



Guidehouse
INSIGHTS

White Paper

Optimizing Solar and Storage Assets with Advanced Monitoring and Controls Technology

Using AI-Driven Solutions to Unlock Greater Value from C&I and Utility-Scale Projects

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Commissioned by Stem

Maria Chavez
Research Analyst

Michael Kelly
Senior Research Analyst

Section 1

Monitoring and Controls Technology

1.1 M&C Technology Defined

Surging demand for both increased electrical power output and reduced fossil fuel emissions has spurred rapid evolution of the energy grid, increasing investment in solar plus storage solutions. As the number and complexity of renewable projects around the world increases and demand for decarbonization of the economy grows, maintaining healthy, connected assets is essential for a stable grid and the long-term economic viability of these projects. In addition, to achieve grid parity, renewable assets must operate efficiently and be cost effective. Optimizing solar and storage assets at scale can be labor intensive and risky, leading to the recognition of an immediate need for advanced monitoring and controls (M&C) solutions.

Guidehouse Insights provides the following definition for a solar PV and storage M&C system:

A combination of hardware and software tools aimed at tracking and managing a solar PV and storage installation to optimize its performance and financial returns. The market is defined with two core segments: hardware and bundled software and services. Its scope focuses on the technologies that enable connected, actionable project optimization. Most offerings include a hardware cost and a bundled software and services solution.

1.2 The Evolving M&C Market

As the solar plus storage M&C market continues to mature, stakeholders are realizing the value of data and the insights that enable improved asset performance, discovery of opportunities for new value streams, and reduced risk. Technology innovation that includes the integration of AI and data analytics is resulting in more intelligent M&C solutions.

Through these developments, organizations are unlocking the power of data analytics and transforming the renewable energy sector across prosumers and consumers. Depending on the end user, different digital features and data points are of interest. Front of the meter (FTM), asset owners, generators, and operators utilize enhanced digital functionality across their assets to better optimize performance and efficiency and maximize value streams throughout asset lifecycles. Behind the meter (BTM) commercial and industrial (C&I) prosumers gain insights that enable benefits such as emissions reduction, electric vehicle (EV) charging capacity, program incentives, demand response participation, and improved bill savings. Organizations that aren't pursuing advanced M&C implementations face lost revenue due to inefficiency, less accurate insights about asset performance, lost opportunities to provide a high level of specificity to

customers. In the case of AI, they miss out on algorithms that continually improve results over time.

Section 2

Solar Plus Storage M&C Solutions Drivers

The call for renewable energy projects around the globe is apparent in private sector emissions reduction targets and through federal government and state plans and legislation. In addition, renewable projects are set to accelerate at increasing rates. In March 2021, the Biden administration released a spending plan citing the goal of decarbonizing the American economy and reducing the cost of solar by 60% in the coming decade,¹ and according to the Energy & Climate Intelligence Unit and the Carbon Neutrality Coalition, 137 countries have committed to carbon neutrality by 2050 or sooner.²

To meet these ambitious objectives and scale up installations, there is a growing need for an interactive grid able to support the addition of the decentralized renewable assets needed to support the energy transition. As a result, there is a growing need for increasingly advanced M&C solutions to support the development of both FTM and BTM solar plus storage projects and grid interconnection. Advanced M&C solutions can help create an interconnected network of smarter energy assets that are more reliable, resilient, predictable, and easier to control, which brings us closer to grid parity and achieving the goal of clean energy transition.

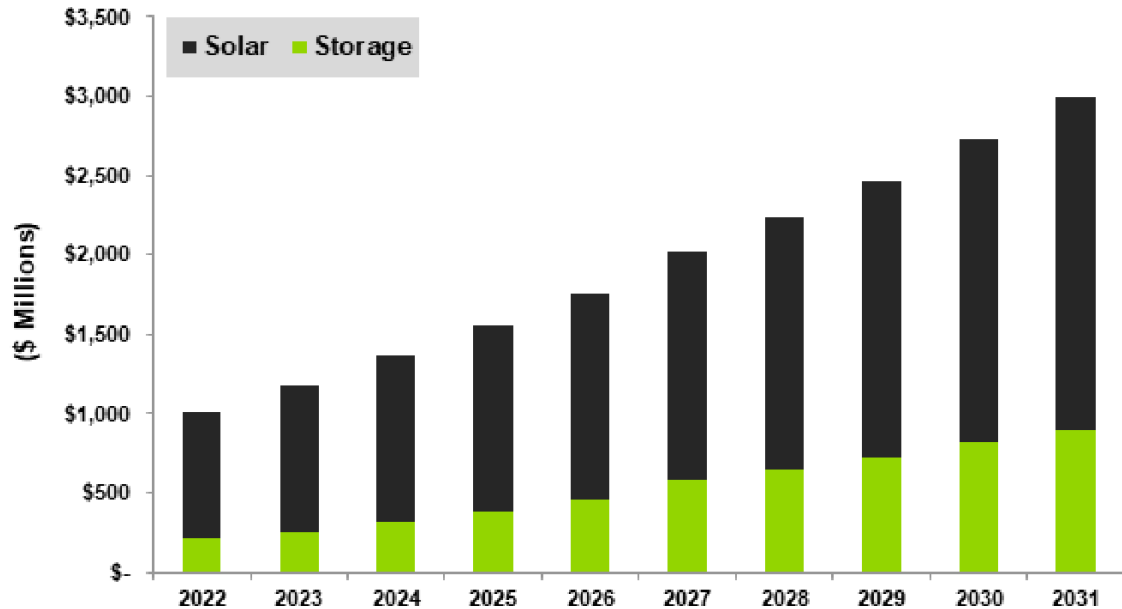
2.1 Surging Solar and Storage Deployments

Guidehouse Insights estimates that distributed storage capacity (annual additions) in the US will grow from ~1.5 GWh in 2022 to ~8.5 GWh in 2031. Meanwhile, annual additions for utility-scale storage in the US are estimated to reach around 15 GWh in 2031, compared to the estimated ~8 GWh of additions in 2022. As the number of deployments increase, so too does the need for more advanced asset management tools to avoid unplanned outages or grid instability; smart technology (e.g., Internet of Things-connected devices, AI-enabled/machine learning technology) means more data to analyze; companies that can create actionable insights from this data gain advantages.

¹ U.S. Department of Energy, "DOE Announces Goal to Cut Solar Costs by More than Half by 2030," March 2021, <https://www.energy.gov/articles/doe-announces-goal-cut-solar-costs-more-half-2030>.

² Energy & Climate Intelligence Unit, <https://eciu.net/about/who-we-are>.

Chart 1. M&C Market Revenue by Technology, World Markets: 2022-2031



(Source: Guidehouse Insights)

However, distributed energy resources (DER) portfolios often grow piecemeal, with disparate M&C technologies spread across assets and fragmented solar and storage hardware and software through portfolios. A lack of standardization can hinder access to insights, which has led to an immediate need for advanced solutions that enable interoperability (e.g., between asset and M&C solution, solar and storage assets) and scalability.

2.2 Constant Cost Reduction

The pressure to reduce costs while optimizing performance is ever present. This is where advanced M&C technology with built-in analytics that can optimize performance and actually create opportunities for new value streams can thrive. These programmable and tailored solutions:

- Lower costs
- Increase performance
- Help humans do their jobs better
- Avoid mistakes
- Catch failures before they cause outages
- Gain efficiencies by monitoring a fleet or a portfolio at scale with fewer resources
- Save operations and maintenance (O&M) costs by using fewer resources to resolve problems and roll trucks for repairs less frequently

2.3 Grid Reliability and Security

Surging occurrences and severity of natural disasters, increased cyber security threats, an aging 50-100-year-old infrastructure, the shift toward decentralization, and the ever-changing policy and regulation around critical infrastructure (i.e., requiring companies to achieve and maintain compliance) have increased the need for solutions that improve grid reliability and security. Monitoring can enhance grid reliability by ensuring connected assets are operating as expected and monitor for security anomalies. Advanced M&C solutions can make sure all connected devices have the latest threat detection and remediation updates to reduce risk. In addition, by providing real-time responsiveness and flexibility, advanced M&C solutions address a myriad of threats and help to improve grid stability.

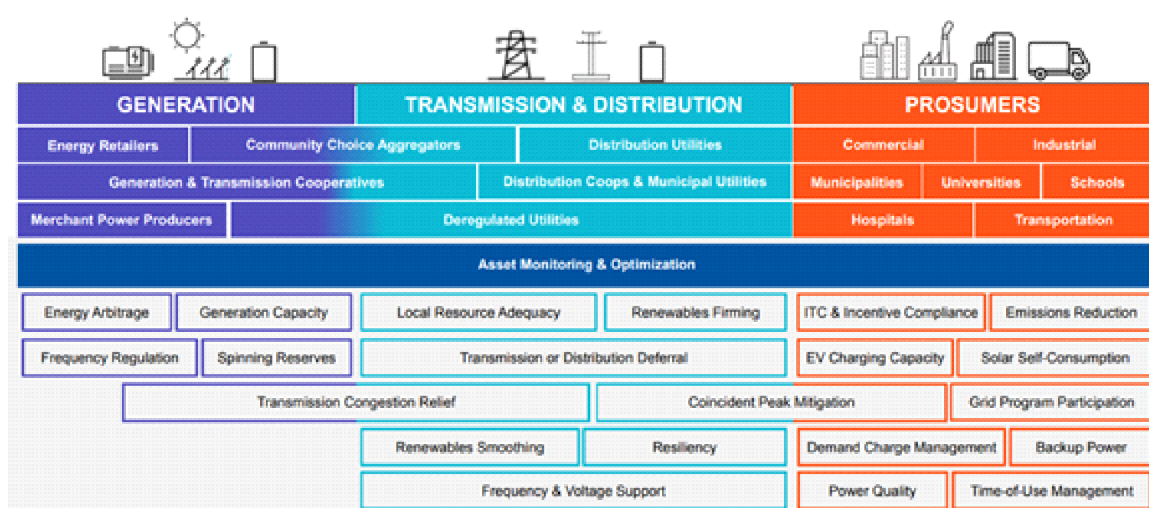
2.4 Innovation and Technology across Fragmented Hardware Suppliers

As more projects have been built and more solar plus storage assets are online, there is a proliferation of disparate systems and hardware suppliers with no standardization of data, making it difficult to make decisions in real-time or innovate for the future. Programmatic collection and standardization of data is increasingly necessary to optimize DER and solar and storage asset performance. And rapid innovation continues to demand dynamic solutions that can draw data-driven insights for any solar plus storage systems and from any suppliers.

2.5 More Value Streams and Monitoring and Reporting Requirements

As solar and storage become more prolific and mature, new value streams are being created in both BTM and FTM projects. That means that over the lifetime of individual projects, new monetization or savings opportunities are likely to present themselves. There is a growing need for M&C solutions that scale across project types and enable opportunities for additional value streams over time. Figure 1 shows examples of value streams for different stages of the clean energy value chain. This can range from energy arbitrage, resiliency, grid participation, and forms of value stacking. Whether the project is looking to achieve more energy bill savings or capture revenue from market or program participation, M&C solutions can improve asset performance for higher economic value.

Figure 1 Value Stream Opportunities Unlocked Across Customer Types



(Source: Stem)

Section 3

Solar Plus Storage M&C Solutions Barriers

Although the solar plus storage M&C market is growing rapidly, there are barriers that need to be overcome. A considerable challenge is the expense of implementation versus the perceived benefits. If stakeholders cannot identify potential inefficiencies, it becomes more difficult to make the case for investment in M&C. As stakeholders begin to recognize the compelling business case for advanced M&C solutions, this barrier should weaken. This section explores additional market barriers.

3.1 **Fragmented Development and Installation**

As new sites are developed and constructed, developers, engineering procurement and construction (EPC) firms, and asset owners all may have different goals and preferences for monitoring and control solutions. For managers and owners of larger portfolios, that could mean that many hardware and software solutions exist across their portfolio, making it more difficult for systems and solutions to be compatible.

3.2 **Lack of Data Sharing**

Energy storage hardware OEMs are often reluctant to share all available data with third party M&C providers that could help fine tune asset performance, perhaps as a result of privacy or intellectual property concerns. This lack of data sharing reinforces silos and fragmentation and has serious ramifications for stifling the growth of the industry. Although OEMs often would like to stay in control of monitoring systems, asset operators and owners would prefer to access and control data across their portfolio. This dynamic prevents a unified view into assets, curtailing opportunities for portfolio optimization and additional revenue.

3.3 **Prevalence of Legacy Systems and Approaches**

As asset operators and owners build portfolios, they inherit different and disparate M&C systems that are not changeable after projects' commercial operation dates (e.g., SCADA systems and proprietary black-box models don't integrate well when companies or new assets are acquired and integrated into portfolios).³ Thus, many portfolios have operational as well as data analytics silos made up of non-interoperable but expensive legacy operational technology systems.

³ Ravi Das, "The Cybersecurity Threats Posed To SCADA Systems," 2021, <https://www.logically.com/blog/cybersecurity-threats-posed-scada-systems>.

Section 4

The Next Step for Solar Plus Storage M&C Technologies

The traditional approach to managing solar and storage assets is siloed due to data disparities and hardware and software fragmentation that resulted from these markets evolving separately. Users must leverage multiple point solutions to manage disparate portfolios. Ultimately, this creates complexity and risk, leading to asset underperformance. It also leads to missed opportunities for new value creation without a common view across the asset portfolio. To address these challenges, market leaders are developing new asset management platforms that apply a range of features, from interoperability to AI, to optimize solar and storage asset management.

The goal of these new developments is to overcome inefficiencies in how asset management and M&C technology are implemented and used today. There is a need to broaden the scope from project-level tools to portfolio-level solutions. Interoperable applications enable stakeholders to unlock value from existing assets,⁴ opening additional revenue and value streams over time. Advanced M&C also aids in addressing the risk, compliance, and security needs presented by both ever-changing regulatory requirements (particularly for assets above 75 MW) and climate change impacts such as natural disasters.

Assets of this size critically impact grid stability and therefore require real-time, dynamically evolving sophisticated edge controls and intelligence. As a result, the market is innovating to apply AI to solar plus storage implementations.

4.1 Advanced Technology Proven Benefits

From 2022-2031, revenue for the solar and storage M&C global market is expected to grow from \$1.0 billion to around \$2.9 billion, reflecting the growing adoption of M&C solutions for renewable asset portfolios. Asset management companies and asset operators are adopting advanced M&C tools, whether in-house or through third-party providers, as core operations solutions that enable competitive positioning and reduced costs. As organizations realize the link between operational KPIs with M&C, the market perception is shifting from the view of M&C solutions as a cost, to recognition of advanced M&C platform providers as partners in improving overall system efficiency, reliability, and economic value.

Advanced M&C technologies implemented across C&I solar plus storage portfolios optimize platforms by connecting portfolio data, enabling intelligent analytics and creating a more flexible, autonomous, resilient asset. Benefits span user types, from power generation through transmission and distribution to prosumers.

⁴ Emiliano Bellini, "NREL Develops Interoperable SCADA Protocols for PV Inverters," 2021, <https://pv-magazine-usa.com/2021/07/23/nrel-develops-interoperable-scada-protocols-for-pv-inverters/>.

Stakeholders gain efficiencies, reduced costs, increased visibility into their entire portfolio, and grid stability. M&C capabilities can also help to optimize assets for scalability.

Sophisticated edge controls, especially AI-driven solutions, enable dynamic interaction and ongoing communication between project sites and the AI-enabled platform. With the ability to aggregate, organize, and optimize real-time data, advanced solar plus storage M&C platforms result in real-time actionable insights that help bridge supply and demand in a more interactive way to transition to the grid of the future.

4.2 Vendor Approaches to Advanced Solar and Storage M&C Technology

The solar and storage M&C market has a growing list of competitive industry players that lead the energy industry in M&C and asset management capabilities, including Stem (with AlsoEnergy), Trimark, and Huawei Technologies. These market-leading vendors are helping customers realize unique value from their portfolios.

For example, Stem has worked with Altus Power, which serves commercial, public sector, and community solar customers with locally sited solar, energy storage, and EV charging stations across the US. With Stem's AI-software, Athena[®], optimizing its solar and storage systems, Altus Power's projects are able to contribute solar energy when it's generated and during evening demand peaks and provide multiple wholesale market services. Stem delivers sophisticated grid-support functionality with remote supervisory communications. High-speed voltage, curtailment, and ramp-rate control support site acceptance by utilities and clear the way for end customers to generate more kilowatt hours per year to the grid.

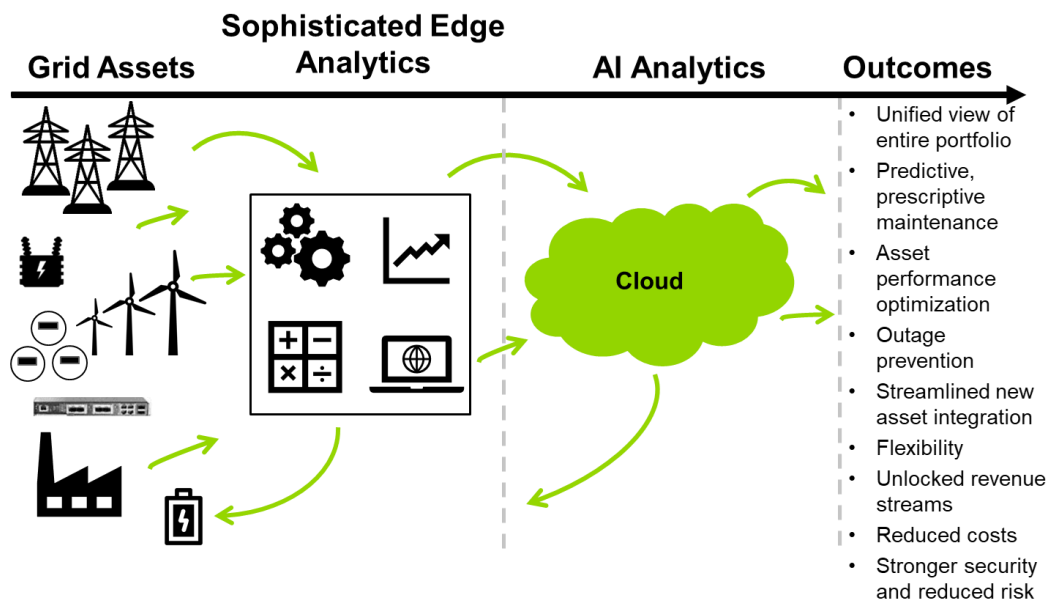
Section 5

Key Takeaways

The solar and storage M&C systems market revenue growth is fueled by new capacity additions as well as maturing capacities across established markets. Businesses, utilities, and developers are benefitting from the addition of storage to solar projects, which are constantly evolving to include, for example, new renewables, fuel cells, and EV charging stations.

Advanced M&C solutions that provide scalability, interoperability, and a unified view are required to realize the full potential of technology investments. Developments such as sophisticated grid-edge controls and AI enable predictive modeling and advanced forecasting. This functionality not only improves asset management, but also facilitates asset performance optimization, peak load mitigation, reduced curtailment, and value stream additions, all while reducing costs through portfolio performance improvements.

Figure 2. Transformative Approach to Advanced M&C Solutions



(Source: Guidehouse Insights)

A transformative approach is needed for the solar and storage M&C solutions market to continue to mature. Commercial and utility-scale solar and storage projects and their associated operations will scale quickly in many parts of the world, requiring portfolio owners and managers to integrate flexible and adaptable O&M solutions that are dependable, yet customizable enough to meet evolving

needs. Advanced solar and storage M&C technology not only addresses this need, but also provides actionable insights, easy integration of new assets, improved grid reliability and security, and reduced risk.

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Section 7

Scope of Study

This white paper was written by Guidehouse Insights and commissioned by Stem to help define the opportunity that greater solar and storage data sharing enables. It explores how the monitoring and controls technology market is evolving to meet the need for advanced solutions to optimize solar and storage assets both BTM and FTM. The paper outlines how industry stakeholders should be thinking about their solar and storage project portfolios and the ways advanced M&C technologies can improve performance, create new value stream opportunities over time, and reduce asset risk. The white paper also provides key takeaways for market participants.

Sources and Methodology

Guidehouse Insights' industry analysts use a variety of research sources in preparing Research Reports. The key component of Guidehouse Insights' analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Guidehouse Insights' analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Guidehouse Insights' reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

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