

White paper

Your Foundation for Solar Success

Screws vs. Piles





Choosing your solar project foundation confidently

The idea that a building is only as strong as its foundation rings true in every industry, including solar. “Perfect” solar project sites can provide ideal foundation conditions but are increasingly harder to obtain and often come at a premium price. Developers may have to defer to more rocky and hilly terrain to take advantage of higher margins from discounted parcels of land. **However, if the appropriate foundation is not deployed for such terrains from the outset, the project runs the risk of delays, higher costs, and lower returns.**

Selecting the right foundation for a project is crucial, with durability, installation speed, and terrain suitability all playing a part in ensuring solar projects are delivered on time and within budget. Foundation options in solar—such as ground screws and driven piles—offer different features and benefits to consider. The decision to use either can have varying impacts on schedules and budgets: one could be good for your project, but another could be better.



Ground screws

Installed with special equipment, ground screws are quick to install but require higher quantities than piles and have a higher installation cost.

So, are piles the better choice?



Driven piles

The affordable option, driven piles have lower installation costs on standard sites but are not ideal for more rugged terrain.

So, are screws the better choice?



What also makes this decision a heavy one is the fact that the racking system—which includes the foundation material and foundation installation—often adds up to 20% of solar project costs.

Then, there are the other factors that cannot be downplayed. There are weather changes, soil conditions, frost heave, and terrain to consider. Pull tests need to be undertaken to check for refusal risk. Product lead times can often derail a project timeline if not given due consideration. Add construction timelines and project schedules to this list, and suddenly the choice between screws and piles becomes highly complex.

Engaging a foundation expert with unbiased experience is key to helping you make the best decision. Leveraging engineering expertise on each foundation option's technical advantages and its application in different scenarios will help you optimize project costs, mitigate risks to project schedules, and maximize revenue.

The trick is figuring out how to weigh the costs and benefits properly to pencil out strong projects and deliver the best returns.

This white paper will guide you in understanding:

1

How a real-world case study in 'screws vs. piles' identified an optimized solar return—a return you can emulate now

2

How to decide between screws and piles for your project—and a checklist you can immediately apply to your upcoming projects

3

Ten key questions to ask when choosing your foundation expert partner

Are screws or piles better for your project and bottom line?

Driven piles are a standard option for cost-effective PV. From a material and construction perspective, they can be deployed quickly and reliably on sites with soft soil and non-rugged terrain. However, they are not the most effective option for frost heave or in unpredictable conditions that can present costly and schedule-derailing refusals.

Ground screws have higher construction costs but are better if you are working with a more challenging site—one with refusal risk or frost heave. With ground screws, you can also bear higher loads with lower anchoring depths. With adaptable racking designed for flexible land use, ground screws can deliver reliable returns from unreliable sites.

The best way to determine the right option for your project—one that is optimized in terms of budget, timelines, and risk—is to compare it across project costs, schedules, terrain, soil, refusal risk, and other useful criteria:

What foundation is the best for different site conditions?

Site Considerations	Ground Screws	Driven Piles
Sloped terrain greater than 15%	⚡	⚡
Soil with high refusal risk	⚡	
Soft soil with low refusal risk		⚡
High corrosion risk	⚡	⚡
Frost heave soil	⚡	
Flat land with low slopes	⚡	⚡

What are the benefits of each foundation?



Ground Screws

- Less risk of refusals
- Fewer change orders
- Less risk of schedule delays
- Long product lifespan



Driven Piles

- Lower upfront material costs
- Fewer foundations required
- Long product lifespan
- Easy to procure

Going through an iterative process (like these comparison tables) is well worth your time, given the complexity in every solar project. With so many considerations to weigh up, engaging the expertise of a racking partner with a broad portfolio and an objective, consultative approach to foundation options can make all the difference for your project.

Cost-benefit approach to optimizing solar returns with ground screws and driven piles

Background

Where foundation options are concerned, we understand and advocate the importance of selecting the right foundation in optimizing a project's cost and risk profile. In this case study, you will find an in-depth analysis on ground screws and driven piles.

Challenge

There are various costs and advantages to using ground screws and driven piles for solar projects. The key challenge in choosing the better foundation for your project site lies in determining the break-even point measured against crucial site conditions for both foundation options.

Ground screws present a higher construction cost but perform better when there are issues associated with subterranean conditions such as soft or hard soils, rocks, caliche, and boulders. On the flip side, driven pile foundations are a cost-effective option for typical sites with soft soils and more even terrain.

Choosing the right foundation is not an easy decision—there are many different scenarios and project drivers to consider. For example, end-of-year projects are often driven by compressed deadlines to get systems online in time to meet PPA production schedules. In contrast, other projects have time flexibilities but tighter budgets. The varied level of risk that developers are able to absorb also requires a case-by-case assessment.

To help you determine the best approach for your projects, we've gathered data from real-world scenarios to find evidence-based answers to two key questions:

1

How impactful are driven pile foundations and ground screws to the bottom line in solar projects?

2

What are the cost and schedule implications of using ground screws versus driven piles? At what refusal percentage do ground screws outperform piles?

Assumptions

To clearly identify a break-even datapoint that pinpoints where driven piles are the best option or where ground screws would deliver a better result, we brought together the combined experience of lead engineers and field teams in solar foundation installation to evaluate the costs and benefits of the foundations against a project site with two subterranean profile scenarios.

Project assumptions

A 20-MW project utilizing a 1P tracker

Based on this setup, we know that:



Ground Screws

- More screws required vs. piles
- Higher installation price per foundation



Driven Piles

- Lower daily install rate
- Higher material price per foundation

Results

1

How impactful are driven pile foundations and ground screws to the bottom line in solar projects?

A breakdown of cost, time, and outcomes in the use of ground screws vs. driven piles for a 20-MW site utilizing a 1P tracker

Foundation	Material Cost	Installation Cost	Total Cost	# of Days to Install
Piles	\$728,000	\$364,000	\$1,092,000	52
Screws	\$632,000	\$804,000	\$1,436,000	64

Fig. A: Example 1 – No refusal

Assuming there is no refusal on the 20-MW project site, piles are the better choice. This is due to the fact that even though piles have a higher material cost, they have a much lower installation cost. When you total up the costs, it's clear that piles are the better choice for this project—as not only do they have a lower cost, but they also have a shorter installation schedule. These results are not surprising as driven piles are a popular choice when building projects on sites with no refusal risk.

Next, let’s look at that same 20-MW project, but assume that there’s a 50% refusal. Since screws remove the risk for refusal, the costs will remain the same. However, that is not the same case for piles.

The top part of Figure B shows the same costs we just reviewed for piles. The bottom part shows the additional installation cost to remediate and number of additional days to install.

Original Pile Cost with No Refusal				
Foundation	Material Cost	Installation Cost	Total Cost	# of Days to Install
Piles	\$728,000	\$364,000	\$1,092,000	52

Remediation Cost	
Additional install cost	\$455,000
Additional days	35
Schedule cost	\$173,333
Total remediation cost	\$628,333

Fig. B: Example 2 – 50% refusal, remediation cost

If we assume that 50% of the piles have to be remediated, there’s an additional cost of \$455,000 to reinstall those pile foundations.

When you experience refusal, you can see that it adds a substantial amount to your installation cost. Additionally, it adds a ton of time to your overall schedule. In this example, you’ve added 35 days to your original schedule. There are costs tied to keeping your project site running, such as machine rentals, trailers, bathrooms, etc. So in total, you have now added \$628,333 in costs to remediate pile foundations.

Now, if we compare the additional remediation costs to the original cost of screws, you can see that screws are the better option. With screws, the cost and schedule remain the same regardless of the refusal rate.

In this scenario, you’re saving over \$284,000 in costs when you use screws—in addition to saving 23 days in your project schedule, making ground screws the clear, better choice.

Foundation	Material Cost	Installation Cost	Original Cost	# of Days to Install	Remediation Cost	Total Cost with Remediation
Piles	\$728,000	\$364,000	\$1,092,000	87	\$628,333	\$1,720,333
Screws	\$632,000	\$804,000	\$1,436,000	64	\$0	\$1,436,000

Fig. C: Example 3 – 50% refusal cost comparison

When comparing cost, time, and outcomes across the board, it is clear that:

- 1** Piles are effective in soft soil conditions with low refusal risk, delivering a better bottom line.
- 2** Screws are more effective in high-refusal sites, delivering a better bottom line.
- 3** Remediation cost for a pile increases project costs and adds additional time to project schedules.

2 At what refusal percentage do ground screws outperform driven piles?

While a 50% refusal assumption was used in this study, it is not the norm. The question then becomes: At what refusal percentage do ground screws outperform piles? And what are the implications from both a cost and schedule perspective? The final step of the study involved identifying break-even points for both cost and installation time to determine an acceptable rate of refusal.

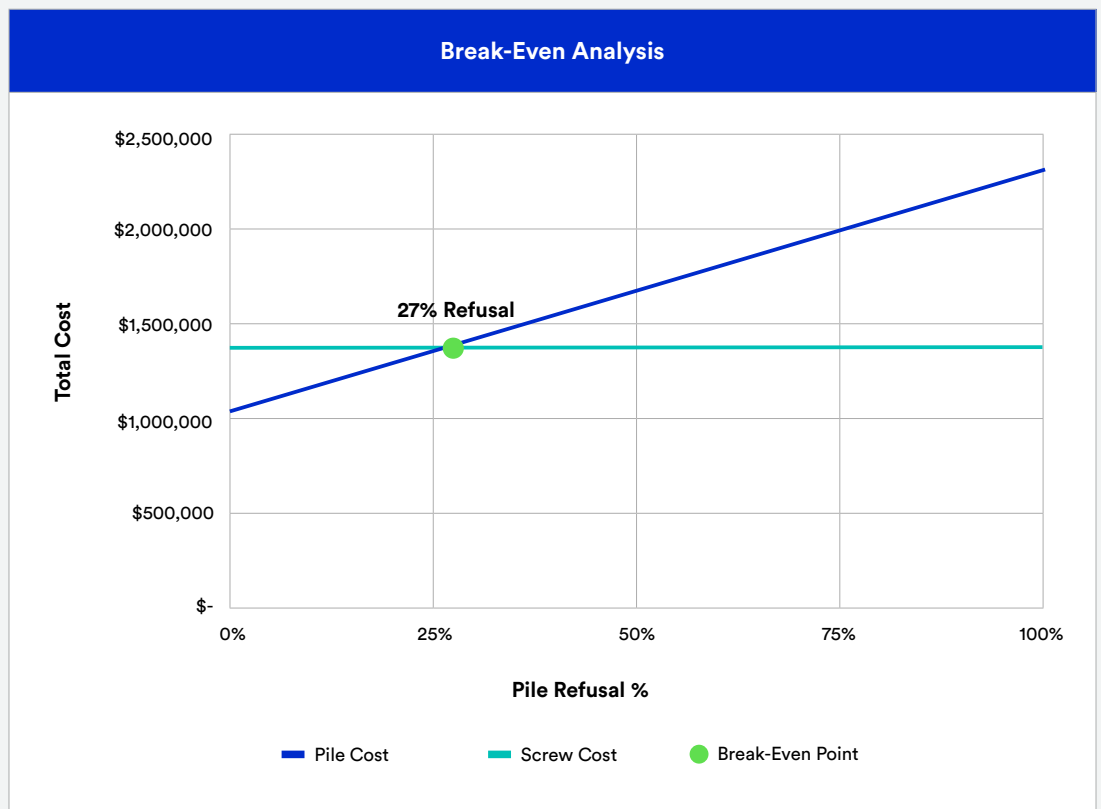


Fig. D: Break-even analysis of installation costs—ground screws vs. driven piles

It can be seen from Figure D that a 27% refusal rate is the break-even point where the cost for ground screws and driven piles is the same. Above this break-even point, the cost for driven piles would exceed the costs for ground screw foundations.

While a 27% refusal rate is the break-even point in this scenario, we understand that every site is different, and each customer has their own set of goals and priorities. Although there is no one-size-fits-all, sites with a 20%–30% refusal rate require additional analysis and engineering expertise. Having a partner with a complete foundation portfolio will ensure that you have the best solution for your project.

To understand how foundation decisions can immediately minimize risk, decrease installation costs, and maximize returns, it is crucial to engage a partner with hands-on installation experience across various foundations and expertise in complex soils and terrains. Selecting the right foundation for your unique site ensures long-term solar success.

10 questions to ask when choosing your foundation partner

Deploying the foundation that suits your project and working with an experienced partner must go hand-in-hand to make sure you can unlock project value, manage project costs, and deliver your projects on schedule.

Here are ten key questions that you should ask when choosing the right vendor:

1

Do you have full spectrum solar experience that will give me confidence that you can understand my project needs and drivers, end-to-end?

2

Do you have hands-on experience installing different foundation types?

3

How much experience do you have performing pull out tests and analyzing geotechnical reports?

4

What soil and weather conditions do I need to consider when selecting a foundation?

5

What is your process if you encounter refusal during installation?

6

Have you installed in this type of soil and/or weather before?

7

How do you advise your customers when there is a site where both piles and screws could be applicable?

8

How long does it take to install each of your foundation options?

9

What are the potential risks I should consider?

10

Which foundation would you recommend for my project?



Ready to break ground with Terrasmart?

In the past, foundation selection was conducted based on assumptions and limited field data, with most implementing a default offering that was easily accessible or inexpensive with the hope of achieving higher margins. Now, with unbiased options geared toward improving solar structures, schedules, and cost, the potential to maximize revenue is much higher.

Starting your project on the right footing by getting foundation expertise ensures you set your project up for success from the outset. Choosing the right foundation product with the help of an expert partner ensures you stay on time, within budget, and unlock maximum project value, no matter how challenging your landscape.



Discover the best foundation for your solar projects. Contact us today.



About Terrasmart

Terrasmart, the renewable energy portfolio of Gibraltar (NASDAQ: ROCK), is a leading provider of solar racking technologies, electrical balance-of-system products, installation services, and project optimization software. Serving the commercial and utility sectors across North America, Terrasmart integrates products and solutions across the PV lifecycle to minimize risks and maximize returns. With over 24 GWs of solar deployed across 5,800 PV systems, Terrasmart creates unique value for more profitable solar anywhere. Visit **Terrasmart.com**.