the organics to energy proposal being submitted to NYSERDA by New York University.

The Food Studies program in the Nutrition and Food Studies Department at NYU Steinhardt is extremely enthusiastic about sustainability solutions at the University level. We confront the issues of food waste in our classes so we are delighted to voice our approval in securing a space for an anaerobic digester. Our student body is extraordinarily invested in changes to the food system and would not only stand to benefit from the educational engagement of an anaerobic digester, but would also see it as departmental support of green energy solutions - a growing sector of food and sustainability for advocates and allies.

This project provides a waste-to-energy system in which the University could treat its compostable material and convert it into energy. On a larger scale, the digester could take food waste from dining on site by collecting pre-consumer food waste from dining halls.

In conclusion, we fully support the efforts of the University to find innovative solutions in the area of clean energy. This project has the capacity to help students, faculty and the entire University community to make better decisions about food waste, energy generation, transportation, urban farming and resiliency.

Sincerely,

Amy Bentley, PhD

Jennifer Berg, PhD

March 30, 2016
Dear Members of the REV Campus Challenge Selection Committee,

I am writing to express my full support of NYU’s submission to the REV Campus Challenge, proposing the installation and operation of a waste to energy system on our campus (“NYUMicroAD”). In my field of research and teaching, there are many benefits inherent in having a “living laboratory” of the scale proposed available and open to university researchers at all levels. Students will especially benefit from the hands-on real-world experience that an active anaerobic digester will give them.

The NYUMicroAD Would Provide a Living Lab Experience. My lab specializes in the developmental and evolutionary genomics of plants and I teach Developmental Biology, which places a strong emphasis on plant cells. My lab has also begun recent projects on microbial evolution and use of algae as biofuels (funded indirectly through NYSERDA under the PowerbridgeNY grant). Undergraduates in the joint NYU Washington Square/Polytechnic program in bioengineering have been involved in that project. Thus, NYUMicroAD would be a natural laboratory for students in interested in microbial engineering and sustainable energy research. The NYUMicroAD presents the opportunity to extend the classroom experience by placing students in a position to study anaerobic digestion, with implementation of the technology that is the first of its kind in North America.

The NYUMicroAD Could Support Research. Operating an anaerobic digester on site would allow students and faculty to analyze the microbial signatures of NYU’s food waste. The study of microbial communities using high throughput sequencing provides a way to analyze microbial communities over time. This approach become increasingly utilized in scientific research, and analogous to comprehensive census, provides a way to monitor the composition of microbial communities. The NYU Biology Department is well positioned to use the anaerobic digester as a model to study the dynamics of long-term digester systems that convert waste to energy. The microbial signatures of NYU’s food waste would provide an interesting analysis of the community’s food sources and nutritional habits, while following the evolution of microbial communities as a function of time, season, and waste inputs. I am enthusiastic about the research prospects of the NYUMicroAD. Performing a prospective analysis of both the organic material digested and the fertilizer produced by the NYUMicroAD would be an interesting extension of my lab’s interests.

The great efforts made by my colleagues in composing this submission are a testament to the creative problem solving and community-minded spirit at NYU. The NYUMicroAD will unite a strong
interdisciplinary team that will work diligently to ensure NYU students, faculty, and surrounding community are engaged and educated on this innovative project.

Sincerely,

Dr. Kenneth Birnbaum  
Interim Director of Graduate Studies, PhD. Department of Biology  
Associate Professor  
Center for Genomics and Systems Biology  
New York University, 12 Waverly Place, New York, NY, 10003, USA  
Tel.: 212-998-8257  
Fax: 212-995-4204  
Email: ken.birnbaum@nyu.edu
Dear Members of the REV Campus Challenge Selection Committee,

I want offer my unqualified support of New York University’s proposal for the development and operation of a waste to energy system on its Manhattan campus, “the project.”

**The Project is Feasible:** Anaerobic Digestion is a proven method for generating energy from biodegradable waste streams such as food waste. Through its fourteen dining facilities, New York University yields a enough excess food to justify the effort and expense of pursuing this project.

**The Project is of Necessity to the Environment:** The very substance from which we would derive this green energy—food waste, would in the best case be transported offsite to be composted, or at worst, placed in a landfill and contribute to the emission of greenhouse gasses with little constraint. This initiative would effectively disrupt the waste cycle to produce energy from excess.

**The Project Presents a Wealth of Opportunities to Unite Transdisciplinary Leaders and Enthusiasts:** In my work I seek to engage researchers and scientists in collaborations to create innovative and effective solutions to complex, “Wicked Challenges” that require the amalgamation of experts from across fields. The Anaerobic Digester is an undertaking which goes beyond the chemistry and biological processes that make it possible. This project requires the participation and engagement of a disparate student body, located in a dense urban environment. Ensuring the sum of our waste is greater than its whole necessitates contributions from experts in the likes of engineering, design, sociobehavior, and other fields. One such challenge might be the design and implementation of an interface that encourages patrons to correctly sort and deposit their excess food. The device could simultaneously analyze and measure each user’s deposit while building a profile of their nutritional habits.

**The Project Would Allow for Student Engagement and Learning:** An anaerobic digester operating on a scale as grand as our own University, would present a magnificent space to foment experiential learning. A community of learners of all levels from undergraduate to PhD and beyond could assemble around this feat. Undergraduate students could participate in its upkeep, ongoing design modifications, operational improvements, and extended research projects as well as any faculty and graduate research associated with the project for credit towards their degree. This system would provide students with first rate, hands on access and exceptional mentorship opportunities.

**The Project is of Use to the Community:** The compost produced by the anaerobic digestion process would go towards community gardens. This would allow us to enlist the greater New
York City community in our conservation efforts. Furthermore, the compost could be used to grow produce served in the dining halls. Patrons would, in effect, see their scraps go towards their next meal.

The anaerobic digester would be of great use to our University and the broader community, helping to produce a generation of inventioneers and conservationists. I respectfully request your assistance in aiding the realization of this vision.

Sincerely,

Winslow Burleson, PhD, MSE, BA
Associate Professor
New York University College of Nursing
April 1, 2016

Mr. Nicolas Gordon  
Manager, Office of Sustainability  
New York University  
740 Broadway St, 6th Floor  
New York, NY 10003


Dear Mr. Gordon:

R. G. Vanderweil Engineers, PC (Vanderweil) is pleased to present our letter report on the connection of a reciprocating engine powered by Anaerobic Digester Gas.

Introduction

Vanderweil has reviewed the submission from the vendor and proposal for equipment that would process campus food waste products and as a byproduct produce methane gas. Vanderweil has completed 20 MW of Methane gas digester and land fill gas projects and is familiar with this technology.

Electrical Interconnection

Vanderweil has reviewed the location and identified for location in Washington Square Village to connect the engine generator output to the existing Washington Square Village Distribution System Campus MicroGrid. These vents are used for the similar venting of natural gas from boilers at this location to safely vent gas during a shutdown of equipment. Please see attached connection Diagram A shown below.

Permitting

City permitting would be done through normal construction process and submission of engineering documents and we do not foresee any special permits as the gas pressures would be under 15 psig. We have also reviewed the local regulatory issues associated with the transport of Methane gas to the engine generator and its possible venting during engine down time. We have identified existing gas vents that can be reused in Washington Square Village for any venting.

Department of Environmental Permitting and State DEC permitting would be required for the new Reciprocating engine and this source added to campus inventory. There are no foreseeable limits which would preclude the installation of this system.

A site OTCR approval for this system may be required and needs to be evaluated with NYC DOB office of OTCR. Depending on the specific reciprocating engine there may be a filing required but no other obstacles are foreseen. There may also need to be an OTCR filing for the Anaerobic Digester system and reactor and this should be presented to DOB OTCR office for review.
Equipment Locations

Vanderweil has not sited the digester equipment and the proposed location of Washington Square Village garage lends itself to easy connection to the four locations identified for connection to Micro-Grid and existing vent lines.

Equipment Capacity

The identified generator size of 7 Kw is under the limit for any special interconnection requirements and can be connected to the existing Micro-Grid taking advantage of its existing Cogeneration interconnection with Utility.

Diagram A Electrical Interconnection
Assumptions, Clarifications, and Exceptions

1. No evaluation of waste streams from the system have been completed for connection to city sewer or water uses. DEP permits for back flow preventers of site connection approval has not been evaluated.

Thank you for the opportunity to work with you on this project. If you have any questions or require additional information, please do not hesitate to call our office. We are looking forward to a successful project with your team.

Very truly yours,

R.G. Vanderweil Engineers, PC

Michael W. Thornton
Principal

MWT/tmm

Cc: J. Bradley, B. Morningstar (NYU)