



This project is being funded through the Solicited Research Program's Energy Challenge, which enables WRF to solve broadly relevant subscriber issues and challenges with targeted, sustained research efforts.

The objective of the Energy challenge is self-sufficiency for wastewater treatment plants. This is pursued as two parallel energy-related research efforts. One for reduction in plant energy demand through lower-energy alternatives to secondary treatment, i.e., activated sludge. The second will examine the capture of energy from wastewater to support plant operations, and ultimately the financial benefits from its export.

Solicited Research RFP

Quality of Biogas Derived from Wastewater Solids and Co-Digested Organic Wastes: A Characterization Study (RFP 4892)

Project Objective

- Identify feedstock characteristics that correlate to different biogas quality, i.e., how the feedstock substrate impacts gas quality
- Characterize the relevant attributes of both the anaerobic digestion processes and feedstock contributions
- Identify and define the relationship between contaminant and feedstock in a clear and concise manner

Budget

Proposals may request WRF funds for \$75,000 to \$100,000. WRF funds requested and total project value will be criteria considered in the proposal selection process.

Background

The energy potential in organic wastes motivates communities and industries to extract energy from waste resources. Biogas originates from the anaerobic digestion (AD) process of organic wastes, including residuals from wastewater, and contains mainly methane and carbon dioxide. The substitution of biogas, a renewable gas derived from organic wastes, for fossil natural gas makes it an attractive energy source in a carbon-constrained future. Over 1,200 water resource recovery facilities (WRRFs) in the United States use AD to process wastewater-derived residuals.¹ Many of these digesters have excess capacity. These WRRFs can increase their production of biogas for energy recovery through co-digestion of organic waste, such as food waste, with wastewater solids.² Also, innovative solids pre-treatment processes, such as thermal hydrolysis, are gaining acceptance and are increasingly used by WRRFs with AD to produce Class A biosolids and enhance biogas production.

Besides methane and carbon dioxide, biogas may also contain a number of contaminants including nitrogen, hydrogen sulfide, siloxanes, mercaptans, other VOCs, and halogenated hydrocarbons. Yet there

¹ Moss, et al. 2017 Accelerating Resource Recovery: Biosolids Innovations and Opportunities, WEF and WERF.

² Parry, 2014. Co-Digestion of Organic Waste Products with Wastewater Solids and Economic Model, OWSO5R07.

is little data on the characteristics of biogas produced at WRRFs. It is expected that the contaminants present in biogas will vary with the waste source and treatment strategies employed to clean biogas for energy recovery; however, the actual biogas characteristics from these different treatment processes and feed stocks has not been examined.

Research Approach

This study is based on the collection of an adequate number of biogas samples from WRRFs throughout the United States to establish relationships between biogas characteristics and anaerobic digestion process configurations and quality of feedstocks. The research team will analyze the samples for the biogas characteristics, identified in the table below, as per ASTM standards and collect the operational data necessary to characterize the relevant attributes of both the AD processes and feedstock contributions. The tests mentioned below are examples. If a different test method is used as per ASTM standards, this must be defined clearly in the proposal. This is to ensure testing is done in accordance with reproducible standards.

Specification	Test Method
Water Dew Point	ASTM D1142, D5454 or equivalent
Methane	ASTM D1945 or D7833
C3 and higher hydrocarbons	ASTM D1945 or D7833
Hydrogen	ASTM D2650, D1945 or D7833
Carbon monoxide	ASTM D2650, D1945 or D7833
Oxygen	ASTM D1945 or D7833
N2	ASTM 7833
CO2	ASTM D4984
Total Sulfur (includes odorant)	ASTM D4084, D4810, D4468, D5504, D6228, D6968, or D7551
Hydrogen Sulfide	ASTM D4084, D4810, D4468, D5504, D6228, or D7551
Siloxanes	AirTox or similar

Siloxanes, a class of organosilicon compounds composed of carbon, hydrogen, oxygen, and silicon, are found in both linear (L2, L3, L4, L5) or circular (D3, D4, D5, D6) arrangements. The major siloxanes in wastewater-derived biogas³ are decamethylcyclopentasiloxane (D5) and dodecamethylcyclohexasiloxane (D6). Siloxane, as D5 and D6, will be analyzed using an appropriate method such as Air Toxics method or AnSol method, as there are no ASTM methods. The proposal should also include a detailed sampling strategy for this project including the number of samples. The sampling strategy should remain consistent throughout the project. If there are differences in the results due to sampling

³ WERF, 2011. State of the Science on Biogas: Treatment, Co-generation, and Utilization in High Temperature Fuel Cells and as a Vehicle Fuel, OWSO10C10a.

methods, they need to be clearly defined and indicated. The research team will evaluate the biogas characteristics against the operational AD data using statistical methods to determine any significant, predictive relationships that advance our understanding. These biogas characteristics will also be compared to the criteria for biogas use for energy recovery from Combined Heat and Power (CHP) to generate electric power and heat, to upgrade to Renewable Natural Gas standards, and for use directly as a vehicle fuel. The findings of this study will provide guidance for utilities on food or organic waste-derived feedstocks or AD treatment enhancements, and biogas quality linked to corresponding biogas energy recovery opportunities. This study will also help identify recommended sampling, analytical methods, and testing procedures for determining biogas characterization. Ideally, the study will provide guidance on predicting and/or minimizing contaminants in biogas and how raw biogas pretreatment costs can be managed effectively before upgrading biogas to renewable natural gas. Identification of the impact on biogas quality of various feedstocks and processes will assist WRRFs in acceptance of feedstocks and the design of biogas utilization systems.

The research team, if desired, can request a BioSENSE measuring device from Pentair on a rental basis, for a nominal amount. The BioSENSE can measure various biogas contaminants mentioned in the table below.

Measurement Ranges and Accuracy BioSENSE				
Component	Unit	Detection limit	Range max.	Accuracy *
Total Ketones	ppm %v	0.5	350	± 10%
· Acetone	ppm %v	0.5	200	± 10%
· 2-Butanone	ppm %v	1	200	± 10%
Total Terpenes	ppm %v	0.5	350	± 10%
· α-Pinene	ppm %v	0.5	200	± 10%
· β-Pinene	ppm %v	0.5	200	± 10%
· 3-Carene	ppm %v	0.5	200	± 10%
· Limonene	ppm %v	0.5	350	± 10%
· p-Cymene	ppm %v	0.5	200	± 10%
Other				
· H ₂ S	ppm %v	1	1000	Breakthrough detection
· NH ₃	ppm %v	1	200	Breakthrough detection
· Dimethylacetimide	ppm %v	1	10	Breakthrough detection
· Phenol	ppm %v	1	10	Breakthrough detection

Deliverables

Successful completion of the tasks specified in this RFP will result in a report yielding a clear documentation of the characteristics of the feedstock that correlate to different biogas quality, i.e., how the feedstock substrate impacts gas quality, and it should thoroughly detail the findings of the study. Additionally, the report should also provide a final outreach product that translates technical findings into a useful communication piece for WRRF staff (e.g., handouts, videos, FAQs, etc.).

Selection Process and Criteria

Selection of proposals is a very competitive process. Proposals will be reviewed by WRF and the Project Advisory Committee (PAC) for this specific project. This external review team may be complemented as needed by subject matter experts. As part of the evaluation process, WRF reserves the right to request interviews, either via conference call or in person, with qualified proposers if necessary.

Proposers are encouraged to develop and submit their intended research plan that meets the research goals of this RFP, provide sufficient details of their budget, as well as schedules and milestones that can successfully deliver on the stated research goals, objectives, and tasks that are proposed.

WRF will evaluate proposals on the following components:

- **Understanding the Problem and Responsiveness to RFP (20%)**
Does the proposal adequately explain the problem? Does it reflect knowledge of the issue and how solving the problem will benefit the water industry? Have the RFP objectives been adequately addressed? If proposed objectives differ from the RFP, do stated objectives address current or future needs of the water industry? Are data quality objectives specified?
- **Technical Approach and Scientific Merit (40%)**
Is the proposal prepared with supportive information and is it self-explanatory and clearly understandable? Is the proposed effort technically defensible? Is the approach practical? Can the project objectives be achieved in the stated time period with the allotted personnel and budget?
- **Management and Communication Plans (10%)**
Are the roles, responsibilities, and assignments clear? Do the supporting organizations on the team have complementary skills? Does the lead organization have adequate resources to provide the appropriate level of management, oversight, and project implementation? Is the Quality Assurance/Quality Plan acceptable? Are schedules and deliverables clearly defined?
- **Budget and Schedule (10%)**
Is the budget within the advertised budget for the project? Has the applicant provided appropriate (at least 25%) and significant in-kind contributions to the project? Is the level of effort allocated to each task logical? Is the Indirect Cost Rate reasonable (35% or less is competitive) and has it been detailed in the proposal? Is the schedule realistic? Do the proposed budget and schedule match funding needs to milestones and demonstrate the value of the research relative to the proposed cost?
- **Qualifications of Organization and Key Personnel (10%)**
Does the lead organization have demonstrated experience and expertise in the issues and objectives discussed in the RFP? Do the key project personnel have experience in the proposed area of research? Have key personnel committed an appropriate amount of time to the project? Are water and wastewater agencies involved?
- **Staff Evaluation and Input Based on Past Performance (10%)**

Proposal Preparation Instructions

Proposals submitted in response to this RFP must be prepared in accordance with The Water Research Foundation's document *Guidelines for Focus Area Program Proposals*. These Guidelines are applied to the Solicited program as well. The most current version of these guidelines is available at:

<http://www.waterrf.org/funding/ProposalDocuments/GuidelinesForFocusAreaProgramProposals.pdf>.

The guidelines contain instructions for the technical aspects, financial statements, and administrative requirements that the applicant must follow when preparing a proposal.

Please note that the selection criteria listed here are different from those listed in the Guidelines for Focus Area Program Proposals document. The selection criteria in this RFP will be used to evaluate the proposal.

Eligibility to Submit Proposals

This RFP solicits proposals from all technically qualified applicants, including educational institutions, research organizations, federal or state agencies, municipalities, and consultants or other for-profit entities.

WRF's Board of Directors has established a Timeliness Policy that addresses researcher adherence to the project schedule. The policy can be reviewed at <http://www.waterrf.org/funding/Pages/policies.aspx>. Researchers who are late on any ongoing WRF-sponsored studies without an approved no-cost extension are not eligible to be a named participant in any proposal. If you have any questions about your eligibility for WRF projects, please contact the WRF research staff listed at the bottom of this RFP.

Administrative, Cost, and Audit Standards

WRF's Solicited Research Program standards for administrative, cost, and audit compliance are based upon, and comply with, Office of Management and Budget Uniform Grants Guidance, 2 CFR Part 200 Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, and 48 CFR 31.2 Contracts with Commercial Organizations. These standards are referenced in the WRF's *Guidelines for Focus Area Program Proposals*, and include specific guidelines outlining the requirements for indirect cost negotiation agreements; financial statements; and the Statement of Direct Labor, Fringe Benefits and General Overhead. Inclusion of indirect costs must be substantiated by a negotiated agreement or appropriate Statement of Direct Labor, Fringe Benefits and General Overhead. Well in advance of preparing the proposal, your financial staff should review the detailed instructions included in WRF's annually released *Guidelines for Focus Area Program Proposals*.

Budget and Funding Information

The funding available from WRF for this project is \$100,000. A minimum of 25 percent of the total project value must be contributed by the applicant (i.e., the applicant's minimum contribution must equal one-third of WRF funds requested). Acceptable forms of applicant contribution include cost-share, applicant in-kind, or third-party in-kind that comply with 2 CFR Part 200.306 cost sharing or matching. The applicant may elect to contribute more than 25 percent to the project, but the maximum WRF funding available remains fixed at \$100,000. **Proposals that do not meet the minimum match of 25 percent of the total project value will not be accepted.**

Period of Performance

The proposed project schedule should be realistic, allowing ample time for the preparation of final reports and for review of project results. It is WRF's policy to negotiate a reasonable schedule for each research project. Once this schedule is established, WRF and its sub-recipients have a contractual obligation to adhere to the agreed-upon schedule. Under WRF's No-Cost Extension Policy, a project schedule cannot be extended more than nine months beyond the original contracted schedule, regardless of the number of extensions granted. The policy can be reviewed at <http://www.waterrf.org/funding/Pages/policies.aspx>.

Utility and Organization Participation

WRF is especially interested in receiving proposals that include both participation and contribution of resources from water utilities and organizations in the research effort. Information on utilities and/or organizations that have indicated an interest in participating in this research project are listed on the last page of this RFP. While WRF makes utility and organization participation volunteers known to applicants, it is the applicant's responsibility to negotiate utility and organization participation in their particular proposal, and the utilities and/or organizations are under no obligation to participate.

Application Procedure and Deadline

Proposals are now being accepted exclusively online in PDF format. Proposals must be submitted before 2:00 PM Mountain Time, Tuesday, November 27, 2018. All the forms and components of the proposal are available online in the "Proposal Component Packet" zip file. A login is required to download this packet and use the proposal website. This information is available at <https://proposals.waterrf.org/Pages/RFPs.aspx>.

The online proposal system allows submission of your documents until the date and time stated in the RFP. To avoid the risk of the system closing before you press the submit button, do not wait until the last minute to complete your submission.

Questions to clarify the intent of this Request for Proposals and WRF's administrative, cost, and financial requirements may be addressed to the Research Manager, Ashwin Dhanasekar, at (303) 734-3423 or by e-mail at adhanasekar@waterrf.org.

UTILITY AND ORGANIZATION PARTICIPANTS

To date, no utilities have indicated an interest in participating in this research. As utilities express interest, their information will be added below within 24 business hours of receipt of a volunteer form, and this RFP will be re-posted with the new information. **(Depending upon your settings, you may need to click refresh on your browser to load the latest file.)**

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