
Published 13 December 2021 - ID G00742256 - 16 min read
By Analyst(s): Nicole Foust, Lloyd Jones, Sruthi Nair, Lauren Wheatley
Initiatives: Energy and Utilities Technology Optimization and Modernization

As the energy transition accelerates, REMSs are emerging tools designed to support capabilities needed to scale and optimize renewable resources to deliver available, affordable, acceptable energy. Energy CIOs can use this guide for insights about technology supporting renewable energy operations.

Overview

Key Findings

- Renewable energy management systems (REMSs) are an emerging software that supports renewable energy (RE) owners/operators in scaling and optimizing large-scale renewable energy generation and operations across multiple asset types, sites/locations and use cases.

- RE companies are at an inflection point and face increasing challenges such as siloed systems and RE intermittency constraining their ability to achieve business and operational benefits.

- Legacy renewable energy support systems and tools have grown organically within generation companies. Sometimes they are provided by vendors focused on a narrow class of asset — making it difficult to support renewable generation at scale, across multiple asset types and multiple locations.

- Given the market immaturity, current REMS deployments are fragmented with vendor products offering varying degrees of functional coverage and often fragmented capabilities.

- REMS could unlock value across complex operational activities. However, this requires integration across many existing enterprise systems and operational data.
Recommendations

When managing technology optimization and modernization, energy CIOs driving transformation to increase RE operations must:

- Prepare for dynamic real-time event-driven business operations and maintenance by establishing expected business capabilities and required performance levels of RE assets. This will then improve operational decision and production coordination.

- Unlock new capabilities through IT/OT alignment and integration to support business operations of large-scale renewable energy by coherent funding of REMS functionality on the RE strategic roadmap.

- Evaluate build versus buy carefully, given the immaturity of the REMS software market. Assess vendor minimum viable product offers against evolving business requirements before going the self-build and operate route.

- Avoid overcommitting to a single REMS vendor by requiring all REMS solutions to be constructed with composable architectures.

- Optimize the value of a REMS by improving the digital footprint to gather, organize, integrate, store and analyze information across the enterprise; action insights; and interact dynamically with other enterprise tools. This may also aid asset automation capabilities.

Strategic Planning Assumptions

By 2030, 80% of new energy generation resources will be renewable, spurring a doubling of utility technology integration investment capital in three years.

By 2024, more than 40% of large oil and gas company R&D spending will focus on enabling global-scale operations of new green technologies.

By 2025, 40% of new monitoring and control systems in the utility sector will use the Internet of Things to enable intelligent operations.
Market Definition

Energy companies that own and/or operate large-scale renewable energy assets use REMS to orchestrate and optimize RE production and operations. To support this, REMS key functionalities include complex data collection, monitoring data in the context of physical models and business processes, managing and controlling asset operations, orchestration of RE, and optimizing performance. To achieve this, REMS uses a composite digital twin of the as-built asset/installation engineering procurement and construction platform for renewables (EPC-R) data to merge with operational and condition data and near-real-time environmental and weather data. This end result is a composable model that can dynamically reconfigure operational states across discrete assets, process controllers and business processes from unit to fleet level, across multiple geographies and markets.

Market Description

The International Energy Agency's (IEA's) Net Zero by 2050 scenario calls for the scaling up of solar and wind rapidly during this decade. Its goal is to reach annual new installation levels of 630 gigawatts (GW) of solar photovoltaics (PVs) and 390 GW of wind generation by 2030 — four times the record levels set in 2020. ¹

Renewable resources will dominate power producers’ asset portfolios, moving from 28% penetration in the 2020s and growing by 250% by 2050 to reach more than 80% penetration. ²

However, RE owners/operators find it difficult to realize these ambitious targets with current siloed IT-OT systems. To scale out renewable energy generation assets across a diverse energy ecosystem, organizations need composable technologies to handle the increase in real-time event signals. These are event-driven signals, such as asset conditions and wind speed and direction, that will drive business operations dynamically and increase orchestration complexity (see How Utility CIOs Can Use Intelligent Operations to Achieve Resilience During the Energy Transition).

Energy companies that own and/or operate large-scale renewable energy assets use REMS to manage and optimize renewable resources at scale across their asset base. They do this with the goal to maximize the production output and value of industrial-scale renewable assets that will dominate future energy production. Secondary benefits may also include improved asset management and reduced operation costs.
REMS is an emerging technology market that is itself on an evolutionary path — from fragmented siloed tools focused on a specific capability to a composable technology platform that supports remote RE operations. This is a typical evolutionary process seen in technology markets; however, the difference is the emphasis on composability, which is driven by market needs. This means that the vendors are intentionally building their products to be modular with individual APIs that can be easily integrated in third-party (or multiple-party) environments.

Figure 1 highlights core REMS functionalities.

**Figure 1: Core REMS Functionalities**

A minimum viable REMS product will cover two or more of the following five core capabilities:

- **Collect.** REMSs collect real-time sensor data (from IIoT), including insights from weather data tools, lidar, real weather measurement and forecasting, SCADA, and site data. This data needs to be validated, error-corrected, estimated and persisted. The time series data can be parsed for events such as anomalies, out of range and trends. When time series data is consumed by a digital twin, the capabilities can deepen beyond monitoring to include simulation, automation and control.
Most current REMS products will only provide a subset of the functionalities natively. It is critical to evaluate vendors on their ability to meet these core areas with native functionality or through established partnerships.

Organizations will need customization to fulfill all key functionalities. Currently, a minimum viable product consolidates only the collect, monitor, and manage and control functionalities (see Figure 2).

- **Monitor.** This capability makes it possible to more easily understand the time series data in the context of physical models and business processes so that the information is accessible to end users to make informed decisions faster. This includes a single view, dashboards, analytics, simulation, reporting and the agility to reconfigure assets as needed to support changing operational needs.

- **Manage and control.** Asset-centric REMS uses the collect and monitor capabilities to guide operators and/or to directly control renewable energy assets to improve asset availability by managing alerts and defects to curtail operations when needed and to schedule and coordinate remedial work. Operational-centric REMS will optimize individual asset performance against local conditions such wind speed and direction by controlling the yaw angle to improve the overall wind farm output. Business portfolio REMS reports real-time business performance through a business-created control paradigm or a process-control paradigm, such as automated closed-loop control, including customizable dashboards and tools for reporting.

- **Orchestrate.** REMSs enable the orchestration of renewable operations across traditional organizational silos, from asset and work management to operations and business performance, spanning business activities across enterprise systems through data and system integration. This includes the orchestration of the RE asset portfolio and orchestration of the work on RE assets. To achieve this, REMSs — which are typically supported by complementary tools — must include four core capabilities (asset management, intelligent operations management, power purchase agreement [PPA] management and market integration) with composability options. These can be native to the vendor, provided through API orchestration or hybrid approaches, or attached as packages of multicloud services.

- **Optimize.** Performance can be optimized either at the portfolio or asset level constrained by trade-offs across market, maintenance and production. This includes the ability to identify, measure, manage, optimize and report portfolio-level operations and performance.
## Figure 2: REMS Minimum Viable Product Functionality

### REMS Minimum Viable Product Functionality

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Native Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core REMS</strong></td>
<td></td>
</tr>
<tr>
<td>Collect</td>
<td>●</td>
</tr>
<tr>
<td>Monitor</td>
<td>●</td>
</tr>
<tr>
<td>Manage and Control</td>
<td>●</td>
</tr>
<tr>
<td>Orchestrate</td>
<td>●</td>
</tr>
<tr>
<td>Optimize</td>
<td>●</td>
</tr>
<tr>
<td><strong>Extensions: Functionality/Integration</strong></td>
<td></td>
</tr>
<tr>
<td>Asset Management</td>
<td>●</td>
</tr>
<tr>
<td>Work Management</td>
<td>●</td>
</tr>
<tr>
<td>Financial Data</td>
<td>○</td>
</tr>
<tr>
<td>SCADA</td>
<td>○</td>
</tr>
<tr>
<td>Market Data</td>
<td>○</td>
</tr>
<tr>
<td>Unit Sensor</td>
<td>○</td>
</tr>
<tr>
<td>Environmental Data</td>
<td>○</td>
</tr>
<tr>
<td>Weather Data</td>
<td>○</td>
</tr>
<tr>
<td>Operations Management</td>
<td>○</td>
</tr>
<tr>
<td>As Build</td>
<td>○</td>
</tr>
</tbody>
</table>

Source: Gartner

Additional technologies to extend product functionality include:

- Machine learning
- Artificial intelligence
- IoT
- Digital twin
- Automation

### Market Direction

As the energy transition accelerates, REMS will be an important tool to scale and optimize the mix of renewable sources in the grid and to enable available, affordable, acceptable energy.
Disruption at the grid edge and renewable energy assets are driving the need for grid modernization. Investments for electricity network resilience will be made via modeling simulation and directed operations rather than by building surplus generation capacity; therefore, modernizing energy data process capabilities in new IT-OT products with specific capabilities is essential. The IEA predicts large increases in investment in expansion and modernization of electricity networks with average annual investments increasing from $260 billion in recent years to around $800 billion in 2030, remaining at this level to 2050. ¹

Adopting a complete platform approach to data and digitalization is paramount to ensuring optimized solutions that work across the energy business units. Increasingly, energy organizations are evaluating the concept of data fabric to help enable this (see Data and Analytics Essentials: Data Fabric).

REMS tools can orchestrate renewable assets and business operations across the full asset and commodity life cycle (from its as-built/installation EPC to reconfigurable operations and business performance). With REMS, organizations can optimize asset maintenance activities, operations (and resource availability) and production (against the wholesale market) to achieve profitable renewable energy and to meet generation commitments and/or bids. Figure 3 highlights the role of REMS in the energy value chain.
Figure 3: REMS Role in the Energy Transition

Market Analysis

Proven generation technologies for a sustainable low carbon electricity system largely exist in the form of wind, hydro, solar and bioenergy. Renewable energy sources will become cheaper to deploy than coal and gas in most regions before 2030. The IEA Net Zero by 2050 scenario predicts that electricity consumption will more than double until 2050 and that 80% of global electricity generated in 2050 will come from renewable sources. These RE assets tend to be sited in areas where land and natural resources are abundant; however, they tend to be at the fringes of transmission grids and remote from demand centers. Due to the intermittent and variable nature of the sources, renewable energy sources stress the legacy energy management systems as they create volatility in the production side and complexity in managing demand-supply balance.
A major challenge of power system operation and control is deployment of appropriate analytical tools to integrate and holistically manage the new technologies, accounting for system restructuring while using existing resources optimally. For this, RE owners/operators will need a larger toolbox to enable asset management automation, including:

- **Big data and predictive analytics** that collate data from different sources (internal systems, IoT devices, external partners) and produce actionable insights in real time.

- **Cloud computing** that enables organizationwide connectivity and data exchanges.

- **Composable architecture** for modularity in delivery and enabling different business models.

- **Intelligent solutions** that enable asset and system operators to gather a variety of data on equipment performance (temperature, vibration, etc.) and dispatch them for further analysis.

- **System security** to address the increase in RE asset-embedded compute that extends the potential attack opportunities, requiring a cyber-physical security encapsulation so that the assets and portfolios are secure by design and enforced by a cybersecurity mesh.

In addition, to achieve improved benefits, REMSs require robust capabilities and data, which are supported by complementary and often third-party tools. Depending on your RE strategy and digital maturity, CIOs should evaluate opportunities for integration across four functional capability areas.

**Asset management.** REMS must include the following functional areas to support asset management capability:

- Inventory management
- Shutdown and outage management
- Tracking actual costs
- Asset management
- Work management
These functions are supported by the integration of tools such as enterprise asset management (EAM) and asset performance management (APM) applications, both of which integrate into discrete digital twins. The digital twins model an asset's performance and reliability by consuming time series and condition data from embedded sensors, and then they recommend (or even apply) near-real-time operation, control and dispatch decisions. These capabilities are used to optimize the operation of individual assets, as well as to manage work, inventory, shutdown/outage planning and actual costs.

**Intelligent operations management.** This capability is an extension to asset management, scaled across the organization's renewable operations. It must include both composite digital twin and site data. Composite digital twins are a portfolio(s) of individual/discrete asset twins combined. These are then layered with enterprise technologies and other resources such as site data to provide an operational view (see [How Utility CIOs Can Deliver Business Value With Digital Twins](#)). REMS seamlessly orchestrates renewable operations across traditional organizational silos, from asset and work management to operations and business performance. Minimum viable REMS are able to consume data such as environmental information (for example, site data, weather data and monitoring tools) and data from components (for example, silicon solar cells, solar panels and inverters). This makes it possible to visualize an asset within the composite digital and view its performance in near real time. REMS must include the following functionality to support operations management capabilities:

- Simulation and analytics
- Outage forecast
- Optimization across unit, site and portfolio performance
- Cost forecast
- Performance forecast
- Risk management
- Real-time financials

The above functionalities are supported by integration of complementary tools and extended to include a broad range of other data. This makes it possible to drive business performance and optimization across the assets or fleets of assets (see [How Utility CIOs Can Use Intelligent Operations to Achieve Resilience During the Energy Transition](#)).
PPA management. REMS must include the following functionality to support PPA management capabilities:

- PPA portfolio management
- Hedge analytics
- Forward price curve production
- Energy at risk
- Trading risk management

The above functionalities are supported by the interaction of tools such as energy trading and risk management (ETRM) applications and stand-alone PPA management tools. PPA management must include the commercial terms for the sale of electricity between the two parties through a contractual agreement. Terms include when the project will begin commercial operations, the schedule for delivery of electricity, payment terms and penalties for underdelivery, termination, and associated risks. Additionally, these systems also assist in providing understanding of the bankability and financial viability of renewable energy projects.

Market integration. This capability supports the management of bid positions based on operational costs and asset reliability, making it possible to understand the profitability of generating and consuming asset life — or waiting for market conditions to improve before bidding. REMS supports this via a bidirectional interaction with market and power purchase agreement management (PPAM) data to reconfigure the operation of the RE assets targeted at maximizing business benefits. REMS must include the following functionality to support market integration capability:

- Actuals visualization and reporting
- Market bids
- PPA offtakes

It is important to first review the existing ecosystem to understand if current systems or models could be better used. Where gaps are identified, invest in supporting scalable solutions to optimize value across the service lines. These should be future-proofed through deployment of interconnected, modularized systems. Early adoption will ensure the business is market leading at the forefront of the energy transition.
Representative Vendors

The vendors listed in this Market Guide do not imply an exhaustive list. This section is intended to provide more understanding of the market and its offerings.

Market Introduction

Table 1: Representative Vendors in Renewable Energy Management Systems
(Enlarged table in Appendix)

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product/Service/Solution Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>3megawatt</td>
<td>BluePoint</td>
</tr>
<tr>
<td>Bahwan CyberTek (BCT)</td>
<td>RETINA360</td>
</tr>
<tr>
<td>BaxEnergy</td>
<td>Energy Studio Pro</td>
</tr>
<tr>
<td>CGI</td>
<td>Renewable Management System (RMS)</td>
</tr>
<tr>
<td>Envision Digital</td>
<td>Smart Solar, Smart Wind, Green Hydrogen, EnOS Revolution, EnOS Advanced Analytics, EnOS Monitoring</td>
</tr>
<tr>
<td>GE</td>
<td>Operations Performance Management (OPM), Digital Wind Farm, Digital Hydro Plant, Digital Solar</td>
</tr>
<tr>
<td>Greenbyte</td>
<td>Wind Energy, Solar Energy</td>
</tr>
<tr>
<td>Greensolver</td>
<td>Asset Optimisation, Repowering</td>
</tr>
<tr>
<td>Mahindra Teqo (MachinePulse)</td>
<td>SolarPulse, WindPulse</td>
</tr>
<tr>
<td>PowerHub</td>
<td>PowerHub</td>
</tr>
<tr>
<td>QOS Energy</td>
<td>Qantum: Solar, Wind, Renewables</td>
</tr>
<tr>
<td>Schneider Electric</td>
<td>EcoStructure for Power Generation: Wind Power, Hydro Power, Solar Power</td>
</tr>
</tbody>
</table>

Source: Gartner (December 2021)

Market Recommendations

Energy companies must move toward an active electricity management system overall and, most poignantly, they need to manage renewable resources. To achieve this, energy CIOs must develop event-driven systems that provide access to appropriate analytical tools. They can accomplish this by reviewing future business needs, maximizing the value of existing systems and investing in new solutions that will deliver value across all business sectors. They must assess their data quality and, if there are deficiencies, invest in strengthening their existing renewables tool system to enforce data quality rules and/or initiate a data quality initiative with a focus on implementing an appropriate form of master data governance.

To best manage the REMS integration, CIOs should:
Plan REMS project deployments to include close integration to other systems from the outset (including ERP, EAM, SCADA, data historians, WDS, work management, GIS and more).

Evaluate vendors on their capability to offer standard APIs to leading asset management, operations management, PPAM and, in case of OT integration, also to IIoT platforms (or even an IoT platform-agnostic approach).

Ensure there is an interface importing third-party tool recommendations directly into the REMS system.

The REMS market is emerging, with vendor products still immature, varying functionality and capability limitations and few full in-production use cases. The immaturity means that there are increased risk considerations associated with products/vendors. Consider build versus buy carefully. Assess vendor minimum viable product offers against evolving business requirements before going the self-build and operate route. To meet business needs, evaluate products available in the market against the risks of in-house development, including assessing the required models, measures, sensors, data quality and artificial intelligence that can be applied across the RE asset life cycle. Avoid overcommitting to a single REMS vendor by requiring all REMS solutions to be constructed with composable architectures.

Confirm the alignment between the vendor’s REMS product roadmap and your own long-term renewable energy strategy (assuming you have one).

Not all REMS vendors have an expansive product strategy. Your long-term plan may include expanding the scope of the toolset to encompass different operations, sites, assets and different approaches to managing their performance. If this is the case, you’ll need to determine if your REMS vendors also have an APM offering, and assess their support of specific classes of assets. If this is lacking, then an APM specialist vendor may be more suitable.

Evidence

This research is based on vendor briefings and associated material Gartner received from 15 REMS vendors from June through November 2021. Gartner also surveyed secondary research sources for information on market trends and vendor activity.

1 Net Zero by 2050, IEA.
Note 1: Representative Vendor Selection
Gartner selected the 12 vendors named in this Market Guide to represent the breadth of offerings in this market, covering different aspects of the REMS impact on the energy and utility business. This representative sample also provides a good geographical spread of the vendors in this market.

Note 2: Gartner's Initial Market Coverage
This Market Guide provides Gartner's initial coverage of the market and focuses on the market definition, rationale for the market and market dynamics.

Recommended by the Authors
Some documents may not be available as part of your current Gartner subscription.

Research Roundup for Accelerated Renewable Energy Deployment
How Utility CIOs Can Use Intelligent Operations to Achieve Resilience During the Energy Transition
The Impacts of Exponential Renewable Generation Growth Across the Energy Ecosystem
Why Business Models Matter for CIOs
How Energy Executives Can Get Ahead of Environmental Risks With Strong Greenhouse Gas Commitments
Urgent Action Needed: Energy Markets Are Changing Faster Than Energy Companies
Digital-Outcome-Driven Metrics for Utilities
## Table 1: Representative Vendors in Renewable Energy Management Systems

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Product/Service/Solution Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>3megawatt</td>
<td>BluePoint</td>
</tr>
<tr>
<td>Bahwan CyberTek (BCT)</td>
<td>RETINA360</td>
</tr>
<tr>
<td>BaxEnergy</td>
<td>Energy Studio Pro</td>
</tr>
<tr>
<td>CGI</td>
<td>Renewable Management System (RMS)</td>
</tr>
<tr>
<td>Envision Digital</td>
<td>Smart Solar, Smart Wind, Green Hydrogen, EnOS Revolution, EnOS Advanced Analytics, EnOS Monitoring</td>
</tr>
<tr>
<td>GE</td>
<td>Operations Performance Management (OPM), Digital Wind Farm, Digital Hydro Plant, Digital Solar</td>
</tr>
<tr>
<td>Greenbyte</td>
<td>Wind Energy, Solar Energy</td>
</tr>
<tr>
<td>Greensolver</td>
<td>Asset Optimisation, Repowering</td>
</tr>
<tr>
<td>Mahindra Teqo (MachinePulse)</td>
<td>SolarPulse, WindPulse</td>
</tr>
<tr>
<td>PowerHub</td>
<td>PowerHub</td>
</tr>
<tr>
<td>QOS Energy</td>
<td>Qantum: Solar, Wind, Renewables</td>
</tr>
<tr>
<td>Schneider Electric</td>
<td>EcoStructure for Power Generation: Wind Power, Hydro Power, Solar Power</td>
</tr>
</tbody>
</table>

Source: Gartner (December 2021)