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BEST PRACTICES

AWARDS

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2019

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AWARD



**2019 NORTH AMERICAN ADVANCED
WATER AND WASTEWATER TREATMENT
ENABLING TECHNOLOGY LEADERSHIP AWARD**

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Background and Company Performance

Industry Challenges

The wastewater treatment industry is facing increasingly stringent requirements to fully treat water and wastewater. While conventional treatment, leveraging technologies such as media filtration and activated sludge, are effective for historic requirements to treat many wastewater conditions, micropollutants and per- and polyfluoroalkyl substances (PFAS) have become ubiquitous and considered harmful to human health. These substances have been in the environment for decades, but only recently has knowledge of their harmful impacts been widely quantified and published. As a result, advanced treatment capabilities are increasingly required across North America.

Therefore, more advanced water and wastewater treatment systems are necessary to ensure industrial and municipal treatment plants deliver on their social, environmental, and public commitments to reliable and high-quality wastewater treatment. Widespread investment for upgrading wastewater treatment infrastructure that will eliminate trace amounts of pollutants, however, is challenging. First, micropollutants and PFAS are new challenges, meaning that treatment solutions are not mature and require a great deal of site-specific investment to ensure efficacy; second, the limited physical footprint of many wastewater treatment facilities hinders the installation of new or additional equipment; and third, many site operators do not have the readily available budget to make the necessary investments.

Research shows that conventional wastewater treatment solutions have a widely variable ability to remove different kinds of micropollutants, which include pharmaceuticals and personal care products (PPCPs). Research published in the *Journal of Hazardous Materials*¹, for example, indicates that only 13.1% of sulfamethazine and as low as 7.0% of carbamazepine are removed from wastewater. Increasing documentation of PFAS in the environment has led to a greater understanding of just how ubiquitous it is, how the chemical compounds do not naturally degrade, and how human exposure to and ingestion of the compounds leads to numerous harmful outcomes. The National Center for Environmental Health at the Centers for Disease Control and Prevention² has found PFAS to be at measurable levels in nearly all Americans and can result in liver disease, high cholesterol, and cancer. Determining what micropollutants and chemical compounds need to be treated at each site and to what specifications, however, is an arduous process, which leads to further debate concerning the best solution and value for money.

Many wastewater treatment plants were built to a certain specification and not designed with future expansion or retrofit requirements in mind. Consequently, it is not always easy to include more advanced treatment equipment. Industrial sites may have space at a

¹Ratola, Nuno et al. "[Occurrence of Organic Microcontaminants in the Wastewater Treatment Process. A Mini Review.](#)" *Journal of Hazardous Materials*, vol. 239-240, 2012, pp. 1-18.

² National Center for Environmental Health. "[An Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns.](#)"

premium for other requirements, and many municipal plants were constructed in locations that have been swallowed up by urban and suburban sprawl, limiting their ability to expand. These space restraints create resistance to the adoption of additional advanced water and wastewater treatment solutions, either because there is no room or the cost to redesign the facility is too great to make the investment feasible for plant operators.

Further, budget complications outweigh the attractiveness of making similar investments. Industrial organizations often see wastewater treatment as a process cost, rather than as an investment that improves the quality of their product or output, which mires the notion of making wastewater treatment investments. On the other hand, municipal authorities often work with specific budget allocations each year, and often see decreases in year-to-year budget levels. These realities make it difficult for plant operators to respond quickly to emerging contaminants. Until firm regulations and compliance deadlines are set, many authorities will put off investment until conditions become more amendable to upgrades, even if further, advanced treatment is required to fully treat water and wastewater.

Because of these challenges, the investment environment in advanced treatment solutions is lower than what is needed, given the harmful characteristics of wastewater. Market participants looking to access this latent need must offer solutions that overcome these challenges, turning them into competitive strengths.

Technology Leverage and Customer Impact

BioLargo Water, a subsidiary of BioLargo Inc., was founded in 2014 and is based in Alberta, Canada. BioLargo Water aims to create “flexible, reliable, and affordable water treatment solutions for a better water future.”³ This mission aligns perfectly with the current requirements and challenges within the advanced water and wastewater treatment industry. Indeed, BioLargo Water has steadily advanced since its 2014 founding when it set out to develop and commercialize its Advanced Oxidation System (AOS) to deliver a disinfection and treatment solution that is affordable, small in footprint, and with data showing efficacy against hard-to-treat micropollutants. Further, BioLargo Water has found AOS to be up to 50% more efficient⁴ in energy use per cubic meter of water than conventional alternatives.

Commitment to Innovation and Creativity

BioLargo Water’s targeting of advanced water and wastewater treatment through its AOS solution was, from the outset, a drive towards innovation and creativity. BioLargo Inc. holds over 20 patents, with six additional pending, and with the AOS solution receiving its own in 2018. The company has participated in more than 20 collaborations with industry and academic researchers from around the world, and has been financially supported by 69 grants and counting. The AOS brings a new technical innovation to the market as it combines proprietary iodine electrochemistry and materials engineering to deliver very high levels of oxidation while using very little electricity. Treatment at the generated

³ [BioLargo Water](#)

⁴ [BeWaterWise](#)

oxidation level drives effective disinfection and the breakdown of organic contaminants. Key to the success of AOS is the innovative use of special graphitic material with high conductivity and surface area within the electrochemical cell chamber. These materials, when employed in the AOS' proprietary design, create conditions that allow for generation of high concentrations of iodine, highly reactive iodine oxides, and hydroxyl radicals which, together, are capable of rapid and effective disinfection and decontamination despite requiring very little energy input than conventional alternatives like UV or ozone. The highly oxidative species generated in the chamber oxidize proteins of bacteria, viruses, and protozoa to disinfect the water, while also reacting with chemical contaminants to render them inactive.

BioLargo Water continues to innovate on its AOS, including a 2018 improvement that fundamentally changed AOS from a stacked to a spiral design. This development introduces multiple benefits of AOS, notably higher performance, lower energy demand, and a 20% size and footprint reduction, which enhances the solution's scalability, ability to fit into smaller spaces, and affordability. These benefits deliver excellent added value over a number of competitors' solutions and position BioLargo Water to enjoy substantial growth moving forward.

Application Diversity

Critical to the commercial success for emerging technology solutions in the wastewater treatment industry is finding diverse applications, both to create as much opportunity as possible and to determine the applications of greatest effectiveness and customer demand. To increase the success of AOS, BioLargo Water is actively driving the solution's application in a number of areas, including highly contaminated poultry farming/processing wastewater treatment and municipal stormwater treatment. These applications reflect critical opportunities in large volumes applications, (e.g., municipal stormwater) and highly contaminated wastewater applications (e.g., the poultry industry). The ability to deliver effective treatment in high volumes and with highly contaminated wastewater will deliver the credibility needed to demonstrate AOS's applicability among a diverse range of industries and customers. While competitors may target and focus on one industry vertical, BioLargo Water sees opportunity in multiple areas including the livestock and agriculture, municipally tertiary treatment, oil and gas, mining, industrial, stormwater, and pharmaceutical sectors.

Performance Value

By the end of 2019, Frost & Sullivan expects that \$33.2 billion will be spent on wastewater treatment technologies globally. A key trend within this spending is a focus on advanced treatment technologies and the need to deliver even finer filtration results. This need positions BioLargo Water advantageously to access these market growth opportunities at a time when the success of AOS is further documented. Interest in light emitting diode ultraviolet (LED UV), and ozone solutions from competitors is increasing through more testing and pilot projects, but AOS has gone further in demonstrated delivery of additional treatment benefits (e.g., removal of micropollutants and low energy consumption).

Frost & Sullivan is impressed that BioLargo Water's AOS solution is proving itself versatile

in application, effective against even harsh wastewater qualities, and comparatively smaller in footprint, thus able to retrofit within many facility types. Ultimately, these characteristics of performance value are reflective of aspects that deliver on customer value and alleviate diverse pain points.

Customer Ownership Experience

The ability to deliver on customer value and alleviate pain points are already evidenced through the BioLargo Water installation at Sunworks Farm (Edmonton, Canada). At this facility, AOS treats poultry industry wastewater to regulatory standards and to a quality that permits treated wastewater reuse in equipment and facility cleaning. Sunworks Farm has now asked BioLargo Water to submit a proposal to expand the pilot to full commercial scale. Ron and Sheila Hamilton, owners of Sunworks Farm, are quoted saying⁵, “Our experience with BioLargo Water’s pre-commercial pilot for their AOS water treatment system has been exceptional....Their technology clearly works, and their team is a pleasure to work with. We believe that the AOS will enable producers like us to manage water and wastewater in the most environmentally sensitive and economical way possible.” The goal of Sunworks Farm now is to achieve 100% water reuse through the AOS. The excellent result, at a site that requires treatment at highly polluted levels, provides strong credentials to BioLargo Water and AOS to assist customers that manage a wide variety of wastewater characteristics.

Brand Equity

BioLargo Water characterizes⁶ its activities as “creating flexible, reliable, and affordable water treatment solutions for a better future.” In particular regarding AOS, BioLargo Water is a partner that improves energy efficiency and creates reusable waste streams. Parent company BioLargo has invested over \$4 million since 2014 to ensure its subsidiary can focus on value and success in these endeavors; this commitment delivers on the parent company’s own mission to “make life better by delivering robust, sustainable solutions for a broad range of industries and applications.” The alignment between BioLargo and BioLargo Water ensures unwavering focus on delivering solutions that target key pain points and overcome them through innovation of sustainable solutions.

⁵ [Pollution Online](#)

⁶ [BioLargo Water](#)

Conclusion

BioLargo Water — from its founded mission to create a better future, to its professional team’s contributions towards over 20 patents, and 6 pending, to its AOS solution pushing innovative advanced oxidation process for use in hard-to-treat wastewater and micropollutant compounds — is built to deliver improvements to the water and wastewater industry that enable more sustainable treatment without compromising efficacy. AOS implementation successes continue to be evidenced through pilot and plant installations, delivering excellent value for a diverse customer base.

For its strong overall performance, BioLargo Water has earned Frost & Sullivan’s 2019 Enabling Technology Leadership Award.

Significance of Enabling Technology Leadership

Ultimately, growth in any organization depends on customers purchasing from a company and then making the decision to return time and again. In a sense, then, everything is truly about the customer. Making customers happy is the cornerstone of any successful, long-term growth strategy. To achieve these goals through enabling technology leadership, an organization must be best in class in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.



Understanding Enabling Technology Leadership

Product quality (driven by innovative technology) is the foundation of delivering customer value. When complemented by an equally rigorous focus on the customer, companies can begin to differentiate themselves from the competition. From awareness, to consideration, to purchase, to follow-up support, organizations that demonstrate best practices deliver a unique and enjoyable experience that gives customers confidence in the company, its products, and its integrity.

Key Benchmarking Criteria

For the Enabling Technology Leadership Award, Frost & Sullivan analysts independently evaluated Technology Leverage and Customer Impact according to the criteria identified below.

Technology Leverage

- Criterion 1: Commitment to Innovation
- Criterion 2: Commitment to Creativity
- Criterion 3: Stage Gate Efficiency
- Criterion 4: Commercialization Success
- Criterion 5: Application Diversity

Customer Impact

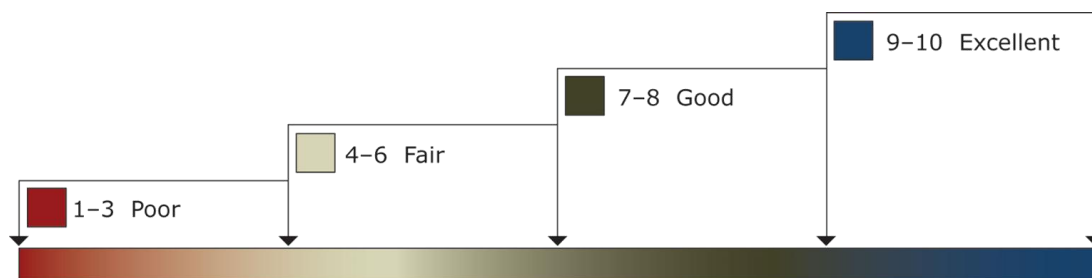
- Criterion 1: Price/Performance Value
- Criterion 2: Customer Purchase Experience
- Criterion 3: Customer Ownership Experience
- Criterion 4: Customer Service Experience
- Criterion 5: Brand Equity

Best Practices Award Analysis for BioLargo Water

Decision Support Scorecard

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Scorecard. This tool allows research and consulting teams to objectively analyze performance, according to the key benchmarking criteria listed in the previous section, and to assign ratings on that basis. The tool follows a 10-point scale that allows for nuances in performance evaluation. Ratings guidelines are illustrated below.

RATINGS GUIDELINES



The Decision Support Scorecard considers Technology Leverage and Customer Impact (i.e., the overarching categories for all 10 benchmarking criteria; the definitions for each criterion are provided beneath the scorecard). The research team confirms the veracity of this weighted scorecard through sensitivity analysis, which confirms that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, Frost & Sullivan has chosen to refer to the other key participants as Competitor 1 and Competitor 2.

<i>Measurement of 1-10 (1 = poor; 10 = excellent)</i>			
Enabling Technology Leadership	Technology Leverage	Customer Impact	Average Rating
BioLargo Water	10	10	10
Competitor 1	8	8	8
Competitor 2	6	7	6.5

Technology Leverage

Criterion 1: Commitment to Innovation

Requirement: Conscious, ongoing adoption of emerging technologies that enable new product development and enhance product performance.

Criterion 2: Commitment to Creativity

Requirement: Technology leveraged to push the limits of form and function in the pursuit of white space innovation.

Criterion 3: Stage Gate Efficiency

Requirement: Adoption of technology to enhance the stage gate process for launching new products and solutions.

Criterion 4: Commercialization Success

Requirement: A proven track record of taking new technologies to market with a high rate of success.

Criterion 5: Application Diversity

Requirement: The development and/or integration of technologies that serve multiple applications and can be embraced in multiple environments.

Customer Impact

Criterion 1: Price/Performance Value

Requirement: Products or services offer the best value for the price, compared to similar offerings in the market.

Criterion 2: Customer Purchase Experience

Requirement: Customers feel they are buying the optimal solution that addresses both their unique needs and their unique constraints.

Criterion 3: Customer Ownership Experience

Requirement: Customers are proud to own the company’s product or service and have a positive experience throughout the life of the product or service.

Criterion 4: Customer Service Experience

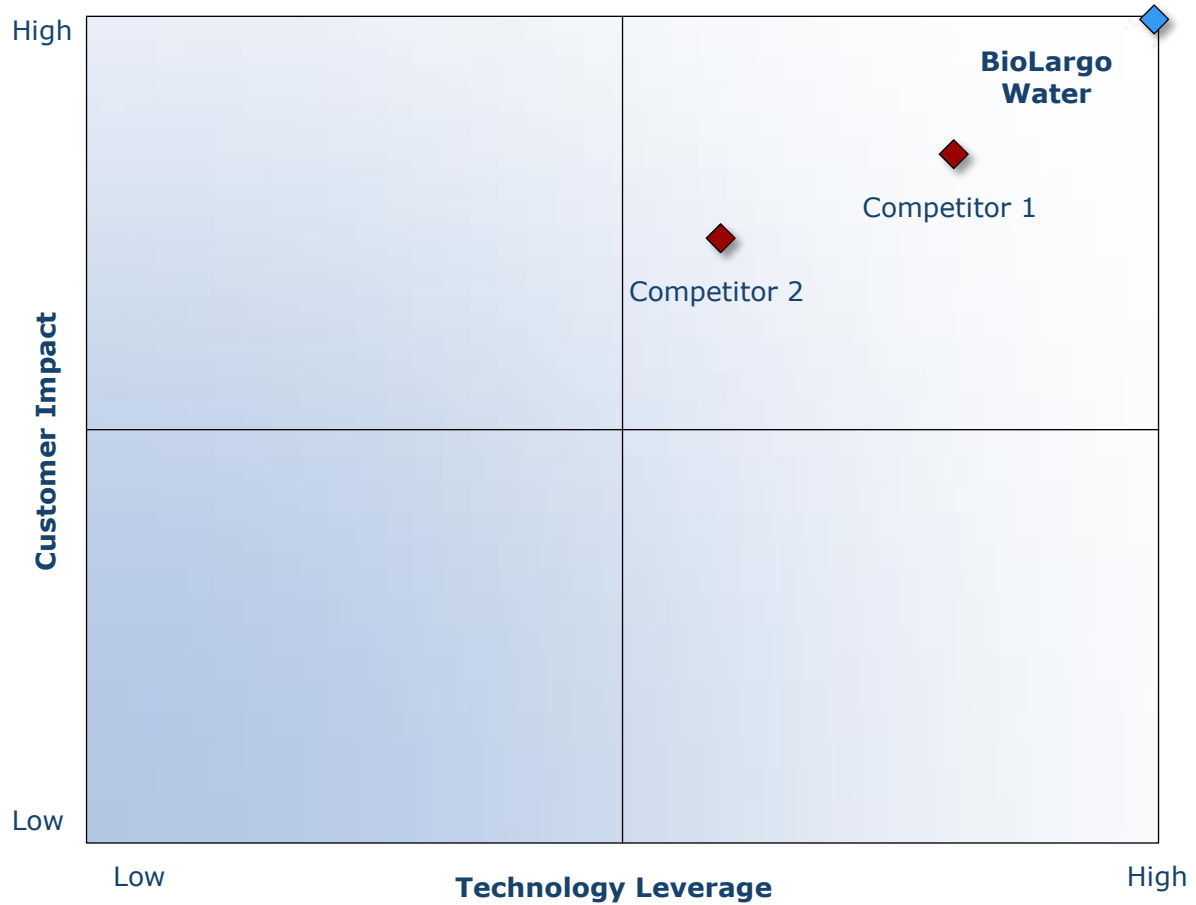
Requirement: Customer service is accessible, fast, stress-free, and of high quality.

Criterion 5: Brand Equity

Requirement: Customers have a positive view of the brand and exhibit high brand loyalty.

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts then position the candidates on the matrix shown below, enabling them to visualize which companies are truly breakthrough and which ones are not yet operating at best-in-class levels.



Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analysts follow a 10-step process to evaluate award candidates and assess their fit with select best practices criteria. The reputation and integrity of the awards are based on close adherence to this process.

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1 Monitor, target, and screen	Identify award recipient candidates from around the world	<ul style="list-style-type: none"> • Conduct in-depth industry research • Identify emerging industries • Scan multiple regions 	Pipeline of candidates that potentially meet all best practices criteria
2 Perform 360-degree research	Perform comprehensive, 360-degree research on all candidates in the pipeline	<ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best practices criteria • Rank all candidates 	Matrix positioning of all candidates' performance relative to one another
3 Invite thought leadership in best practices	Perform in-depth examination of all candidates	<ul style="list-style-type: none"> • Confirm best practices criteria • Examine eligibility of all candidates • Identify any information gaps 	Detailed profiles of all ranked candidates
4 Initiate research director review	Conduct an unbiased evaluation of all candidate profiles	<ul style="list-style-type: none"> • Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles 	Final prioritization of all eligible candidates and companion best practices positioning paper
5 Assemble panel of industry experts	Present findings to an expert panel of industry thought leaders	<ul style="list-style-type: none"> • Share findings • Strengthen cases for candidate eligibility • Prioritize candidates 	Refined list of prioritized award candidates
6 Conduct global industry review	Build consensus on award candidates' eligibility	<ul style="list-style-type: none"> • Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates 	Final list of eligible award candidates, representing success stories worldwide
7 Perform quality check	Develop official award consideration materials	<ul style="list-style-type: none"> • Perform final performance benchmarking activities • Write nominations • Perform quality review 	High-quality, accurate, and creative presentation of nominees' successes
8 Reconnect with panel of industry experts	Finalize the selection of the best practices award recipient	<ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select recipient 	Decision on which company performs best against all best practices criteria
9 Communicate recognition	Inform award recipient of recognition	<ul style="list-style-type: none"> • Present award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance 	Announcement of award and plan for how recipient can use the award to enhance the brand
10 Take strategic action	Upon licensing, company is able to share award news with stakeholders and customers	<ul style="list-style-type: none"> • Coordinate media outreach • Design a marketing plan • Assess award's role in strategic planning 	Widespread awareness of recipient's award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of the research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, resulting in errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, helps clients accelerate growth and achieve best-in-class positions in growth, innovation, and leadership. The company's Growth Partnership Service provides the CEO and the CEO's growth team with disciplined research and best practices models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages nearly 60 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on 6 continents. To join Frost & Sullivan's Growth Partnership, visit <http://www.frost.com>.