

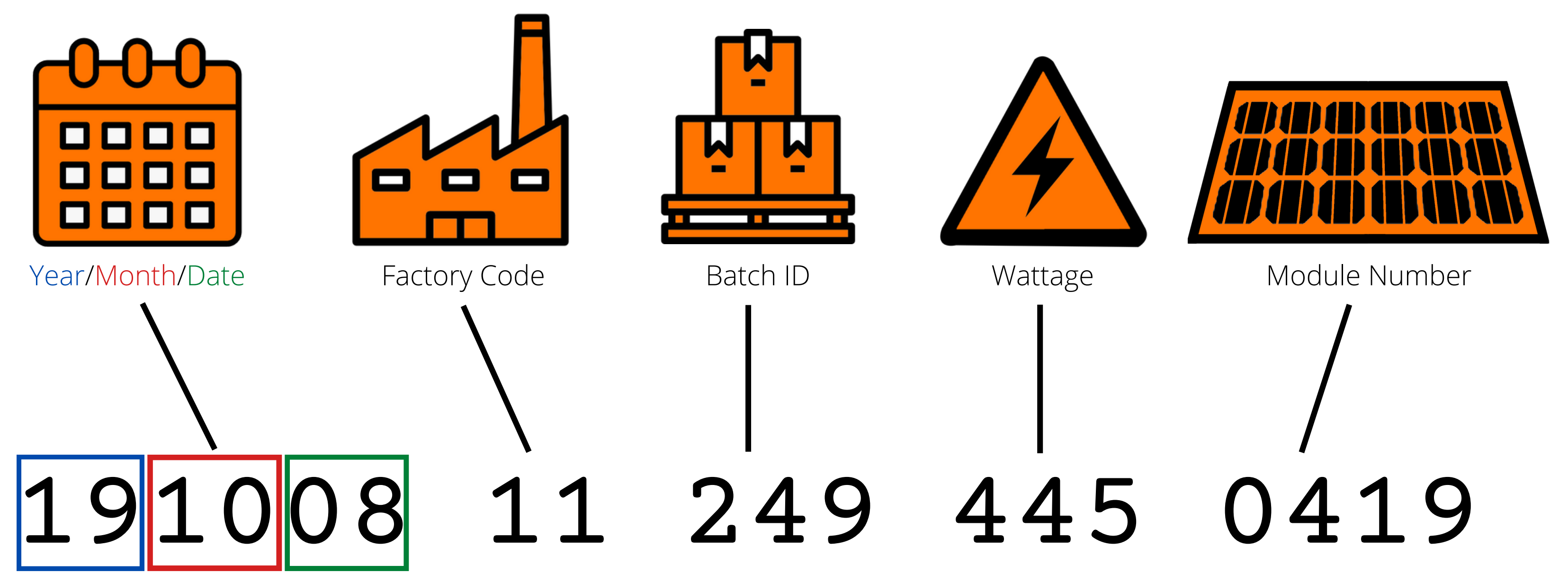
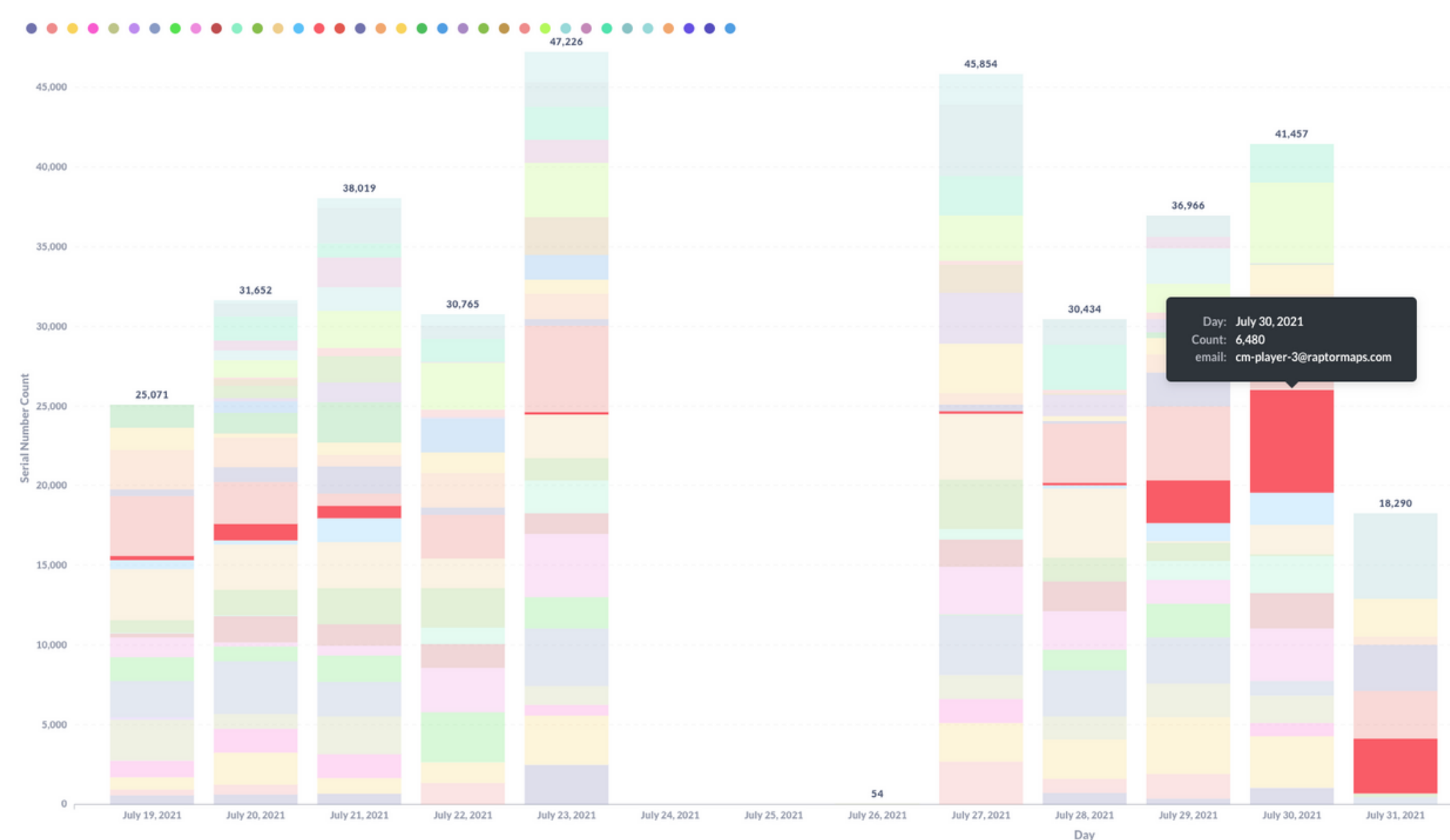


SERIAL NUMBER SCANNING IMPROVES SPEED AND ACCURACY OF COMMISSIONING VALIDATION

Introduction

Solar assets are larger and more complex than ever, with more counterparties having direct involvement in all stages of the solar lifecycle. Stakeholders still heavily rely on manual processes when it comes to managing and monitoring solar assets across the lifecycle. This case study examines utilizing serial number scanning software in place of manual commissioning and validation processes.

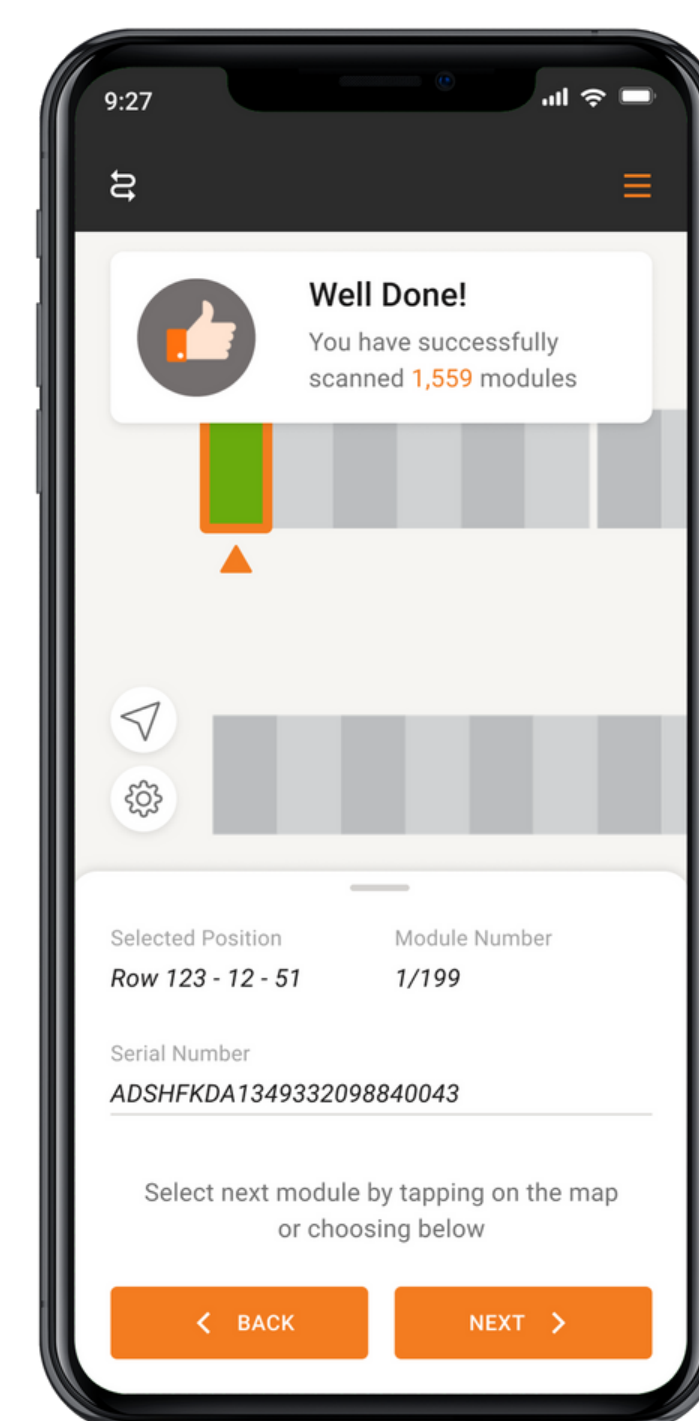
The EPC in this study was able to validate module installations at least 5 times faster than traditional methods with a mobile application for serial number scanning. The mobile application which was developed by Raptor Maps, automatically cross-references serial numbers with module original equipment manufacturers (OEM) enterprise resource planning (ERP) data provided to asset owners. It provides an accurate geospatial location of each serial number overlaid on the as-built drawing in a queryable data structure. During commissioning, engineering, procurement, and construction companies (EPCs) are incentivized to provide accurate and timely data to asset owners. This case study examines how utilizing serial number scanning software in place of manual commissioning and validation processes improves speed and accuracy.



Methods

Raptor Maps has partnered with Rosendin Electric, the largest employee-owned electrical contracting company in the US. Rosendin utilized Raptor Maps mobile software for this case study and completed serial number scanning for a 300MWdc+ site with 1 million modules scanned and documented. Rosendin implemented up to 27 simultaneous first-time users on site allowing for the instantaneous generation of both individual user reports as well as daily progress reports. The mobile software incorporates time-stamped data logs which allowed Rosendin to continuously monitor site scanning progress, deliver progress reports, and compare to traditional validation methods.

Traditional validation methods require a reliance on manual processes. These often involve recording serial numbers in a spreadsheet, formatting and building the spreadsheet to reflect rows of the solar asset, and manually verifying that all serial numbers accurately match the layout of the site as well as match ERP documentation provided by the module manufacturer. EPCs report a large amount of rework stemming from the lack of instant verification in these traditional validation methods.



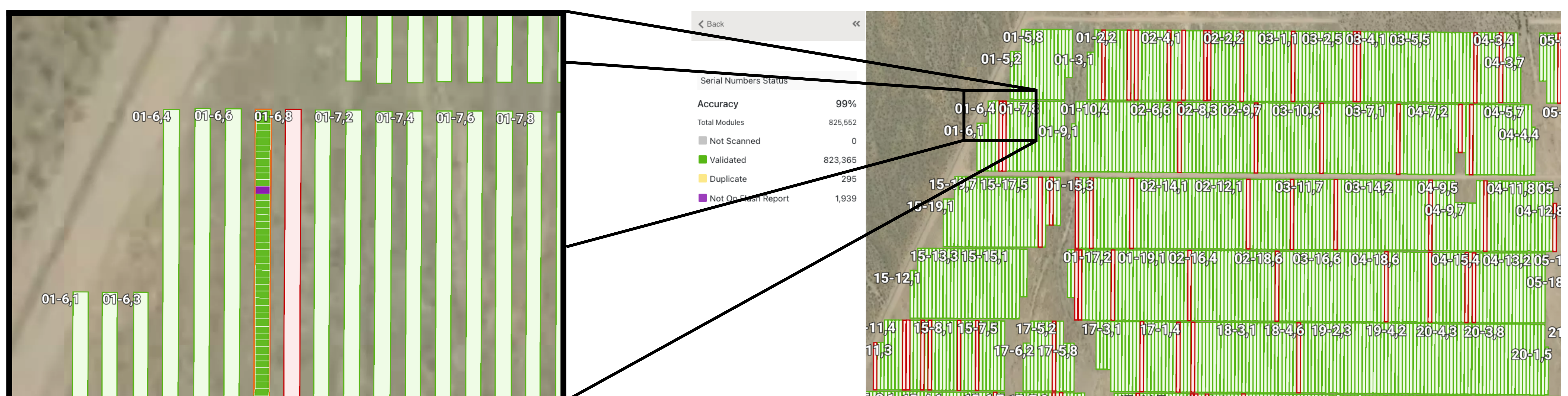
Next Steps/Future Work

- Outside of commissioning, mobile validation tools are valuable for other stages in the solar lifecycle such as routine operation and maintenance (O&M) of an asset. The ability to have an interactive, dynamic database for modules and balance of system components allows for seamless tracking of all changes or swaps that occur. The ability to leverage this database also enables O&M counter-parties to correlate serial numbers with lists from OEMs to verify supply chains and easily monitor and facilitate warranty claims
- To facilitate the usability of the digital twin the focus of in-field module verification with Raptor Maps is also to provide module OEMs with visibility into field performance of modules and streamline the RMA process for warranty claim validation
- The EIA projects 19 GW of new solar installations in the US in 2023, if all EPCs utilized Raptor Maps' mobile software in 2023 for commissioning validation and reporting, a total of 114,400 EPC and asset owner labor hours could be saved
- Ultimately this work can be incorporated into a larger framework to help mitigate risk across the lifetime of the asset

Findings/Conclusion

Users achieved scanning speeds of less than **2 seconds per module** using Raptor Maps software. Interviews with project managers at utility-scale sites reveal that similar work requires 10-20 seconds per module. The digital twin was populated in real-time on users' smartphones and synced whenever a data connection was established. The modules for this utility-scale site were supplied by a Bloomberg NEF (BNEF) Tier 1 manufacturer, and data was validated against supplied documentation exported from the ERP system in compliance with the module sales contract. In this case study, the findings show that in the hands of first-time users, the software was able to instantaneously scan and verify that the serial number matches that provided by the module manufacturer and that the module installed in that location matches that of the digital twin which is designed from construction as-built drawings.

Raptor Maps' software allows customers to leverage serial number records to verify supply chains for tax incentive eligibility, streamline warranty claims, as well as store an accurate living log of all changes made to modules on site. There is an increasing necessity to have a living record of module equipment and balance of system components given the uncertainty in the current supply chain and its surrounding issues, including the Antidumping and Countervailing Duties (AD/CVD) Petition. These issues have led to asset owners becoming increasingly guarded of holding risks associated with growing costs. It was found that by using the serial number scanning mobile application, EPCs were able to validate module installations at a maximum rate of about **1.4 hours per MWdc per one user*** This is compared to an estimate of 7.5 hours per MWdc, leading to about a 5X time decrease when using the Raptor Maps software.



*Scanning time assumes 400W module.