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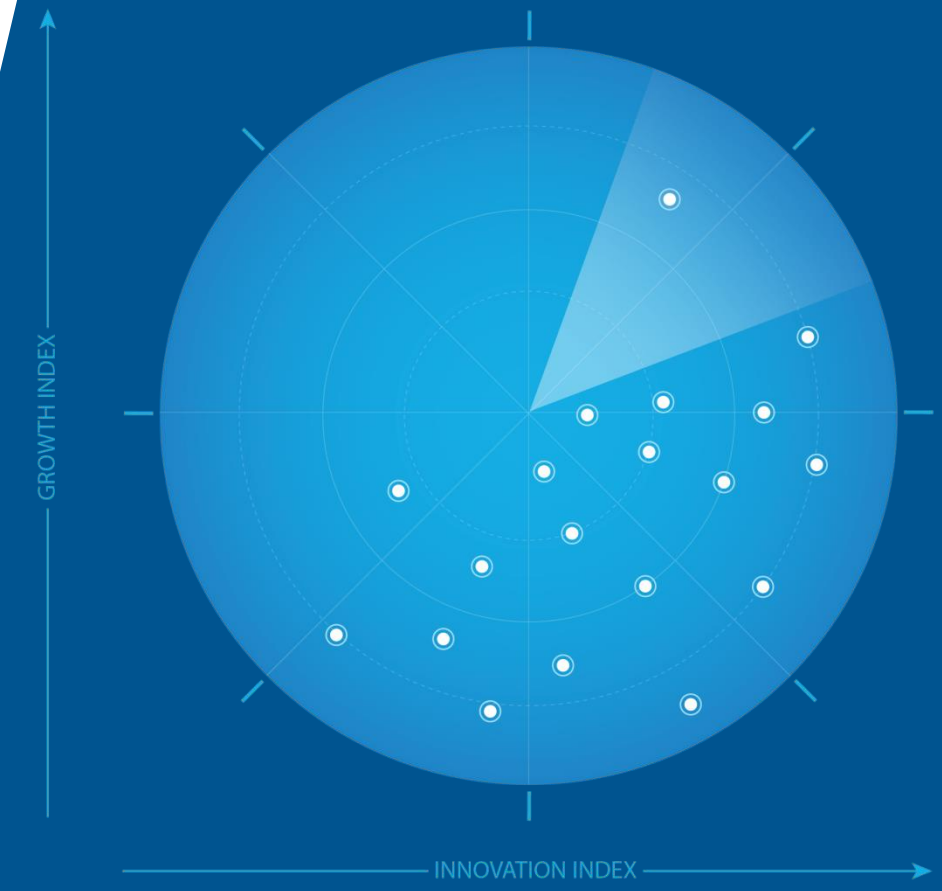
# Frost Radar™: Digital Platforms for Renewable Energy and Battery Storage Optimization and Trading, 2022 Front-of-the-Meter Focus

## A Benchmarking System to Spark Companies to Action—Innovation that Fuels New Deal Flow and Growth Pipelines

Global Energy & Environment Research Team at Frost & Sullivan




K7C6-27

September 2022

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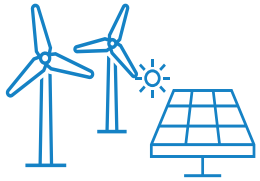
# Strategic Imperative and Growth Environment

# Strategic Imperative

- Flexible generation capacity and storage are elements of the energy transition and the continued expansion of intermittent renewable energy (RE) as they offer unparalleled flexibility to optimally deliver energy and ancillary services. Frost & Sullivan forecasts global grid-scale battery energy storage systems to experience rapid expansion in the coming years, reaching 259.8 GW by 2030 at a compound annual growth rate of 34.2% from 2021.
- As the energy transition advances, power generation portfolios and market rules become more sophisticated, making decision analysis more difficult. Traditional human control for optimizing power generation and market participation becomes ill-equipped to maximize the value of stand-alone storage or hybrid power plants, requiring machine-driven forecasting and optimization and trading algorithms to help in this endeavor.

Decarbonization demands massive deployment of intermittent RE



… that brings unprecedented volatility to power and grid management.

A battery energy storage system is considered an element of modern, flexible grids

… but its effective operation, trading, and dispatch is highly complex

… demanding the aid of artificial intelligence (AI), machine learning (ML), and cloud computing.

Source: Frost & Sullivan

# Strategic Imperative (continued)

**Optimization and trading platforms combining AI, ML, and cloud computing are becoming vital components to ensure efficient use of energy.**

## Why Batteries Need AI for Optimization and Trading

**Plenty of variables to input**

**Forecasts**
- Weather
- Power generation
- Power demand
- Prices

**Grid Dynamics**
- Physical characteristics
- Outages
- Congestion
- Tariffs

**Asset Parameters**
- Status
- Degradation
- Warranties
- Owners' goals and risk preferences

**Market Rules**
- RE-only charging
- Export limits
- Owners' goals
- Programs

**…into AI platforms to predict, make, and act upon optimal decisions**

| Forecasting | Optimization | Bidding | Dispatch | Operate |
|---|---|---|---|---|
| Combines historical and real-time inputs to provide accurate forecasts | Using models and analytics to run multiple scenarios and determine best strategy | Bids for day-ahead and real-time markets and market settlements | Automated dispatch of batteries trough integration with control systems | Optimized energy management operations |

**… to maximize economic, environmental and operational value.**

| | | | |
|---|---|---|---|
| **Peak reduction** | **RE time-shift** | **Backup** | **Carbon footprint reduction** |
| **Grid constraint management** | **Capacity markets** | **Ancillary services** | **Incentives** |

Source: Frost & Sullivan

# Growth Environment

Powerful digital solutions are required for more efficient use of energy resources and to optimize the strategic and financial value of stand-alone battery storage assets and those collocated with renewables. Frost & Sullivan estimates that about 20 GW of RE and battery storage systems are being optimized using a combination of AI-based software and human expertise. As RE and battery storage markets expand, so will the demand for software platforms to address price and demand volatility, manage risk, and unlock the full value of batteries.

AI platforms operate under similar premises. Combining historical and real-time operating data, ML is leveraged to forecast a set of parameters that are input into models. AI-powered analytics are used to run multiple simulation scenarios and find strategies to optimize bidding processes and asset operations.

It is financially and technologically difficult for battery asset owners to develop such solutions in-house, which leads them to look for third-party optimization and trading services. As storage portfolios grow, some asset owners will opt for bringing optimization capabilities (e.g., forecasting, simulation, trading, automated dispatch, market settlements) in-house, for which software-as-a-service (SaaS) platforms would become a better fit.

The most attractive markets for front-of-the-meter (FTM) RE and battery storage optimization and trading platforms are the United Kingdom, the United States, and Australia. However, as renewable penetration advances across markets, so will the need for flexible services and the business case for intelligent platforms.

Source: Frost & Sullivan

# Growth Environment (continued)

**Market intelligence and insights provided by intelligent platforms can be leveraged to cover the entire project life cycle and support multiple stakeholders across the value chain.**

| Stage | Stakeholders | Issues Addressed | Deliverables |
|---|---|---|---|
| **Project Development** | **Developers** | • How much storage power and capacity?<br>• Where should batteries be placed?<br>• What original equipment manufacturers (OEMs) should be considered?<br>• What incentives and markets could be leveraged? | • Conceptual designs<br>• Optimal siting and sizing<br>• Asset valuation |
| **Portfolio Management** | **Asset Owners** | • What assets should be built and where should they be deployed?<br>• How can I optimize portfolio and hedge strategies? | • Portfolio analysis<br>• Resource plan selection<br>• Capacity expansion |
| **Financing and Insurance** | **Insurers, Banks, Risk Managers** | • How should the system be configured to mitigate merchant revenue exposure?<br>• How can I maximize revenue within the desired risk threshold? | • Risk analysis and reporting<br>• Valuation |
| **Operations Optimization** | **Asset Operators** | • How and when should I dispatch/charge my battery? | • Operating plan<br>• Asset management plan |
| **Asset Management** | **Asset Operators** | • Am I compliant with OEM warranties? | • OEM warranty compliance |
| **Bidding** | **Traders** | • How can I optimize my bid strategy?<br>• What is the risk and return of each strategy?<br>• When will price spikes and negative prices occur? | • Price forecasting<br>• Automatic bid generation<br>• Performance reporting |

Source: Frost & Sullivan

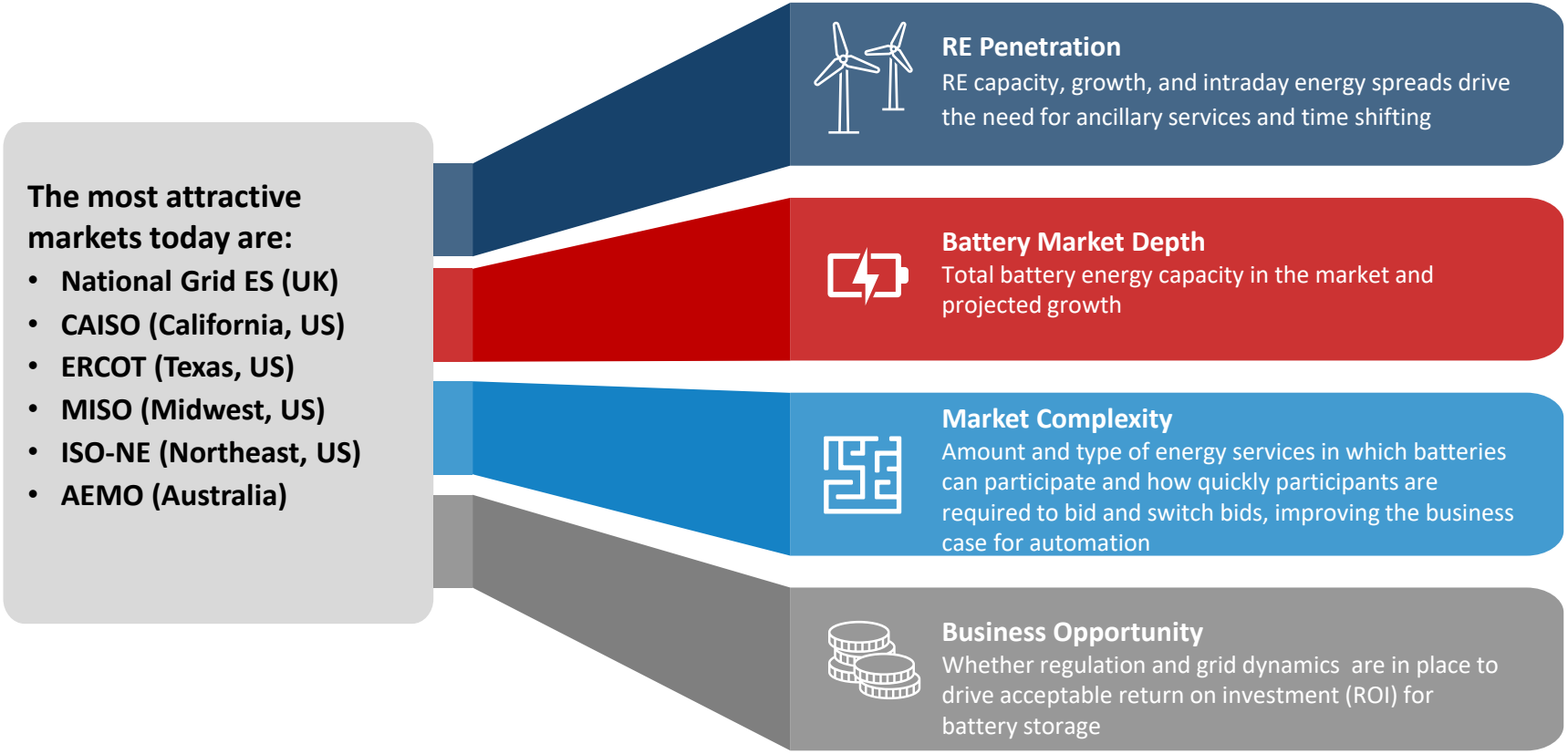
# Growth Environment (continued)

**Market rules in each energy market distance optimization and trading platforms from a plug-and-play business. Participants must carefully assess opportunities before embarking on geographical expansion plans.**

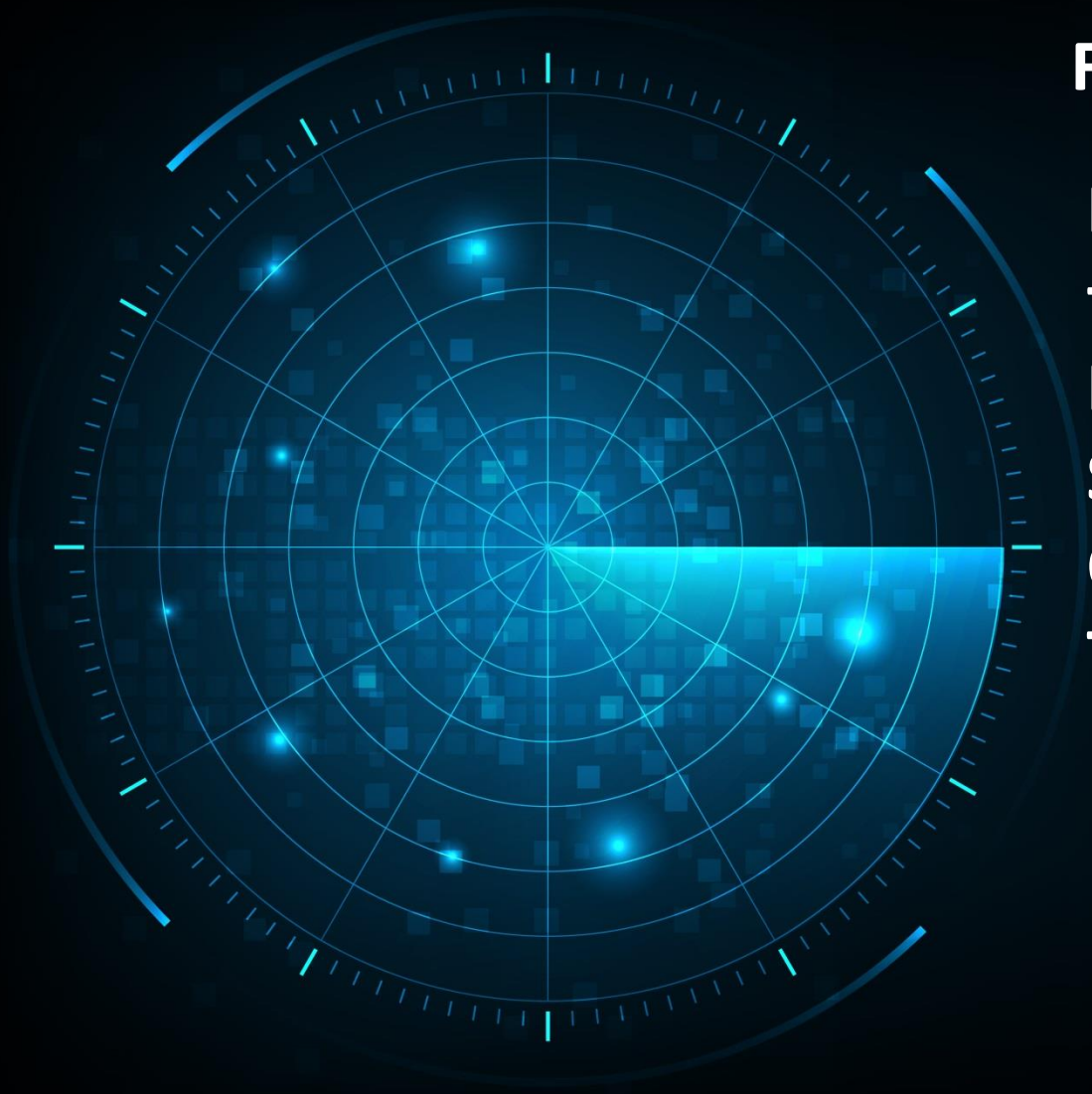
## What Makes Markets Attractive for FTM Trading and Optimization?

**The most attractive markets today are:**

- National Grid ES (UK)
- CAISO (California, US)
- ERCOT (Texas, US)
- MISO (Midwest, US)
- ISO-NE (Northeast, US)
- AEMO (Australia)



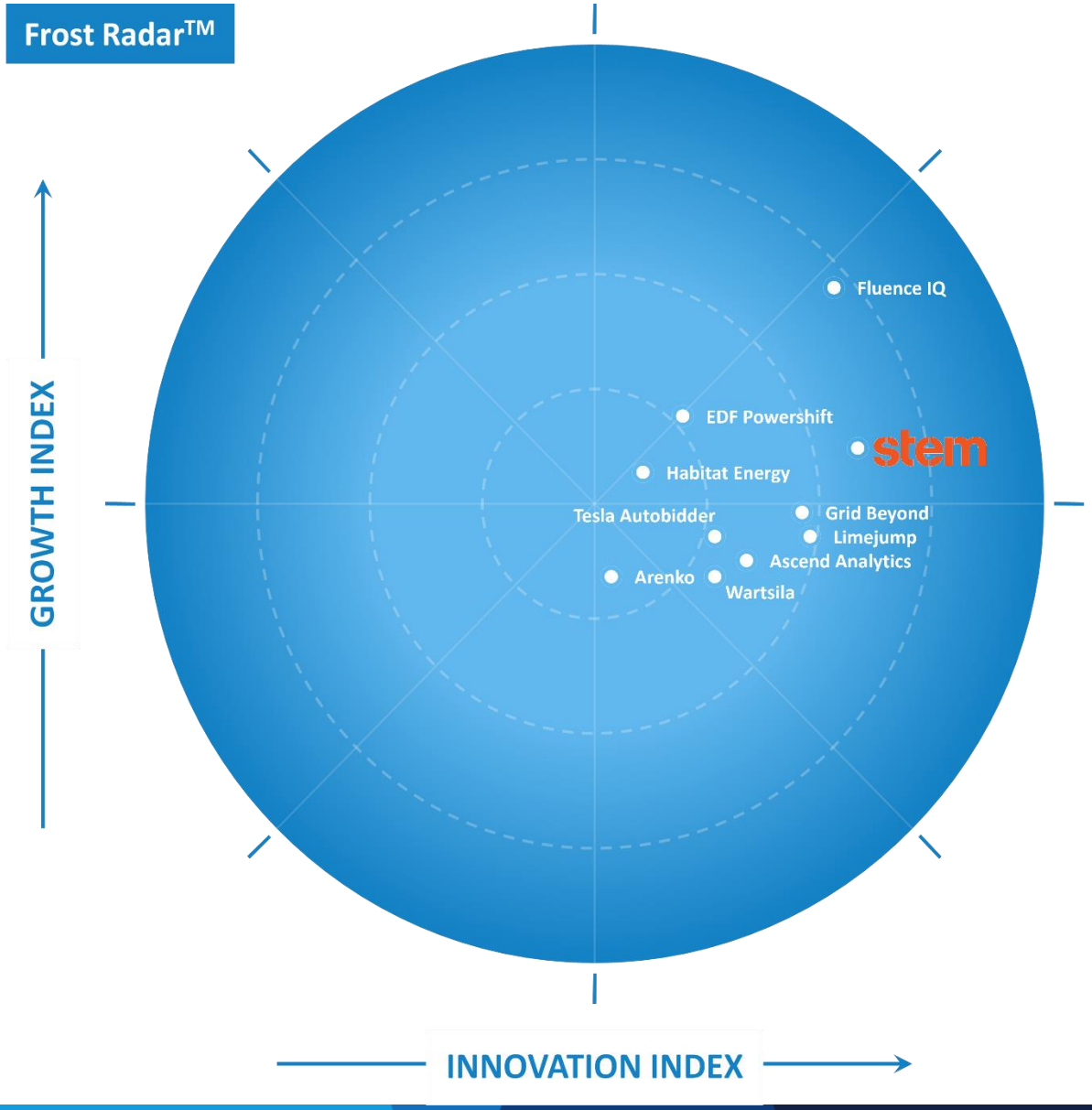

Source: Frost & Sullivan



# Frost Radar™

## Digital Platforms for Renewable Energy and Battery Storage Optimization and Trading

# Frost Radar™: Optimization and Trading Platforms




Source: Frost & Sullivan

# Frost Radar™: Competitive Environment

- Frost & Sullivan independently plotted the top 10 companies offering battery storage and RE trading and optimization services in this Frost Radar™ analysis.
- The benchmark features Stem, while more than a dozen smaller companies either are exploring the market or have recently entered it, Frost & Sullivan has identified these 10 as the market powerhouses. A notable competitor Stem, is a pioneer in BTM analytics and asset optimization, the company announced its entry into the FTM in 2019 leveraging its expertise, credibility, and AI platform, Athena. The company can serve regulated and unregulated markets in the high-growth US battery storage market, with many contracts already announced.
- In a market that is still at a nascent stage and highly fragmented, these companies are looking to establish long-term relationships with assets owners and investors. They also exhibit a genuine commitment to the decarbonization path, as they maintain that by that unlocking the untapped value of battery energy storage, they can help accelerate the energy transition.
- An examination of company backgrounds reveals 3 major groups.
  - Battery integrators that have developed an optimization and trading solution layer that sits on top of their technology and control stacks. Tesla, Fluence and Wärtsilä are in this group.
  - Pure-software vendors with energy trading backgrounds, which is the case of Ascend Analytics, GridBeyond, Habitat Energy, Limejump, and Stem.
  - Companies that started their journey owning and operating large-scale batteries and generation portfolios and decided to leverage the know-how to deliver optimization and trading solutions for third parties. EDF and Arenko are included here.

Source: Frost & Sullivan

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# Companies to Action

## Companies to Be Considered First for Investment, Partnerships, or Benchmarking

# Stem

## INNOVATION

- Stem's Athena platform simplifies clean energy management and helps customers achieve value stacking through co-optimization and automated bidding. The suite is configurable to capture revenues from day-ahead, real-time energy, and ancillary services markets while staying compliant with grid programs and earning incentives.
- Athena optimizes the operation of individual assets, sites with multiple assets, and groups of sites coordinated as virtual power plants. The platform provides value for different players across the RE value chain, leveraging insights to support technology selection, economic modeling, financing, and operations across a project life cycle.
- Stem has more than 600 employees, 200 of them focused on innovation.
- The cloud-native SaaS platform leverages AI and continuous ML with fully automated training and model selection to constantly improve the results of its optimization and forecasting.
- Innovation Index = 4.65

## GROWTH

- Founded in 2009, Stem established its presence in the BTM storage and virtual power plant segments in the United States, operating storage assets.
- Stem has grown rapidly to more than $120 million in annual revenue, more than doubling in 2021, with a projected 50% CAGR over the next 5 years. The company manages more than 1.4+ GWh across 385 customers and 950 energy storage sites, with excellent customer relations realizing over 98% retention.
- Stem expanded its reach into the FTM segment. Today, Athena optimizes storage throughout the US.
- The company has a strong project pipeline, recently announcing a 20-year, $500 million contract with Available Power to optimize 100 sites in ERCOT and NineDot Energy's 110 MWh battery energy storage in New York.
- Stem has a solid financial reserve to fund further development of the Athena platform and technology M&A. Software contracts are 10 to 20 years, providing healthy recurring revenue.
- Growth Index = 3.35

## FROST PERSPECTIVE

- Stem has leveraged its industry and technology expertise in the BTM market to become a leader in FTM clean energy tech and optimization.
- The Athena platform is a top software solution with a track record of delivering tangible, high-value ROI.
- Stem has built a team of specialists that support the entire value chain, providing insights on how projects can capture more returns given market dynamics across jurisdictions.
- Its backlog and quality of revenue is high given the recurring, long-term contracts and high levels of customer satisfaction.
- The acquisition of Also Energy brings PowerTrak into the Athena platform, expanding Stem's reach into solar assets and adding monitoring and asset management stack to the portfolio. The public company has resources for further R&D in Athena and new acquisitions.
- With a continued focus on product leadership and customer value, Stem is well positioned to continue consolidating its FTM market leadership position.

Source: Frost & Sullivan

# Strategic Insights

1. The market for digital platforms for optimization and trading of RE and battery storage is still nascent, with innovative players focusing on the competitive UK and US energy markets.

2. Market participants leverage AI and ML to support forecasting and optimization in combination with experts' insights. While some companies opt for a SaaS delivery model, others stick to asset management contracts combining software with human proficiency.

3. Given the expected increase in battery storage systems and evolving energy market regulations, there is lots of room for growth and market share is up for grabs.

4. Companies must continue fine-tuning forecasts, increasing automation and integration levels, and deploying aggressive marketing, partnering, and brand recognition strategies to attain market leadership and stave off consolidation.

Source: Frost & Sullivan

# Next Steps: Leveraging the Frost Radar™ to Empower Key Stakeholders

# Significance of Being on the Frost Radar™

Companies plotted on the Frost Radar™ are the leaders in the industry for growth, innovation, or both. They are instrumental in advancing the industry into the future.

**GROWTH POTENTIAL**

Your organization has significant future growth potential, which makes it a Company to Action.

**BEST PRACTICES**

Your organization is well positioned to shape Growth Pipeline™ best practices in your industry.

**COMPETITIVE INTENSITY**

Your organization is one of the key drivers of competitive intensity in the growth environment.

**CUSTOMER VALUE**

Your organization has demonstrated the ability to significantly enhance its customer value proposition.

**PARTNER POTENTIAL**

Your organization is top of mind for customers, investors, value chain partners, and future talent as a significant value provider.

Source: Frost & Sullivan

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# Frost Radar™ Analytics

# Frost Radar™: Benchmarking Future Growth Potential

## 2 Major Indices, 10 Analytical Ingredients, 1 Platform

**VERTICAL AXIS**

**Growth Index (GI)** is a measure of a company's growth performance and track record, along with its ability to develop and execute a fully aligned growth strategy and vision; a robust growth pipeline™ system; and effective market, competitor, and end-user focused sales and marketing strategies.

**GROWTH INDEX ELEMENTS**

- **GI1: MARKET SHARE (PREVIOUS 3 YEARS)**
  This is a comparison of a company's market share relative to its competitors in a given market space for the previous 3 years.
- **GI2: REVENUE GROWTH (PREVIOUS 3 YEARS)**
  This is a look at a company's revenue growth rate for the previous 3 years in the market/industry/category that forms the context for the given Frost Radar™.
- **GI3: GROWTH PIPELINE™**
  This is an evaluation of the strength and leverage of a company's growth pipeline™ system to continuously capture, analyze, and prioritize its universe of growth opportunities.
- **GI4: VISION AND STRATEGY**
  This is an assessment of how well a company's growth strategy is aligned with its vision. Are the investments that a company is making in new products and markets consistent with the stated vision?
- **GI5: SALES AND MARKETING**
  This is a measure of the effectiveness of a company's sales and marketing efforts in helping it drive demand and achieve its growth objectives.

# Frost Radar™: Benchmarking Future Growth Potential

## 2 Major Indices, 10 Analytical Ingredients, 1 Platform

**HORIZONTAL AXIS**

**Innovation Index (II)** is a measure of a company's ability to develop products/services/solutions (with a clear understanding of disruptive Mega Trends) that are globally applicable, are able to evolve and expand to serve multiple markets, and are aligned to customers' changing needs.

**INNOVATION INDEX ELEMENTS**

- **II1: INNOVATION SCALABILITY**
  This determines whether an organization's innovations are globally scalable and applicable in both developing and mature markets, and also in adjacent and non-adjacent industry verticals.
- **II2: RESEARCH AND DEVELOPMENT**
  This is a measure of the efficacy of a company's R&D strategy, as determined by the size of its R&D investment and how it feeds the innovation pipeline.
- **II3: PRODUCT PORTFOLIO**
  This is a measure of a company's product portfolio, focusing on the relative contribution of new products to its annual revenue.
- **II4: MEGA TRENDS LEVERAGE**
  This is an assessment of a company's proactive leverage of evolving, long-term opportunities and new business models, as the foundation of its innovation pipeline. An explanation of Mega Trends can be found here.
- **II5: CUSTOMER ALIGNMENT**
  This evaluates the applicability of a company's products/services/solutions to current and potential customers, as well as how its innovation strategy is influenced by evolving customer needs.

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