FROST & SULLIVAN

altergy®

2018 North American Fuel Cells for Backup Power Technology Innovation Award

2018
BEST PRACTICES
AWARDS

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Background and Company Performance

Industry Challenges

With numerous innovations relying on constant connectivity in today's digital world, a reliable and uninterrupted power supply is required. The United States faces more power outage scenarios than any developed nation around the world, hitting the US economy with a massive $150 billion in estimated annual costs. Power outages can strike a business or an entire nation without any warning. As a safeguard, applications such as telecommunication (telecom), cable/MSO, signaling and data centers rely heavily on backup power provided by internal combustion (IC) engines (diesel generator sets) and/or heavy battery packs. However, such backup power sources are constrained by drawbacks such as limited run-time, abundant maintenance, inconsistent power, and harmful environmental impact. Despite these drawbacks, backup power is no longer considered a non-obligatory option but a necessity, and technological advancements addressing the above-mentioned challenges are quickly gaining importance.

Fuel cells are becoming well established in a number of markets where they are now recognized as a better backup power technology option than conventional IC engine generators or batteries. Fuel cells offer the potential for drastic reduction in noise emissions commonly associated with diesel generators. They also offer exceptionally quiet operation, more efficient use of energy, and a high energy storage density (i.e. runtime) compared to batteries. And though fuel cells overcome many of the technical drawbacks found in batteries and diesel generators, a major hurdle in deploying fuel cell backup power is cost. This mainly relates to expensive materials, such as graphene, to fabricate their components. In addition to the added cost, fuel cells made of graphene are fragile and hence cannot be deployed in many environments and applications because they are prone to failure.

About Altergy's Freedom Power Technology

Altergy Systems (Altergy) has designed what Frost & Sullivan sees as a truly innovative technology known as 'Freedom Power'. This impressive technology enables Altergy to design on-demand fuel cells that are clean, very reliable and cost effective. Freedom Power technology replaces the most undesirable attributes found in traditionally designed fuel cells (i.e fragile and expensive components, hand-made assemblies, etc.) and instead it enables the creation of cells with rugged, affordable and everyday materials. Alongside this revolutionary technology the company has also established the first automated fuel cell assembly line in the world.

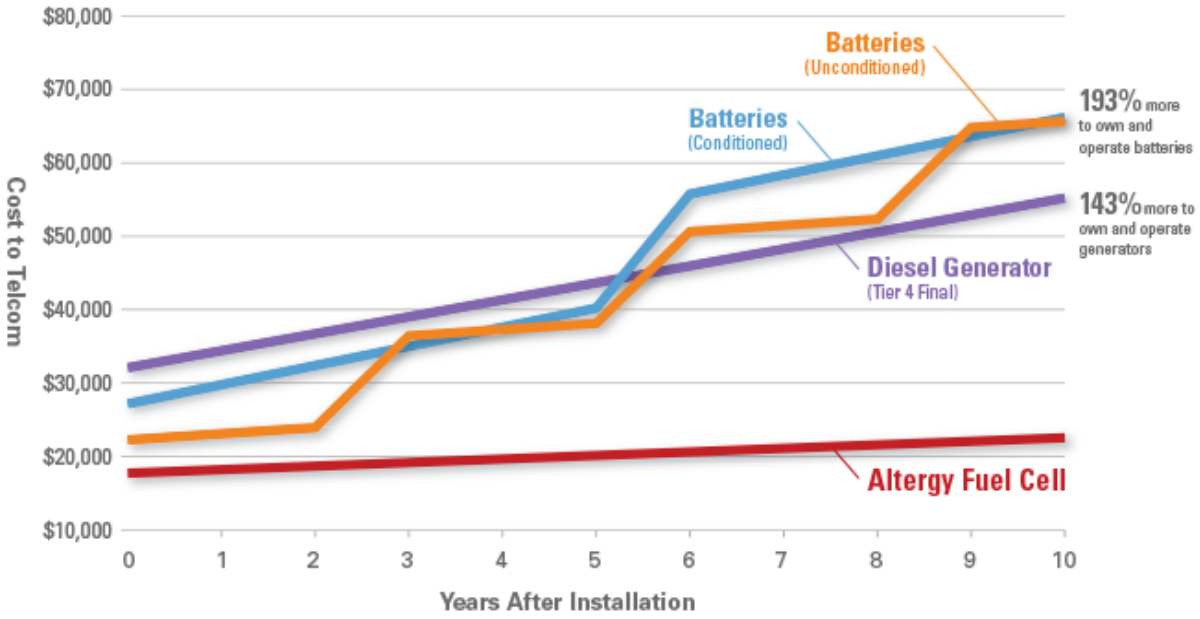
Altergy develops polymer electrolyte membrane (PEM) fuel cells, a grid-free and battery-free power system that can provide long-running, primary or backup power for various industries. These modern fuel cells are quiet, rugged and durable, generating reliable, long-running power at hard-to-access locations or sites that are subject to harsh or inclement weather.

Technology Attributes and Future Business Value

Industry Impact

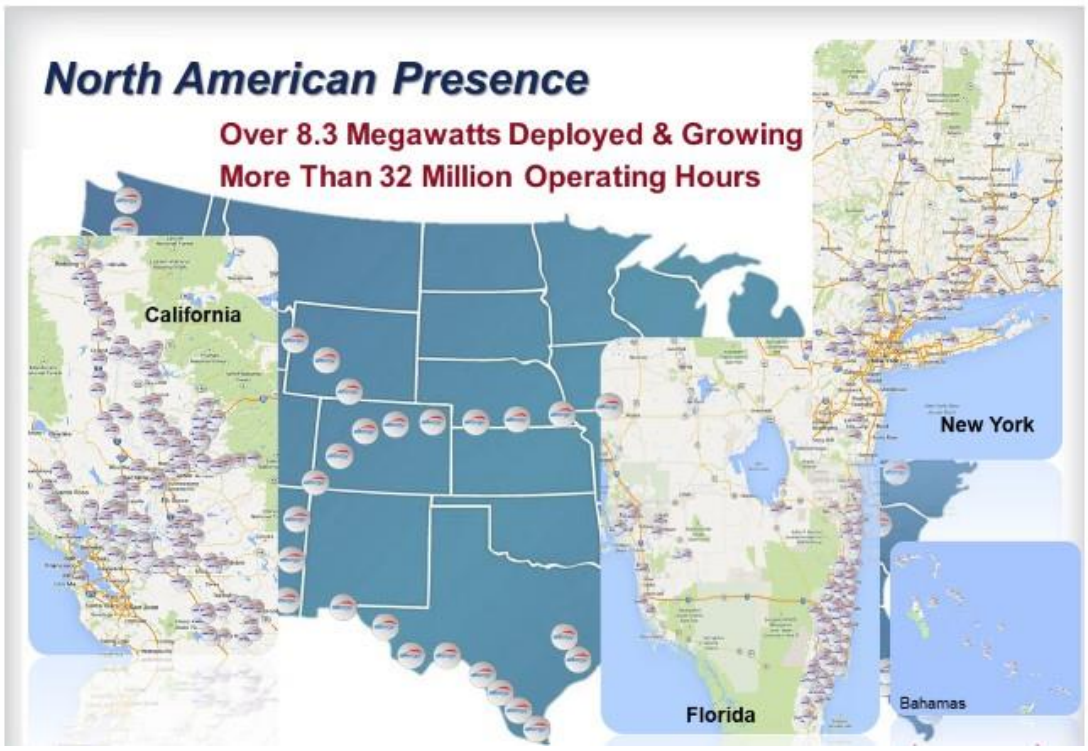
Grid outages that result from contingencies including generator outage or transmission/distribution line failure cause fluctuations in electricity and ancillary service prices. The market for fuel cells is evolving, driven by the demand for numerous stationary applications and the need to gradually replace existing batteries and generators in telecom, cable, signaling and data center facilities where mission-critical operations require uninterrupted power to ensure operation. Freedom Power technology answers the call by providing a reliable source of emergency backup power through fuel cells. Altergy's fuel cell systems also address the challenges of intermittent grid disruption, power outage, and network interruption due to natural disasters via a cleaner and more reliable supply of power than conventional backup power sources offer.

For telecom customers specifically, Altergy's Freedom Power fuel cells deliver a significant reduction in cost of ownership:



TCO based on a 5kW load, 8 hours of runtime. Battery quantities and size determined at end of the life (2.5 years). Generators are Tier 4 Final. Analysis includes acquisition costs, plus permitting and installation costs, as well as ongoing maintenance (and battery replacement) costs for all three technology alternatives. Data sources for the analysis include research reports (Batelle, Battery Council International, etc.), Manufacturer data sheets, prices, white papers and Altergy Systems information.

http://www.altergy.com/products-2/freedom-power-technology/



Pitted against battery power systems and diesel generators, Altergy fuel cells have lower capital expenditure (CapEx) costs and they reduce ongoing maintenance costs. Specifically, the technology gives Altergy the advantage of using readily available and low-cost materials. It utilizes flex-plates to maximize the electrical contacts and improve energy efficiency, mitigating the need for high-precision machine work required for the production of conventional fuel cells. Altergy's patented design reduces critical component costs by more than 80%, which in turn makes the CapEx for its fuel cells considerably less expensive than batteries and generators. Additionally, Altergy has eliminated the use of gaskets by bonding membranes directly to plates within the cell stack. Such a unique method of making contact between the bipolar plate and membrane electrode assembly ensures superior current collection, robustness, scalability, and ease of manufacture.

Moreover, Freedom Power technology is designed to use stainless steel to fabricate the fuel cell components, thereby replacing the fragile graphite-based components used in conventional fuel cells. Thus Freedom Power technology enables Altergy to manufacture low-weight and durable fuel cells that can provide reliable backup power in any location, even in adverse climatic conditions, without affecting the product performance and lifespan.

Another key benefit for customers in the telecom, cable, signaling and data center sectors is that Altergy's fuel cells are certified to deliver better environmental performance compared to competing backup power systems. Altergy fuel cells have been certified by the California Air Resources Board (CARB) to produce zero-emissions, helping customers greatly reduce their carbon footprint and meet sustainability goals.

Product Impact

Freedom Power fuel cell systems power-up instantaneously and provide continuous operation for longer periods on a single fuel fill-up compared to traditional solutions. Start-up time has always been a key problem with diesel generators while batteries typically suffer from short runtime and limited hours of performance; these are very insufficient runtimes to adequately back up critical systems.

With more than 8.3 million watts deployed and 32 million operational hours logged, Altergy fuel cells have provided facilities with uninterrupted and continuous power even during severe natural calamities including Hurricanes Sandy and Joaquin and the Napa Valley earthquake where conventional batteries and diesel generators failed. Hurricane Sandy passed over the East Coast of the United States in October 2012 with devastating effect, but during this time Altergy's fuel cell powered cell phone towers remained in operation for extended periods for customers in New York, New Jersey, and Connecticut. Altergy has more than 60 fuel cell systems installed in the disaster area and all were reported to function normally throughout the storm.

Additionally, because Freedom Power technology allows Altergy to produce lightweight fuel cells with a compact footprint, installation is no problem on rooftops and tight spaces where batteries and diesel generators cannot be used owing to space and safety restrictions. Also, the innovative design is responsible for the extremely quiet operation of the fuel cell power system as there are no moving parts and no internal combustion involved.

Using fuel cells as backup power systems in the telecom market gained prominence as an application, thanks to the US government's 2009 Recovery Act funding. Since then, stakeholders around the world have reaped the benefits and cost savings that can be achieved through using fuel cell backup power. The power capacity of the backup system used for cell towers is typically 4 to 6 kW. However, with Freedom Power Altergy can deliver flexible, modular, and configurable power systems for a wide range of power demands from 1 to 100 kW. Frost & Sullivan is especially impressed that the fuel cell stack can be fabricated in a modular unit that has the plug-and-play flexibility to scale within a wide range of applications.

Being highly durable and considerably low in weight, Altergy's Freedom Power technology is completely encapsulated within a single cabinet. Frost & Sullivan sees this configuration as more compact and relevant compared to competing backup power systems for applications in telecom stations and data centers complemented by faster start-up time in

comparison to diesel generators and batteries. Frost & Sullivan expects these benefits to set a benchmark and influence emerging fuel cell technologies, resulting in the development of more viable solutions in this market.

Visionary Innovation

With its Freedom Power technology, Altergy is set to transform the fuel cell industry as it has created a path-breaking robotic assembly line for fuel cell manufacturing that greatly simplifies the overall manufacturing process and eliminates manual labor, which eventually translates to a lower cost fuel cell power system. The world's first robotic assembly system for fuel cell production automates the fabrication process using durable and readily available automation components plus common stamped and molded fabrication techniques. This results in higher volume output and lower cost per unit performance than the conventional fuel cells that are manually assembled. Using this groundbreaking technology that meets the stringent US and International certification and listing requirements, Altergy can manufacture one fuel cell every 30 seconds and the complete fuel cell engine in minutes on a commercial scale with no compromise to quality.

With a clear understanding of the evolving fuel cell market needs and challenges, Frost & Sullivan applauds Altergy for its vision and execution of successfully designing, mass-producing, and commercially deploying rugged, low-cost fuel cells.

Application Diversity

Altergy serves hundreds of customers including telecommunications, data centers, cable operators, public safety (from 911 centers to Homeland Security and sensitive government operations), military, traffic signaling, and other mission-critical networks. Altergy's fuel cell systems are used by telecom companies to provide backup power for telecom base stations, repeaters, cell towers, and other electronic systems.

Additionally, Altergy's fuel cells are capable of being utilized for energy demand management in various industries by providing power during peak periods. Energy demand management is being mandated for implementation by various governments, which includes reducing power consumption from the grid during peak demand periods. Failure to adhere to the energy demand management mandate often results in the customer facing huge penalties in charges per kilowatt hour. Companies can now save loads of money by utilizing Altergy's affordable and reliable fuel cell solutions.

Customer Acquisition

Altergy has partnered and established relationships with key industry stakeholders such as Alpha Technologies, Eaton, Clary and 101 Telco. In 2018, CSX Railroad, a Florida-based transportation service provider, partnered with Altergy to deploy fuel cell power solutions at its signal gate crossings to replace unreliable and polluting diesel generators.

Altergy Systems donated several of its portable fuel cell-powered generators for use in lighting the streets and stages of Super Bowl City during Super Bowl 50 (Santa Clara, CA), held in February 2016. Unlike diesel generators, fuel cells operate quietly, which allowed Altergy's systems to be sited in, or adjacent to, food and beverage areas without disturbing patrons. In the customer's own words:

> *"We were thrilled that Altergy supported our low carbon goals and supplied a large percentage of our hydrogen fuel cell power in Super Bowl City. We were able to get nearly 100% of our energy without using any dirty diesel."*
>
> -John Mitchell, Director of Event Productions, San Francisco Bay Area Super Bowl 50 Host Committee

Freedom Power technology has enabled Altergy to provide a fuel cell power system with a low cost of ownership while the flexible lease and financial options make it highly attractive and affordable. Customers can opt for Altergy's lease agreements in which the equipment cost is built-in and the customer can choose to pay the acquisition cost in low monthly payments.

Frost & Sullivan strongly believes that Altergy has considerable potential to further strengthen its position in the fuel cells market with the cutting-edge Freedom Power technology, which will be enabled by its long-range and macro-level innovation, affordable business model strategies, and community development activities.

Conclusion

Altergy's Freedom Power technology is providing abundant value in the market by reducing system costs, environmental impact, and dependence on fossil fuels while ensuring uninterrupted power. Altergy's Freedom Power technology and allied fuel cell products are the mark of true innovation and, in Frost & Sullivan's opinion, serve as a superior replacement to traditional backup power technologies such as diesel generators and batteries.

Altergy has built the world's first fully automatic robotic fuel cell fabrication plant to manufacture fuel cells at a commercial scale. Altergy's fuel cells feature lower capital investment, higher durability, lightweight construction, fast start-up, and high modularity. For these reasons, Altergy is recognized with Frost & Sullivan's 2018 Technology Innovation Award in Fuel Cells for Backup Power.

Significance of Technology Innovation

Ultimately, growth in any organization depends upon finding new ways to excite the market and upon 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 three 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. That 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 two key factors—Technology Attributes and Future Business Value—according to the criteria identified below.

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 revenues, 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 sectors 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.

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

Frost & Sullivan analyst follow a 10-step process to evaluate Award candidates and assess their fit with select best practice 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 globe	• Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies	Pipeline of candidates who potentially meet all best-practice 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-practice 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-practice 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-practice 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-practice Award recipient	• Review analysis with panel • Build consensus • Select recipient	Decision on which company performs best against all best-practice criteria
9	**Communicate recognition**	Inform Award recipient of Award 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 future 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 our 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, leading to 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, enables clients to 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 practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages more than 50 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit http://www.frost.com.