
Balancing the ROI Equation

How Balance of System Can Contribute
to PV Installation Profitability



A Constant Balancing Act

Over the past decade, developers have learned how to successfully balance the gains of increased efficiency with the costs of increasing complexity. According to the International Renewable Energy Agency (IRENA) the levelized cost of utility-scale solar energy dropped 85% between 2010 and 2020. 61% of that drop was due to cost reductions in PV modules and inverters. Between 2016 and 2020, balance of system (BOS) as a percentage of installation costs rose from about 50% to 65%.¹

Then COVID-19 changed the landscape entirely. The renewable energy industry is facing pricing, labor, and supply chain challenges that threaten to unbalance the cost and ROI of solar projects for years to come.

The cost of raw materials such as silver, copper, aluminum, and glass have been climbing since early 2020; more recently, the price of industrial silicon surged 300%. Meanwhile, pandemic-era shipping delays and bottlenecks have resulted in a near 500% increase in prices.²

One study has estimated that these price surges could result in the postponement or cancellation of up to 56% of new PV developments originally planned for 2022; a total of 50GW. The levelized cost of energy (LCOE) for new projects has increased by between 10% and 15%, signaling a major cost bump for most of the projects planned for 2022.³

This leaves developers with two options: negotiating higher power purchase agreements or absorbing those inflationary costs. Where higher purchase agreements are not an option, developers struggle to balance the ROI equation despite higher project costs and lower margins.

¹ IRENA Power Generation Costs 2020.pdf

² Solar Power World, More than half of global utility solar projects planned in 2022 threatened by supply chain issues, 9/30/21

³ Ibid



BOS and the ROI Equation

WHAT IS BALANCE OF SYSTEM?

One of the ways utility-scale solar projects can get back on track is by taking a harder look at their BOS plans and efficiency. Until now, the conversation on efficiency has mainly focused on modules, inverters, and batteries. Advances in these components are seeing diminishing returns as the years go by, so it's time for developers to take a closer look at BOS.

BOS refers to the electrical components of a PV system other than the solar modules and major equipment such as inverters and medium voltage transformers. Traditionally, these components consist of cables/wires, switches, grounding and power connectors, cable management solutions, as well as the software that integrates the entire system together. It also includes the combiner boxes and disconnect enclosures. Essentially, it encompasses the parts of the system that work together to bring the DC power produced by the modules to the inverter.

Because BOS comprises so many systems, changes in one area will not make a huge impact. But with BOS now comprising a larger percentage of project costs, these small changes taken together can make a big difference to the bottom line.

THE ROI EQUATION

At its most basic, the return on investment of a solar project is the benefit generated over the life of the project divided by the cost of building the project. There are two ways to increase ROI: reduce costs or increase generation. BOS can have an impact on both.

ROI =	Lifetime Benefit	÷	Total System Cost
HOW DO YOU IMPROVE ROI?	<ul style="list-style-type: none">• Maximize uptime• Increase system longevity		<ul style="list-style-type: none">• Reduce installation time• Decrease sourcing time

Leveraging BOS to Reduce System Costs

DECREASE TIME SPENT ON SOURCING

It's simple: time is money. Time spent dealing with multiple suppliers can negate any savings on product costs. Money saved on cheaper components is wasted on replacement costs when those components turn out to be inadequate for harsh outdoor conditions.

Take connectors, for example. Despite intermating of connectors being prohibited by the NEC, the practice remains common, partly due to a flood of generic connectors being marketed as “inter-compatible” with those of major manufacturers. This is especially important—and risky—when it comes to electrical infrastructure. Unprotected, improperly connected, or incompatible connectors are an increasingly common source of PV panel failure and fires.

Panduit can help EPCs and developers avoid these issues thanks to our broad portfolio of renewable energy solutions. We can cover up to 75% of a typical PV installation's electrical BOS—more ground than any other manufacturer. What's more, our customers have access to technical solutions engineers that can help them get solar specifications in compliance by providing application review and installation expertise.

Being proactively involved in project management from the early stages gives Panduit and our network of distributors the lead time to ensure that the necessary components are available when you need them. Our extensive distributor network includes the industry's key distributors and reaches around the globe.

Together, these strengths mean Panduit can optimize supply chain efficiency, helping infrastructure projects stay on-time and on-budget from the start, and decrease the total cost of ownership across the entire project.

REDUCE INSTALLATION TIME

When calculating the true cost of components, installation time is often overlooked—especially when considering BOS components.

Cable management is an excellent example. Application-specific cabling components like edge clips may have a higher upfront cost than traditional cable ties, but because they can be installed much faster, can result in significant savings on labor costs.



More Meaningful Connections ■■■■

Panduit's solar edge clips come in two versions: UV-resistant acetal plastic and stainless steel. The plastic version can be installed in 11 seconds, including capturing the wire bundle, which is nearly half the time it takes to do the same job with traditional cable ties. This plastic version also includes a locking feature for enhanced stability. The metal version provides an even quicker installation. Both versions can accommodate a range of panel thicknesses consistent with many various PV modules found in the market.

When it comes to installations using trackers, cables can sever if run across sharp metal edges, and connectors can pull apart if cables are not given adequate slack. Drilling is often required to install cable clips, hangers, or ties along the tracker axis, which both adds to labor costs and compromises structural integrity. To avoid these problems, Panduit has developed a clip that eliminates the need to drill into the axis, while also reducing installation time from 90 seconds to just 21 seconds.

Another source of BOS savings, both in time and money, can be the use of cable trays or wire cable hangers instead of trenched conduit. Both are less labor-intensive to install, less costly to maintain, and easier to inspect. Cable trays with IEC-rated cable cleats have the added benefit of securing cables in case of a short-circuit event. On panels or racking with mounting holes, wire cable hangers can be installed quickly and without tools, and allow cables to be added or removed quickly.

Installation Time⁴



Traditional Zip Tie



Panduit Solar Cable Clip



$$\times 3 \text{ clips per panel}$$

$$\times 2,900 \text{ panels per mW} =$$

50.75
HOURS

labor time per mW
with a traditional
zip tie

26.58
HOURS

labor time per mW
with a Panduit solar
cable clip



Cable Tie

Secures cables tightly; must be replaced each time cables are added or removed



Metal Cable Clip

Durable and long-lasting; sharp edges can damage cables



Plastic Cable Clip

Quick installation; eliminates corrosion concerns



Wire Cable Hanger

Easily add or remove cables; installation requires holes drilled in panel or frame

⁴ Panduit Japan, 2020

Leveraging BOS to Increase Generation

MAXIMIZE UPTIME

Maximizing uptime may be the most obvious way to maximize project ROI, since every minute an installation is down means a minute of lost power generation that can't be recovered. This is where utilizing high-quality components certified to industry performance and safety standards can make an important impact.

One example is cable cleats. Cable trays and cable cleats can better protect equipment and personnel from dangerous ground faults than trenched conduit, but only if they are properly secured. Both NEC and IEC standards require cables to be secured against short circuit events, but only IEC sets requirements for resistance to electromechanical forces as well as temperature rating, corrosion, and UV resistance.

Panduit's cable cleats are tested to this more stringent standard, IEC 61914, making them better able to withstand harsh environmental conditions and protect against potential ground faults.

Another example is grounding and bonding. Panduit's GCE grounding connectors meet the UL 467 standard as well as the more stringent IEEE 837 standard, which puts components under test conditions simulating 30 to 40 years of service.

While the quality of the connectors themselves is important, proper installation also comes into play. Most manufacturer's lugs lose their UL certification—and will not pass inspection—if installed with a different manufacturer's tools, potentially leading to costly re-work, cost, and time overruns. This is another argument for sourcing from a single supplier. Since this can't always be done, Panduit has gone a step further and made sure our grounding clamps and connectors are UL certified even when installed with another manufacturer's tools.

Any supplier you work with should be able to provide external or self-declaring test reports in line with ALL the standards required for the project. If they don't, they need to explain why or what parts do not fully comply.

INCREASE SYSTEM LONGEVITY

A well-designed electrical BOS built with components designed to last in harsh environments can help reduce operational expenses and increase system longevity. This is another area where standards compliance can help by providing engineers and procurement with a baseline to read beyond a supplier's marketing and compare products.

IEC 61215 sets the standard for PV module design and performance under various environmental conditions. But the long-term performance of PV modules is moot if the other surrounding components aren't designed to stand the test of time in harsh conditions.



Electrical Installation Component Standards

Component	Relevant Standard
Cable Ties	UL 62275/IEC 62275
Cable Clamps	UL 1565
Cable Clips	UL 1565
Conduit Clips	UL 1565
Wire Connectors	UL 486A-486B
Lugs	UL 486A-486B
Grounding Clamps	UL 467/ IEEE 837
Grounding Connectors	UL 467/ IEEE 837
Bonding Straps	UL 467/ IEEE 837
Compression Connectors	UL 467/ IEEE 837
Cable Cleats	IEC 61914

More Meaningful Connections ■■■

Environmental conditions are one of the many factors that need to be taken into consideration when selecting components for cable management. For example, materials designed for dry conditions will not perform as well in damp areas, and vice versa. Stainless steel components provide extensive durability, but salty environments can cause metal clips to corrode and damage the galvanized edges of PV panels.

Heat and temperature fluctuations can make non-UV-resistant plastic brittle, but given a careful selection of the right material for the environment, plastic components can provide long life at a cost savings. Many installations make the mistake of using general-use plastic cable ties instead of application-specific ones like Panduit's nylon 12 plastic or nylon-coated stainless steel cable ties.

Panduit has done extensive outdoor testing to help installers decide on the best material to fit the application and environment. Picking the right cable tie based on material, style, and strength rating will help gain the most impact at the most effective cost. On a project with thousands of modules, it's critical to source high-quality, application-specific components to avoid replacement costs for deteriorating components.

DESIGNED WITH ROI IN MIND

Whether you are facing supply issues, rising labor costs, or installation challenges, having the right infrastructure is the key to balancing the ROI equation. That means having products that are engineered to meet your project's requirements and the project's particular environmental conditions.

Panduit has partnered with EPCs and solar installers on PV installations totaling more than 5GW of capacity over the last decade. Our commitment to research and development means our solar energy portfolio has grown to cover almost all aspects of BOS, from grounding and cable management to safety and communications solutions.

We're continually working to develop solutions that improve on industry standards and decrease total cost of ownership, from tools that reduce installation time to innovative solutions that enable easier standards compliance.

More importantly, we offer the expertise needed to get the most out of your BOS investment, with a dedicated capital projects team that provides end-to-end support. If one of our existing solutions can't address your specific application challenges, we can work with you to design, engineer, and test custom solutions that will.

Visit our website to learn more about our [solar energy capabilities](#), explore our solar energy resource center, and contact our capital projects team.

⁵UCC-family clips are made of 20+ year rated weather resistant acetal. Panduit PLT Nylon 12 cable ties have a demonstrated life expectancy of over 20 years, based on empirical testing conducted at a Panduit USA facility in accordance with ASTM D1435. Outdoor weather is the best and most realistic method of determining the suitability of a product for outdoor use, because it exposes the plastic to not only UV, but all other outdoor elements. As such, these products made in these materials are suitable for a 20+ year life expectancy. Please note, however, that outdoor life expectancy of a part is dependent on many factors, and as such, Panduit does not provide a guarantee for the life of our products in a customer's application.

20+ Year Lifespans⁵



Panduit Plastic Solar Clip



Panduit Nylon 12 Cable Ties





Since 1955, Panduit's culture of curiosity and passion for problem solving have enabled more meaningful connections between companies' business goals and their marketplace success. Panduit creates leading-edge physical, electrical, and network infrastructure solutions for enterprise-wide environments, from the data center to the telecom room, from the desktop to the plant floor. Headquartered in Tinley Park, IL, USA and operating in 112 global locations, Panduit's proven reputation for quality and technology leadership, coupled with a robust partner ecosystem, help support, sustain, and empower business growth in a connected world.

For more information

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