THE FUTURE OF PRECISION FASTENING FOR THE SOLAR INDUSTRY

The solar industry has experienced exponential growth in recent years, with an average annual growth rate of 24% in the last 10 years alone (SEIA, 2023). Government incentives at federal, state and local levels paired with an increase in product efficiencies and a continued reduction in supply cost have rapidly driven demand for clean energy across the United States. The Inflation Reduction Act (IRA) passed in 2022 solidified this growth, with solar deployment expected to nearly triple by 2028 compared to pre-IRA projections (SEIA, 2023). With the continued implementation of ambitious clean energy goals, more work is required to meet the pace of these timelines, placing a spotlight on the solar industry.

The utility-scale segment (>20 MW, 100 acres) is predicted to see the largest incremental growth of installed capacity in the United States, reporting its best first quarter ever in 2023 with 66% year-over-year growth (SEIA, 2023). Served by large construction companies that purchase large quantities of tools and support equipment, this segment's growth requires complementary expansion in EPC (Engineering, Procurement and Construction) capacity. For industries serving these EPCs, important opportunities are consequently created, requiring significant growth in solar farm construction to meet this growing demand and innovative equipment to support this acceleration.

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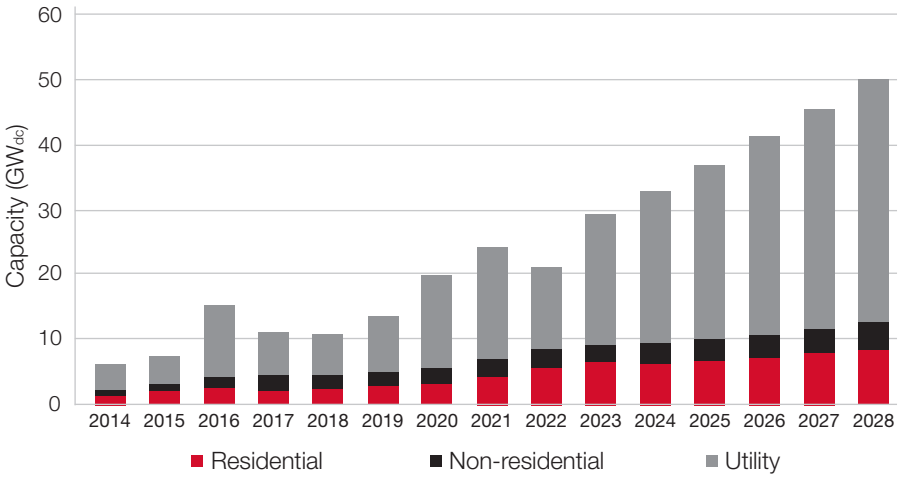
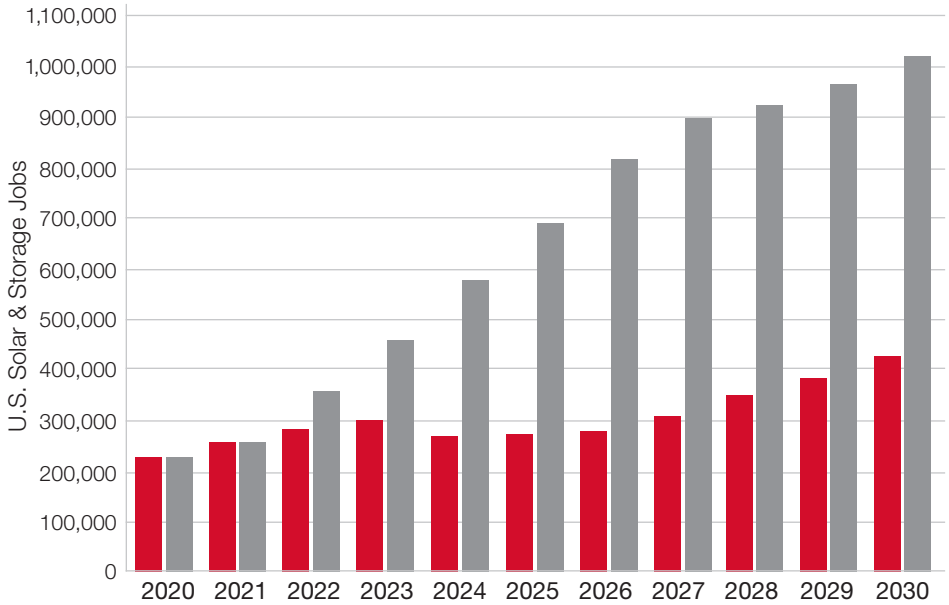
US PV installation Historical Data and Forecast, 2014 - 2028



Source: SEIA/Wood Mackenzie Power & Renewables U.S. Solar Market Insight Q2 2023

Labor Shortages

With increases in demand, the task of arming companies with prepared and technically trained employees becomes even greater, placing further pressure on an already limited workforce. In the midst of this labor shortage, set against the backdrop of historic industry growth, utility-scale solar installers are experiencing a widening gap between their desire to invest in growth and sourcing the work to support it. In its analysis of job growth projections for the solar and storage sectors, SEIA revealed the significant need for unprecedented job growth to achieve the outlined trajectory for solar advancement in the near future. To address this acceleration while adhering to current labor limitations, enhancing productivity through waste reduction across the jobsite without compromising quality output is crucial. The most significant opportunity for solar EPCs to boost operational efficiency lies in removing the second person from the 2-step method and eliminating associated rework. Through the integration of advanced tools and equipment across a solar site, the possibility of this operational enhancement becomes a reality.



Source: SEIA 30 by 30 Issue Brief

Torque on the Jobsite Today

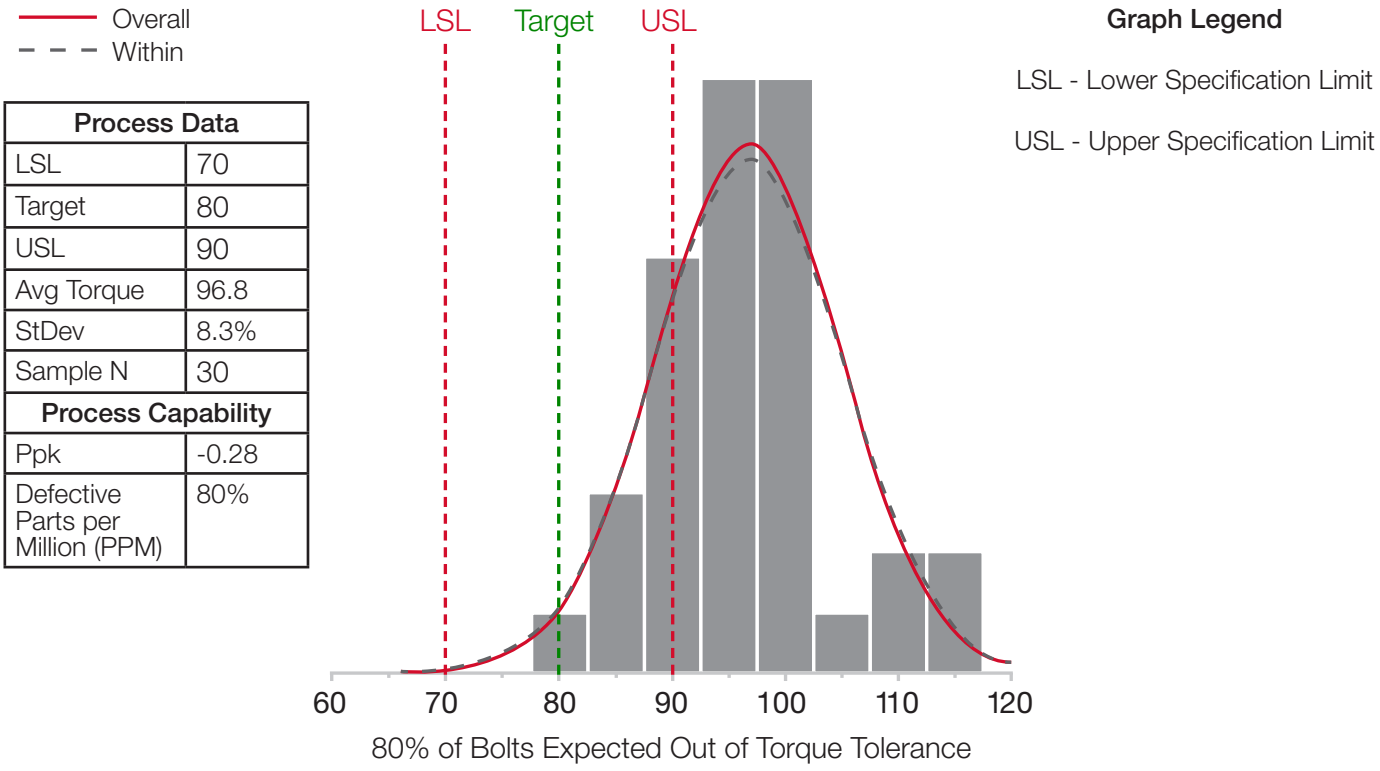
Original Equipment Manufacturers (OEM) of solar tracking companies (I.E. - Array Technologies, Gamechange Solar) have published torque specs that EPCs are required to adhere to and provide proof of proper installation. Today, most companies rely on the “2-Step Method” to achieve this mandate by first fastening the bolt down with an impact wrench, followed by the second step of manually torquing the bolt with a click-style torque wrench.

The clear disadvantage to this process is wasted labor hours spent touching every bolt on the jobsite twice. However, the process is also extremely dependent on operator technique which, when improperly done, can lead to poor torque repeatability and significant over-torquing. These broad distributions of torque output directly impact a jobsite’s quality, and with current limitations in auditing methods, hidden risks can emerge across a solar site.

Potential Rework

Commonly, the methods used for Quality Assurance audits only gauge the minimum torque achieved, failing to offer a comprehensive view of the actual torque applied. This restricted insight leads to hidden risks across the worksite, as instances of over-torqued bolts remain undetected, thereby posing potential hazards. Additionally, the inherent fault in secondary quality checks and the difficulty in streamlining processes of rework introduce elements of human error that further these risks. To better understand this problem and collect unbiased data, Milwaukee Tool worked with a third-party Industry Expert, Eclipse-M, to visit utility-scale solar jobsites across the country to conduct torque audits. The data collected revealed trends of positive mean shift above OEM specifications, with some jobsites having over 80% of the bolts on site predicted to be out of spec, and a very wide distribution of torque values. Most notable, however, was that the bolts had already passed quality checks by the EPC, OEM and developer.

Process Capability Report - 2-Step Process



Process Data	
LSL	70
Target	80
USL	90
Avg Torque	96.8
StDev	8.3%
Sample N	30
Process Capability	
Ppk	-0.28
Defective Parts per Million (PPM)	80%

Graph Legend

LSL - Lower Specification Limit

USL - Upper Specification Limit

SOURCE: Anonymous EPC and jobsite location audited by Eclipse-M

Available Torque Solutions

While many solutions on the market today seek to address some of these issues, common frustrations emerge among EPCs with the results of these alternatives:

1. Precision tooling used in assembly environments is available to utility-scale solar racking; however, the cost, speed of application, weight and inability to survive jobsite conditions or installation duty cycle render them suboptimal.
2. Some EPCs have seen and tried to adopt programmable cordless impact wrenches on the market today, but these blow-counting torque control algorithms are limited and struggle to account for common variations seen on the jobsite (such as bolt-bolt variation, part variation, improper alignment of parts, dust, water, temperature, etc.)

When speaking with leading EPCs in the industry, Milwaukee Tool received very clear feedback that there was a hunger for smarter, more precise fastening power tools that can handle the extreme use that is required of this industry while eliminating steps and minimizing risk.

Reflecting on this demand, Nick Hunt, General Superintendent at Moss Solar, emphasized, “Aggressive escalation in the demand for clean energy across the United States is requiring solar companies to amplify our scale of projects, often doubling or even tripling them within short periods of time.” Hunt continued, “To meet these ramp-ups, we are in need of cutting-edge technology and innovative solutions that can enhance our operational efficiency and streamline training procedures.”

With a clear opportunity for innovation, Milwaukee Tool’s leadership in lithium-ion power tool technology provided the ability to challenge current solutions in the industry, bringing a new-to-world solution to market that is developed uniquely to solve this complex jobsite challenge.

Introducing the M18 FUEL™ Controlled Torque Impact Wrench with TORQUE-SENSE™

Developed and tested for the solar industry, The M18 FUEL™ Controlled Torque Impact Wrench with TORQUE-SENSE™ are the industry’s most repeatable impact wrenches. TORQUE-SENSE™ torque control overcomes common variances seen on the jobsite, maintaining target torque better than competitive products that use blow counting algorithms. This performance is enabled by new to world sensors designed in house by Milwaukee Tool, that feed sophisticated machine learning algorithms. Every trigger pull is recorded, and data can be downloaded via the ONE-KEY™ application for customizable reporting to ensure confident installation. This product is ideal for utility-scale solar projects where eliminating the 2-step method on the jobsite can deliver up to 3X faster installation speed. Milwaukee offers best in-class performance and application speed with FUEL™ technology, enabled by POWERSTATE™ brushless motors, REDLINK PLUS™ tool intelligence, and REDLITHIUM™ battery technology. Operating torque range for the Compact version is 50 –150 ft-lbs. and 50 – 250 ft-lbs. for the Mid-Torque option.

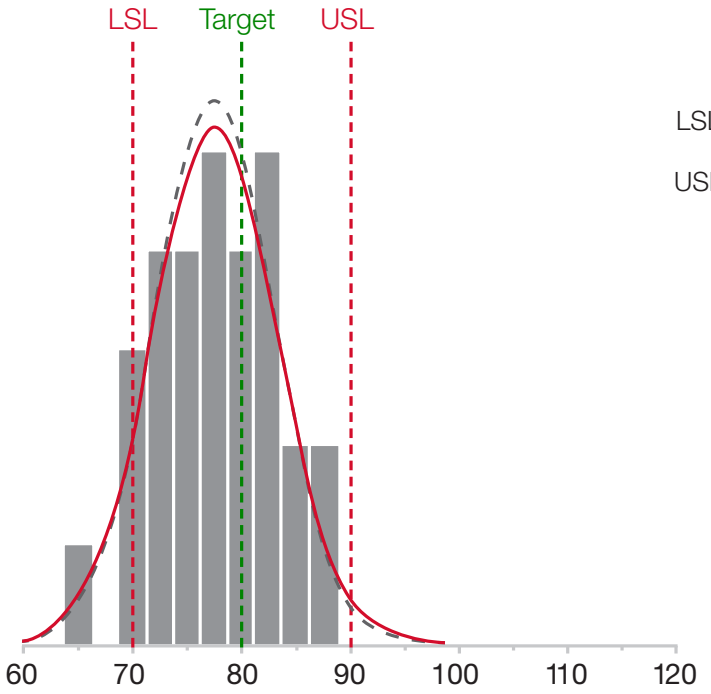
Jobsite Performance

While conducting research on jobsites across the country, Eclipse-M audited the same applications utilizing the new M18 FUEL™ Controlled Torque Impact Wrenches with TORQUE-SENSE™. Results revealed significant improvement in torque repeatability and tightly centered around the target torque value. With this data, Eclipse-M validated that TORQUE-SENSE™ can significantly outperform the current process on the jobsite today in one step, introducing the opportunity to complete racking installation 3X faster.

Process Capability Report - Milwaukee Tool

Overall
Within

Process Data	
LSL	70
Target	80
USL	90
Avg Torque	77.5
StDev	7.4%
Sample N	30
Process Capability	
Ppk	0.44
Defective Parts per Million (PPM)	10.9%



10.9% of Bolts Expected Out of Torque Tolerance

Graph Legend

LSL - Lower Specification Limit

USL - Upper Specification Limit

SOURCE: Anonymous EPC and jobsite location audited by Eclipse-M

Cost Savings

"Growth in the solar market ultimately will be limited by available labor," explains Eclipse-M, "The use of tools that are self-controlling, that get the process right the first time, is an essential way to reduce effort on the jobsite by eliminating multi-step processes and rework. MILWAUKEE's new technology is a very important step in this direction." The advancement introduced by the M18 FUEL™ Controlled Torque Impact Wrenches with TORQUE-SENSE™ technology improves quality and productivity, inevitably leading to significant cost savings for solar companies. This impact on cost savings per megawatt increases as headcount and labor hours per project are reduced, a direct result of the enhanced efficiency brought to the jobsite.

	TRACKER SYSTEM 1	TRACKER SYSTEM 2	TRACKER SYSTEM 3
Project Size (MW)	100	100	100
Mechanical Build Hours*	61,125	65,250	97,500
Torquing Hours	10,542	11,346	13,432
Labor $/Hr (loaded)	40	40	40
Mechanical Build Cost*	$2,445,000	$2,610,000	$3,900,000
Avoided Torquing Cost 100 MW	$421,668	$453,843	$537,263
Avoided Torquing Cost 1 MW	$4,217	$4,538	$5,373
Typical Headcount	40	40	60
Headcount Reallocated	7	7	8

*with utilization, weather, and other typical delays

In Summary

Solar energy is thriving within an energy industry that is simultaneously undergoing an explosive surge of growth and contending with a challenging job market, creating a highly competitive environment. In order to see continued success and profit, EPCs must strategically deploy their available workforce, equipping them with industry-leading technology to drive efficiency in the solar installation process and streamline methods to ensure confidence in output quality. Through the groundbreaking innovation of the new M18 FUEL™ Controlled Torque Impact Wrenches with TORQUE-SENSE™ technology, Milwaukee Tool is leading these efforts and redefining the industry's understanding of capability and performance. This revolutionary solution delivers unmatched improvements in productivity, efficiency, and cost-effectiveness across the solar jobsite. Through extensive research and third-party evidence from the field, Milwaukee Tool recommends that utility-scale solar installers adopt the new M18 FUEL™ Controlled Torque Impact Wrenches to not only enhance productivity and precision but also effectively mitigate risk. With the introduction of the M18 FUEL™ Controlled Torque Impact Wrenches, Milwaukee Tool is propelling fastening into the future, uniquely tailored for the solar industry.

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