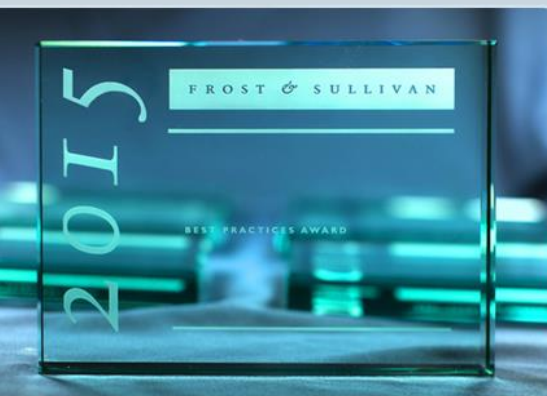


SIEMENS

2015 European Industrial Steam Turbine New Product Innovation Award



FROST & SULLIVAN



50 Years of Growth, Innovation & Leadership

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Background and Company Performance

Industry Challenges

Industrial Steam Turbine is one of the key components that drive efficiency in industries, ranging from chemicals to pulp & paper. Used mainly in power production and mechanical drive applications, industrial steam turbines are used to run key functions of a plant and are considered vital to the proper functioning of the plant. The key challenge that the manufacturers face is that of safety and reliability. This is because the turbine must function without any break, as stoppages would lead to the loss of industrial production, affecting the efficiency of the plant in the process. As industries evolve and requirements change, another key challenge faced by turbine makers is the quality of equipment. This is because new processes require the turbine quality to be high in order to withstand high steam pressures and be flexible enough to be able to adapt the turbine to a variety of industrial processes. Companies also face challenges in the form of pricing, as several customers are price sensitive and striking a balance among quality, reliability and price is the key to success for any manufacturer of industrial steam turbine. Therefore, companies constantly need to innovate in order to adapt to the changing industry demands while maintaining high standards of quality at affordable price to the customer.

New Product Attributes and Customer Impact

Match to Needs

One of the key challenges faced by the industry is to match the needs of the customers for safety with increased efficiency. The Enhanced Platform Design for Industrial steam turbines introduced by Siemens AG in 2012, is unique in that it combines the advantages of all the established Siemens Industrial Steam Turbine product lines and integrates latest technologies. The Enhanced Platform is a technology platform which establishes a common basis for all Siemens Industrial Steam Turbine product lines that helps significantly to reduce the need for maintenance and upgrade efforts required for various steam turbine models. The Enhanced Platform can be used in various industries, such as petrochemicals, oil & gas, steel and mining. These industries have stringent criteria for turbine selection and usage, and the key requirements of these industries has been for a turbine, which would have better environmental protection and has up to 2% higher efficiency. Also, optimized homogenous geometrical casing design leads to reduced start-up time of up to 50% and higher flexibility in operation (load changes). This turbine also ensures the reduction of CO2 emissions by averaged 15% over the entire lifetime of the turbine.

A specific technical feature to highlight is the possibility to realize a complete oil free steam turbine unit. Siemens developed an active magnetic bearing. In combination with an electromechanical actuator (EMA) Siemens successfully installed and operated the first oil free steam turbine unit on customer side. A lube oil system becomes unnecessary. By these features the attractiveness of Siemens Steam Turbines for Oil & Gas application is raised. The rotor does not have any contact with the bearings and is not supported by a film of oil. This reduces losses, as there is no contact with the bearing, thus facilitating

increase in the efficiency of the turbine by up to 1%, further. Also, due to no oil usage, this turbine is useful for customers who require better fire protection and who have high safety requirements, such as petrochemical and oil & gas industry.

Reliability

The Enhanced Platform is Siemens' response to its customers' need for extended operating capabilities and improved economical solutions. The improved blading design and an optimized steam path help increase the efficiency of the SST-600 steam turbine, thereby increasing both efficiency and reliability of the operations of the plant. With extensive testing and design improvements- such as symmetrical casing, the turbine is able to withstand high steam temperatures up to 565 degree Celsius and pressure up to 165 bar without any breakage or stoppage of operation. Running speeds of 3000 to 18000 rpm ensures, for generator or mechanical drive applications, consistent performance and reliability throughout the life of the turbine in operation. The modular design of the turbine also ensures that the turbine can be assembled to meet any personalized customer requirement. As certain industries, such as oil & gas, are bound by American Petroleum Institute (API) standards for equipment, which mandate the use of reliable and quality equipment from known manufacturers- such as Siemens, it testifies to the reliability of the turbine.

Positioning

The Enhanced Platform is a technology platform that supports the design of well-known and proven product lines, such as customized and standardized turbine configurations as single and multi-casing solutions. It uses predefined components to cover different turbine solutions and applications. This allows for maximum flexibility due to standardization at the sub-part level, leading to increased efficiency.

The specific design on an oil free steam turbine is recommended for industries with high safety requirements and the need for environmental protection due to having operations in ecological sensitive areas. The installed Siemens oil free Steam Turbine, being the world's first oil-free turbine with a power output up to 10MW, guarantees this unique combination for industries- such as chemicals, refineries, oil & gas, and in offshore locations- such as drilling platforms, by using magnetic bearings that ensures the turbine requires no oil storage. This positions the platform ideally for industries with high safety requirements, as accidents due to oil spillage can be avoided. This technology is difficult to replicate as it requires special cooling systems, which are patented by Siemens and cannot be replicated by competitors easily, thereby giving Siemens a competitive advantage in key industries.

Design

The Enhanced Platform steam turbine design combines the advantages of all the established well known Siemens industrial steam turbine product lines. It integrates the latest technological developments which form the basis for the modified versions of existing product lines. The Outer Casing design reduces start-up times due to optimized turbine casing. The Steam Guide is the ideal steam path for a highly efficient steam

turbine: Depending on the live steam conditions (pressure and temperature) and the turbine operation different technical solutions for the steam admission are available (nozzle casing & inner casing) allowing best customer fit product solutions. The Steam Inlets allow High temperatures with short heat-up times: The Enhanced Platform technology employs a valve piping arrangement for control of live steam. To ensure short turbine customer design processes a dedicated number of pre-designed arrangements were created covering most applications. Blades with improved profiles: The improved cylindrical high pressure blades and conical (twisted) intermediate pressure blades allow longer airfoils and, therefore, contribute to the overall high efficiency. The improved sealing system allows more sealing strips per blade row at both moving and stationary blades. Extraction Points offer Additional options for thermal cycles are available: External control valves, applicable for very high steam extraction conditions; Internal control valves in combination with and without nozzle group, both profiled and un-profiled grid valves. Smaller Bearings: The possibility of applying up to three balancing pistons minimizes thrust and allows smaller axial bearings. Exhaust Casings - Larger condensing stages and higher backpressures: Axial and radial exhaust solutions ease installation in our customers' environment. Radial as well as axial exhaust casings allow for both air and water cooled condensation.

The creation of the first oil-free steam turbine requires further innovations in design and materials, which can support the functioning of critical equipment- such as compressors. The key to Siemens' turbine is an active magnetic bearing, which use magnetic forces to suspend a rotor. Combined with an electro mechanic actuator (EMA) applied for the steam supply control an oil system isn't required. If the equipment powered by the steam turbine also use magnetic bearings, then this eliminates the need for a system to manage oil, such as tanks, pumps, pipes, and oil disposal systems, leading to increased safety and protection for the plant. Also, as the rotor has no contact with the bearings, there is no risk of friction, thereby boosting the efficiency of the turbine.

Another achievement by Siemens is its newly patented cooling system for the active magnetic bearings. As steam temperatures often exceed 500 degrees Celsius- leading to difficulty in using magnetic bearings, the new air cooling system reduces the effect of the steam temperature to ensure a safe operation of the magnetic bearings. Another system is the monitoring of the rotor using sensors and controlling the position of the rotor that adjusts the magnetic field. This also opens up the possibility of online monitoring of rotor systems as well as active positioning of the rotor while operation. The actual active magnetic bearing design is applicable for steam turbine with a total rotor mass of up to 10 tones.

Customer Service Experience

Siemens' Steam Turbines are customized and designed for the specific needs of the customer. In close cooperation with the customer, the Siemens team evaluates all customer conditions and demands, only then a steam turbine is designed, which fits exactly to the customer's needs. Siemens also has the largest installed service base in the world for industrial steam turbines. Unlike other competitors who have no local service or

manufacturing base, Siemens has installed manufacturing and service centers at key locations around the world, where clients are based, which leads to shorter delivery and service time for turbine and other industrial equipment's. By having local facilities, Siemens has ensured regular detailed inspections and testing of its equipment at the facility of the customer itself. Additionally, any emergency repair or support that the customer needs can be done on the customer's site. This leads to shorter downtimes for the customers and access to original high-quality products from Siemens without the need to rely on 3rd party products for repairs. Siemens also has a dedicated team of specialists at various facilities, which allows for on-hand fault finding and repair instead of having to return the equipment to the manufacturer. These factors have played a crucial role in positioning Siemens as the preferred partner for industrial steam turbines. This has also enabled it to acquire a dominant market share, based on reliable and quality service that it delivers in the key markets of Europe, Asia and North America.

Brand Equity

Siemens enjoys the highest brand recognition in the Industrial steam turbine industry, as consistent reliability and high-end performance of its products have empowered it to gain the leading market share of 35% in Europe. A wide range of innovative and high-quality products, speedy delivery and large established service has made Siemens the preferred choice for industrial steam turbines among its customers.

Also, due to the high quality of its products, Siemens' products are mandated for several process industries and the oil & gas sector, which are bound by stringent regulations and standards. Siemens steam turbines dominate the markets of pulp and paper, solar power plants and many more. With a fleet of more than 20,000 steam turbines, Siemens has, thus, established itself as a reliable and experienced partner for all industries, worldwide.

Conclusion

Siemens has established itself as the world leader in industrial machines, backed by its decades of experience and a dedicated focus on product quality. Through its research and innovation-based approach to industrial products, and also by tying up with various universities and research establishments such as the University of Zittau/Görlitz, Technical University of Dresden, University of Stuttgart for the development of products, Siemens has ensured a successful collaboration between industry and academia, leading it to create world-class products that define and set industry standards, thus making it the leader in the global industrial steam turbine industry.

With its strong overall performance, Siemens AG has earned Frost & Sullivan's 2015 New Product Innovation Award.

Significance of New Product Innovation

Ultimately, growth in any organization depends upon continually introducing new products to the market, and successfully commercializing those products. For these dual goals to occur, a company must be best-in-class in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.



Understanding New Product Innovation

Innovation is about finding a productive outlet for creativity—for consistently translating ideas into high quality products that have a profound impact on the customer.

Key Benchmarking Criteria

For the New Product Innovation Award, Frost & Sullivan analysts independently evaluated two key factors— New Product Attributes and Customer Impact—according to the criteria identified below.

New Product Attributes

- Criterion 1: Match to Needs
- Criterion 2: Reliability
- Criterion 3: Quality
- Criterion 4: Positioning
- Criterion 5: Design

Customer Impact

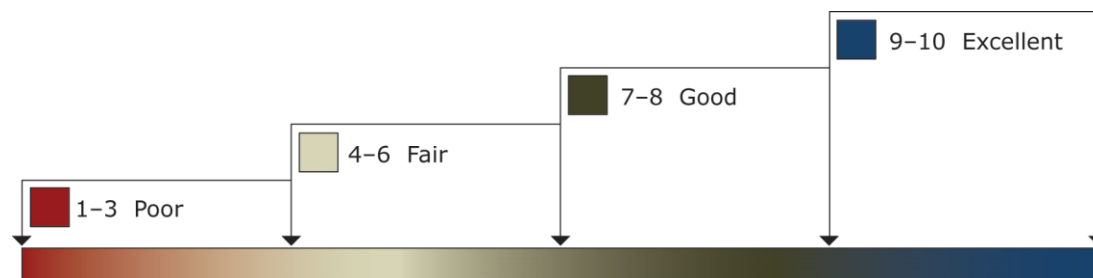
- Criterion 1: Price/Performance Value
- Criterion 2: Customer Purchase Experience
- Criterion 3: Customer Ownership Experience
- Criterion 4: Customer Service Experience
- Criterion 5: Brand Equity

Best Practice Award Analysis for Siemens AG

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 our 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 is organized by New Product Attributes and Customer Impact (i.e., the overarching categories for all 10 benchmarking criteria; the definitions for each criteria 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, we have chosen to refer to the other key players as Competitor 2 and Competitor 3.

DECISION SUPPORT SCORECARD FOR NEW PRODUCT INNOVATION AWARD

<i>Measurement of 1-10 (1 = poor; 10 = excellent)</i>			
New Product Innovation	New Product Attributes	Customer Impact	Average Rating
Siemens AG	9	9	9
Competitor 2	7	7	7
Competitor 3	6	5	5.5

New Product Attributes

Criterion 1: Match to Needs

Requirement: Customer needs directly influence and inspire the product’s design and positioning

Criterion 2: Reliability

Requirement: The product consistently meets or exceeds customer expectations for consistent performance during its entire life cycle

Criterion 3: Quality

Requirement: Product offers best-in-class quality, with a full complement of features and functionality

Criterion 4: Positioning

Requirement: The product serves a unique, unmet need that competitors cannot easily replicate

Criterion 5: Design

Requirement: The product features an innovative design, enhancing both visual appeal and ease of use

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 like they are buying the most 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

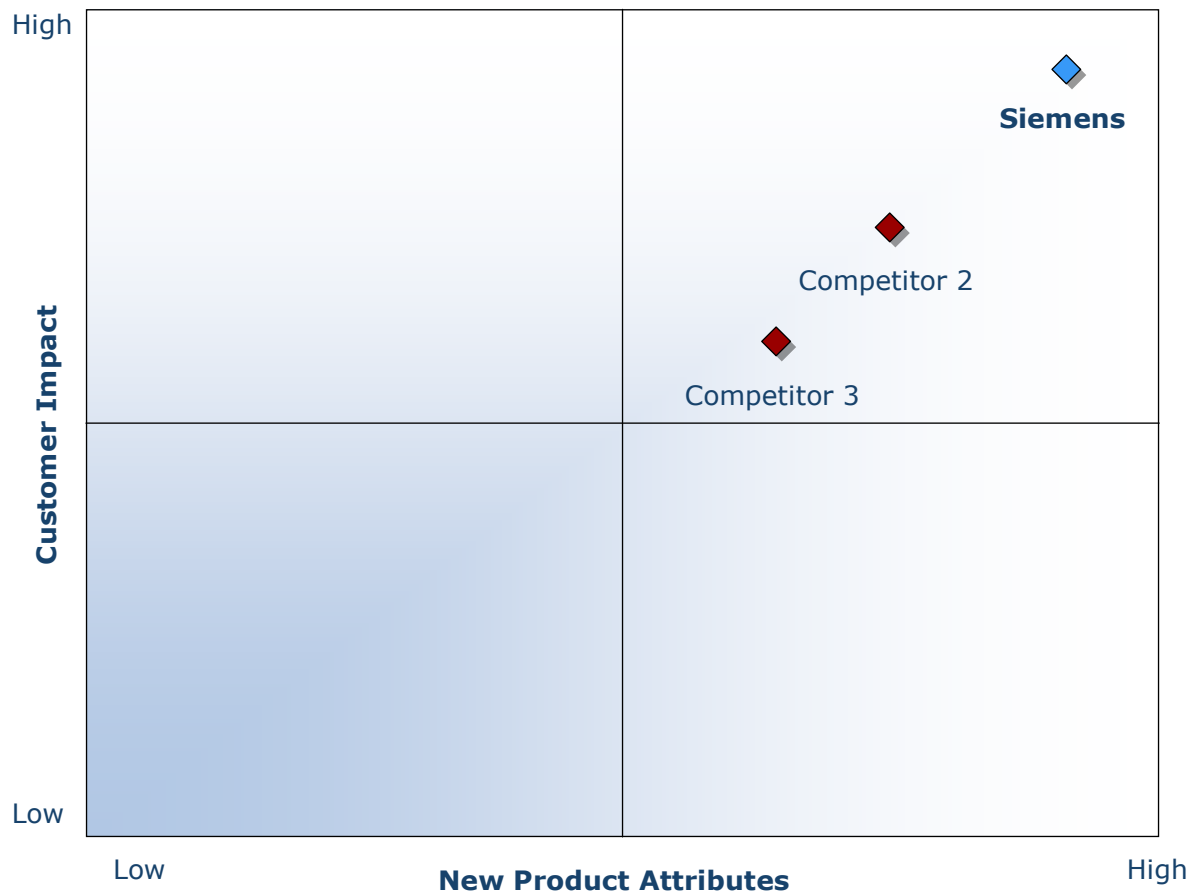
Criterion 5: Brand Equity

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 can 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.

DECISION SUPPORT MATRIX FOR NEW PRODUCT INNOVATION AWARD



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

Frost & Sullivan Awards 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates 	Matrix positioning 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-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	<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-practice 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-practice award recipient	<ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select winner 	Decision on which company performs best against all best-practice criteria
9 Communicate recognition	Inform award recipient of award 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 may 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 future strategic planning 	Widespread awareness of recipient's award status among investors, media personnel, and employees

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 almost 50 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from 31 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.