FROST & SULLIVAN

BEST PRACTICES AWARDS

NOSTROMO

2020 EUROPEAN ICE-BASEDTHERMAL ENERGY STORAGE TECHNOLOGY INNOVATION LEADERSHIP AWARD

Contents

Background and Company Performance

Industry Challenges

Over 40% of the global population lives in hot tropical areas known for soaring temperatures. As many countries in these regions undergo fast economic growth, as seen in parts of Asia, the standard of living is equally on the rise, which causes an increasing demand for cooling systems. Access to cooling is becoming a basic need in nearly all tropical countries. According to the International Energy Agency (IEA), the demand for air conditioners (ACs) to meet the increasing cooling demand is expected to triple by 2050. According to Rocky Mountain Institute, India is currently only 7% air-conditioned. In the next 20 years, India will become 60 to 70% air-conditioned, which indicates that country's electricity demand will rise significantly in the coming years. Consequently, the huge rise in peak power demand will have to be met by demand-side management via energy storage solutions. The problem is that the adoption of energy storage by utilities is not growing at par with the rise in peak demand by consumers, and this puts undue stress on the grid. This peak power situation is further aggravated by the penetration of renewable energy resources into the grid.

Grid-scale energy storage by means of lithium-ion batteries is popularly used to store energy during times of low demand, and then later the stored energy is used during peak demand periods. However, utilizing lithium-ion batteries comes at huge environmental costs. Lithium is an earth metal that when used in batteries experiences high degradation over time and is difficult to recycle. Nevertheless, demand for lithium is growing rapidly, which can lead to a sharp increase in lithium prices, yet lithium and cobalt are mined in only a few countries, posing supply chain risks. Therefore, it is vital to eliminate dependence on politically unstable countries for lithium and instead aim to adopt a sustainable resource for use in energy storage solutions.

Frost & Sullivan recognizes the need for an alternative source of energy storage to meet the rising global cooling demand, one that is environment-friendly and safer when compared to existing energy storage solutions.

Technology Attributes and Future Business Value

Industry and Product Impact

Nostromo Energy, an Israel-based thermal energy storage (TES) company, has developed a novel TES solution made up of a thermal cell, the IceBrick™, which uses water as the medium of heat/cold storage. Water is a clean, renewable, and environment-friendly medium of energy storage. Nostromo's TES technology uses the high latent heat of water to store and release cold energy. To melt one gram of ice to water at a constant temperature, 80 calories of heat is required.

With the IceBrick™ thermal cell, Nostromo Energy plans to make water a capacitor of energy in behind-the-meter energy storage. The IceBrick™ TES system utilizes electricity during low demand periods to freeze water and form the ice that stores cold thermal energy; this constitutes the charging process. The stored cold energy is discharged during times of peak demand when electricity prices are high, which reduces undue stress on the grid.

Nostromo Energy enables storage of cold energy through IceBrick™ to facilitate cooling at hotels, hospitals, shopping malls, and other commercial establishments. IceBrick™ delivers a constant rate of cold energy for 4 hours straight to meet a building's cooling demands. Frost & Sullivan notes that this success is unprecedented in the TES industry. Moreover, unlike electrochemical energy storage systems, the IceBrick™ thermal cell is rigid and has zero degradation, even after 10 years of usage.

Moreover, the use of 100% recyclable materials makes IceBrick™ an environment-friendly solution. It is also totally safe and never explodes, which cannot be said of lithium-ion storage solutions. With IceBrick™, it is possible to offset an average of 30% of the peak electricity demand in hot locations that have huge cooling needs.

Frost & Sullivan is impressed by the wide array of benefits with regard to safety, efficiency, and environment-friendliness offered by IceBrick™ in comparison to prevalent electrochemical energy storage solutions. The ice-based TES solution's ability to reduce grid stress by offsetting peak demand with a minimal environmental impact is highly commendable and makes it a sought-after TES solution.

Scalability

A key problem associated with competing ice-based TES solutions is that they are not compatible with commercial end-user needs. Conventional TES solutions involve placement of large tanks that occupy considerable space behind a building, whether a hotel or shopping mall, for instance. Ideally, commercial customers prefer a more compact system, which Nostromo addresses with its groundbreaking IceBrick™ solution. An IceBrick™ cell has storage capacity of 12.5 kWh (Li-ion equivalent). With a compact dimension of 25 cm x 50 cm x 400 cm and weighing just 750 kg (325 kg per sq. Meter or 70 pounds per square foot, IceBrick™ can be easily integrated within a building, requiring minimal real estate. As momentum picks up and the IceBrick™ solution achieves increased market penetration, Nostromo plans to design its modular thermal cell to be easily considered as part of a new building's initial blueprint, thereby making the product fully scalable.

According to the US Department of Energy, out of all the energy storage systems available worldwide, only 0.005% comprises ice-based thermal energy storage. Frost & Sullivan believes that considering the global market need for next-generation cooling systems and the many benefits offered by IceBrick™, Nostromo Energy is well suited to fill a gapping

market need with its groundbreaking product that will set an industry benchmark and subsequently spur the adoption of ice-based TES solutions globally.

Customer Acquisition

Major ice-based energy storage companies focus solely on the direct expansion cooling sector, which forms about 60% of the AC market and typically covers rooftop AC units. Yet these companies do not serve the chiller sector, which forms the remaining 65% of the commercial and industrial AC market. Nostromo Energy targets the chiller sector. The company services all medium-to-large chiller users, such as hospitals, hotels, shopping malls, office buildings, and data centers. While some makers of competing solutions focus on a smaller market segment, such as refrigeration in retail spaces, Nostromo's IceBrick™ facilitates refrigeration and air-conditioning for a wide array of commercial institutions. Moreover, the company uses a zero-down-payment business model to minimize its customers' financial risk. From an investment perspective, IceBrick™ costs half as much as lithium-ion systems. In comparison to major ice-based energy storage systems, IceBrick™ reduces the cost per installed kWh of energy storage by about 40%. Frost & Sullivan believes that the unmatched value proposition offered by Nostromo's IceBrick™ positions the company for high growth in the future.

Brand Loyalty

Nostromo Energy is funded by some major investors, including Royal Dutch Shell, a billion-dollar oil and gas *supermajor*. Overall, Nostromo has received investment of about $4.6 million for equity and 2.5 millions as grants (mainly from the Israel innovation authority and the US department of Energy) for demonstration systems. The partnership with Royal Dutch Shell has provided Nostromo Energy a multitude of benefits in developing the IceBrick™ technology. Moreover, Nostromo has conducted various degradation tests on its IceBrick™ thermal cell in cooperation with Royal Dutch Shell. The tests have shown that the thermal cell can achieve a 166,000 charge-discharge cycles without any degradation. In contrast, 30 to 40% degradation occurs in lithium-ion batteries over just 3,000 to 4,000 cycles.

In July 2019, Nostromo Energy was invited to present its innovation to the then US Secretary of State during his visit to Jerusalem. Nostromo was among a group of innovative companies selected by the Israeli Innovation Authority to showcase their innovations. Nostromo Energy can potentially leverage such laurels as product marketing channels to drive the adoption of IceBrick™ within the commercial segment.

Frost & Sullivan lauds Nostromo Energy for securing funding and establishing partnerships with energy industry majors such as Royal Dutch Shell. The association with such global brands will help the company access the market faster and position IceBrick™ as a credible energy storage solution.

Conclusion

Amid rising cooling demand the world over that puts undue stress on the energy grid, conventional energy storage solutions such as lithium-ion batteries are neither sufficient nor sustainable, so they must be augmented by cleaner, environment-friendly, and more efficient energy storage solutions. Nostromo Energy developed an innovative ice-based thermal energy storage solution, IceBrick™™, which utilizes water, a clean, cheap, and safe source, as the medium of energy storage. The differentiating, attractive feature of IceBrick™ is its modularity, which creates the opportunity for it to be retrofitted into commercial buildings and occupy minimal space.

Frost & Sullivan believes that Nostromo, by positioning itself as an end-to-end solution provider that requires no investment from the commercial customer to adopt its system holds a robust competitive edge over other ice-based thermal energy storage companies. Also, financial support and partnership with Royal Dutch Shell make Nostromo Energy well-poised to expand its market reach and serve the cooling needs of commercial buildings globally, thereby creating the means to safeguard the increasingly over-stressed energy grids.

For its strong overall performance, Nostromo Energy has earned Frost & Sullivan's 2020 Technology Innovation Leadership 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. 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 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

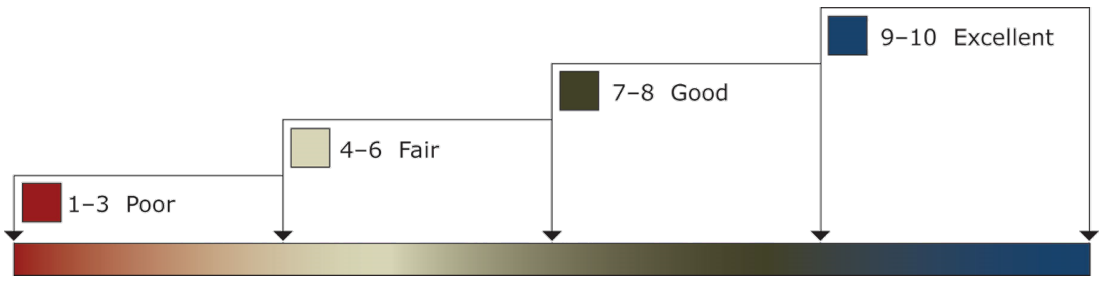
Criterion 1: Financial Performance
Criterion 2: Customer Acquisition
Criterion 3: Technology Licensing
Criterion 4: Brand Loyalty
Criterion 5: Human Capital

Best Practices Award Analysis for Nostromo Energy

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 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 1 and Competitor 2.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Innovation	Technology Attributes	Future Business Value	**Average Rating**
Nostromo Energy	**9**	**9.5**	**9.25**
CALMAC	8.5	8.5	8.5
Axiom Energy	7.5	8	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

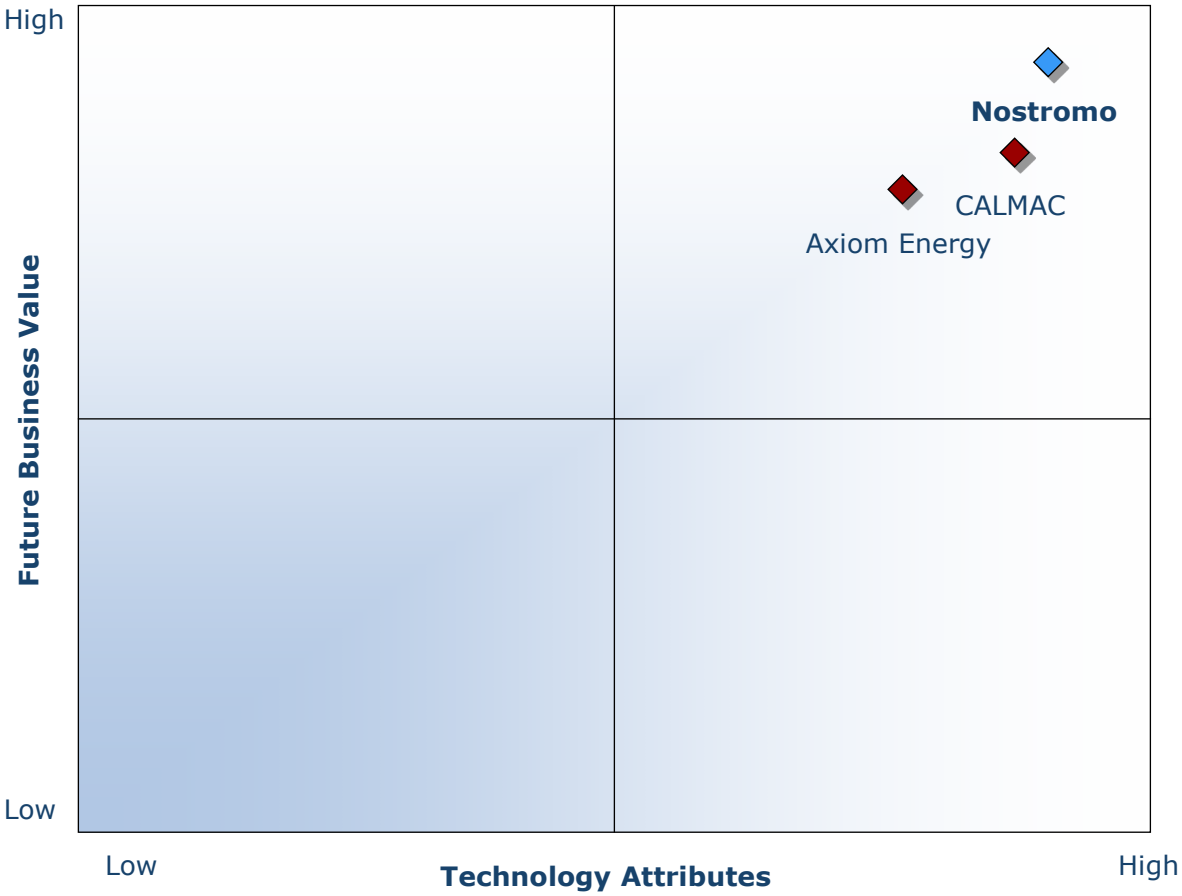
Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

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	• Announce 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

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