U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Bioenergy Technologies Office (BETO)

Waste-to-Energy Technical Assistance for Local Governments

Informational Webinar, 3/18/2021

Beau Hoffman (BETO), Anelia Milbrandt (NREL)

Webex Tips

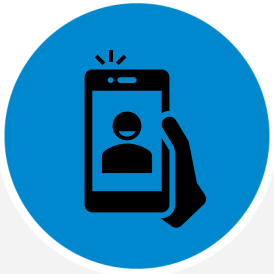
Want to ask a question to the Presenters?

Ask questions in Q&A window

Can't see all the presenters?

Change your layout

Screen cluttered with gray boxes?



Hide participants with video off

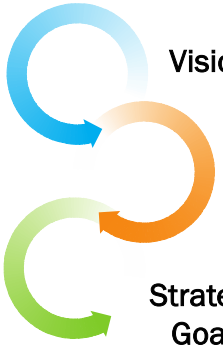
Can't hear anything from your device?

Check speaker settings in toolbar

Still having trouble connecting to the event?

Chat with the Host

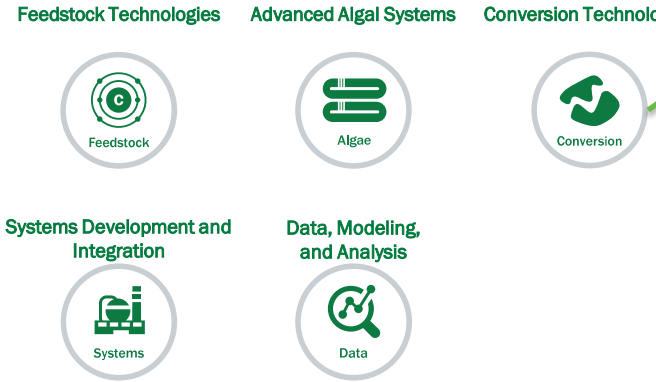
EERE - Bioenergy Technologies Office



A thriving and sustainable bioeconomy fueled by innovative technologies

Developing transformative and revolutionary sustainable bioenergy and coproduct technologies for a prosperous nation

Develop industrially relevant technologies to enable domestically produced biofuels, biopower, and coproducts



Conversion Technologies Strategic Goal: develop efficient and economical biological and chemical technologies to convert biomass feedstocks into energy-dense liquid transportation fuels, such as renewable gasoline, diesel, and sustainable aviation fuel, as well as bioproducts, and chemical intermediates

Research and Development Funding since FY19:

- Liquid Fuels from Waste ($7.5M)
- Products/Chemical Intermediates from Waste ($12.1M)
- Innovations in Anaerobic Digestion ($5.2M)
- Renewable Natural Gas ($8.1M)
- Organic Waste Analysis ($2.2M)

What does BETO mean by “organic waste”?

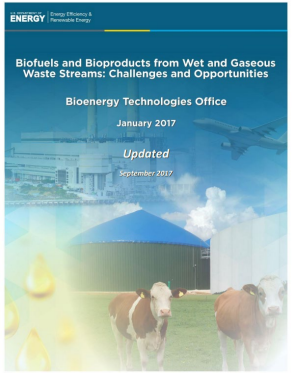
- Municipal Sludge Residuals
- Animal Manure (mostly swine and dairy)
- Food Waste
- Inedible Fats/Oils/Greases

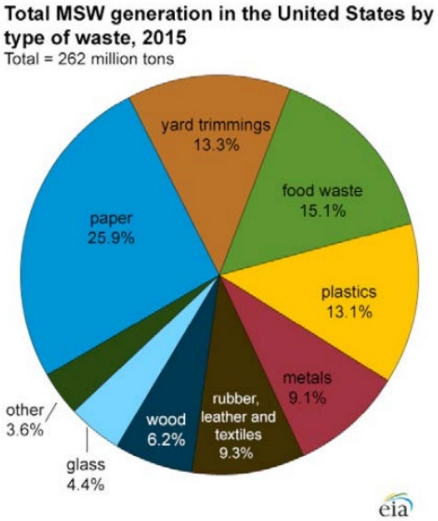
- Significant congressional interest in solving these problems:
  - *“Within available funds, $5,000,000 is to continue the biopower program… $5,000,000 is to improve the efficiency of community and smaller digesters that accept both farm and food wastes…” – FY19 Senate Energy and Water Development Appropriations Subcommittee (SEWD)*

Wet Resources	Annual Beneficial Utilization (Current) Estimated Resource Availability (MM Dry Tons)	Inherent Energy Content (Trillion Btu)	Fuel Equivalent (MM GGE)[2]	Annual Potential Excess[1] Estimated Resource Availability (MM Dry Tons)	Inherent Energy Content (Trillion Btu)	Fuel Equivalent (MM GGE)[2]
Wastewater Residuals	7.12	107.6	927.0	7.70	130.0	1,119.6
Animal Waste	15.00	200.2	1,724.3	26.00	346.9	2,988.7
Food Waste	1.30	6.8	58.2	14.00	72.8	627.1
Fats, Oils, and Greases	4.10	147.4	1,269.3	1.95	66.9	576.6
Total	27.52	462.0	3,978.8	49.65	616.6	5,312.0

[1] Unused excess in this definition includes landfilled biosolids and other wet resources.

[2] 116,090 Btu/gal. This does not account for conversion efficiency.



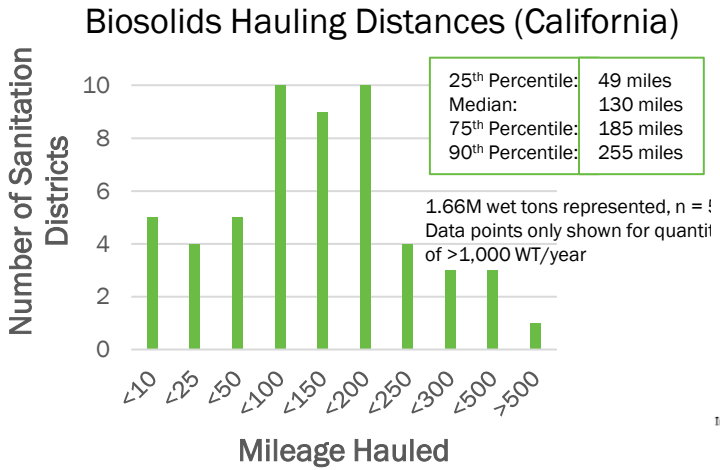


Organic Waste is an economic/environmental liability

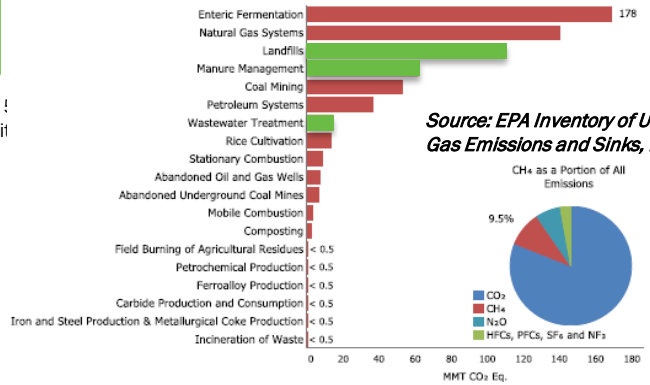
- "it is estimated that 40% of a wastewater treatment facility's total annual operating cost is spent on solids management[1]"
- Biosolids management comprised $11M of DC Water's Annual Operating budget in 2015 and 2016[2]
- "…for all five facilities (Calgary, Vancouver, Orlando, Santa Rosa, and Tohopekaliga) , sludge is ultimately shipped off-site at a cost ranging between $21-102/wet ton or $121-645/dry ton…Thus, there is the potential for significant cost savings if the volume of solids requiring disposal (and associated preparation work) can be reduced)"[3]

The wastewater industry spends >$3.3B/yr disposing of their residual waste:

Dewatering/drying
Sterilization/treatment
Transportation
Tipping fees at landfills/compost facilities



Sources: BACWA 2016 Biosolids Trends Survey
2016 SCAP Biosolids Trends Survey

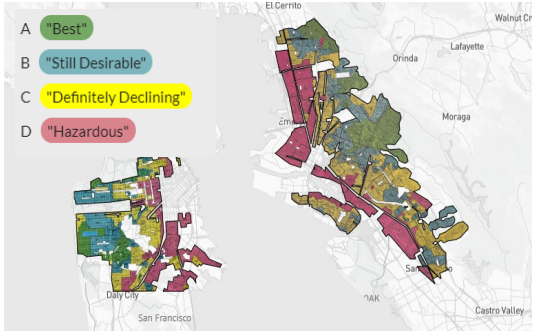


Source: EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2018

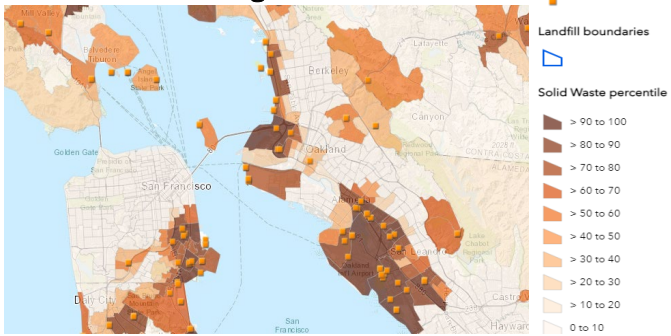
[1] https://legislature.vermont.gov/assets/Legislative-Reports/2016-DEC-Sludge-and-Septage-Report-1-16-2016.pdf
[2] https://www.dcwater.com/sites/default/files/documents/operating_budget_book_final.pdf
[3] https://www.waterrf.org/system/files/resource/2019-10/LIFT6T14%20web.pdf

Organic Waste is a Social Sustainability Liability

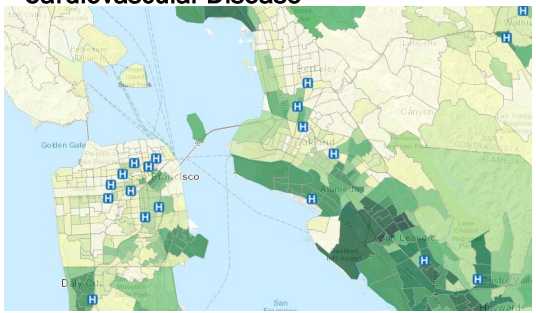
1937 Redlining Map[1]



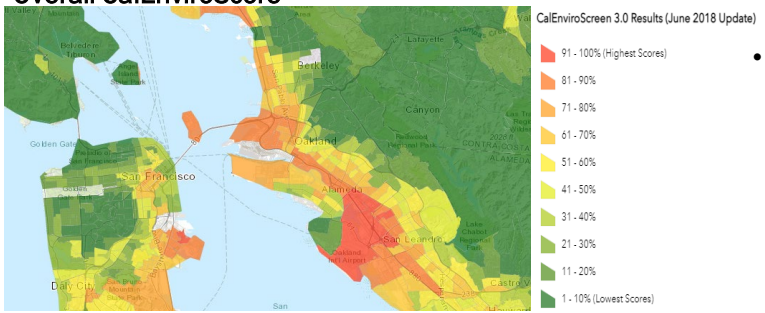
Solid Waste Handling Facilities[2]



Cardiovascular Disease[2]



Overall CalEnviroScore[2]



Organic waste is generated by all members of society. However:

- Siting of waste handling infrastructure is disproportionately in disadvantaged communities[3]
- Environmental impacts are numerous from waste processing facilities: odor, noise, infectious disease vectors, litter, particulate emissions[4]…
- Leading to negative consequences, particularly health
- Social licenses are critical as approval rates are low for living near a waste-to-energy or waste resource recovery facility
  - -14% of survey respondents say they "approve" or "accept" living near a WTE plant (n=623)[5]
  - -11% say they "approve or "accept" living near a WRR facility (n=621)[5]

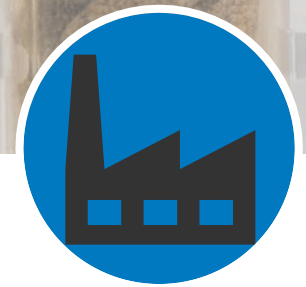
[1] https://dsl.richmond.edu/panorama/redlining/#loc=5/39.1/-94.58
[2] https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30
[3] Paul Mohai and Robin Saha 2015 *Environ. Res. Lett.* **10** 115008
[4] Krystosik A, Njoroge G, Odhiambo L, Forsyth JE, Mutuku F and LaBeaud AD (2020) Solid Wastes Provide Breeding Sites, Burrows, and Food for Biological Disease Vectors, and Urban Zoonotic Reservoirs: A Call to Action for Solutions-Based Research. *Front. Public Health* 7:405. doi: 10.3389/fpubh.2019.00405
[5] Walton, A., McCrea, R., and Jeanneret, T. (2019). *Changes in Victorian attitudes and social acceptance in the waste and resource recovery sector: 2016 to 2019* CSIRO, Australia.

Overview of Existing Research

Organic Waste

Food Waste

Discarded food from residential, commercial, institutional, and industrial sources



Sewage Sludge

Solids remaining after wastewater processing

Animal Manure

Organic material from concentrated animal feeding operations (e.g., dairy, swine)

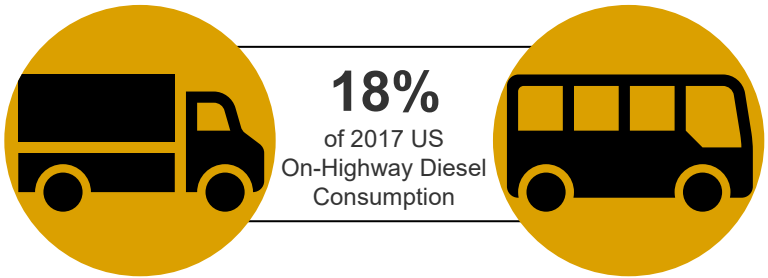
Fats, Oils & Greases

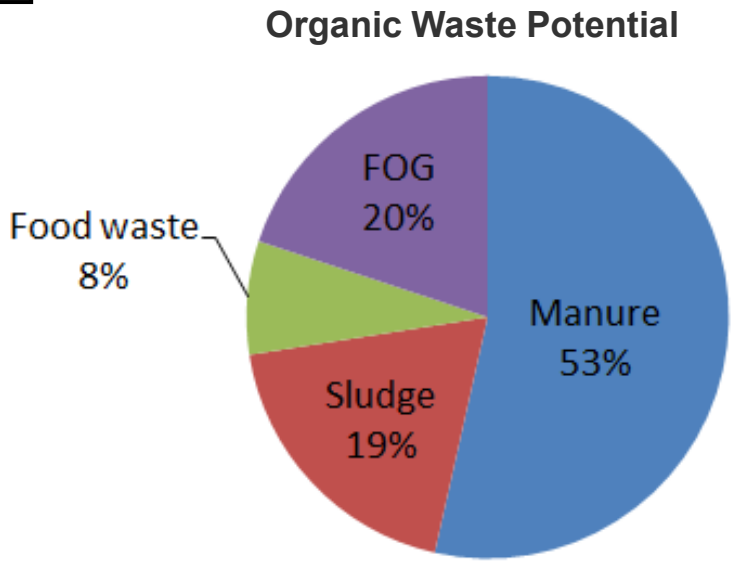
Animal byproducts and grease from food-handling operations (e.g., used cooking oil, animal fats, trap grease)

Photo by Dennis Schroeder, NREL 51862

Resource Assessment

Organic waste has the equivalent energy content of about one quad or 7 billion diesel gallon equivalent (DGE) per year



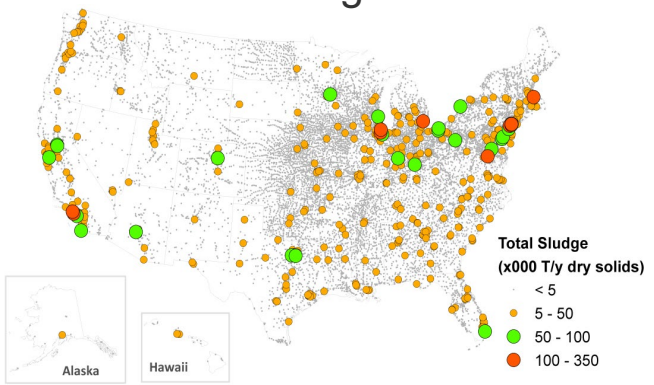


- About half of this potential is generated by animal manure

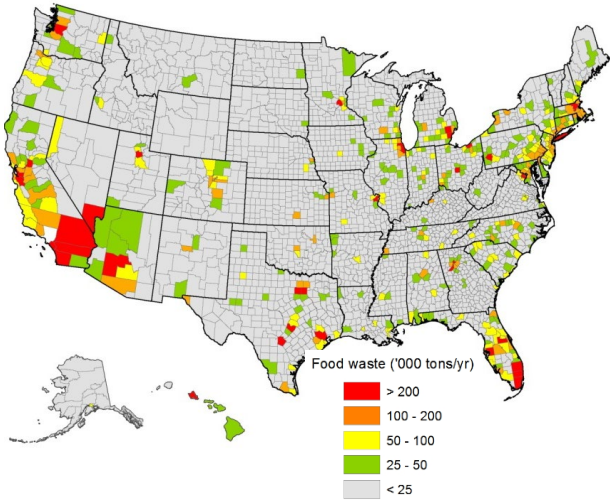
Milbrandt et al. 2018. "Wet Waste-to-Energy Resources in the United States". *Resources, Conservation & Recycling.*

Geographic Distribution of Organic Waste

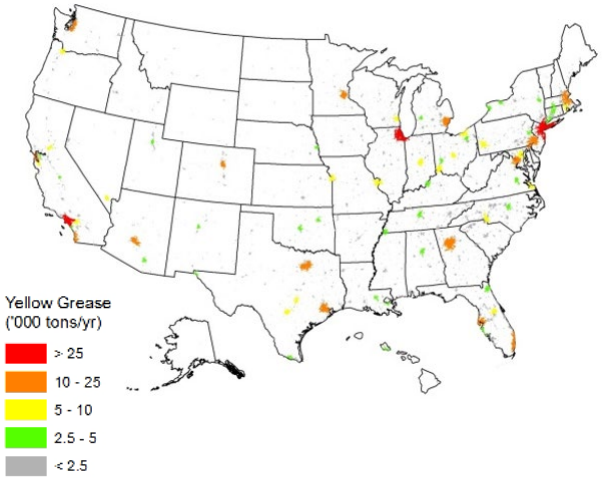
Sludge



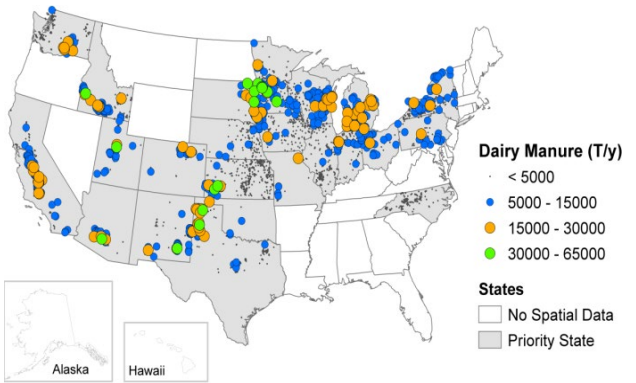
Food Waste



Yellow Grease



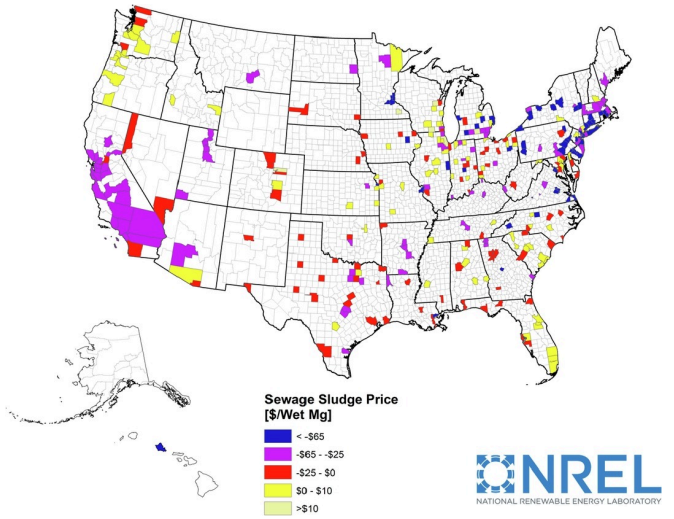
Dairy Manure

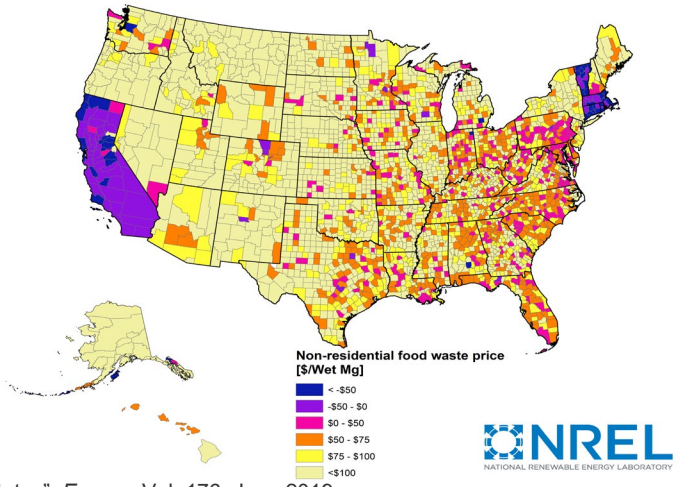


Milbrandt, A., Seiple, T., Heimiller, D., Skaggs, R., Coleman, A. "Wet waste-to-energy resources in the United States". *Resources, Conservation and Recycling.* Volume 137, October 2018, Pages 32-47.
Seiple, T. et al. "Municipal wastewater sludge as a sustainable bioresource in the United States". *Journal of Environmental Management.* Volume 197, July 2017, Pages 673-680.

Organic Waste Prices

- Price maps developed for each feedstock, except FOG
- If a resource has been commoditized (e.g., FOG), its price is determined by market demand
- If a resource is regarded as waste, its price is driven by the cost of its disposal
- Negative prices occur in areas with:
  - Organic waste disposal bans
  - High disposal costs (e.g., landfill tipping fees)
- Formal or informal local markets can drive prices in a given area

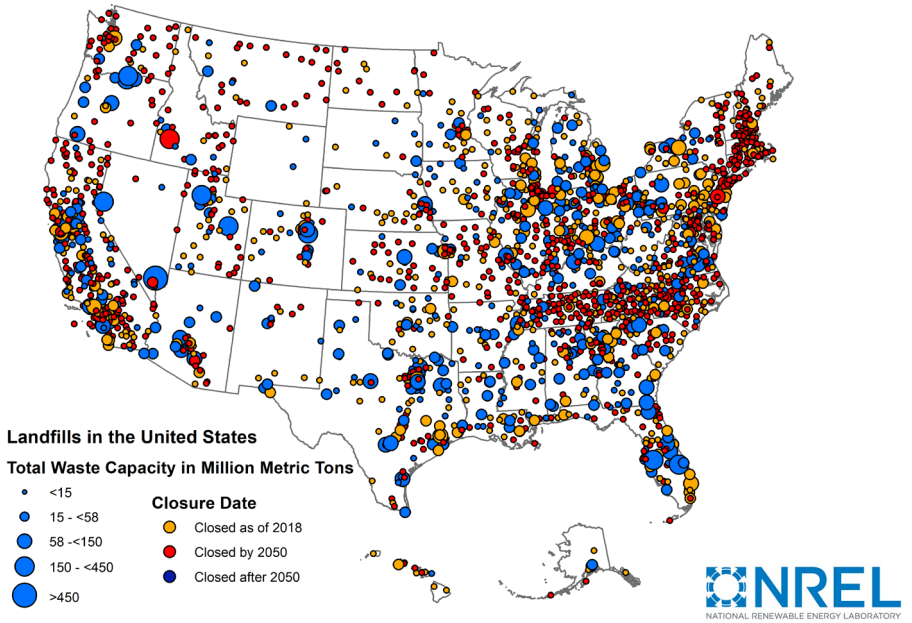


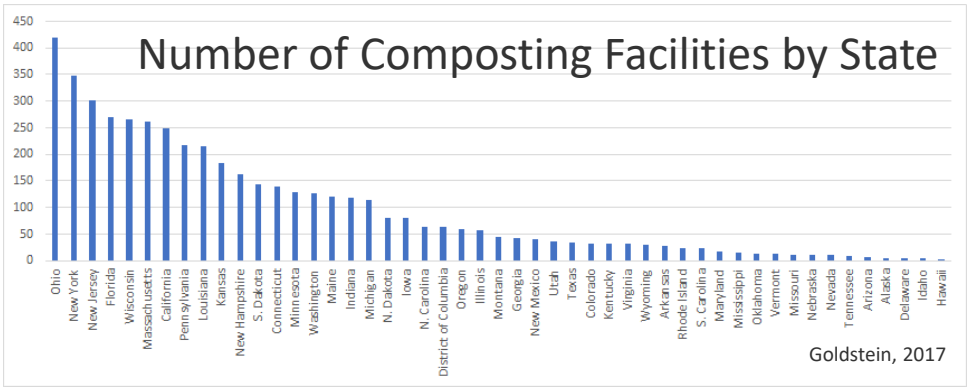


Badgett, A., Newes, E., Milbrandt, A. "Economic Analysis of Wet Waste-to-Energy Resources in the United States". *Energy*. Vol. 176, June 2019.

Disposal and Utilization Options for Organic Waste

- Landfilling
- Composting
- Food banks (food)
- Animal feed (food waste)
- Rendering (FOG)
- Energy recovery



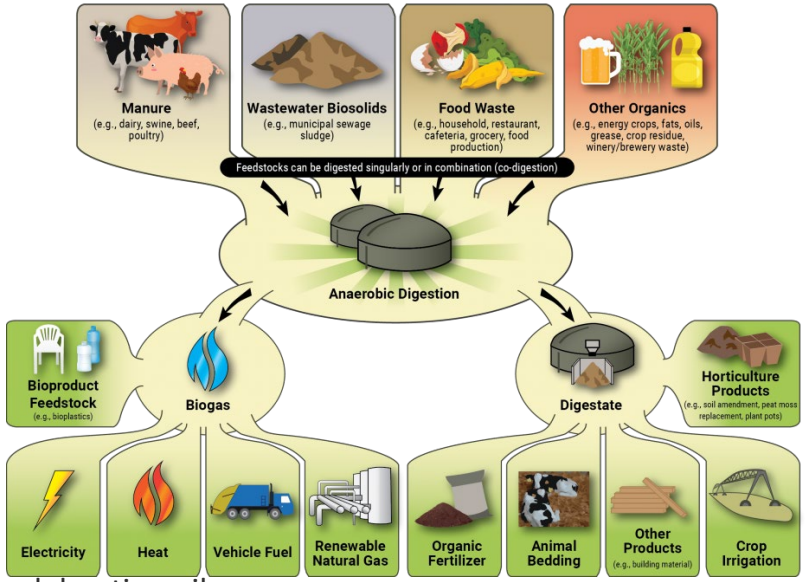


Badgett, A., Milbrandt, A. "Food Waste Disposal and Utilization in the United States: A Spatial Cost-Benefit Analysis". Submitted to *Journal of Cleaner Production*.

Energy Recovery

Commercial Applications

- Anaerobic digestion [AD] (power, heat, pipeline-quality gas, renewable CNG/LNG)
- Incineration (power, heat)
- Transesterification of FOG to biodiesel
- Hydroprocessing of FOG to renewable (drop-in) diesel, jet fuel, heating oil
- Pyrolysis of organic waste to biochar

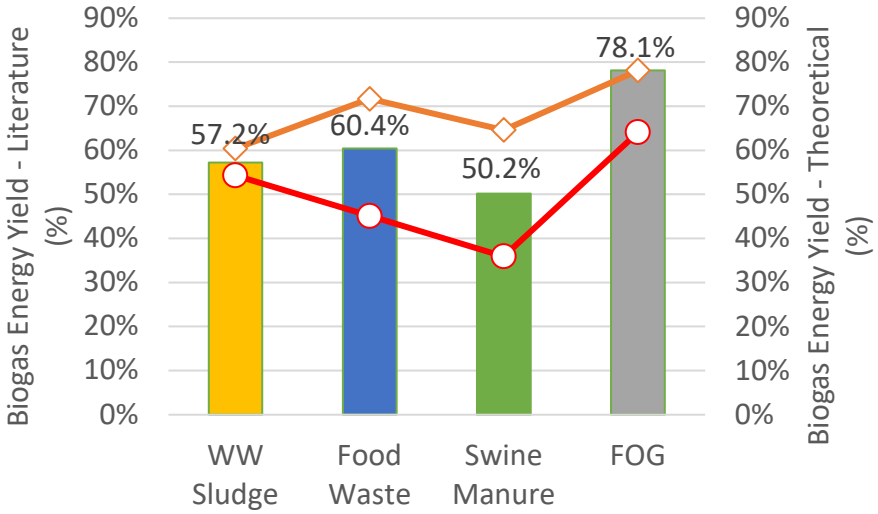


Source: EPA

Advanced Applications

- Hydrothermal liquefaction [HTL] of organic waste to renewable (drop-in) diesel, gasoline, jet fuel
- Advanced AD (e.g., arrested methanogenesis, anaerobic membrane reactors, and various pre and post-treatment strategies) to renewable fuels and chemicals

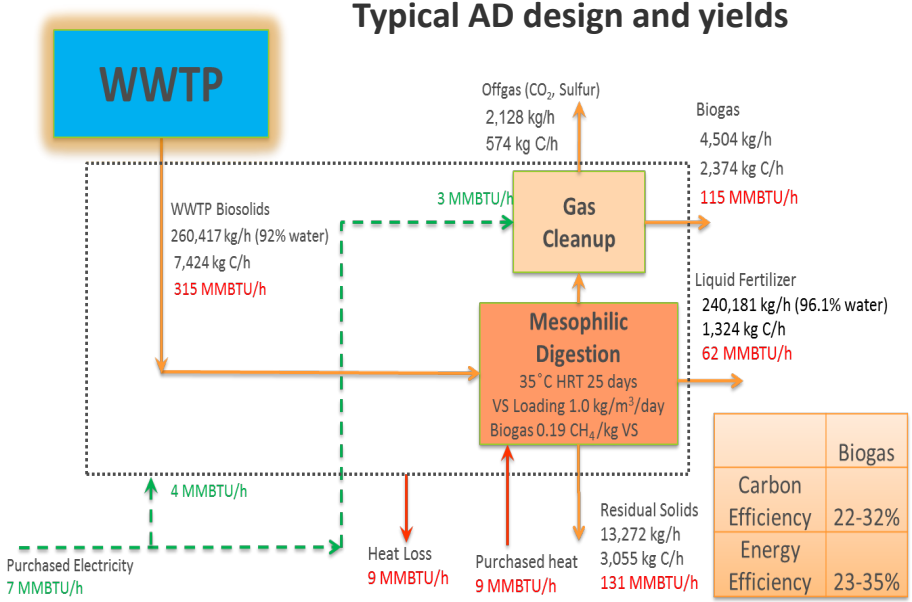
Techno-Economic Analysis of Anaerobic Digestion



- **Factors affecting AD costs:** temperature, hydraulic retention time (HRT), organic loading rate, and pH
- **Factors affecting biogas production:** tank volume, feedstock type, feeding pattern, C/N ratio

TEAs identify key cost drivers, technical challenges, and the most critical performance targets

Typical AD design and yields



Tao, Han and Tomberlin, FY15Q3 QPM

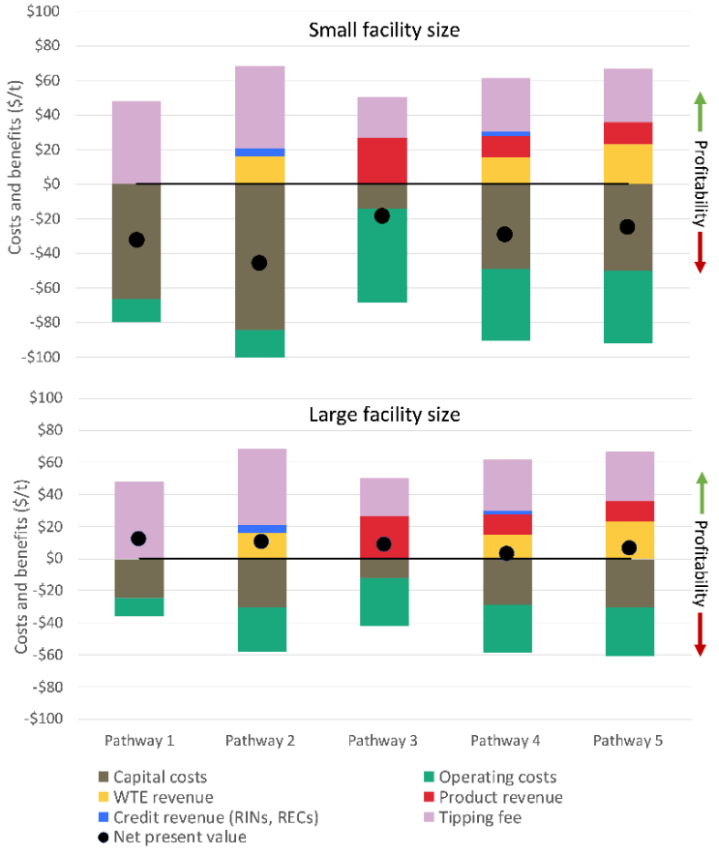
Cost-Benefit Analysis of Food Waste Disposal and Utilization Pathways

CBA pathways at state level and various capacity

- Landfilling: flare, electricity, CHP, CNG, and pipeline injection
- Composting: windrow, in-vessel, and aerated static pile
- AD (dry and wet): flare, electricity, CHP, CNG, and pipeline injection
- Incineration: electricity, CHP
- HTL: biocrude

Key results

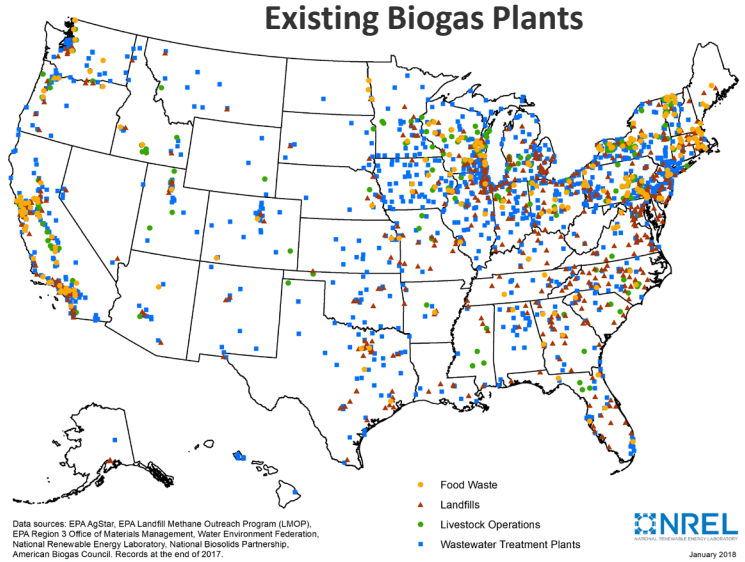
- For a pathway to break even it requires: 1) Tipping fee, 2) A facility of particular scale (larger facilities are able to offset costs easier), and 3) Revenue streams from product sales
- Results vary by capacity and geographic location

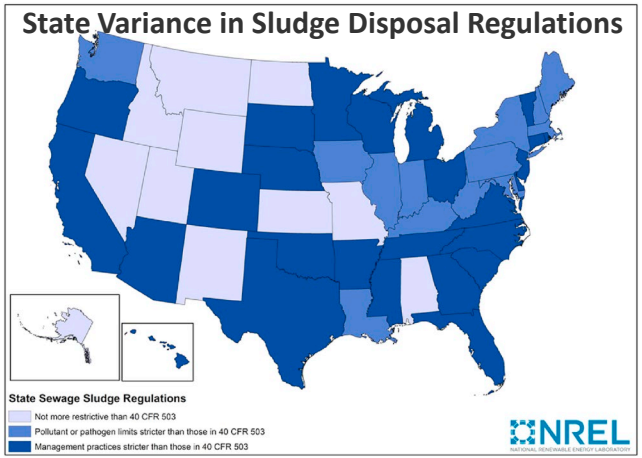


Badgett, A., Milbrandt, A. "Food Waste Disposal and Utilization in the United States: A Spatial Cost-Benefit Analysis". Submitted to *Journal of Cleaner Production*.

Market and Policy

- "Hot spot" analysis identifies areas with the best potential for developing advanced WTE technologies
- Monitor and evaluate existing biogas, biodiesel, and renewable diesel plants
- Renewable energy certificate (REC):
  - Evaluate REC market rules and policy changes
  - Provide guidance on claims that organizations can make from the purchase and sale of RECs
  - Help organizations understand pathways for purchasing REC products
- Renewable Identification Numbers (RIN) and California Low Carbon Fuel Standard (LCFS) analyses (e.g., generation, prices, sales)
- Summarized existing practices and regulatory standards for handling and disposal of organic wastes in the US

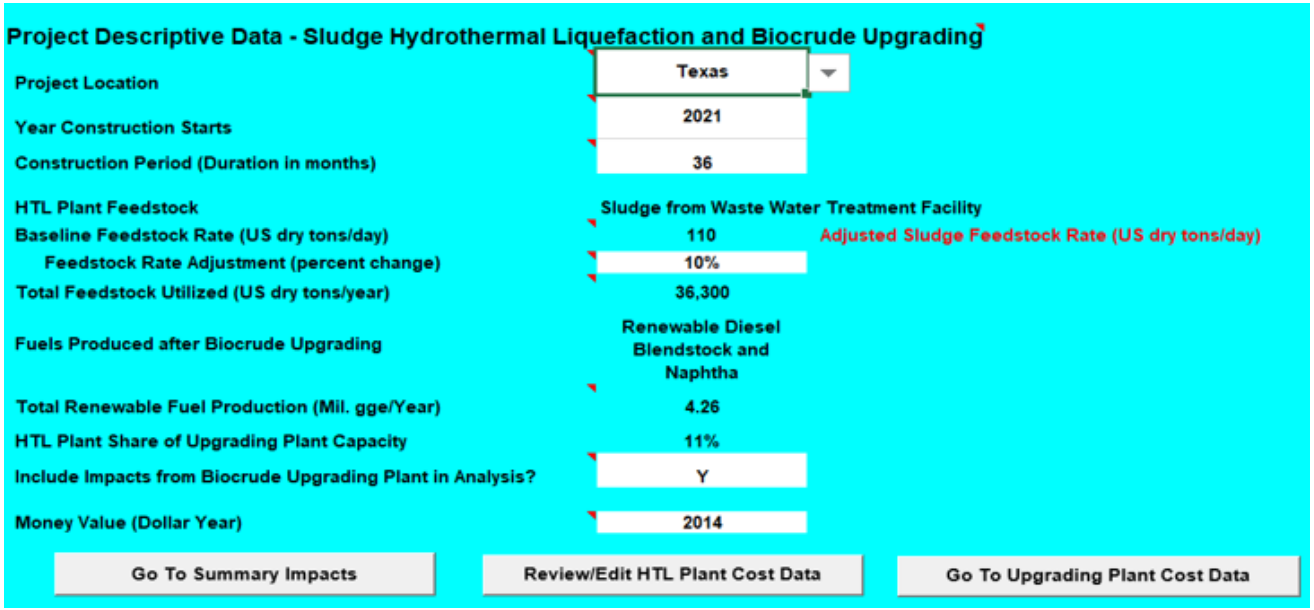




Socio-Economic Impact

The **Jobs and Economic Development Impact (JEDI)** models estimate the economic impacts of constructing and operating renewable energy plants at the local and state levels

Example: Hydrothermal liquefaction using sewage sludge with biocrude upgrading to renewable diesel



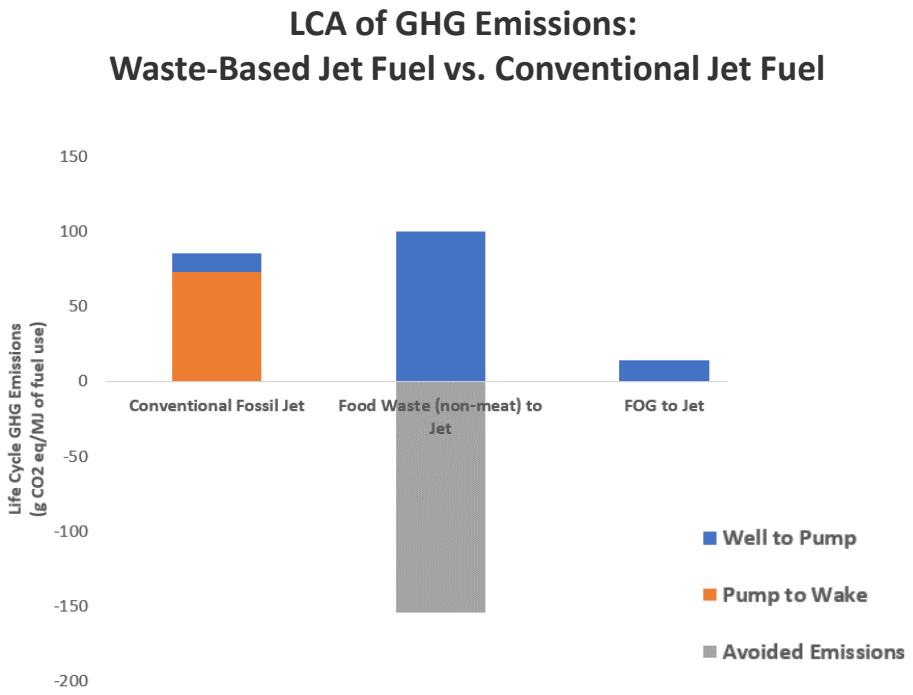
Life Cycle Analysis of GHG Emissions and Energy Use

Description

- Used to account for inputs (raw materials and energy) and outputs (products, waste materials, and environmental impacting components such as CO_2) to complex systems
- Used to quantify the environmental benefits and drawbacks of a process
- Performed on all processes, cradle-to-grave, resource extraction to final disposal
- Ideal for comparing new technologies to the status quo
- Helps to pinpoint areas that deserve special attention
- Reveals unexpected environmental impacts

Variables in NREL's LCAs include:

- Greenhouse gas emissions (CO2, CH4, N2O)
- Air pollutants (SO2, NOx, CO, particulates, ozone)
- Water contaminants and water use
- Net energy value
- Fossil fuel requirements
- Land use



Huq, N. et al. "Towards Net-Zero Sustainable Aviation Fuel with Wet Waste-Derived Volatile Fatty Acids". Pending. *PNAS*. 2021

Additional Decision-Making Support

- Provide assistance with **Request for Proposal** (RFP) development and reviews (e.g., RNG)
- **Review AD projects** (e.g., business organization, project technical details, cost and tax basis, and annual operations)
- Evaluate acquisition **feasibility of AD/RNG projects**, environmental permitting, co-product market, and offtake agreement with LCFS/RIN value
- Support **strategic energy planning** for state, local, and tribal communities considering current status, local resources, challenges, and pathways to achieve their energy goals
- Support **resilience planning** of energy, water, transportation, and waste systems in remote communities (e.g., island jurisdictions, tribes)

WTE Technical Assistance

WTE TA Overview

- **Goal: The goal of the WTE technical assistance is to mobilize data and information compiled about organic waste streams and:**
  - Provide this data to local decision makers
  - Deploy the analyses that have been developed for a variety of energy/resource recovery strategies
  - Foster local public-private partnerships.
- **Eligibility: All U.S. municipalities in the lower 48 states, Alaska, Hawaii, and U.S. territories, as well as tribal governments**
- **Cost: No cost to applicants**

Types of WTE TA - Examples

- ❑ Resource information (e.g., quantity, current use, availability, economics, logistics, etc.)
- ❑ Technology options for energy recovery, product considerations
- ❑ Market/policy considerations
- ❑ Social and ethical considerations (e.g., jobs development, equity assessment)
- ❑ Environmental considerations
- ❑ Analysis support (e.g., cost-benefit analysis, feasibility studies, project screening, etc.)
- ❑ Discuss project financing options
- ❑ Roadmap consultation, energy/waste management planning support, resilience planning assistance
- ❑ Education (e.g., webinars, networking meetings)
- ❑ Other

Types of WTE TA - Examples

Example Request 1: *The city of ____ is in the progress of preparing a climate action plan and is interested in quantifying the greenhouse gas footprint associated with its existing waste management practices.*

- ☑ Environmental considerations
- ☑ Roadmap consultation, energy/waste management planning support, resilience planning assistance

Example Request 2: *The town of ____ is comparing several options for managing their food waste including incineration, anaerobic digestion, and composting. The town is looking for techno-economic analysis to support the decision-making process. The town also would like to evaluate the local jobs impact of these processes.*

- ☑ Analysis support (e.g., cost-benefit analysis, feasibility studies, project screening, etc.)
- ☑ Social and ethical considerations (e.g., jobs development, equity assessment)

Example Request 3: *The city of ____ is considering an anaerobic digester that converts its wastewater residuals and some of its food waste to renewable natural gas. The city would like to explore the cost of implementing this and what sorts of financing and incentives should be considered including renewable energy certificates, EPA Renewable Identification Numbers, and Low Carbon Fuel Standard carbon intensity credits.*

- ☑ Technology options for energy recovery, product considerations
- ☑ Market/policy considerations
- ☑ Discuss project financing options

Timeline and Process for Requesting Technical Assistance

Timeline and Process

- March 18th – Informational Webinar
- March 22nd through April 9th – Phase 1 Application Window
  - Application fields will launch on Monday 3/22
- Mid April – Project Proposal Review
  - 3rd party reviewers will assess the merit and potential impact of the project
- Late April – Announcement of Phase 1 Selections
- May – Calls with Phase 1 projects to establish Scope of Work
- Starting in May – Phase 1 projects begin
- Summer – Phase 2 Application Window*
- By September 30th – Phase 1 projects complete

*subject to funding availability

WTE TA Application Form

Local Government Waste-to-Energy Technical Assistance Application

To request NREL's waste-to-energy (WTE) technical assistance for your municipality, please complete and submit this application form.

NREL and U.S. Department of Energy Bioenergy Technologies Office staff will review your request and respond by the end of April 2021.

For more information about the WTE technical assistance provided, see frequently asked questions.

Name (Required)

Title (Required)

Email Address (Required)

Phone Number (Required)

Organization (Required)

City (Required)

State (Required)

Zip Code (Required)

What type(s) of WTE technical assistance are you interested in receiving? Check all that apply. (Required)

- ☐ Resource information (e.g., quantity, current use, availability, economics, logistics, etc.)
- ☐ Technology options for energy recovery, product considerations
- ☐ Market/policy considerations
- ☐ Social and ethical considerations (e.g., jobs development, equity assessment)
- ☐ Environmental considerations
- ☐ Analysis support (e.g., cost-benefit analysis, feasibility studies, project screening, etc.)
- ☐ Discuss project financing options
- ☐ Roadmap consultation, energy/waste management planning support, resilience planning assistance
- ☐ Education (e.g., webinars, networking meetings)
- ☐ Other

If other, please describe.

Briefly provide more specific information about the WTE technical assistance you need. (Required)

Please provide any additional background information relevant to this request, such as energy goals, past studies, initiatives the technical assistance will support, and timeframe considerations, etc. (Required)

SUBMIT

Data and Privacy Notice

NREL staff will use the information provided to identify and track requests for WTE technical assistance, to evaluate the program, and to inform future research. NREL will not share this information, and it will be retained for 2 years. See NREL's security and privacy policy.

Proposal Review Factors

3rd Party Reviewers are being chosen to independently evaluate these request proposals. All reviewers will sign a conflict of interest/non-disclosure agreement

Reviewers will evaluate each proposal on the following criteria:

Criteria 1: Merit of Request (50% of score)

The degree to which:

- the Technical Assistance request is relevant to resource and energy recovery from waste;
- the Technical Assistance request is explained and justified;
- the Technical Assistance request conveys and is aligned with the goals of local government; and
- the applicant team will be engaged during the process to provide local expertise and insight

Criteria 2: Potential Impact of the Technical Assistance Request (50% of score)

The degree to which:

- The Technical Assistance request achieves and advances local government needs and initiatives;
- the NREL technical assistance team would complement, supplement, and/or provide expertise that the local government does not have;
- the analysis could provide models for other communities to follow or data of use to other communities;
- the analysis provided could enable deployment of resource/energy recovery from waste streams in that local community in the near- or mid-term; and
- the analysis support efforts that promote energy justice/equity goals (e.g. decreasing energy burdens, increasing access to benefits, mitigating/eliminating harms and costs associated with waste management, are inclusive and responsive in decision-making)

Proposal Review Factors

In addition to the above criteria, the Selection Official may consider the following program policy factors in determining which requests are selected for Technical Assistance. **For meritorious proposals**, the Selection Official may consider the following factors relative to other requests during a particular phase of the Technical Assistance program:

- **Geographical Diversity:** The degree to which the applicant represents a unique geographic area;
- **Community Size:** The degree to which the applicant represents different population sizes;
- **Demographic Diversity:** The degree to which the proposed project exhibits team member diversity and is inclusive of communities of color and historically disenfranchised communities
- **Socio-economic status of the Community:** The degree to which the proposed project is located in an area that lacks access to resources (e.g. monetary, technical expertise) or is overburdened with waste management hazards and/or issues
- **Regulatory/Policy Diversity:** The degree to which the applicant represents an unique issue based on regulatory and other political factors
- Uniqueness of the requested topic(s) relative to other requests

What Happens after Selection

An initial call between NREL subject matter experts and technical assistance requesting agency staff will discuss the following:

- Technical assistance request in more detail
- Existing relevant information, expertise, and resources
- Timeline and activities for the technical assistance request to be executed

Goal is to have all Phase 1 projects completed by the end of Fiscal Year 2021 (September 30th)

What Happens after Selection

- For technical assistance requests that were not selected, NREL will strive to provide existing analyses, data, and information to assist that community's efforts on resource and energy recovery from waste
- Technical assistance requests that were not selected will automatically be considered as part of the Phase 2 program in Summer*

*subject to funding availability

FAQs

- **What kind of projects can receive technical assistance?**

  Types of assistance and activities include providing resource, technology, market, and policy information; analysis assistance; targeted discussions with stakeholders; assistance in strategic energy planning; education through webinars; consultations with technical experts; and other issues and topics.
- **Is there a formal agreement for this technical assistance?**

  No, a technical assistance agreement is not required under this program.
- **What is the process after I submit a request?**

  Following the first-round application timeframe (March 22 through April 9), NREL and BETO staff will review received requests and respond to the applying agency about whether their request is selected by end of April 2021.
- **How many applicants will receive technical assistance? Will NREL be able to fulfill every submitted request?**

  Technical assistance will be provided for as many applicants as budget allows. Due to limited resources, NREL may not be able to fulfill all received requests. Each request, however, will be reviewed and a response will be provided to the applying agency. If a request cannot be met, NREL will still provide useful information (e.g., links to existing analyses and/or data) to assist in the agency's efforts related to WTE development.

FAQs

- **How many hours of technical assistance support will be available?**

  The technical assistance is limited to 40 hours per request per municipality.
- **How quickly will my agency receive technical assistance?**

  Technical assistance can begin shortly after the initial call depending on the requested services, NREL staff's availability, urgency of the request, etc.
- **Can I request more than one type of technical assistance at the same time?**

  Yes, as long as the total of all requests are within the 40-hour limit.
- **What is the difference between information on funding and financing?**

  This assistance is provided through the DOE BETO's Conversion R&D Program and does not support direct funding to municipalities. Through this assistance, NREL provides information about project-level finance (e.g., terms, structures, and innovations), financial policies such as feed-in tariffs, clean renewable energy bonds, and power purchase agreements. DOE's funding opportunities website provides information on available funds from DOE for specific projects and programs, including how to apply.

FAQs

- **What is the benefit of participating in the technical assistance program?**

  The benefits of participating in the technical assistance program include access to subject matter experts at no cost to the entity, access to data and information on the options available for energy/resource recovery, and support in waste management plan development and how to incorporate WTE technologies.

- **What happens after I receive technical assistance?**

  We will provide an optional feedback form on this program (e.g., implication, usefulness, areas for improvement, etc.).

NREL WTE TA Team


Anelia Milbrandt


Alex Badgett


Jacq Streur


Ling Tao


Jenny Heeter


Edward Settle


Yimin Zhang

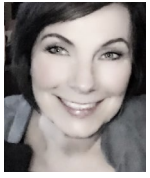

Steve Decker


Michael Resch


Eliza Hotchkiss


Sherry Stout


Debbie Meixner


Cheryl D'Alessandro

Thank you!

www.nrel.gov

Q&A

www.nrel.gov