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2019 BEST PRACTICES AWARD
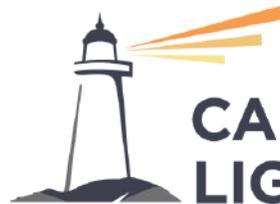
CARBON LIGHTHOUSE

**2019 NORTH AMERICAN
BUILDING ENERGY OPTIMIZATION
TECHNOLOGY INNOVATION AWARD**

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Background and Company Performance

Industry Challenges

Buildings are a major source of greenhouse gas emissions; about 40% of greenhouse gas emissions come from buildings in the United States and 20% worldwide. Today, adopting climate change strategies for reducing CO_2 emissions from buildings is becoming a priority for building owners, financial planners, and key decision makers because of sustainability compliance requirements, investor interest, and brand recognition, with a core focus on generating a profit out of such measures.

Frost & Sullivan independent research reveals the below challenges hindering the industry:

Challenge 1: Lack of Consumer Trust

Data is being touted as the 'new oil' in the current global landscape. With the growing importance of data, the use of data analytics in the building industry has increased, as building owners need to further reduce their energy consumption. Traditional energy efficiency software solutions are limited by the lower amounts of data collected and can thus only make estimates with low data accuracy. Building owners often do not receive the savings projected by the solution provider, thereby diminishing their interest in such solutions, which clearly indicates inefficiencies in the model used for projecting savings estimations to customers.

Challenge 2: Lack of Deep Insights

In addition to identifying and extracting data efficiently and integrating with existing platforms, this data must be translated into a common format model using appropriate algorithms to replicate real-world scenarios and arrive at useful insights. Even though many companies are developing middleware technologies that are designed to obtain the data, the data accuracy associated with these solutions is quite questionable, and many do not support the latest communication protocols. Moreover, Frost & Sullivan notes that a unified platform is needed that can integrate a building's energy data acquisition, monitoring, and analysis.

Frost & Sullivan analysts conclude that companies in this space must provide a robust, state-of-the-art software platform that leverages the power of data science to facilitate intelligent and energy-efficient buildings - all while delivering financial returns to building owners.

Technology Attributes and Future Business Value

Industry Impact and Product Impact

Founded in 2010, California-based Carbon Lighthouse is a technology company that delivers profitable climate solutions through its patented groundbreaking building energy analytics engine called Carbon Lighthouse Unified Engineering System (CLUES®), which gathers large amounts of building data and arrives at deep insights to help reduce a building's energy consumption.

The CLUES platform applies statistical and thermodynamic models to real-world building data to obtain a highly accurate energy savings prediction. In addition, the platform uses advanced AI and machine learning algorithms to improve the accuracy of models even further based on the data collected. Unlike standard industry software, CLUES allows Carbon

Lighthouse engineers to develop customized simulations based on each client's building design. Leveraging the CLUES platform, Carbon Lighthouse takes the following three steps in converting data into insights:

- Data collection and analytics

- Implementation

- Energy performance management

Data Collection and Analytics

Carbon Lighthouse deploys hundreds of sensors across a building to measure its performance metrics, such as airflow temperatures, chilled water flow rates, relative humidity, pressure differences, CO_2 levels, occupancy levels, electrical flows, and lighting levels. These sensors are placed in various locations, such as mechanical rooms, roofs, and other areas, to collect various data. This data, in combination with data obtained from existing building automation systems, interval meter data from utilities, weather data, and sub-meter data, is integrated into the cloud-based CLUES platform. Carbon Lighthouse engineers can then use various modeling techniques to gain insight into possible energy savings opportunities and then propose energy efficiency measures to building engineers and work with them to implement those changes. Frost & Sullivan notes that a highlighting feature of CLUES, with respect to data acquisition, is that it is both hardware and software agnostic. The data is collected from different sources, independent of data format or manufacturer, and is unified on in CLUES to obtain a holistic picture of the building's energy use. Frost & Sullivan independent analysis confirms that other solutions from key competitors do not collect large amounts of data utilizing hundreds of sensors, as with CLUES - and they simply do not have the deep analytics capability offered by CLUES.

Implementation

CLUES looks for two scenarios: one-time changes and ongoing optimization measures to reduce energy savings. One-time changes include small modifications, such as lighting retrofits and HVAC upgrades. Ongoing optimization measures involve the automatic optimization of building systems to reduce unnecessary energy loss and maximize energy savings.

Energy Performance Management

Buildings are a dynamic environment, where energy use often changes based on occupancy levels, energy use trends, and other scenarios. For example, a building's energy use sometimes experiences anomalies, such as an increase in energy consumption because of changes in tenant occupancy levels, which Carbon Lighthouse's engineering team detects and flags and then consults with the building operator to resolve any potential problems. This continuous monitoring enables Carbon Lighthouse to guarantee its energy savings.

With the above three-step approach, Carbon Lighthouse services each building by collecting highly granular data from all available sources, deriving accurate insights with its CLUES platform, and then supporting the projected energy savings through implementation, in addition to guaranteeing the savings to ownership with its continuous energy monitoring and management.

Frost & Sullivan analysis indicates that Carbon Lighthouse's turnkey approach, in terms of reducing a building's overall energy use, is a key differentiating factor. While some competitors provide dashboards that offer basic analytics based on all available data collected, they lack in-depth modeling and data-driven insights. Other competitors include equipment vendors that offer justified energy efficiency measures to sell their equipment, yet require significant capital investment. Carbon Lighthouse is equipment agnostic and only focuses on generating energy savings for building owners.

Scalability and Technology Licensing

With the data collected and its CLUES platform, Carbon Lighthouse can model a variety of systems. For example, generic models can be tailored to each building to augment its energy efficiency savings. The data collected from various sources is utilized to understand building behavior and how various systems interact. In addition, machine learning algorithms allow the model to learn in real time when new systems are integrated into the building, when new energy efficiency measures should be implemented, and when the building isn't behaving as intended. Frost & Sullivan research shows that Carbon Lighthouse's CLUES offers a great degree of flexibility, making it ideal for adapting to new building configurations, changing building designs, and integrating new energy efficiency measures.

Recent Funding Activity Drives Growth

Carbon Lighthouse is facilitating its expansion strategy through a recent funding of $32.6 million, led by National Grid Partners and other companies, such as Cox Enterprises and Ulupono Initiative. This funding will help Carbon Lighthouse expand its ongoing service to a larger customer base of building owners and investors and translate their energy savings into guaranteed profits. In addition, the company will spend a major portion of this funding on hiring more data scientists, engineers, and software developers. This growth strategy is supported by the company's recently received patent from the United States Patent and Trademark Office (USPTO) for CLUES.

Flexible Expansion Strategy

Carbon Lighthouse's expansion strategy involves implementing CLUES in a larger number of buildings, without a change in the engineering team that manages the building's energy savings measures. As CLUES becomes easier and faster to use over time, the company is open to new possibilities for future expansion.

Customer Acquisition

Unique Business Model—Efficiency-as-a-service

Carbon Lighthouse works on a guaranteed savings model. For example, when analyzing a customer's collected building data and baselining the building's performance, the company arrives at a specified amount of savings that it guarantees upon implementation of certain energy efficiency measures. The accuracy of the energy intelligence engine ensures that this savings can be achieved; however, if Carbon Lighthouse is unable to achieve the predicted savings, it writes a check to the customer for the difference.

The reliability of the company's technology platform is clearly visible in the results obtained. Carbon Lighthouse missed its energy savings guarantee in only 20 out of 500. The company has assigned the term Efficiency Reserves to possible hidden energy savings that customers

are unaware of but that can deliver significant energy savings. Carbon Lighthouse has identified Efficiency Reserves of up to 55% of a building's energy. By using the CLUES platform, a customer can potentially save 10 to 30% of its building's energy, in addition to the energy savings delivered by its existing building automation systems.

Frost & Sullivan's own research indicates that this guaranteed savings model has helped Carbon Lighthouse expand its customer base and gain customer trust, compared to offering traditional software-as-a-service models, where the customer is enrolled on a subscription basis and must pay an on-boarding fee. While many of its other competitors work with estimates to generate savings projections, Carbon Lighthouse works with real and dynamic data to guarantee energy savings.

Brand Loyalty

Strong Mission Statement

Carbon Lighthouse's mission is to stop climate change by improving the building environment and reducing CO_2 emissions. The company has an attractive base of many well-known customers, including The Carlyle Group. An interesting aspect of the project for The Carlyle Group was that CLUES helped make a business case for boosting net operating income (NOI) of 6000 Shoreline, a 140,000 square foot mixed office/life sciences lab, through clean energy action. The project involved Carbon Lighthouse engineers identifying the interconnectedness of the property's lighting, heating and cooling systems and performing upgrades to them. Then engineers implemented advanced controls and ongoing monitoring for variances so they could work with ownership to take corrective action as the building changed. The superior technology and engineering expertise offered by the Carbon Lighthouse team ensured that the project's energy savings goals were met. Furthermore, this project is a testimony to the high quality of service provided by the Carbon Lighthouse team, enabled by placing hundreds of sensors at strategic locations across the building to uncover hidden data. Using CLUES, a strong financial return of 23% was achieved for the project, not to mention an annual carbon elimination of 103 metric tons of carbon. A year after Carbon Lighthouse completed implementation, Carlyle sold 6000 Shoreline for a healthier profit due to the energy efficiencies implemented by Carbon Lighthouse. Carlyle featured the property in its 2018 sustainability report, and noted: "Not only do solutions like these improve cost efficiency, but the physical upgrades also signal to tenants and prospective tenants that our property and property systems are best in class," according to Dave Kingery, Managing Director, Carlyle U.S. Real Estate. Carbon Lighthouse's association with brands, such as The Carlyle Group, that have intersecting climate change and sustainability driven mission statements, is a significant stride forward in terms of enhancing the company's brand name.

Superior Internal Expertise

Carbon Lighthouse has a strong team of 130 employees to support its endeavor to stop climate change. Around two-thirds of Carbon Lighthouse's workforce constitutes the engineering team and technology team. The engineering team includes mechanical engineers who identify the potential energy savings opportunities in buildings using CLUES, with the help of suitable libraries. These engineers ensure the energy savings measures are implemented efficiently and that the company delivers the guaranteed savings to its clients. The technology team includes software developers, data scientists, and researchers that build and modify CLUES to support the engineering team.

Leveraging an Industry-experienced Advisory Board

In addition to its strong internal expertise and customer service, Carbon Lighthouse places significant importance on leveraging its advisory board. This advisory board comprises senior management professionals, such as co-founders and executive vice presidents from real estate investment firms. These real estate firms operate and own a large and wide variety of building assets, including luxury hotels and resorts, residential properties, office spaces, department stores, retail spaces, industrial properties, and medical facilities in the United States and worldwide. A strong advisory group provides significant brand credibility to Carbon Lighthouse and provides it with a platform for unparalleled industry access to building portfolios across sectors and geographies.

Conclusion

Frost & Sullivan appreciates how Carbon Lighthouse properly identified the need for data-driven building energy efficiency solutions that can provide in-depth insights and a superior client experience. To match that need, the company developed CLUES, a cloud-based energy optimization platform that facilitates intelligent and energy-efficient buildings. Carbon Lighthouse's turnkey approach, including data collection, implementation, and performance management, provides the company with a clear edge over other competing solutions that only offer partial services, such as equipment installation or maintenance. Carbon Lighthouse's efficiency-as-a-service business model ensures that the energy savings are guaranteed, thus offering a straightforward value proposition for any sustainability conscious and profit-driven building owner. The recently awarded patent for the CLUES platform, combined with a significant funding of $32.6 million, provides the company with the impetus for future expansion strategies. Frost & Sullivan commends Carbon Lighthouse for its advisory board in the real estate industry that enhances its expansion plans and ensures its brand credibility. With its strong overall performance, Carbon Lighthouse has earned the 2019 Frost & Sullivan Technology Innovation Award.

Significance of Technology Innovation

Ultimately, growth in any organization depends on finding new ways to excite the market and maintaining a long-term commitment to innovation. At its core, technology innovation, or any other type of innovation, can only be sustained with leadership in 3 key areas: understanding demand, nurturing the brand, and differentiating from the competition.

Understanding Technology Innovation

Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. This spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole.

Key Benchmarking Criteria

For the Technology Innovation Award, Frost & Sullivan analysts independently evaluated 2 key factors—Technology Attributes and Future Business Value—according to the criteria identified below.

Technology Attributes

      Criterion 1: Industry Impact
      Criterion 2: Product Impact
      Criterion 3: Scalability
      Criterion 4: Visionary Innovation
      Criterion 5: Application Diversity

### Future Business Value

      Criterion 1: Financial Performance
      Criterion 2: Customer Acquisition
      Criterion 3: Technology Licensing
      Criterion 4: Brand Loyalty
      Criterion 5: Human Capital

Best Practices Award Analysis for Carbon Lighthouse

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

| 9–10 Excellent |
| 7–8 Good |
| 4–6 Fair |
| 1–3 Poor |
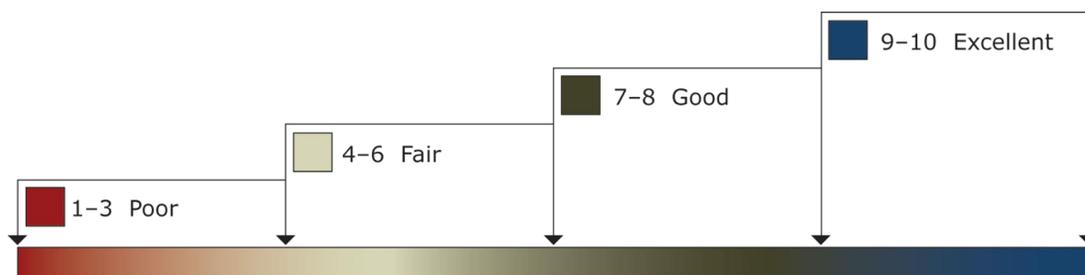
The Decision Support Scorecard considers Technology Attributes and Future Business Value (i.e., the overarching categories for all 10 benchmarking criteria; the definitions for each criterion are provided beneath the scorecard). The research team confirms the veracity of this weighted scorecard through 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 2 and Competitor 3.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Innovation	Technology Attributes	Future Business Value	**Average Rating**
Carbon Lighthouse	**9.0**	**9.5**	**9.25**
Competitor 2	8.5	8.5	8.50
Competitor 3	7.5	8.0	7.75

Technology Attributes

Criterion 1: Industry Impact
Requirement: Technology enables the pursuit of groundbreaking ideas, contributing to the betterment of the entire industry.

Criterion 2: Product Impact
Requirement: Specific technology helps enhance features and functionalities of the entire product line for the company.

Criterion 3: Scalability
Requirement: Technology is scalable, enabling new generations of products over time, with increasing levels of quality and functionality.

Criterion 4: Visionary Innovation
Requirement: Specific new technology represents true innovation based on a deep understanding of future needs and applications.

Criterion 5: Application Diversity
Requirement: New technology serves multiple products, multiple applications, and multiple user environments.

Future Business Value

Criterion 1: Financial Performance
Requirement: Potential is high for strong financial performance in terms of revenue, operating margins, and other relevant financial metrics.

Criterion 2: Customer Acquisition
Requirement: Specific technology enables acquisition of new customers, even as it enhances value to current customers.

Criterion 3: Technology Licensing
Requirement: New technology displays great potential to be licensed across many verticals and applications, thereby driving incremental revenue streams.

Criterion 4: Brand Loyalty

Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

Criterion 5: Human Capital

Requirement: Customer impact is enhanced through the leverage of specific technology, translating into positive impact on employee morale and retention.

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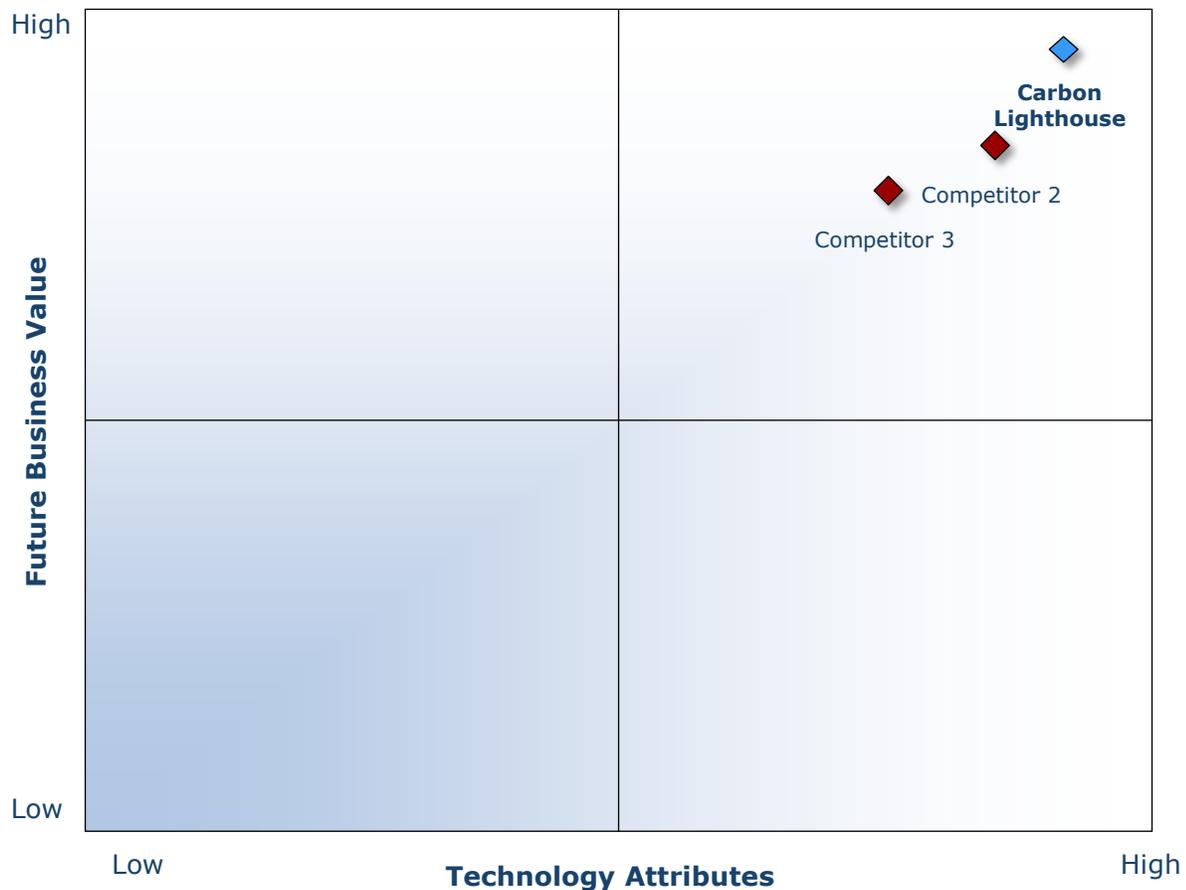
Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

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	• 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	• 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	• 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	• 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	• 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	• 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	• 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	• 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	• 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	• 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.