CADMUS

Memorandum

To: Mitch Horrie; Public Service Commission of Wisconsin

From: Amalia Hicks, Jill Krueger, David Molner, David Ladd, Nick Brucaliere, and Cordell Owsley; Cadmus

Subject: Wisconsin Wastewater Treatment Plant Market Assessment

Date: May 4, 2023

Introduction

The evaluation team conducted a market assessment of Wisconsin's wastewater treatment plants (WWTP) by analyzing response data from the Compliance Annual Maintenance Report (CMAR) compiled between 2016 and 2020. The Wisconsin Department of Natural Resources (DNR) developed the CMAR to collect and compile self-assessment forms from owners of publicly and privately owned domestic WWTPs. Data collected describe the plants' wastewater management activities, physical conditions, energy use for the calendar year, and saturation of energy-efficient equipment to "promote an owner's awareness and responsibility for wastewater conveyance and treatment needs."[1]

A follow-up survey of WWTP owners and facility managers who provided their CMAR reports to the DNR was developed and administered by the evaluation team between January and February 2023. The market assessment provides insight into the penetration and saturation of energy-efficient equipment and processes of WWTPs, barriers that facility managers and owners see to adopting energy-efficient equipment, energy-efficient decision-making practices of facility managers and owners', and facility and owner awareness of current Focus on Energy offerings and interest in potential new offerings.

Analysis of CMAR Data

This section outlines the analysis of compiled CMAR survey data from 2016 to 2020. The analysis included a review of raw data survey responses from WWTP facility managers and owners who answered questions related to the average daily flow in millions of gallons per day (MGD), the presence of energy-efficiency equipment, code and testing compliance, plant-assessment information, and energy usage.

Plants are grouped by output size in MGD from 0 to 0.05 MGD as the smallest output category to >1 MGD as the largest. In total, 618 plants (out of approximately 1,000 plants in Wisconsin) responded to the CMAR survey between 2016 and 2020. Two-thirds (n=417) of these plants had an MGD of 0.25 or less. Only 14% (n=89) had an MGD over one. Table 1 shows the number of CMAR responses by plant size and the percentage of plants represented in the plant category.

[1] Wisconsin Department of Natural Resources. n.d. "Compliance Maintenance Annual Report (CMAR) | Wastewater Treatment Works Compliance Maintenance Program | Wisconsin DNR." https://dnr.wisconsin.gov/topic/Wastewater/CMAR.

Table 1. CMAR Responses by Plant Size

Plant Size	Number of CMAR Responses	Percent of Total Responses
0-0.05 MGD	206	33%
0.05-0.25 MGD	211	34%
0.25-1 MGD	112	18%
>1 MGD	89	14%
Total	**618**	**100%**

Treatment Plant Equipment Saturation

The CMAR survey asked WWTP respondents about the installation and usage of specific WWTP equipment at their plants (shown in Table 2).

Table 2. WWTP Equipment Options in CMAR

Aerobic Digestion	Anaerobic Digestion
Biological Phosphorus Removal	Coarse Bubble Diffusers
Dissolved Oxygen Monitoring and Aeration Control	Effluent Pumping
Fine Bubble Diffusers	Influent Pumping
Mechanical Sludge Processing	Nitrification
Supervisory Control and Data Acquisition (SCADA) System	Ultraviolet (UV) Disinfection
Variable Speed Drives (VSD)	Other (Optional)

Source: 2020 CMAR Data. Question 7.2.1 "Indicate equipment and practices utilized at your treatment facility (Check all that apply)".

Equipment saturation increased with the capacity of the plants, with the highest saturation found in plants with a capacity of >1 MGD.

Across all plant sizes, supervisory control and data acquisition (SCADA) systems were installed in 56% of all plants, 97% of plants with a capacity of >1 MGD, and 90% of plants with a capacity of 0.25 to 1 MGD. SCADA systems are used as automated monitoring controls that allow plant operators to view real-time data. Similarly, variable speed drives (VSD), which increase efficiency in pumps, compressor systems, and motors, were reported in 56% of all plant sizes combined and found in 96% of facilities with an MGD >1 MGD and 90% of facilities with a capacity of 0.25 to 1 MGD.

SCADA and VSD equipment had notably lower saturation in smaller facilities, with only about half of the plants with a capacity of 0.05 to 0.25 MGD using both systems and about one-fifth of plants with a capacity of 0 to 0.05 MGD.

Forty-seven percent of all plants surveyed contained an aerobic digester. Plants with a capacity >1 MGD had the lowest saturation of aerobic digester systems (27%), making them the least installed type of equipment across >1 MGD plants. Larger plants are more likely to implement anaerobic digestion systems that cover both solid and liquid disposals. These systems are used to separate and recycle liquids, then follow a separate process for solid disposal. Smaller plants, however, focus on aerobic digesters converting bio solids into liquid disposal.

Over 50% of all survey respondents reported their plant had a SCADA system installed (n=346) and VSD installed (n=328) installed. Respondents reported saturation of between 30% to 49% for other measures:

- Aerobic digestion (n=290)
- Dissolved oxygen monitoring and aeration control (n=278)
- Fine bubble diffuser saturation (n=272)
- UV disinfection (n=241)
- Effluent pumping (n=198)

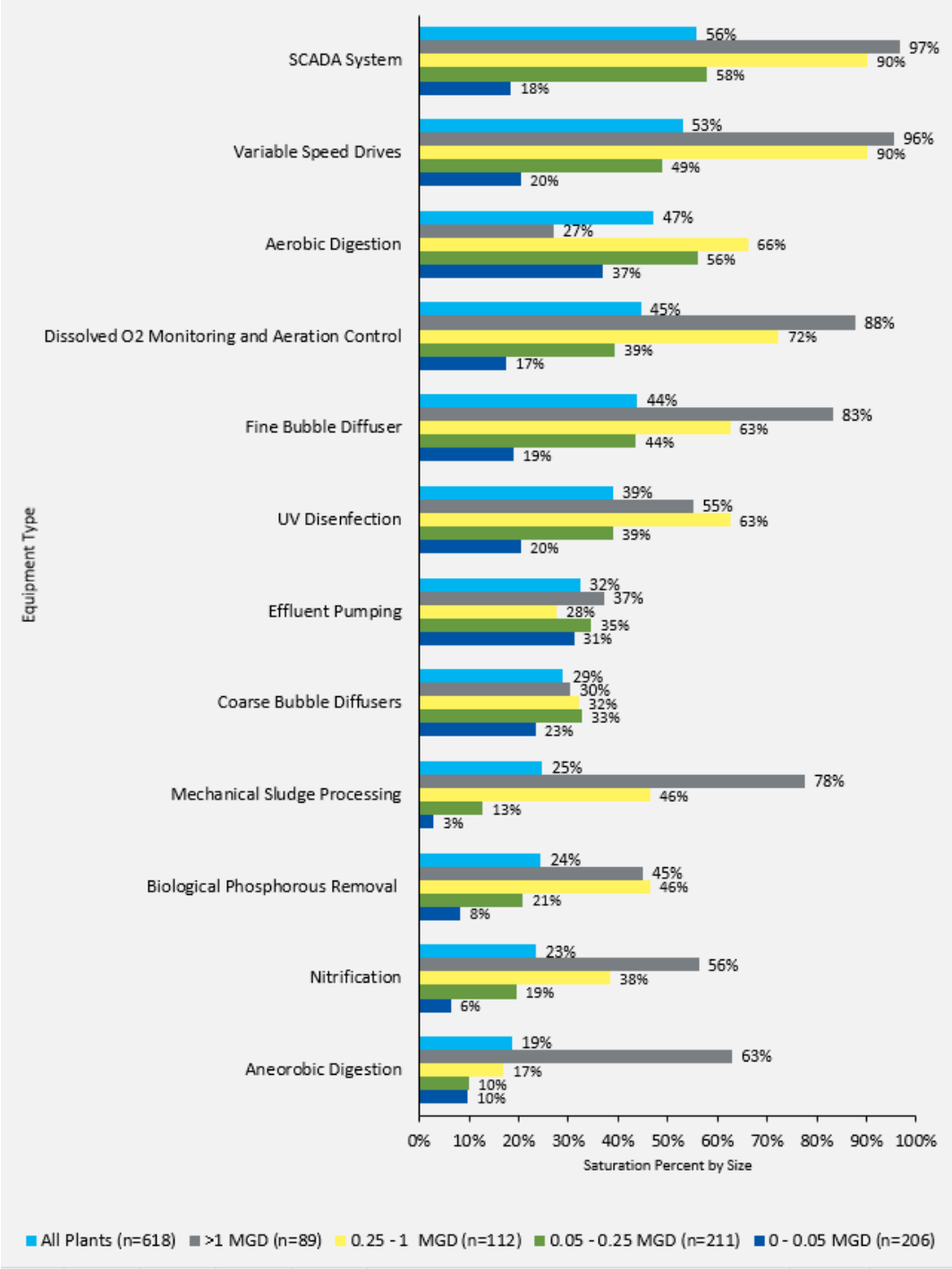
Respondents reported saturation below 30% for the following measures:

- Coarse bubble diffusers (n=179)
- Mechanical sludge processing (n=155)
- Biological phosphorous removal (n=148)
- Nitrification (n=142)
- Anaerobic digestion (n=117)

In general, plants with an average MGD capacity of 0.25 or greater had higher levels of equipment saturation than plants with an average MGD below 0.25. However, certain measures had comparable levels of saturation in all plants. For example, effluent pumping systems (or sump pumps) and coarse bubble diffusers had relatively equal levels of saturation regardless of plant size.

Figure 1 shows the saturation of energy-efficient equipment across WWTPs by plant size.

Figure 1. Saturation of WWTP Equipment and Practices in WWTPs



Source: 2020 CMAR Data. Question 7.2.1 "Indicate equipment and practices utilized at your treatment facility (Check all that apply)".

Pump and Lift System Equipment Saturation

Pump and lift stations contain a variety of components such as pumps, valves, and control systems to move wastewater from a low elevation to a higher elevation within a given wastewater collection

system. [2] A wastewater collection system is responsible for moving sanitary wastewater from the point of discharge to a wastewater treatment plant.

At least 50% of plant collection systems used three types of the listed equipment. The most utilized equipment was the submersible pump (79% of all plants). After that, the most utilized equipment included flow metering and recording (53%) and SCADA systems (50%). The use of pneumatic pumping stations was low across all plants (4%). Pneumatic pumps have benefits for tank cleaning and are more effective for sludge pumping, while the submersible pump is more efficient for liquid pumping. [3] Low saturation of pneumatic pumps in comparison to the high saturation of submersible pumps, suggest a higher versatility in usage for submersible pumps than in pneumatic pumps.

The use of equipment increased with the WWTP MGD capacity. Facilities with a capacity of >1 MGD had the highest representation of equipment with a saturation above 50% for submersible pumps (83%), flow metering and recording devices (62%), SCADA systems (88%), self-priming pumps (54%), and variable speed drives (66%). However, utilization and high saturation were comparable for all plant sizes for submersible pumps, flow metering, and recording equipment.

Extended shaft pumps with combined saturation across all plants (7%) were at least three times more likely to be used in plants with a capacity of >1 MGD (21%) than all other plants (5% across plants with an average MGD of 1 or lower).

Figure 2 summarizes the saturation of equipment across WWTP collection systems by plant size.

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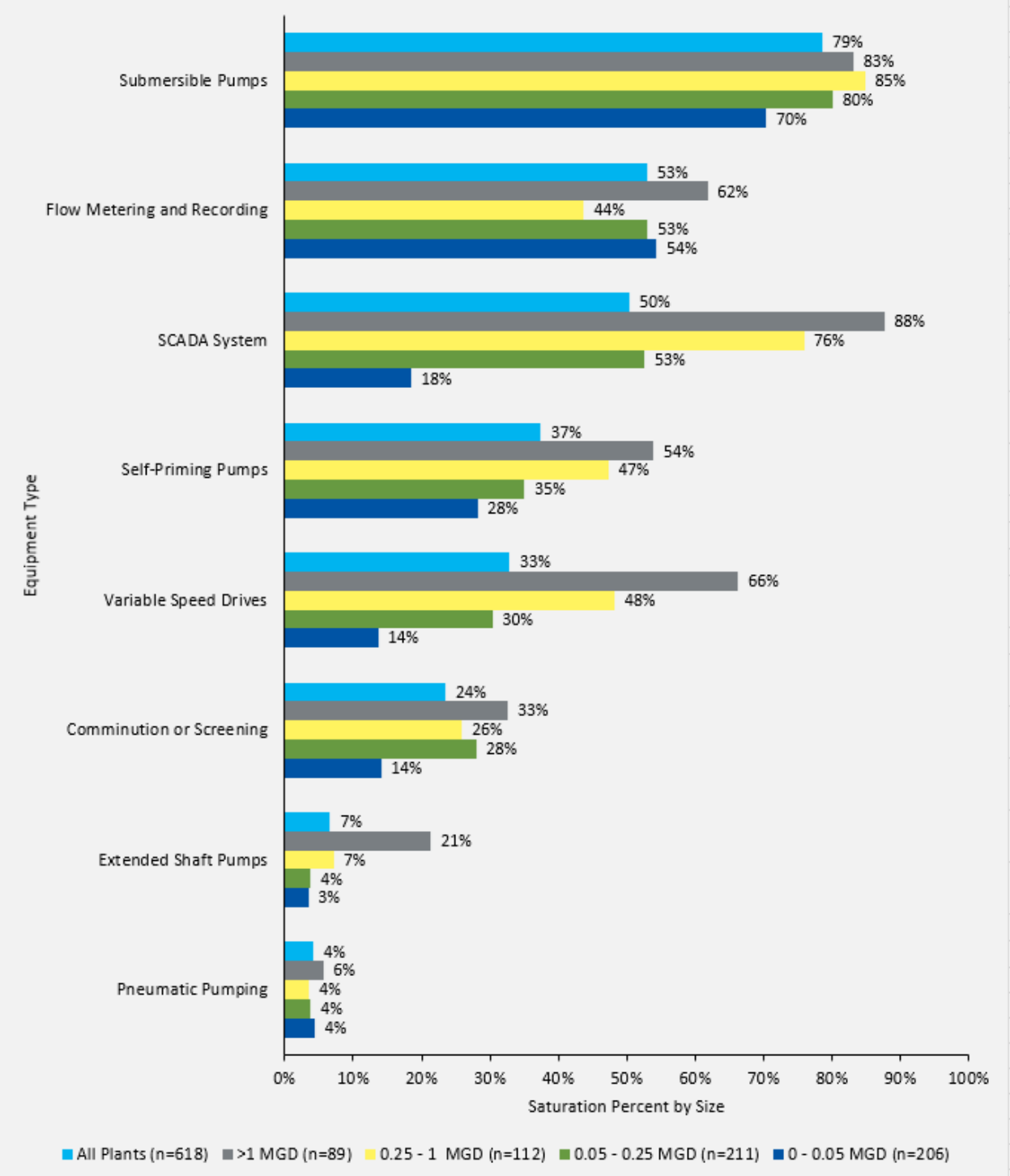
[2] Water Environmental Federation. 2019. *Sanitary Sewer Systems: Lift Stations and Data Management Fact Sheet*. wsec-2019-fs-013---csc-mrrdc---lift-stations-and-data-management---final.pdf (wef.org)

[3] Environmental Protection Agency. 2000. *Collection Systems Technology Fact Sheet Sewers, Lift Station.* Collection Systems Technology Fact Sheet: Sewers, Lift Station (epa.gov)

Figure 2. Saturation of Collection System WWTP Equipment

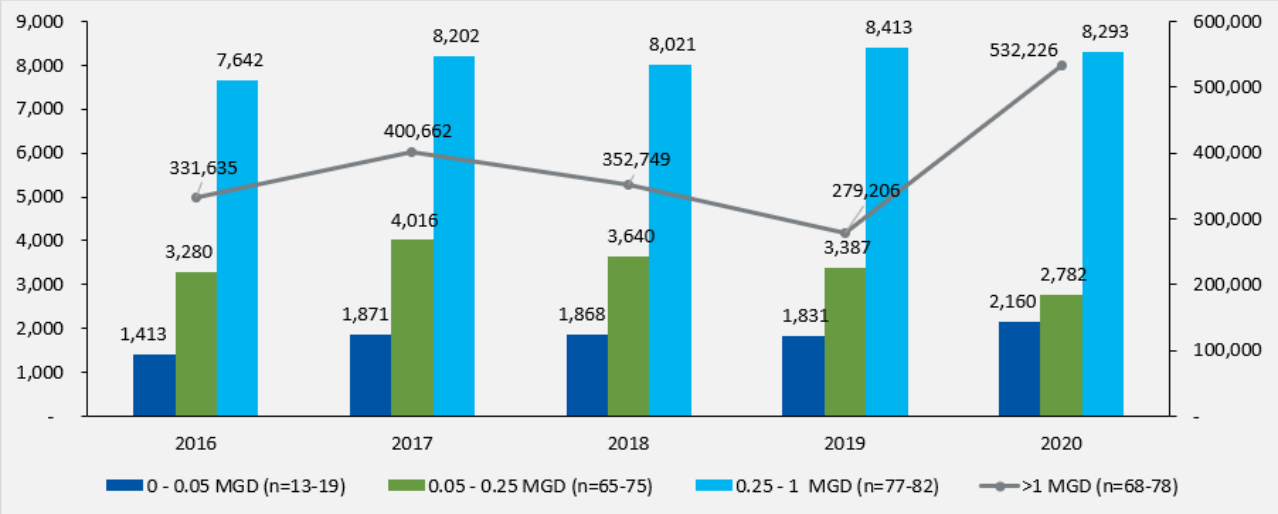


Source: 2020 CMAR Data. Question 6.2.1 "Indicate equipment and practices utilized at your pump/lift stations (Check all that apply)"

Treatment Plant Energy Usage

Figure 3 shows the average annual natural gas consumption for WWTPs by plant size. Given the large difference in scale between natural gas usage in plants sized >1 MGD compared to plants below that size, the usage for plants sized >1 MGD is shown in a gray line, and usage for other plant sizes is shown in bars. Average annual natural gas usage increased from 2017 to 2020 for all plant sizes except those sized between 0.05 and 0.25 MGD. CMAR data showed that plants sized 0 to 0.05 MGD deviated from the yearly trend and increased by 412% from 2018 to 2019. The evaluation team determined that this was likely due to a user input error for a single WWTP. After removing the outlier facility from the analysis, 0-0.05 MGD plants show a consistent trend of gradual increase in therm consumption throughout the years.

Figure 3. Average Annual Natural Gas Consumed (therms) by Year and Size

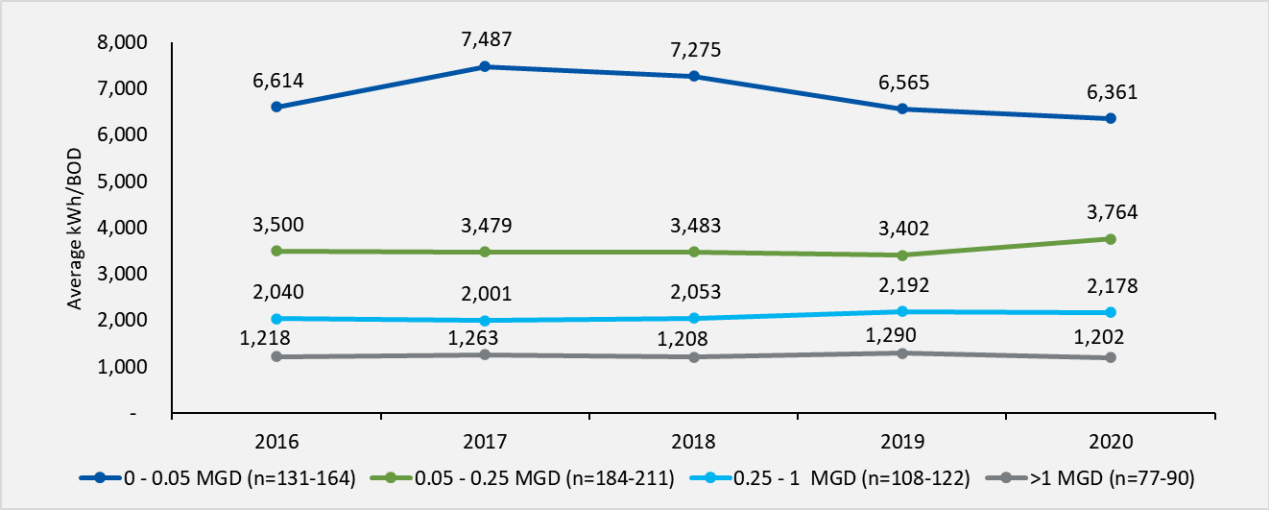


Source: CMAR Analysis Source: 2020 CMAR Data. Question 7.1.1 "Enter the monthly energy usage from the different energy sources:"

Water and wastewater utility managers index their facilities' electricity usage through a production or demand index, such as kWh per 1,000 lbs of Biological Oxygen Demand (BOD) or kWh per MGD. This index is called a Key Performance Index or Energy Performance Index.

As shown in Figure 4**,** the average kWh per BOD did not vary greatly from 2016 to 2020 across plants of all sizes. Plants sized 0 to 0.05 MGD had the highest average kWh per BOD usage, while plants sized >1 MGD had the lowest average kWh per BOD.

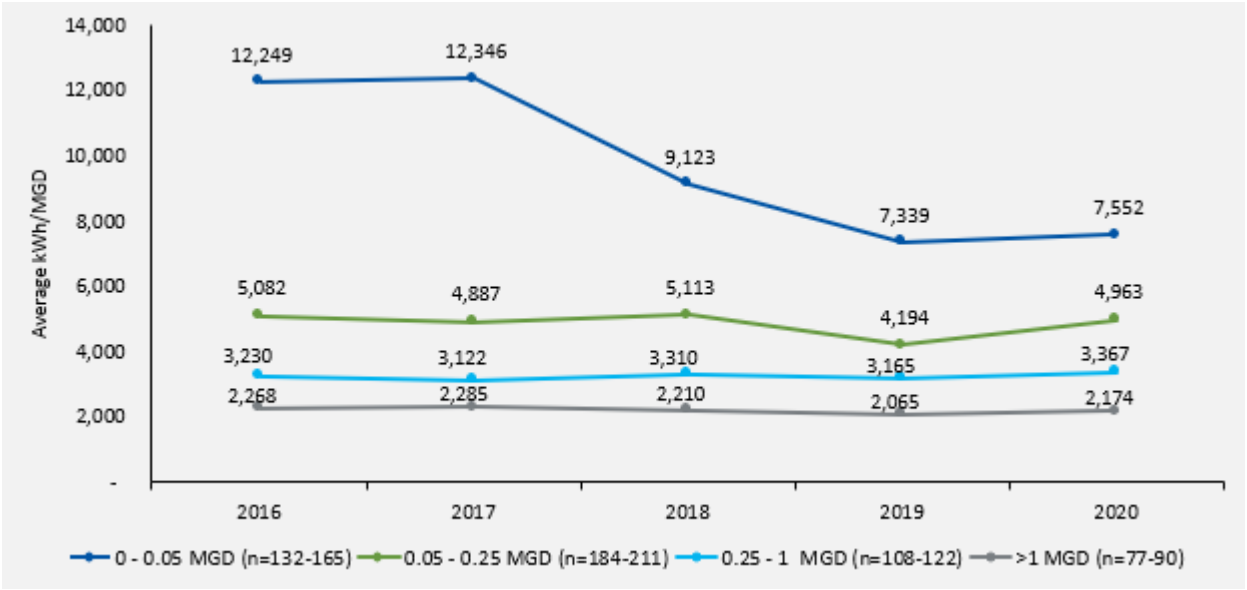
Figure 4. Average Wastewater Treatment Plant kWh Per BOD by Size and Year



Source: 2020 CMAR Data. Question 7.1.1 "Enter the monthly energy usage from the different energy sources:"

Figure 5 shows the average reported kWh per MGD also remained consistent across plants of all sizes from 2016 to 2020, except for plants sized 0 to 0.05 MGD, which decreased by 4,697 kWh per MGD (38%) between 2016 and 2020.

Figure 5. Average Wastewater Treatment Plant kWh/MGD by Size and Year



Source: 2020 CMAR Data. Question 7.1.1 "Enter the monthly energy usage from the different energy sources:"

Energy Studies

This section outlines treatment plant energy assessments, the collection system energy assessments and how they relate to various WWTPs by facility size (MGD), and the various providers' focus on different sized facilities for assessment. The primary study providers are Focus on Energy, The University of

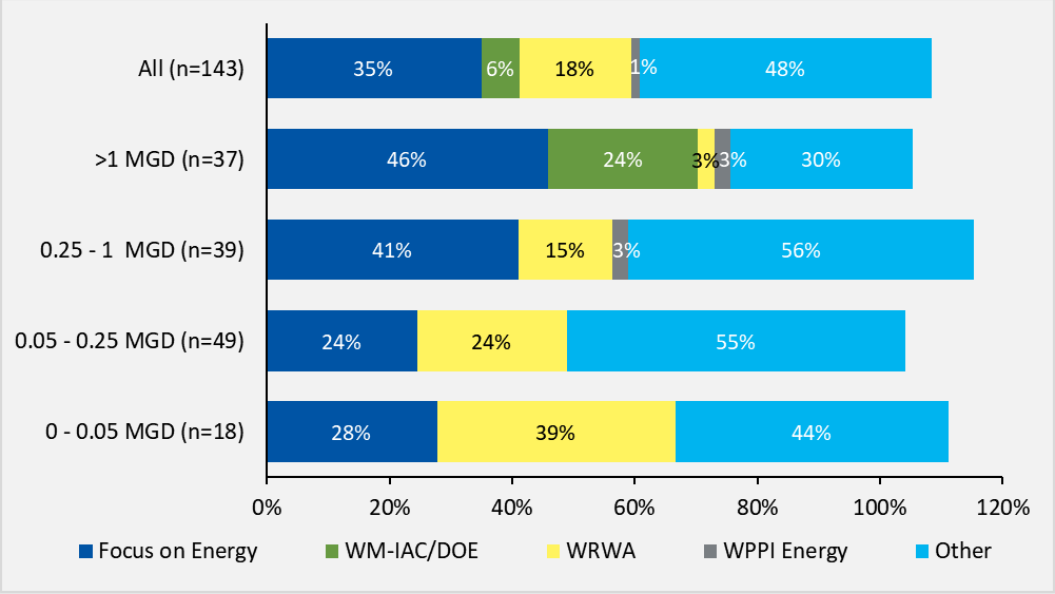
Wisconsin-Milwaukee Industrial Assessment Center/U.S. Department of Energy (WM-IAC/DOE), Wisconsin Rural Water Association (WRWA), and WPPI Energy.

Treatment Plant Energy Assessments

WWTPs sized >1 MGD and 0.25 to 1 MGD were more likely to use Focus on Energy as their study provider (46% and 41%, respectively) than plants sized 0.05 to 0.25 MGD and 0 to 0.05 MGD (24% and 28%, respectively). Additionally, plants sized 0 to 0.05 MGD and 0.05 to 0.25 MGD were more likely to use WRWA as their study provider (39% and 24%, respectively). The WM-IAC/DOE only performed 6% of all collection system studies across all plants and had only conducted assessments on plants sized >1 MGD. After the Other category, which mostly encompasses private engineers, Focus on Energy was the main study provider for plants of all sizes (35%).

Figure 6 shows the WWTP assessments by plant size and study provider.

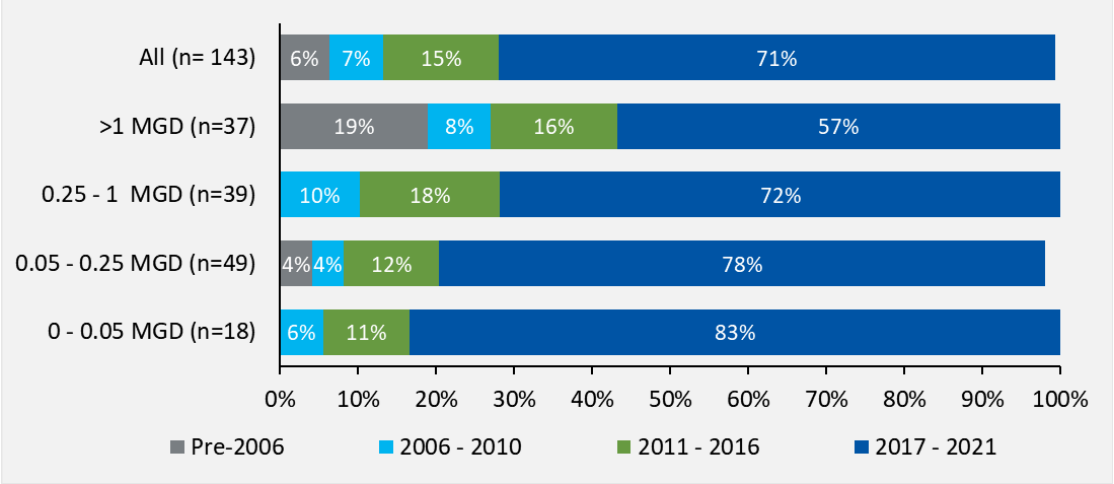
Figure 6. 2020 Treatment Plant Energy Assessment by Size and Study Provider



Source: CMAR Data. Question. 9.1 "Has an energy study been performed for your treatment facility?" Multiple responses were allowed, which resulted in a sum greater than 100% for every plant size category.

As shown in Figure 7, 71% of WWTP energy assessments across plants of all sizes occurred between 2017 to 2021. Eighty-three percent of plants sized 0 to 0.05 MGD and 78% of plants sized 0.05 to 0.25 MGD received an assessment after 2016. While only 57% of plants >1 MGD received an assessment after 2016. Nineteen percent of plants >1 MGD received a plant assessment prior to 2006, compared to 6% of all plants.

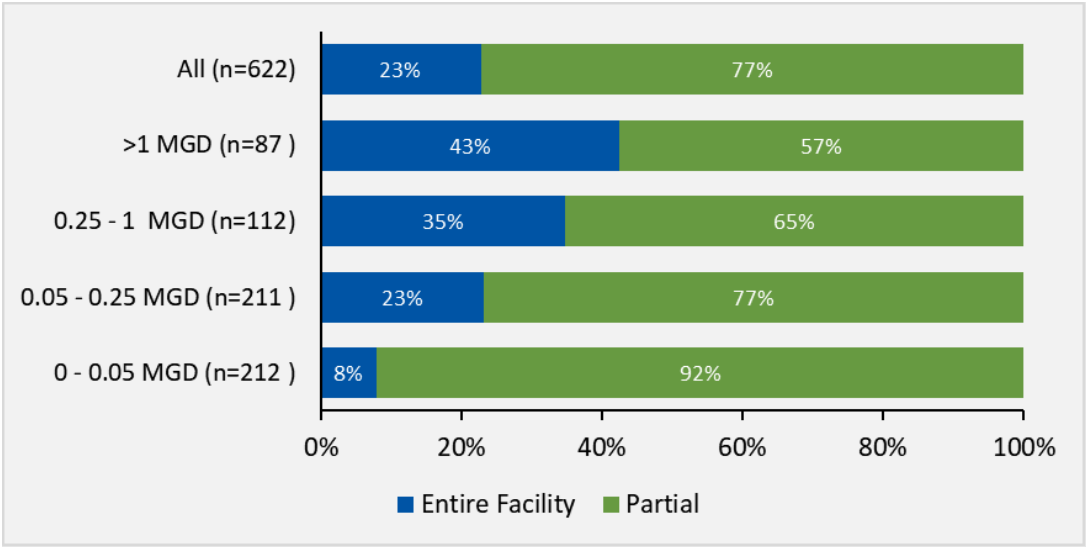
Figure 7. 2020 Treatment Plant Energy Assessment by Size and Year



Source: CMAR Data. Question. 9.1 "Has an Energy Study been performed for your treatment facility?"

Figure 8 breaks out entire-facility assessments versus partial-plant assessments. Partial-plant assessments were three times more common than whole-plant assessments across plants of all sizes, and over 11 times more common in the smallest plants sized 0 to 0.05 MGD. The prevalence of entire-facility assessments increased as plant size increased. Forty-three percent of plants sized >1 MGD completed entire-facility assessments compared to only 8% of plants sized 0 to 0.05 MGD.

Figure 8. 2020 Treatment Plant Energy Assessment by Size and Assessment Type



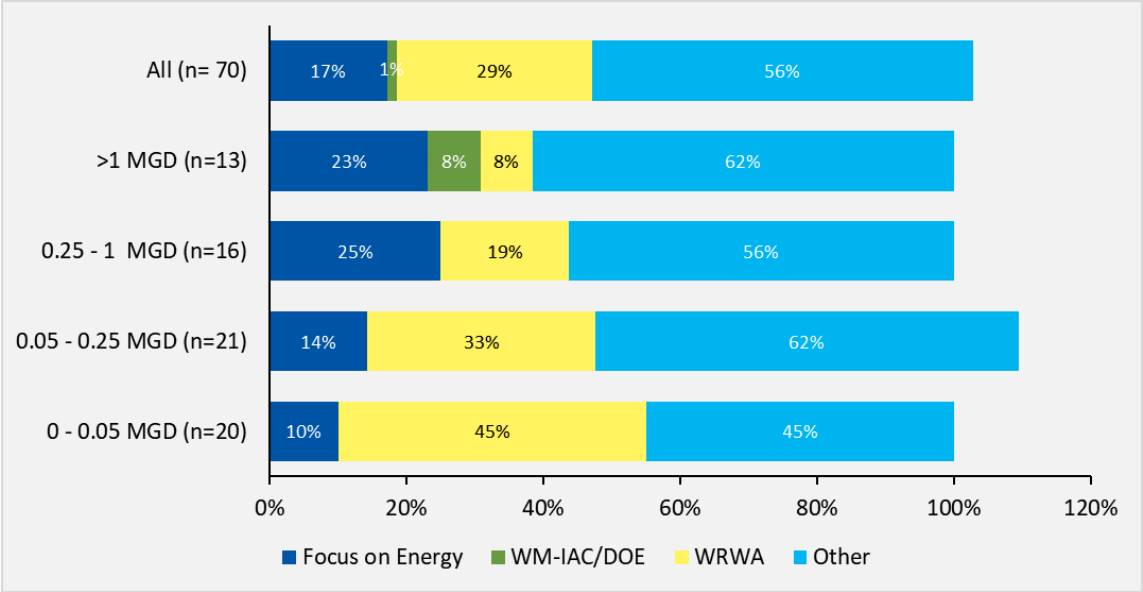
Source: 2020 CMAR Data. Question 9.1 "Has an energy study been performed for your treatment facility?"

Collection System Energy Assessments

As shown in Figure 9, the majority (56%) of WWTPs that received a collection system energy assessment used a study provider other than Focus on Energy, WM-IAC/DOE, or WRWA between 2000 and 2020. After the Other category, WRWA provided most of the studies for plants of all sizes (29%). Larger plants (sized >1 MGD and 0.25 to 1 MGD) were more likely to use Focus on Energy as their study provider (23%

and 25%, respectively) than the smaller plants. Smaller plants (0 to 0.05 MGD) were more likely to use WRWA as their study provider. The WM-IAC/DOE only performed 1% of all collection system studies and only conducted assessments on plants sized >1 MGD.

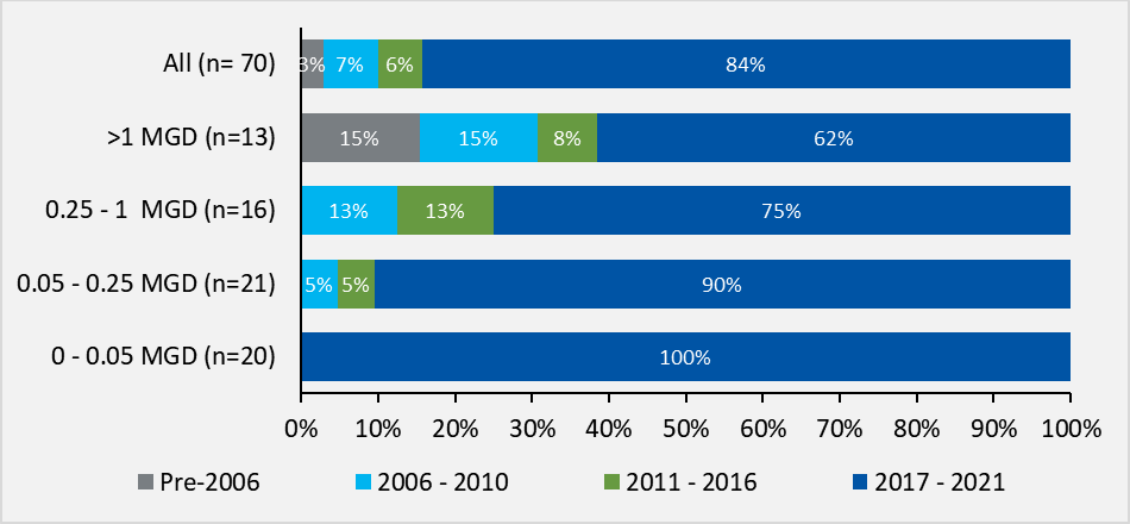
Figure 9. Collection System Energy Assessment by Size and Study Provider (Between 2000 and 2020)



Source: CMAR Data. Question. 9.1 "Has an energy study been performed for your treatment facility?"
Question Sums over 100% indicate plants having multiple studies completed by different providers.

As shown in Figure 10, most collection system energy assessments across plants of all sizes occurred between the years 2017 and 2021. The time between each plant's last assessment increased with plant size. All plants sized 0 to 0.05 MGD received an assessment between 2017 and 2021, and only 62% of plants sized >1 MGD received an assessment after 2016.

Figure 10. 2020 Collection System Energy Assessment by Size and Year



Source: 2020 CMAR Data Question. 6.3 "Has an energy study been performed for your pump/lift stations?"

Wastewater Treatment Plant Survey Results

The evaluation team conducted a multimode survey with 84 publicly and privately owned WWTP decision-makers who had submitted their CMAR report to the Wisconsin Department of Natural Resources in 2020. Respondents had to be responsible for making equipment decisions for a WWTP and collection system in Wisconsin to participate in the survey.

The objectives of the survey were to assess the following by size and ownership type:

- The level of concern about energy costs by plant ownership type and size
- The saturation of efficient measures and likelihood to install efficiency measures as well as barriers to installing energy-efficient measures
- How Focus on Energy can help overcome barriers to install efficient measures
- Awareness of Focus on Energy offerings and recent participation levels
- Interest in trainings and potential Focus on Energy offerings
- Decision-making around plant upgrades

From January to February 2023, the team contacted a sample of 620 WWTP decision-makers across Wisconsin. Of these, 84 completed the survey. As shown in Table 3, the team met its quota of survey completes for all plant-size segments. The team created the sample frame from the contact information provided in the CMAR reports. Based on this population size, the 84 surveys completed achieved ±9.9% precision at the 95% confidence level. For the four size segments, the smaller sample sizes achieved ±15% precision or better at the 85% confidence level.

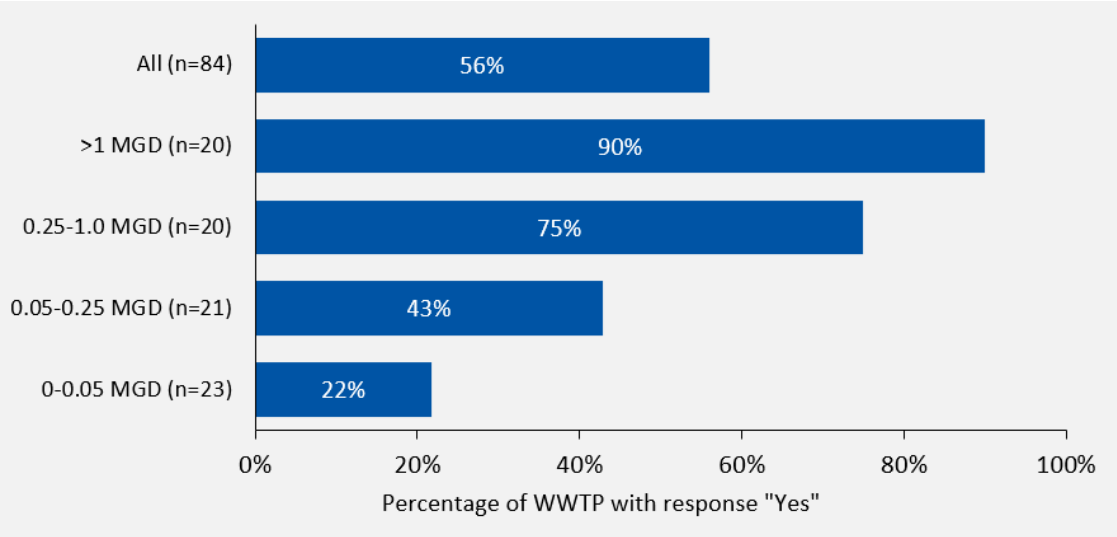
Table 3. CY 2022 Wastewater Treatment Plant Survey Sample Information

Segment	Sample Frame	Target Completes	Completed Surveys	Precision and Confidence Level
0 - 0.05 MGD	211	21	23	±14.2% at 85%
0.05 - 0.25 MGD	210	21	21	±14.9% at 85%
0.25 - 1 MGD	112	20	20	±14.6% at 85%
>1 MGD	87	19	20	±14.1% at 85%
Total	**620**	**81**	**84**	**±9.9% at 95%**

Awareness and Interest in Focus Offerings

Of the 84 WWTP decision-makers surveyed in CY 2023, 56% were aware of Focus on Energy's incentive offerings before taking the survey (Figure 11). Respondents varied in their familiarity with Focus on Energy's incentive offers in accordance with their size. Of the larger plants, 75% of the respondents in the 0.25 to 1.0 MGD segment and 90% of the >1 MGD segment had heard of the offerings. Respondents from the smaller plants showed less awareness of the incentive offerings, with 22% of the respondents in the 0 to 0.05 MGD segment and 43% of the 0.05 to 0.25 MGD segment aware.

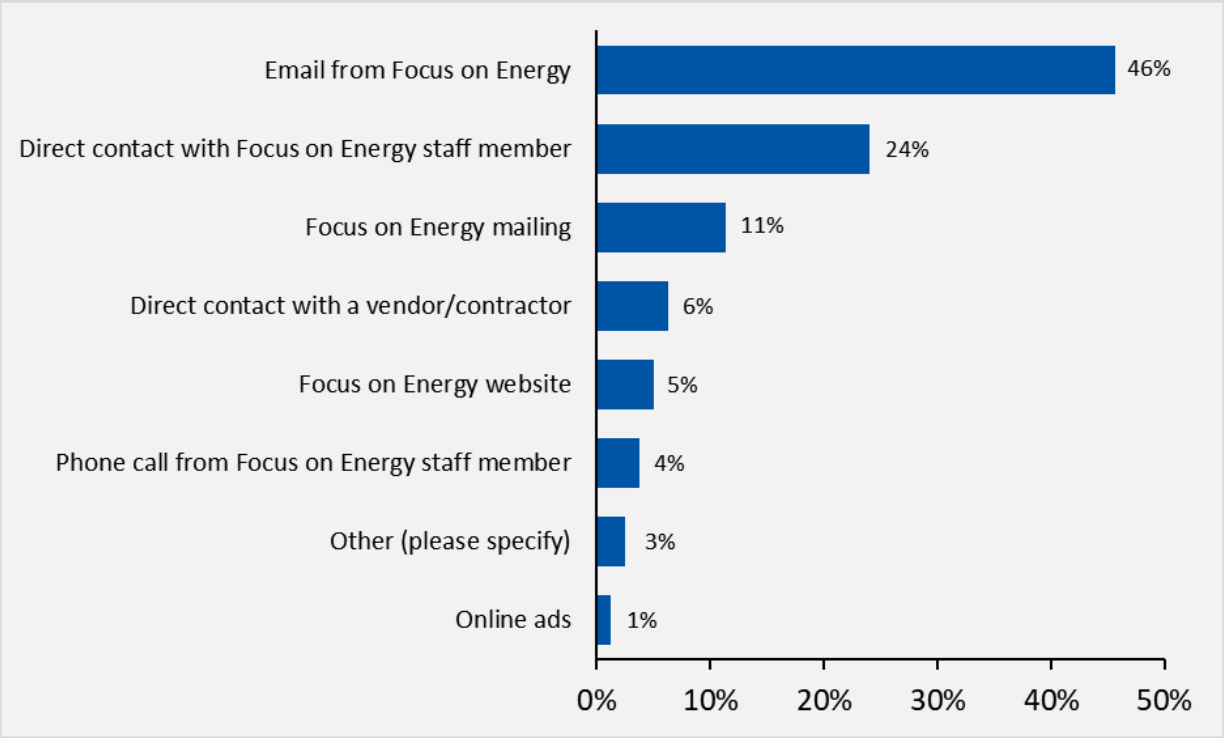
Figure 11. Awareness of Focus on Energy Offerings



Source: 2022 Wastewater Treatment Plant Survey Question G2. "Before today, had you heard anything about Focus on Energy's energy-efficiency incentive offerings that help wastewater treatment plants reduce their energy consumption and save money on their energy bills?"

In CY 2023, respondents reported that emails from Focus on Energy (46%) and direct contact with Focus on Energy staff (24%) were their preferred ways of learning about incentives from Focus on Energy (Figure 12).

Figure 12. Preferred Method of Communication for Information About Incentives

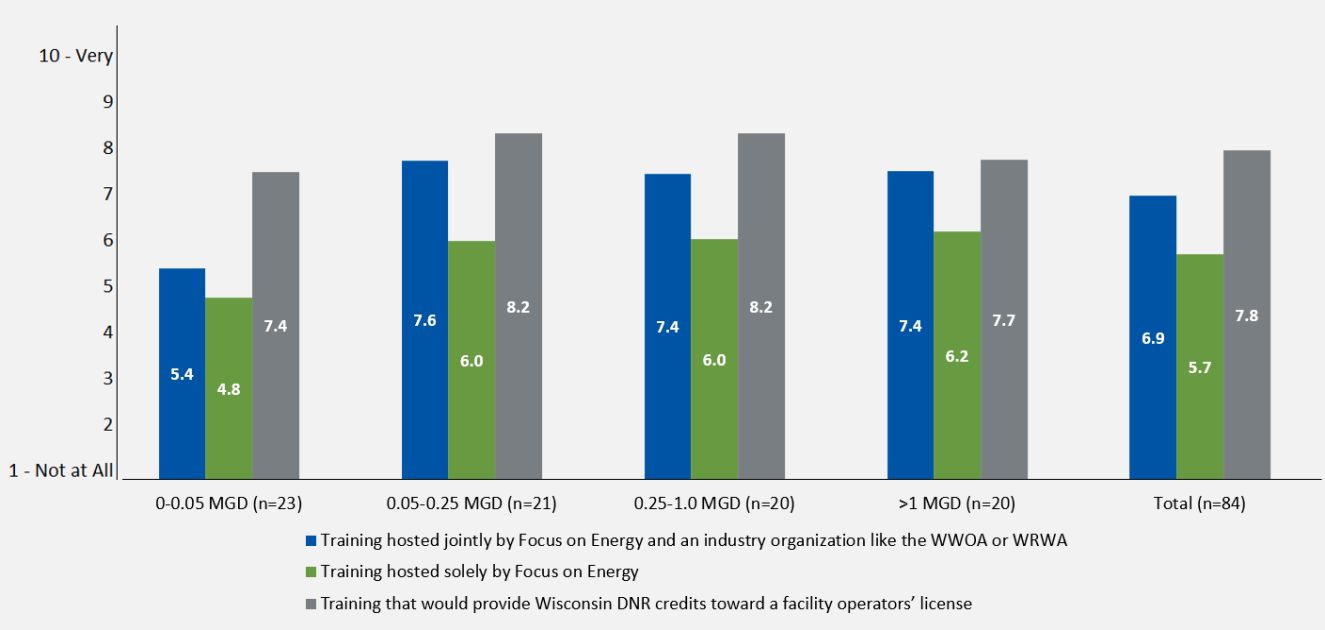


Source: 2022 WWTP Survey Question G7. "What is the best way for Focus on Energy to let you know about their incentives for energy-efficiency improvements?" (n=79).

The survey asked respondents to rate their interest in receiving various trainings on energy efficiency, energy generation, and renewable energy opportunities on a scale of 1 (*not at all interested*) to 10 (*very interested*). Trainings that would provide continuing education credits, which the DNR requires to maintain a Wastewater Operator Certification within Wisconsin,[4] generated the most interest (average rating 7.8), followed by trainings held jointly with industrial organizations (6.9), and trainings hosted solely by Focus on Energy generated the least interest (5.7). This pattern was consistent across plants of different sizes (Figure 13). Respondents from small-sized plants (0 to 0.05 MGD) showed less interest in all types of training compared to those from larger plants (0.05 MGD or greater).

[4] Wisconsin Department of Natural Resources. "Wastewater Operator Certification." https://dnr.wisconsin.gov/topic/opcert/wastewater.html

Figure 13. Interest Ratings for Focus on Energy Trainings



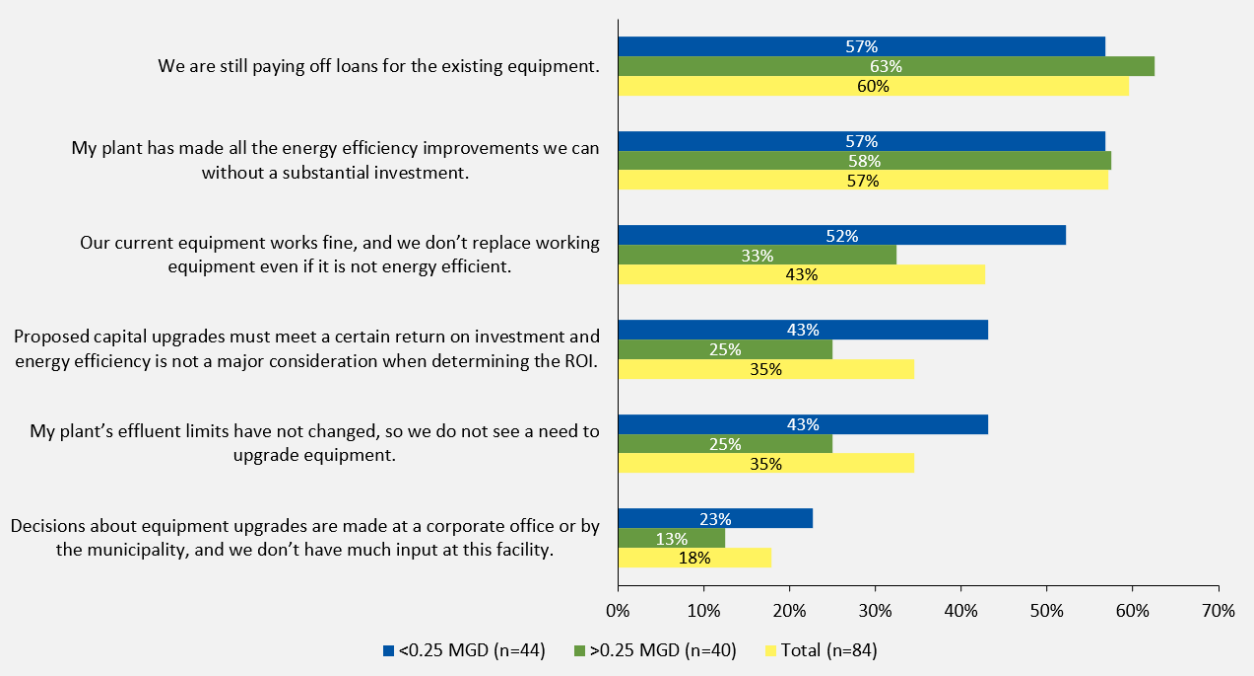
Source: 2022 Wastewater Treatment Plant Survey Question G8. "On a scale of 1 to 10 where 1 is *not at all interested* and 10 is *very interested*, how interested are you in the following types of training about wastewater treatment plant energy efficiency, energy generation, or renewable energy opportunities?" (n=84).

Barriers to Participating in Focus on Energy

The study asked respondents about the perceived barriers to participation in Focus on Energy programs. Out of the 84 respondents, the most common challenge cited to implementing energy efficiency projects and upgrades was cost (77%, n=65), followed by the organization's internal decision-making or budgeting process (12%, n=10). Larger plants (>1 MGD, N=20) were the most likely to mention internal processes as a barrier (20%, n=5) and smaller plants (0 to 0.5 MGD, N=23) were the least likely (4%, n=1). No other barriers were cited by more than two respondents.

The survey asked respondents to rate their agreement with several scenarios that organizations experience when considering energy-efficient improvements using a 4-point scale where a response of 1 is *strongly disagree* and a response of 4 is *strongly agree* (Figure 14). Most respondents agreed that the following two scenarios applied to their organizations: "we are still paying off loans for existing equipment" (60%) and "we made all the energy efficiency improvements we can without a substantial investment" (59%). Respondents agreed with these scenarios at similar rates across plant sizes. For the four remaining scenarios, respondents from plants < 0.25 MGD (0-0.05 MGD and 0.05-0.25 MGD) were more likely to agree than respondents from plants > 0.25 MGD (0.25-1 MGD and > 1 MGD). The fewest number of respondents (18%) agreed that the scenario "decisions about equipment upgrades are made at a corporate office or by the municipality" was applicable to their situation.

Figure 14. Agreement with Scenarios When Considering Energy-Efficient Improvements



Source: 2022 Wastewater Treatment Plant Survey Question F3. "For the following scenarios that companies experience when purchasing new equipment or considering energy-efficient improvements, please indicate whether you agree with these statements. If the statement doesn't apply to you, please indicate it is not applicable." The percentages shown are for combined *strongly agree* and *somewhat agree* responses.

Decision-Making and Energy Efficiency Attitudes

Eighty-seven percent (n=73) of respondents reported that their facilities were municipally owned and operated, while 5% (n=4) were privately owned and operated, and 8% (n=7) were municipally owned but privately operated.

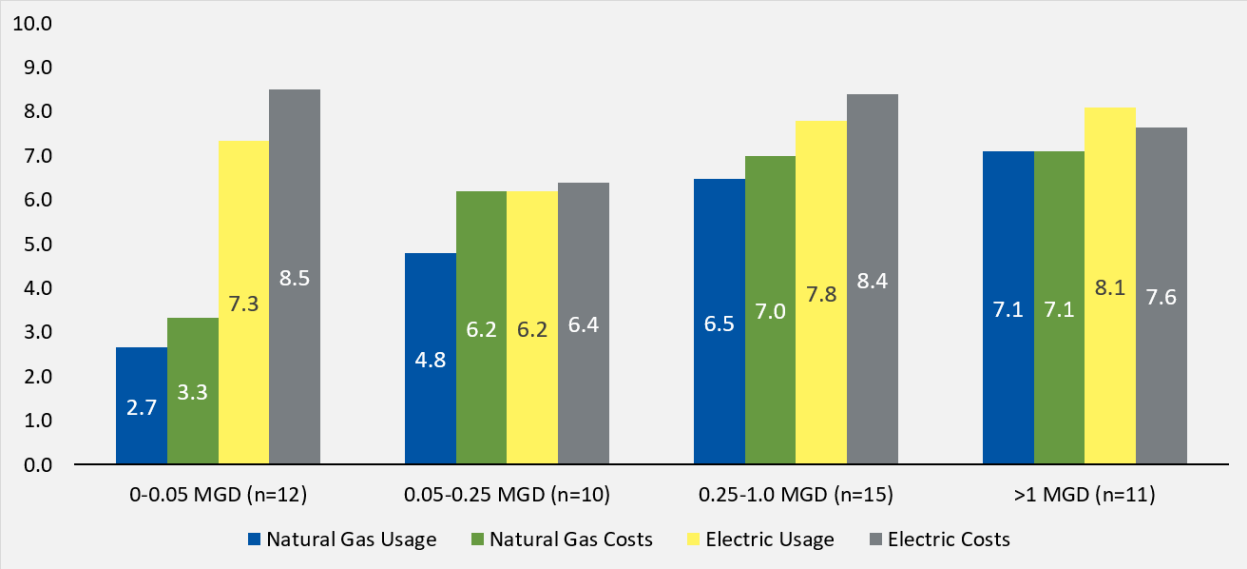
Only 7% of respondents (6 out of 84) said that nobody at their plant receives monthly energy bills, and five of those six plants were smaller plants (<0.25 MGD). Among the plants that had someone designated to receive utility bills, 33% (n=52) monitored monthly bills *very closely* and 60% monitored them *somewhat closely*. Larger plants (>1 MGD) were more likely than smaller plants to monitor bills *very closely* (54%, n=13). Only one respondent (1%) reported monitoring monthly bills *not at all closely*, and this respondent also represented a large plant (>1 MGD).

The study asked respondents who were familiar with the energy bills at their facilities about their energy use and cost concerns on a scale of 1 to 10, where 1 is *not at all concerned* and 10 is *very concerned* (Figure 15). Across all plant sizes, respondents expressed concerns about electric costs and usage greater than natural gas costs and usage. Facilities that produce greater than 0.05 MGD (n=36) show higher concerns with natural gas costs and usage, while facilities that produce less than 0.05 MGD (n=12) express lower concerns for natural gas costs.

Respondents from plants >1 MGD rated their concern with natural gas costs and usage (7.1 for both) the highest compared to other sized facilities. Respondents from the smallest plants sized 0-0.05 MGD rated

their electric costs concern the highest of the facilities (8.5), however, small facility respondents were not particularly concerned with natural gas usage (2.7) and costs (3.3), with all other plant sizes rating their concerns above a four. Overall, electric usage and costs are a higher concern for plant managers than natural gas.

Figure 15. Electricity and Natural Gas Use and Cost Concerns



Source: 2022 Wastewater Treatment Plant Survey Question D6_1 – D6_4. "On a scale of 1 to 10 where 1 is not at all concerned and 10 is very concerned, how concerned are you about the following at your wastewater treatment plant?"– Electricity costs, Electricity use, NG use, NG cost.

The survey asked respondents whether liquid treatment or solids management had more influence on energy costs at their facilities. Among 42 respondents who monitored their energy bills at least *somewhat closely*, 86% said liquid treatment had more influence on energy costs and 14% said solids management. Respondents from larger plants >0.25 MGD were more likely to say solids management was more influential than liquid treatment (22%, n=23) than respondents at smaller plants <0.25 MGD (5%, n=19).

The survey asked respondents about the impact of effluent discharge permit[5,6] changes for WWTPs that recalculates the formula for effluent discharge limitations (Figure 16). Overall, 89% (n=75) of respondents said the permit changes were having an impact at their plant. Fifteen percent (n=13) indicated they were having a *large impact*, while another 40% (n=34) said they were having a *moderate impact*. Only 11% (n=9) reported having *no impact* from the permit changes. Respondents from smallest

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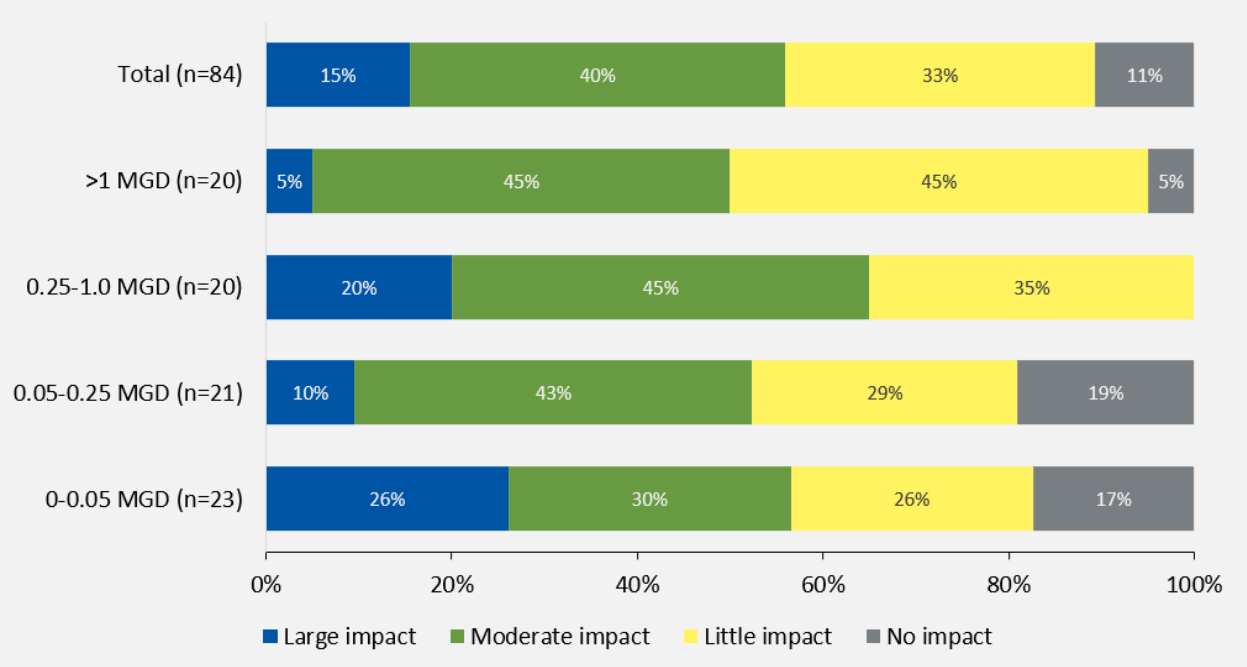
5 Wisconsin Department of Natural Resources. August 1, 2021. WPDES Permit. https://dnr.wisconsin.gov/sites/default/files/topic/Wastewater/B057681-05-0_Permit.pdf

6 Wisconsin Department of Natural Resources. 2021. Chapter NR 106 Procedures for Calculating Water Quality Based Effluent Limitations for Point Source Discharges to Surface Waters. https://docs.legis.wisconsin.gov/code/register/2021/782B/insert/nr106

plants (0-0.05 MGD) were more likely to report having a *large impact* (26%, n=6) compared to largest plants (> 1 MGD) where only one plant (5%) reported a *large impact.* However, respondents from the smallest plants (0-0.05 MGD) were also the segment most likely to describe permit changes as having a *no impact* (17%, n=4). Facility responses indicating impacts on their plant processes indicate plant size is not a factor in impact of the effluent discharge rules.

Figure 16. Effluent Discharge Permit Change Impact



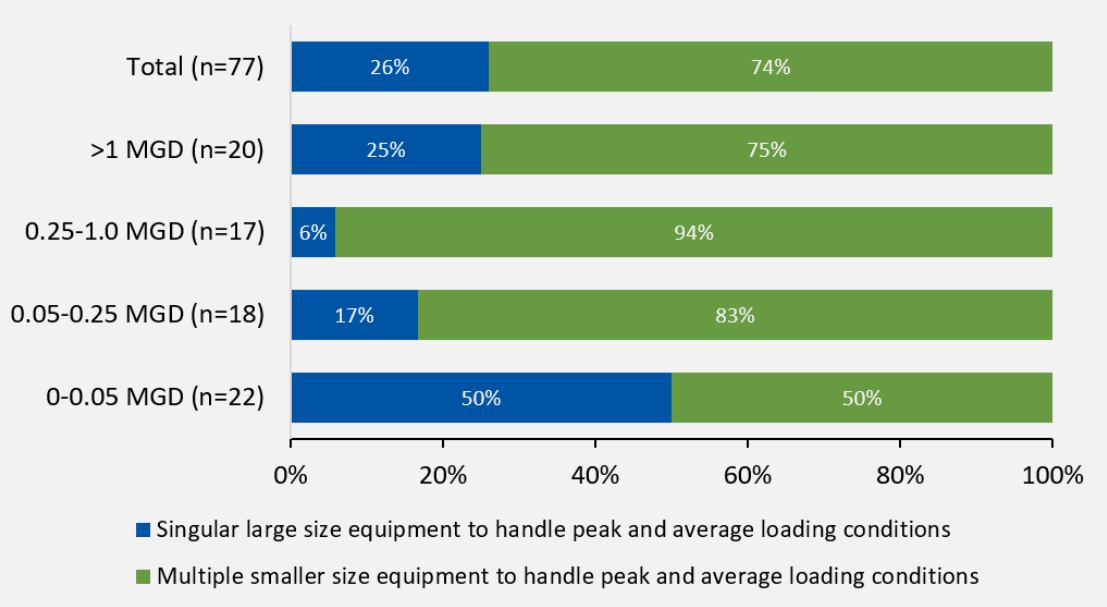
Source: 2022 Wastewater Treatment Plant Survey Question D8. "To what extent do you think your plant's energy use has been impacted by recent effluent discharge permit changes?"

The survey asked respondents if their plants have energy efficiency policies that are taken into consideration when purchasing new equipment or making improvements. None of the respondents from plants sized <0.05 MGD reported having such policies, though 26% (n=23) of them did not know if their plant had such a policy. Among respondent from plants that process 0.05 MGD or more, 21% reported having energy efficiency policies, and only 5% did not know if their plant had such a policy. Among the 12 respondents who could describe the energy efficiency policies at their plant, most described their policy as *purchase energy efficient equipment if it meets return on investment criteria* (50%) or *purchase energy efficiency equipment if it fulfills goals or requirements in a sustainability plan* (42%). Only one respondent reported that their policy was to *always purchases energy efficient equipment as a rule* (8%; response from a plant sized 0.25 to 1.0 MGD).

The survey asked respondents if they were more likely to implement one large piece of equipment or multiple small-sized pieces of equipment as follow up questions. Overall, 74% (n=77) of respondents were more likely to implement multiple pieces of small-size equipment over a single piece of large-size equipment (Figure 17). However, respondents from plants sized 0 to 0.05 MGD were split evenly between the singular and multiple equipment options (50% each, n=22).

Respondents reported three primary factors for implementing singular large sized equipment (n=20): 30% said ease of maintenance, 20% didn't know, 15% said cost. However, respondents were more likely to implement multiple small-sized equipment for the following reasons (n=55): system backup (35%), flexibility (18%), and costs (15%).

Figure 17. Potential Implementation over the Next 20 Years by Plant Size



Source: 2022 Wastewater Treatment Plant Survey Question H7. "When designing your plant upgrades for the next 20 years, which design scenario are you more likely to implement?".

Energy-Efficient Equipment Saturation

The evaluation team asked respondents to answer questions about specific types of energy efficiency equipment: what was already installed at their plants, their potential interest in installing those types of equipment, and their likelihood of actually installing the equipment.

Current Utilization of Energy Efficient Equipment

Nearly 70% of respondents from plants sized 0 to 0.05 MGD (n=16) were not aware of any of the energy efficient equipment listed in the survey was included at their plants, which meant only 30% (n=7) plant managers were aware of efficient equipment in their plants. Conversely, 85% of respondents from plants sized 0.05 to >1 MGD (n=52) were aware of the current utilization of energy efficient equipment in their plants. Overall, 59 respondents provided installed equipment types.

Depending on plant operations and design, aeration can take place in multiple processes such as aerobic digestion, aerated grit removal, Dissolved Air Flotation (DAF), and ammonia removal.

The survey asked about equipment that was related to bubble diffusers and aeration blowers with VFD or VSD technologies. Bubble diffusers are discs installed in equipment pipes that force air bubbles through to allow the aeration of water, and in the case of aerobic digestion, increase the flow of oxygen for microorganisms to break down the pollutants in sewage. Aeration blowers are critical for containing

activated sludge content in a suspended environment. The application of VSDs or VFDs within the system would increase the electric energy efficiency of the aeration blower systems.

Table 4 shows responses by plant type and indicates which plants already have the specific energy-efficient equipment installed. Overall, the use of fine bubble diffusers in aerations tanks was most prevalent (56%). Aeration blowers with a VSD and automatic control system were the next (41%) and in place at 24 plants. This was followed by fine bubble diffusers in aerobic digesters and aerator blowers with VFD or VSD without automatic control systems (36%), each used at 21 plants.

Table 4. Current Facility Equipment by Plant Type

Equipment	0-0.05 MGD (n=7)	0.05-0.25 MGD (n=14)	0.25-1.0 MGD (n=20)	>1 MGD (n=18)	Total (n=59)
Fine bubble diffusers in the aeration tanks (Instead of coarse bubble diffusers or mechanical aeration)	3	7	10	13	**33**
Aeration blowers with variable speed drives and an automatic control system to monitor dissolved oxygen and automatically adjust the speed of the blower	0	3	9	12	**24**
Fine bubble diffusers in aerobic digesters	4	7	8	2	**21**
Aeration blowers with variable frequency drives or variable speed drives that are sized for energy efficient	0	5	9	7	**21**
Cascade-aeration system for post-aeration	1	1	3	7	**12**
Highly efficient turbo aeration blower technology	0	2	3	2	**7**
Equipment to beneficially utilize biogas	0	0	1	5	**6**
Fine bubble diffusers for post-aeration	0	0	3	2	**5**
Fine bubble diffusers for channel aeration	0	1	0	1	**2**

Source: 2022 Wastewater Treatment Plant Survey Question. E2 "Which of the following equipment does your wastewater treatment plant currently have?"

Interest in installing Energy-Efficient Equipment

The survey asked respondents to rate their interest in potentially installing equipment on a scale of 1 to 10, where 1 is *not at all interested* and 10 is *very interested*.

The figures in this section use abbreviated descriptions of the equipment options to allow the results to be displayed in a legible way. Table 5 lists the abbreviated text and the full text as it appeared in the survey.

Table 5. Abbreviated Text for Figures 18, 19, and 20

Abbreviated Text	Full Description Text
Aeration variable speed drives and automatic control system	Aeration blowers with variable speed drives and an automatic control system to monitor dissolved oxygen and automatically adjust the speed of the blower
Aeration variable frequency drives or variable speed drives	Aeration blowers with variable frequency drives or variable speed drives that are sized for energy efficient operation
Fine bubble diffusers in the aeration tanks	Fine bubble diffusers in the aeration tanks (Instead of coarse bubble diffusers or mechanical aeration)

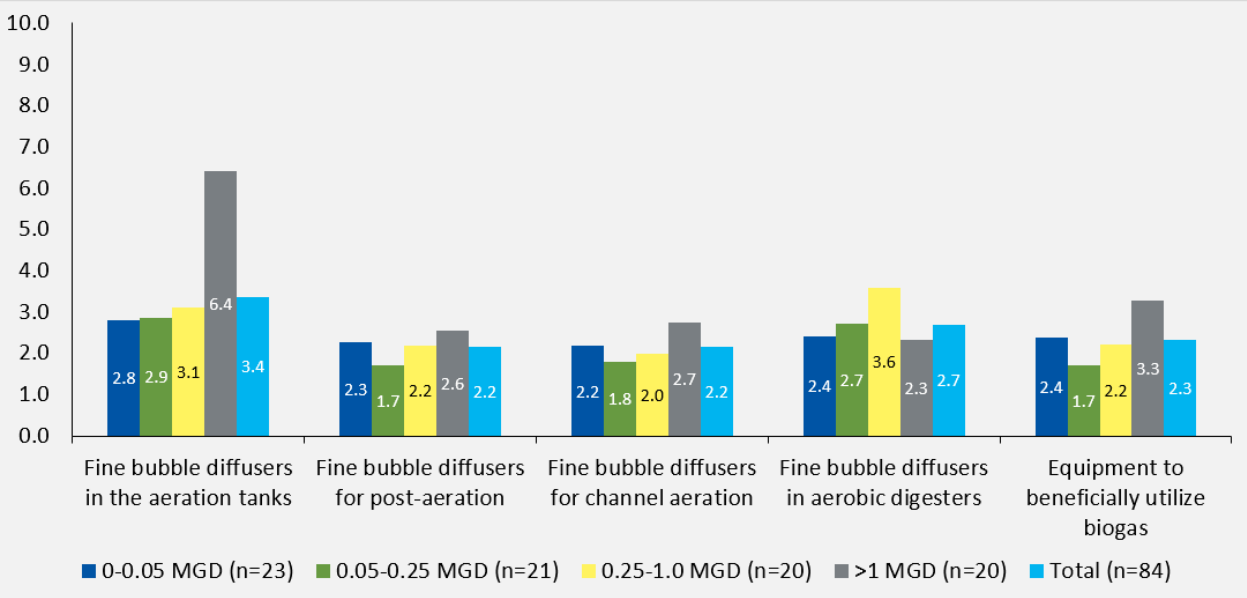
Overall, none of the equipment listed in the survey achieved an average rating above a 5.0 across all plant respondents, indicating low-to-mid interest of installation for all measures.

Figure 18 shows respondents' general interest in equipment related to fine bubble diffusers and biogas. Overall, the only type of equipment respondents rated their level of interest above a 3, on average, was the fine bubble diffuser in aeration tank. In comparison to coarse bubble diffusers, fine bubble diffusers provide a greater oxygen transfer rate to the water within aeration tanks, which allows for more efficient aerobic treatment. This also allows for the blowers connected to these fine bubble diffusers to be run at much lower loads, thereby reducing energy consumption for the same amount of aeration.[7]Most of this interest came those at plants sized > 1 MGD. Respondents rated their level of interest in other fine bubble diffuser measures between an average of 2.2 (for post-aeration and for channel aeration) and 2.7 (for use in aerobic digesters).

Respondents also rated equipment to beneficially utilize biogas on the lower end. This ranged from an average rating of 1.7 from those at plants sized 0.05 to 0.25 MGD to 3.3 from those at plants sized > 1 MGD. On average, respondents rated their interest level in biogas equipment a 2.3.

[7] U.S. Department of Energy. December 1, 2021. Utilize Fine-Bubble Diffusers in Aeration Tanks. https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Tipsheet%201%20-%20Fine%20Bubble%20-%20Final.pdf

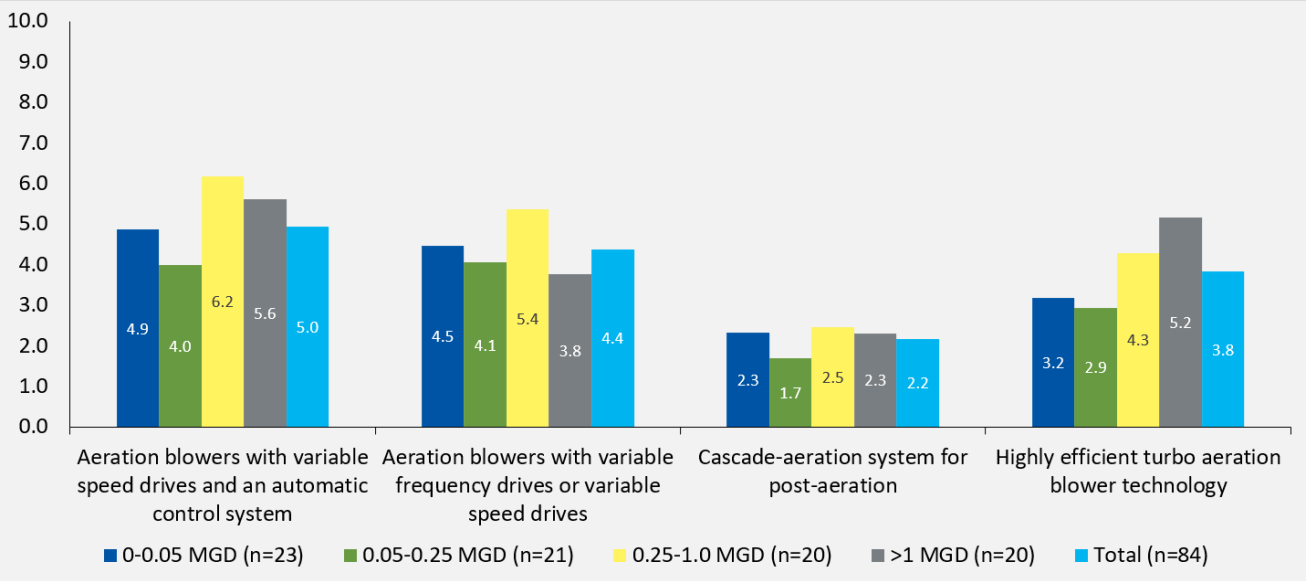
Figure 18. General Interest in Installing Fine Bubble Diffusers and Biogas Efficient Technologies



Source: 2022 Wastewater Treatment Plant Survey Question. E3 "On scale of 1 to 10, where 1 is not at all interested and 10 is very interested, how interested are you installing the following technologies?"

Figure 19 show respondents' general interest in aeration blower technologies. Respondents rated their interest level in aeration blowers with variable speed drives and automatic control system the highest, with an average rating of 5.0 across all plants. This was followed by aeration blowers with VFDs and VSDs, which had an average rating of 4.4. Overall, respondents were more interested in aeration blowers than bubble diffusers or biogas equipment technology.

Figure 19. General Interest in Installing Aeration Blower Technologies



Source: 2022 Wastewater Treatment Plant Survey Question. E3 "On scale of 1 to 10, where 1 is not at all interested and 10 is very interested, how interested are you installing the following technologies?"

Likelihood to Install Energy-Efficient Equipment

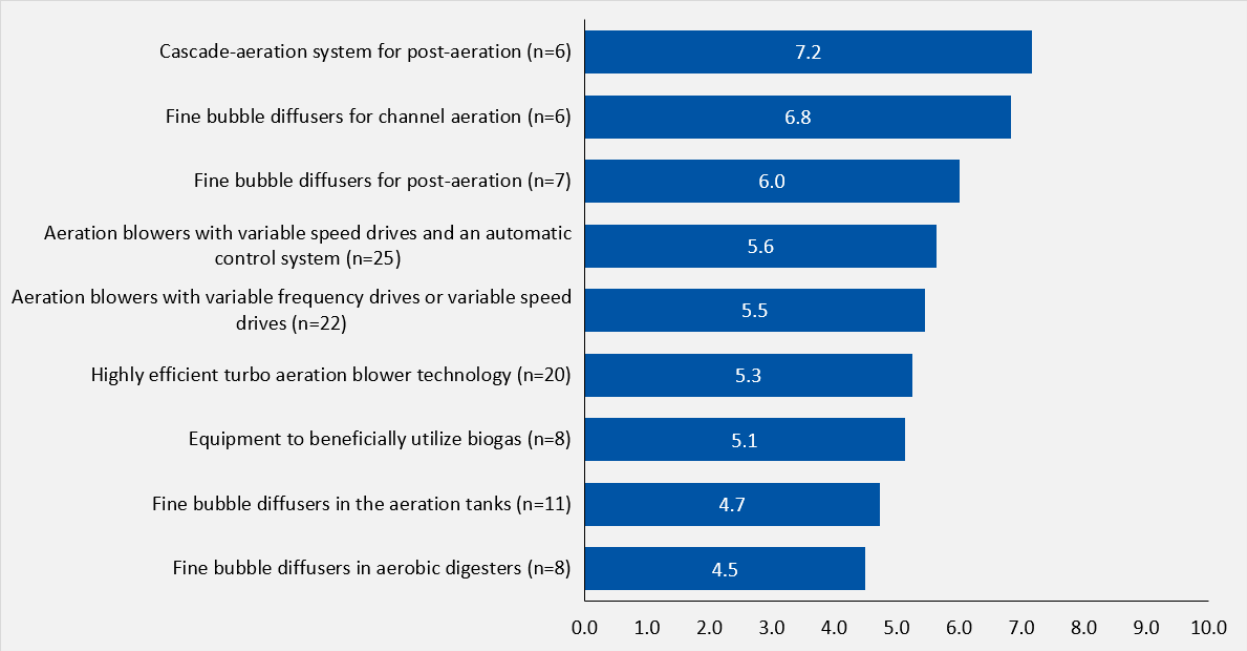
The survey followed up with respondents who rated their interest with a specific technology higher than 5 to rate their likelihood to install the equipment within the next five years, where 1 is *not at all likely* and 10 is *very likely*.

As shown in Figure 20, while respondents gave an average rating of 2.2 for their overall interest in the cascade-aeration system, the respondents who were interested in the technology were likely to install it (7.2, n=6). Respondents were the next mostly likely to install fine bubble diffusers for channel aeration and post-aeration, with average ratings of 6.8 and 6.0, respectively.

Aeration blowers with VSDs and an automatic control system had the highest number of responses with 25 plant owners or facility managers indicating interest in installation of that equipment in their plant within the next five years. However, the average rating for likelihood to install was only 5.6. The aeration blowers with VFDs or VSDs without the automatic system had a similar average rating for likelihood to install (5.5, n=22). Twenty respondents showed high interest in adopting high-efficiency turbo aeration blower technology, with an average rating of 5.3 for the likelihood of installation.

Equipment that received lower ratings for likelihood to adopt were fine bubble diffusers in aeration tanks (n=11) and fine bubbler diffusers in aerobic digestors (n=8), which had average ratings of 4.7 and 4.5, respectively.

Figure 20. Likelihood to install equipment in next five years by plant size



Source: 2022 Wastewater Treatment Plant Survey Question. E4 "If E3>5, On scale of 1 to 10, where 1 is not at all likely and 10 is very likely, how likely are you to install the following equipment in the next five years?"

Overall, aeration blower technology had the highest amount of interest, both in terms of average level of interest ratings and number of plant owners and facility managers who rated their interest above a 6. Interest and likelihood to install aeration systems did not differentiate between the plant sizes, which indicates that there is a wide market for those types of systems in the WWTP industry.

Fine bubble diffusers had lower interest on average when compared to aeration blower technologies. The few respondents who were interested in pairing that technology with post-aeration or for channel aeration had the highest average ratings for likelihood of installation within the next five years.

Outcomes and Recommendations

The evaluation team reviewed information from CMAR and survey results administered by Cadmus to inform the following outcomes for the WWTP market assessment. The team offers recommendations to improve energy efficient equipment, offerings, and services to WWTPs in Wisconsin.

Outcome 1: While awareness of Focus on Energy's WWTP offerings correlated with facility output size, electric energy usage was a concern across facilities regardless of size. Ninety percent of facilities with an output size >1 MGD were aware of Focus on Energy offerings, compared to only 22% of facilities with an output size between 0-0.05 MGD. Responding WWTP's rated their concern of electric usage at 7.4 and their concern for electric costs at 7.8 (compared to 5.3 and 5.9 to gas usage and concerns, respectively). Electric incentives would benefit plant facilities of all sizes, while gas incentives would generally benefit larger facilities.

Outcome 2: Most facilities prefer to install large size equipment to handle peak and average load conditions. Seventy-four percent of responses (n=57) said they would prefer singular large equipment replacements over installing multiple smaller sized equipment. Facilities with an output size of 0.05 MGD or greater (which represented 71% of respondents) predominantly preferred large size equipment replacements. However, facilities with an output size of 0-0.05 MGD (n=22) were split 50/50 (as shown in Figure 17) between their preferences to replace large and small equipment.

Recommendation 1. Increase awareness of Focus on Energy offerings within smaller plant facilities. While smaller plants have less awareness of Focus on Energy offerings, their concerns about energy usage are comparable to larger facility sites. Increasing awareness of the value in selecting right-sized equipment for operation from startup through design conditions and providing right-sized tools for operation of the facility could allow it to grow but be energy efficient in the growth process.

Outcome 3: Plants sized 0.25-1 MGD as well as >1 MGD sized plants have the highest saturation of listed CMAR WWTP technologies as well as the highest general interest in, and likelihood to install, new equipment. However, mean ratings for adding VSDs in aeration technology present average and mixed interest in the highly efficient technology in turbo aeration and low interest in bubble diffuser technology. WWTPs want to ensure quality of wastewater treatment above all else.

Outcome 4: Key identified barriers were related to costs. The top two barriers identified by the evaluation team for WWTPs adopting energy-efficient technology were 1) need to pay off loans for the existing equipment (60%, n=50), and 2) need for substantial investment to make additional energy-efficient improvements (57%, n=49).

Recommendation 2. Increase education and awareness of benefits of fine bubble diffuser technology for WWTPs. Interest for installing fine bubble diffusers was low across all plant facilities with the exception of large facilities which have increased interest in fine bubble diffuser technologies within their aeration blower systems.

Recommendation 3. While this survey provides market insights to a significant sample of WWTP's in Wisconsin, the evaluation team recommends a follow up analysis with in-depth interviews or focus groups with facility managers and owners to better understand the barriers and motivation to adopt energy-efficient technology.