REPORT

THE DEFINITIVE GUIDE TO HELICAL PIER FOUNDATIONS FOR RENEWABLE ENERGY PROJECTS

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INTRODUCTION

Renewable energy in America is growing by leaps and bounds.

Despite a challenging few years of disruptions, industry analysis shows the combination of demand for clean energy and generous incentives will create strong growth.

This strong growth has led to a boom in construction for renewable energy projects. In 2023 alone, for example, it's reported that the U.S. will add **29.1GW** of large-scale solar power and **9.4GW** of energy storage.

That's not to mention other sources of green energy, like wind power.

As the demand for renewable energy in the U.S. continues to explode there's a question that engineers, estimators, and designers have to answer:

What's the best foundation for renewable energy construction?

Traditionally, the "go-to" foundation solutions have either been concrete piers or driven technologies like steel piles.

Over the past decade or so, there's a growing demand for a foundation that can be installed faster easier: **the helical pier foundation**.

Helical pier foundations for renewable energy projects have quickly established themselves as an efficient, effective, and economical alternative to the usual poured concrete or driven pier systems.

On average, a helical solution can be installed faster and in more locations while dramatically reducing the overall raw material and carbon-emissions costs of your project.

Despite the increase in their popularity and use, however, much of the green energy construction industry is still unfamiliar with helical foundation technology.

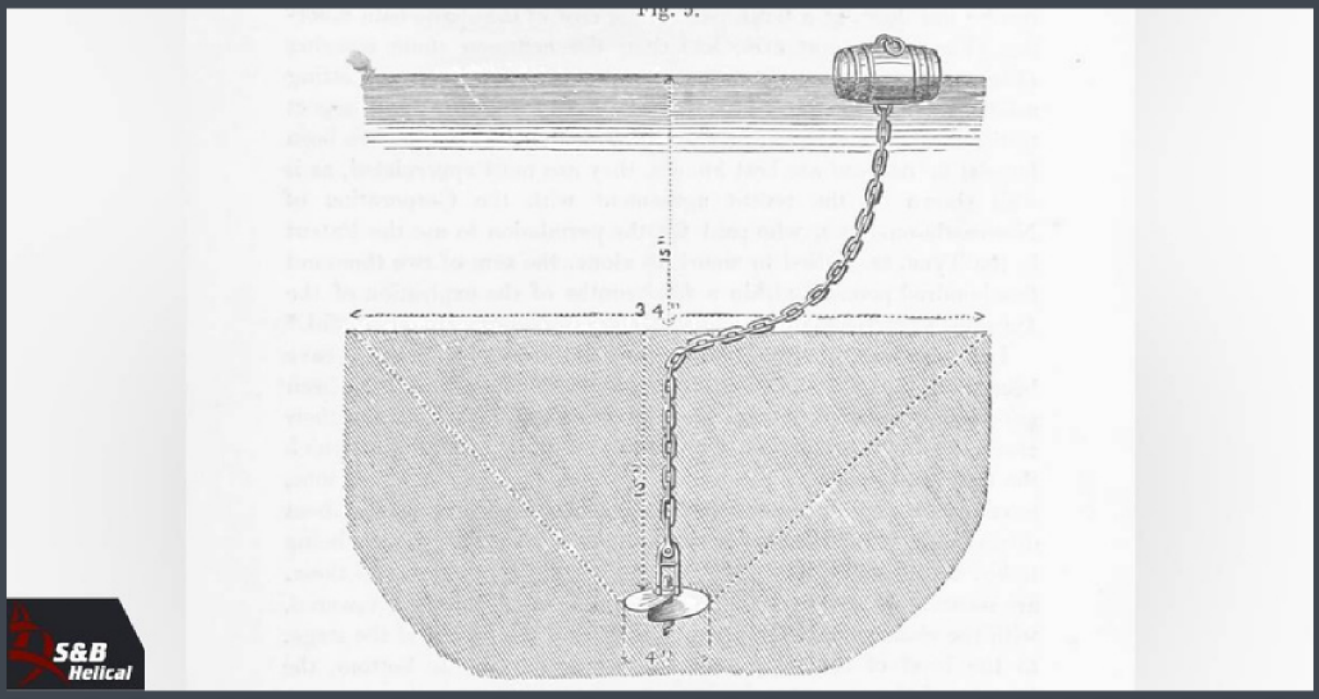
In this comprehensive report, you're going to learn:

- Exactly **what** helical pier foundations are and **how** they work
- The **story** of this nearly two-century old foundation solution and why it's still **relevant** in 2023
- Why helical pier foundations can be **more efficient and versatile** for renewable energy projects
- Some of the **renewable energy construction projects** that can be supported using a helical pier foundation

WHAT ARE HELICAL PIERS & THEIR HISTORY?

Helical piers are far from a new or novel foundation technology. For nearly 200 years, they've helped support everything from towering lighthouses to sprawling battery energy storage systems.

The helical pier (originally called a "screw pile" and also known as a "helical pile"), was invented around the early 1830's by a blind Irish engineer named Alexander Mitchell. The remarkable Mr. Mitchell was inspired to create the helical pier after seeing the methods used to anchor ships in harbors at the time.



Example of an early "screw mooring" used to anchor ships in harbors - and Alexander Mitchell's inspiration for the helical pier foundation

Mitchell noted these short shafts of wrought iron, with a helix-shaped plate attached to them, worked exceptionally well at resisting the upwards force of heavy ships pulling on them.

They were installed by lowering the screw mooring into the water, and attaching iron shafts until the helix plate reached the sandy bottom. It was then turned a relatively short depth into the ground and the iron shafts were removed, the mooring chain was kept afloat by attaching a buoyant wooden barrel.

WHAT ARE HELICAL PIERS & THEIR HISTORY?

These anchors proved to be substantially more effective at holding harbored ships in place, especially in rough waters or violent storms.

Mitchell had the ingenious idea to take this helix-plate concept and apply it as a deep foundation for structures like lighthouses. The loose and shifting sands of the U.K. coastline made the construction of life-saving lighthouses impossible in many locations.

In the early 1800's, deep foundation technology couldn't match the brutal conditions found along much of the waterways and coastlines. Unconsolidated and highly-saturated soils were a lethal combination to the foundation technology of the time.

An illustration of an early "screw-pile lighthouse" used on a river. For over a century these structures supported on helical piers were common throughout the United States

Patented in 1833, the "screw pile" instantly revolutionized marine construction. Suddenly, critical safety infrastructure like lighthouses could be built in even the most savage locations.

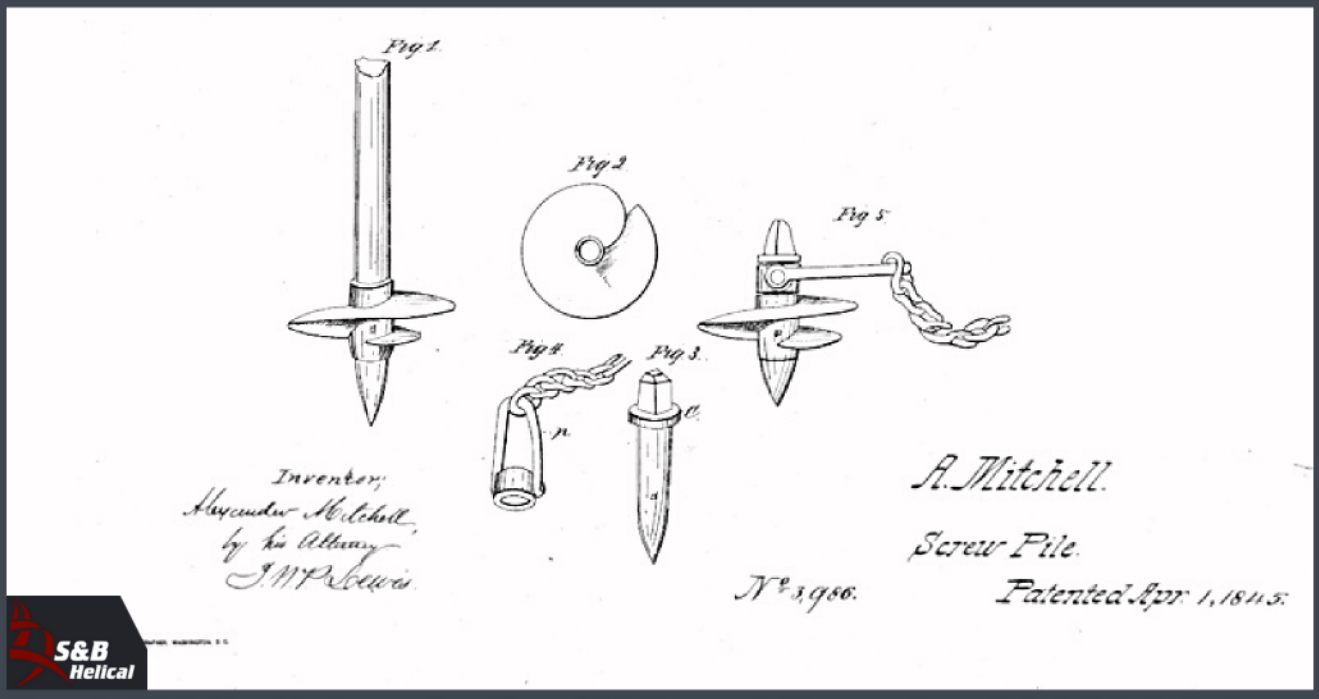
From storm-ravaged coastlines to wind-whipped offshore installations, even the most difficult waterways could finally be protected by navigational lights.

WHAT ARE HELICAL PIERS & THEIR HISTORY?

Through the rest of the 1800's, hundreds of lighthouses would be built on screw pile foundations. And lighthouses wouldn't be the only structures supported on this new technology. Bridge and pier construction would also be transformed, as engineers were free to build in more places than ever before.

Screw piles (helical piers) would enjoy widespread use in marine construction through the latter 1800's and early 1900's. However, as advanced in steam-powered hammers made driven piles easier to install, helical piers would find new uses in the agricultural and utility industries.

Over the past 30 years or so, rapid advancements in hydraulic drive technology has allowed larger-diameter helical piers to be installed at greater depths in a wider array of soils than previously possible. This has dramatically increased the axial and lateral load capacity of helical piers and firmly established their place as a strong, durable, and reliable deep foundation.



Alexander Mitchell's original patent for a "Screw Pile". It's remarkable to note how relatively little the basic design has changed over nearly two centuries - further proof of Mitchell's engineering genius

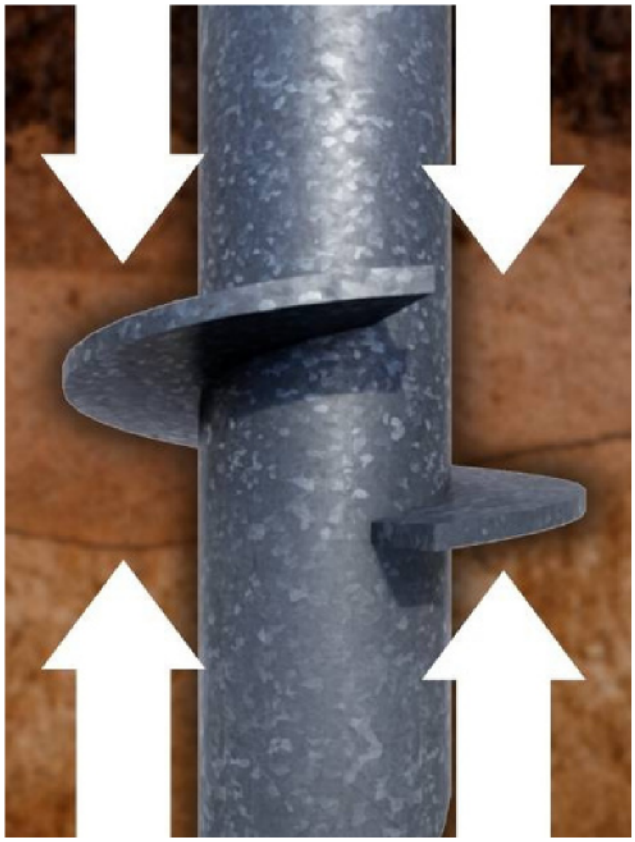
HOW HELICAL PIERS SUPPORT RENEWABLE ENERGY CONSTRUCTION

A helical pier resists compression and tension loads transmitted axially or laterally primarily by the unique action of the surrounding soil pressing on the helix plates.

Unlike a poured concrete foundation that needs bore-holing or a driven steel pile system that creates noise and vibrations, a helical pier is turned into the ground by a hydraulic gear motor.

As the helical pier turns down into the ground, the soil exerts force on the helix plates and, to a lesser extent, the shaft of the pier itself (known as "skin friction").

Because a helical pier turns into the ground instead of being excavated or driven, it doesn't displace the soil or create piles of spoils that you need to deal with.



The soil exerts force on the helix plates which are firmly anchored in the ground. This unique and well-studied action provides most (if not all) of a helical piers' load capacity

This action of the soil pressing on the helix plates anchors the pier firmly in the soil. Because the helix plates are much wider than the pier shaft, they provide a large surface area for the soil to act on.

This is why a helical pier can withstand enormous amounts of force, even if shaft diameter is relatively small. The secret isn't in the shaft, it's the action of the soil on the helix plates.

That doesn't mean that skin friction plays *no* role in the performance of a helical pier. As shaft diameters increase, skin friction may contribute to load capacity. Still, even in large-diameter helical piers, we tend to calculate the load capacity from the helix plates.

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HOW HELICAL PIERS SUPPORT RENEWABLE ENERGY CONSTRUCTION

While in Mitchell's day a helical pier would generally have only one helix plate, today our engineers can add two, three, or even more helix plates to the pier depending on the conditions and requirements. Multiple helix plates create independent columns of support in the soil, helping add even more load capacity in extremely loose or saturated conditions.

Multiple helix plates may be present on a helical pier depending on the application, design, and soil conditions

We can also tweak other components to achieve a desired result in virtually any conditions. Even more important, our crews closely monitor the installation and collect crucial data regarding performance and soil conditions.

This means our team can help confirm, or refute, assumptions that a geotechnical investigation is forced to make based on the limits of their observations.

After all, no matter how outstanding the geotechnical engineer *(and they are a critical part of a successful foundation)*, they don't have "x-ray vision" to see exactly what's happening under the surface. Soil conditions are a challenging beast to tackle, and what a geotech observes at one location on your site may not hold true even 20 feet away.

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HOW HELICAL PIERS SUPPORT RENEWABLE ENERGY CONSTRUCTION

For example, on a hydro substation project, we discovered one area of the site was the location of an old and unmarked retention pond. The geotech couldn't have known it was there, and so it wasn't noted on the report.

Once we were on-site and installing, however, our data told us the soil conditions were not as expected.

Because our installers quickly identified the discrepancy, we could investigate conditions and devise a solution with virtually zero delays.

Helical pier technology is also being combined with other technologies, like sheet piles, to make their installation more efficient and versatile.

As the industry looks for better building materials that provide better support while reducing impact on the environment, we're experiencing another "helical pier revolution".

And to think it all came from the brilliant mind of a tirelessly-dedicated engineer who had a dream of making traversing waterways safer.

This extremely muddy and saturated site for a transmission substation would have been a problem for other solutions, helical piers offered a fast and efficient high-capacity foundation

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HELICAL PIERS - WHERE THEY CAN BE USED?

Now you've seen that helical piers are a highly adaptable deep foundation that's been in-use for a very long time. But, it's time to answer the burning question of the day: where can helical pier foundations be used in renewable energy construction and why would you even want to?

Let's start by answering the first part of the question - **where can helical piers be used in renewable energy construction?**

Energy storage systems, solar farms, transmission & distribution equipment - these are just a few of the renewable energy projects that can be supported on a helical pier foundation

Because of their versatility, helical piers are used for a large range of structures. In fact, it would be easier to list where you **can't** use a helical foundation.

Let's examine a few examples of renewable projects that can greatly benefit from a helical foundation.

This isn't an exhaustive list by any means, instead it's meant to give you an idea of the popular use-cases and foremost advantages of a helical solution.

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HELICAL PIERS FOR BATTERY ENERGY STORAGE SYSTEMS

When generating power via renewable sources, like wind or solar for example, an energy storage medium is required in order to smooth-out the peaks and dips in power delivery (called "load leveling").

In high-production times, like sunny or windy days, these enormous banks of industrial-sized batteries store valuable power. Later on, when the wind dies down or nighttime comes, these systems release power into the grid.

Energy storage systems capture the power produced by sources like solar or wind and store it for future use. They can also capture energy from the "traditional" grid to support local power distribution

Energy storage systems can also save power to be released at peak times, such as a hot day where people are turning on air conditioners and putting more strain on the grid. They also protect the grid from energy spikes on days where power generation is especially high.

They're not limited to renewable energy systems, either. Energy storage can be used in "traditional" grid systems to help ease strain and increase reliability during peak demand times.

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HELICAL PIERS FOR BATTERY ENERGY STORAGE SYSTEMS

Other examples of energy storage installations here in the U.S.A. include Vistra Energy's recent 400MW setup at the Moss Landing power plant.

When it comes to the foundation for an energy storage system, however, there's key considerations you need to account for.

This helical pier foundation for a battery energy storage system was a perfect match for the unbelievably muddy and saturated soil that was found across the entire site

First, the battery units themselves are heavy. Batteries are dense, and putting thousands of cells into a steel box along with other command and control equipment makes the overall unit a hefty one.

HELICAL PIERS FOR BATTERY ENERGY STORAGE SYSTEMS

The new Tesla Megapack BESS, for instance, comes in at a weighty 83,996 pounds. That kind of weight demands a strong foundation, especially if you're building on a site with less-than-desirable soil conditions.

Another consideration is the lifespan of the energy storage installation, and what will happen to the site when it's time for decommissioning. The renewable industry is experiencing rapid technological development, especially in energy storage. Your energy storage site may require extensive changes in the near future, and at some point could be decommissioned and require removal.

That means, whatever your foundation solution, you need to carefully consider how it might be dismantled and the site remediated someday. Dealing with hundreds of thousands of battery cells can represent a substantial cost in itself, why add to it with extensive reclamation and remediation of the soil?

The more efficient it is to remove foundation elements, the more cost-effective it will be to decommission an energy storage site.

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HELICAL PIER FOUNDATION BENEFITS FOR ENERGY STORAGE SYSTEMS

Faster and easier to install than other foundation solutions, increasing efficiency and dramatically reducing time-to-build

Provides large load capacities in the most challenging soil conditions, particularly soils that are extremely weak or highly saturated and prone to shifting

Removal and remediation of the helical pier foundation can be accomplished with the same simple equipment used to install (excavators or skidsteers with a hydraulic drive attachment), making future restoration of the site more economical

Environmentally-friendly, uses vastly less raw material than a comparable concrete foundation solution which reduces overall CO2 emissions related to construction activities

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HELICAL PIERS FOR SOLAR PANELS (SOLAR FARMS)

Solar energy generation in the United States is growing at an incredibly rapid pace. According to the U.S. Energy Information Administration, more than half (54% to be precise) of the new energy-generating capacity planned for the grid in 2023 will be powered by solar.

That's significantly more than wind, which comes in at just 11%. Clearly, solar installations are only going to continue growing - especially in markets like Texas and California where sunny days are in abundance. In fact, of the 29.1GW of planned solar energy expansion for the U.S. grid for 2023, Texas and California will account for 41% (11.9GW) of the capacity.

Spanning enormous plots of land and subjected to the forces of severe weather and climate, solar farms demand unfaltering and economical foundation support

Solar installations typically span hundreds, if not thousands, of acres and require a staggering amount of foundation work.

Add to that the fact that solar installations may be built on decommissioned landfills or other sites with extremely challenging soil conditions, and the foundation technology becomes absolutely paramount to the long-term success of the site.

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HELICAL PIERS FOR SOLAR PANELS (SOLAR FARMS)

In fact, the Travers Solar Farm project in Alberta, Canada used nearly 230,000 helical piers to provide reliable support for 3,300 acres of solar panels outputting over 460MW of power.

While our team wasn't involved in that project, I can imagine some of the reasons their engineers would have chosen a helical pier solution would be the increased efficiency and drastic reduction of impact on the local environment.

Many solar farms are being built on agricultural land, which may someday need to be returned to agricultural purposes. This means it's more critical than ever to consider the impact your foundation will have on the soil during its life and on removal. Not only is it important to minimize the displacement of the soil itself, think about what impacts the materials themselves may have on the organic life in the soil.

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HELICAL PIER FOUNDATION BENEFITS FOR SOLAR PANELS (SOLAR FARMS)

Lightweight and manoeuvrable installation equipment reduces impact on the land, increases safety, and minimizes hassles that come from heavy machines on your job site

Made from steel and can be protected with galvanization, which is used to coat countless metals that come into contact with agricultural soil and even municipal water pipes

Can be used immediately after installation, meaning if staged correctly you can be installing solar panels in one area of your site while the foundation is still being installed in another area

Removal of a helical pier foundation and remediation of the site is simple. The helical pier is reversed out of the ground, like removing a screw. This results in zero soil displacement and virtually no evidence a deep foundation was present on-site

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HELICAL PIERS FOR GRID INFRASTRUCTURE AND MICROGRIDS

There's more that goes into a renewable energy generation than solar panels or wind turbines. It takes extensive supporting infrastructure to actually **transmit** that power efficiently and safely to where it's needed.

Examples of some of the hydro transmission and distribution equipment S&B Helical has installed helical pier foundations to support

Actually building this infrastructure in a way that ensures it can carry power to communities for decades to come is a big question facing the U.S. government and energy companies right now. From transmission lines to substations, our grid is in need of some serious expansion and support if we're going to enjoy modern and reliable power.

That's not even mentioning the extensive improvements *(and in some cases, complete overhauls)* that are desperately needed to replace aging infrastructure.

Most Americans never stop to think about how we support the countless miles of power lines, transmission stations, and extensive command-and-control facilities needed to deliver the energy that charges their smartphones while they watch Netflix.

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HELICAL PIERS FOR GRID INFRASTRUCTURE AND MICROGRIDS

Of course, you and I don't have that luxury.

We do have to think about how we're going to support the myriad structures that comprise our extensive electrical grid. Especially if we want to build a better, stronger, more durable grid that can withstand a new era of threats - from violent storms to physical attacks.

I'm not going to claim that a helical pier foundation can stop a physical attack, but if we want to build an stronger grid overall, we need to assess what we use to physically support that grid.

Here again, helical piers offer an attractive value proposition when compared to other foundation technologies.

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HELICAL PIERS FOR GRID INFRASTRUCTURE AND MICROGRIDS

Take the construction of a long run of hydro transmission towers, for example. These hulking structures of steel, often crossing remote or otherwise difficult terrain, have traditionally been supported using concrete foundations that require extensive excavation and raw material.

In areas where this isn't possible, long and awkward driven piles have to be trucked to site along with extensive heavy equipment like cranes and power hammers.

This slows construction, adds unnecessary cost, and can cause negative impacts to the surrounding environment. Additionally, foundation solutions like concrete can be prone to failure and lead to the collapse of transmission towers.

This transmission tower foundation failed due to uplift forces from frost (Image courtesy of "Adfreeze Forces on Lightly Loaded Pile Foundations of Solar PV Farms in Cold Regions"

HELICAL PIERS FOR GRID INFRASTRUCTURE AND MICROGRIDS

Helical piers, owing to their steel construction, are vastly more durable than a concrete foundation. While the exact lifespan of a helical pier depends on a number of factors, the functional life of a helical foundation can be well over 100 years. The Gunfleet Lighthouse in the United Kingdom, for example, has been standing on a helical pier foundation since 1850 (that's 173 years!)

Even though the lighthouse has been neglected for many decades, the wrought-iron helical piers are still faithfully holding firm against the relentless force of the sea.

With modern engineering and materials, a properly-designed and installed helical pier will confidently provide many decades (if not well over a century) of unshakable support

When it comes to projects like:

Transmission Towers | Capacitors | Circuit Breakers | Regulators | Communication Towers | Transformers | and more...

Helical piers are a versatile and capable foundation solution.

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HELICAL PIER BENEFITS FOR GRID INFRASTRUCTURE/ MICROGRIDS

Sturdy, durable, long-lasting support in even the most difficult and challenging conditions and climates the U.S. has to offer

When properly designed and installed, no maintenance should be required over the life of the foundation

Highly effective at resisting corrosion, movement, seismic activity, and other forces that can negatively impact other foundation technologies

Low mobilization costs due to the minimal amount of equipment required and the ease of transporting and handling helical pier sections

High uplift capacity makes them ideal for securing guy-wires and other structures that require large pull-out resistance

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Helical Piers vs. Driven Steel Piles vs. Concrete Foundations

	Helical Piers	H-Piles	Concrete
Installation	No disturbance to the soil or surrounding structures during install - zero vibration	Hammering piers can cause site disturbance and might risk nearby structure damage via soil vibrations	Can require extensive excavation and/or drilling to install, serious site disturbance
Removal	Quickly and easily uninstalled using same equipment as installation, leaves zero trace behind	Removal could be more challenging and costly, requiring specialized equipment	Typically demands extensive excavation to remove, costly and challenging site remediation
Equipment	Uses common equipment like excavators and skidsteers to install, reducing mobilization costs	Piling rigs, cranes, skidsteers, telehandlers, excavators, and possibly more	Concrete trucks, pumps, cranes, and more depending on conditions/foundation design
Carbon Emissions	Produces dramatically fewer emissions as it requires much less raw material and equipment	Additional equipment requirements could increase emissions cost to install foundation	Cement production generates large amounts of CO2 emissions compared to steel foundations
Versatility	Can install at an angle, suitable for wide range of site conditions, minimal lay-down space	May not be the most suitable for deeply saturated soils, cutting/splicing can add time and cost, relatively bulky equipment	Cannot install at angle, long cure times, not the best for saturated soils, susceptible to weather and climate delays

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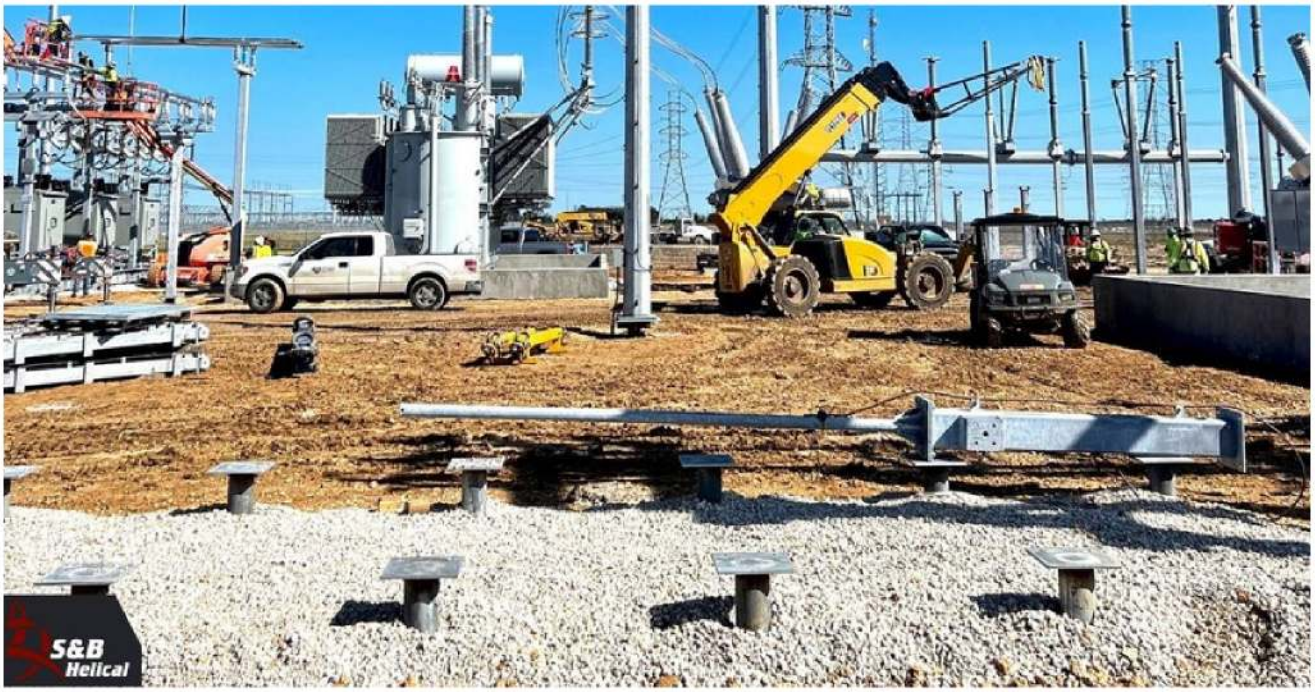
CONCLUSION

Renewable energy claims to be the way to a more environmentally-sound future for America and the rest of the world. Doesn't it make sense to ensure the foundation you use to support your renewable energy project is one for the future, too?

Helical piers aren't new, strange, or unknown. They've been used successfully all over the world for the past 190 years, and modern technology has only increased their performance and made them more convenient to use.



Our team installed hundreds of helical piers for transformers, circuit breakers, transmission lines, and more, for this hydro transmission substation - an ideal solution for this expansive hydro project

As a deep foundation solution, they're unlike anything else. For renewable energy construction projects, a helical pier foundation can help you:

- **Save** time, headaches, and (in many cases) money on your renewable project
- **Minimize** your impact on the soil and local environment by eliminating excavation, vibrations, and noise
- **Improve** recyclability, as helical piers can be easily removed and completely recycled
- **Reduce** CO2 emissions, helical piers require less raw materials
- **Slash** mobilization costs, reduce the amount of equipment and crew on your site
- **Start** building immediately after installation, no cure times
- **Keep** investors, regulators, and stakeholders happy

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CONCLUSION

Foundations like poured concrete or driven steel piles will likely continue to have their place in renewable energy construction throughout the foreseeable future. After all, no technology is perfect and there will be situations where a helical foundation might not make sense.

However, in my experience, those situations are getting fewer and fewer as the years go on. Helical piers are here to stay, and they're ready to help you put a better foundation under your next green energy project.

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Questions or comments about this report?

Let our team of foundation experts answer your questions about **faster**, **easier**, more **efficient**, and more **environmentally-friendly** foundations.

Get In Touch

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