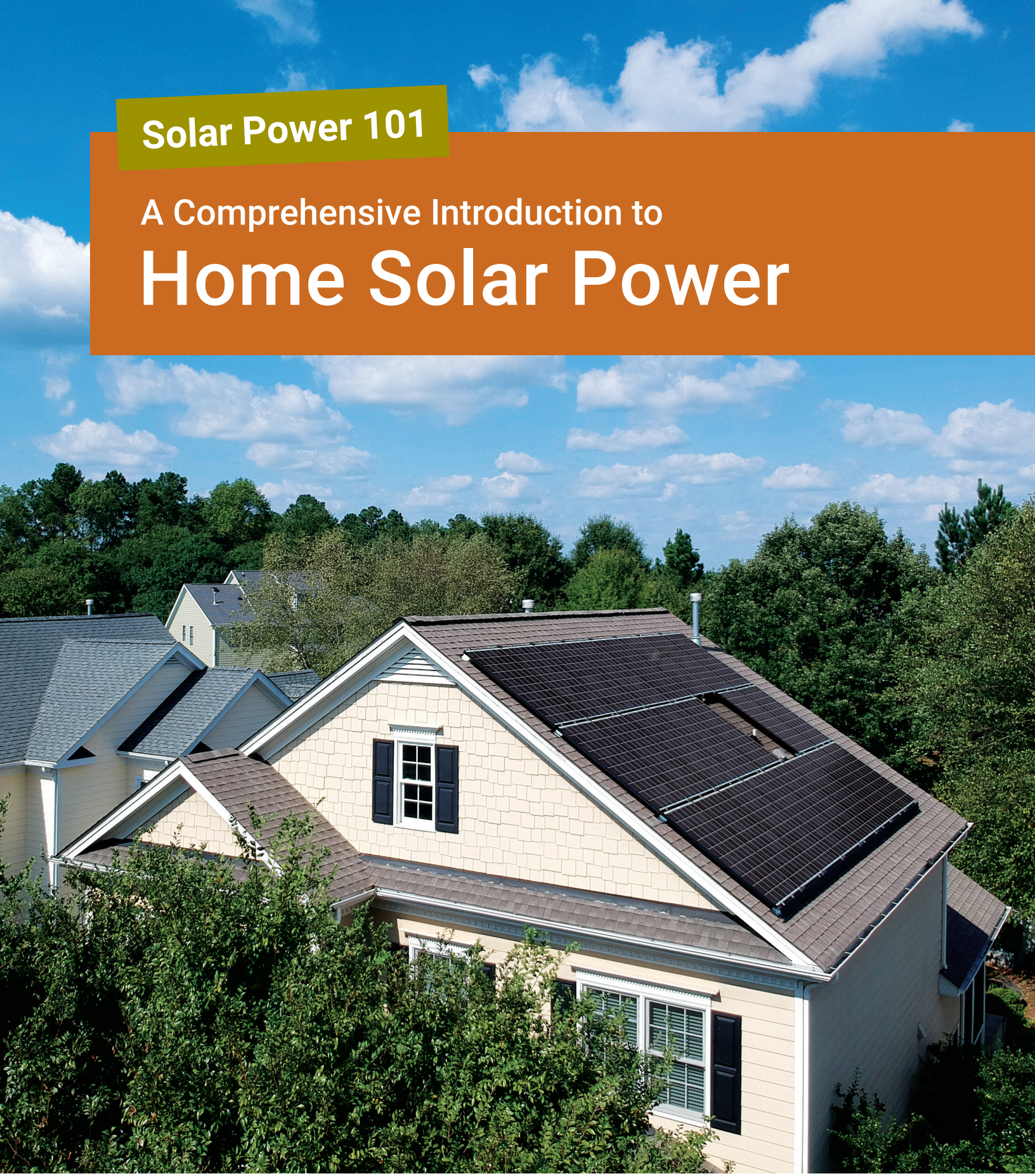
Solar Power 101

A Comprehensive Introduction to

Home Solar Power



SOUTHERN ENERGY MANAGEMENT

LEAD THE CHANGE

SOUTHERN-ENERGY.COM

V2.2

Hi There!

If you're curious about solar power, you've made a great decision to download this guide. Whether you're interested in going solar for the dollar savings, you're on a mission to lower your carbon footprint, you're looking for greater energy independence, or all of the above, having a strong understanding of solar basics will go a long way to assure you're making an impactful investment.

Not interested in reading? No problem! Our solar educators are happy to walk you through the basics. Just reach out and let us know you're ready to get started!

Table of Contents

PART 1

Solar Power Basics 3

- How Does Home Solar Work? 4
- Solar System Components 6
- Types of Solar Systems 10
- Connecting to Your Electric Utility 15
- Solar Production Basics 17
- Battery Storage 19
- Maintenance and Durability 20
- Process of Going Solar 22

PART 2

Is Your Home Right For Solar? 24

- Evaluating Solar Potential 25

PART 3

How Solar Friendly Is Your Neighborhood? 31

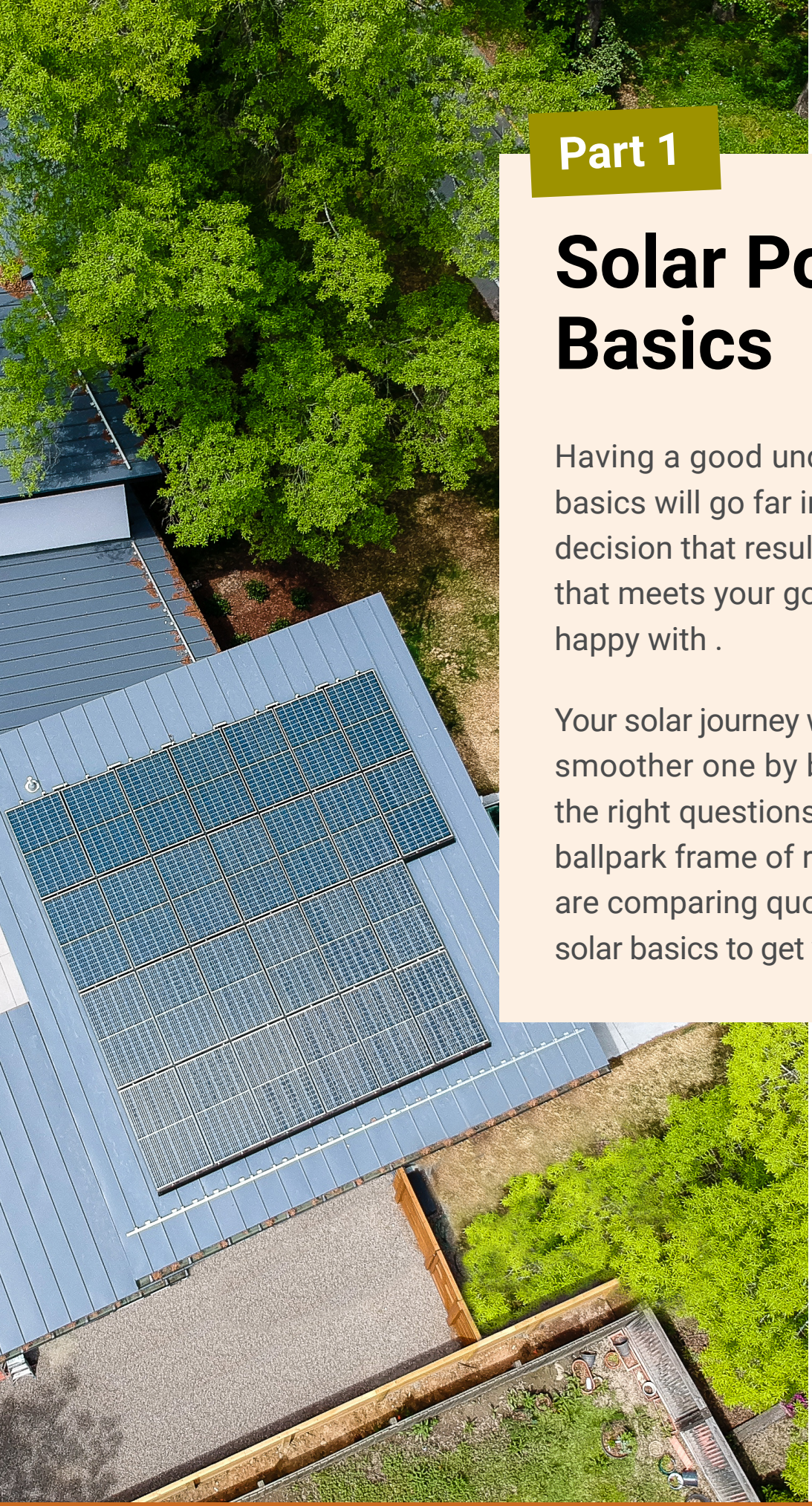
- Solar Friendly Neighborhood Policies 32

PART 4

What Size Solar System Do You Actually Need? 39

- Calculating Your Solar Needs 40

About Southern Energy Management 48



Part 1

Solar Power Basics

Having a good understanding of solar basics will go far in guiding you to a decision that results in a solar system that meets your goals and you are happy with .

Your solar journey will be a much smoother one by being able to ask the right questions and having a ballpark frame of reference when you are comparing quotes. Here are a few solar basics to get you started.

How Does Home Solar Work?

Here's an overview of how solar panels power your home in five simple steps.

1. Solar panels absorb sunlight and create direct current (DC) electricity.
2. The electricity is passed through an inverter which converts the DC electricity to usable alternating current (AC) electricity for your home.
3. Your home is now powered by the sun! Any excess electricity generated by your solar system is sent back to the grid and recorded as a credit on your monthly utility bill or purchased by the utility at a rate they set (we'll get to that later).
4. At night or when the sun is not shining, you will either draw electricity from the utility's grid or from your battery system (if you choose to install one).
5. You'll continue to rack up solar savings everyday for 30+ years while generating clean, renewable energy for your home and family.

What happens when the utility power goes out?

Solar panels generate electricity but they don't store it. When the utility power goes out, your system will not produce electricity without a battery. This is a common misunderstanding (and an understandable one) about how solar systems work! Almost all the systems we install are grid-tied. This means the solar system is connected to the utility's grid and sends power back to the grid when more solar electricity is produced than the home is using.

In the event of a grid failure or power outage, National Electrical Code requires that the solar system automatically shut-off to protect utility workers. If your system were to continue to generate power, it could injure linemen working to repair power lines that are being fed live power by your solar system. Shutting the system off is the best way to ensure everyone's safety, which is why it is required by code.

In order to have power during an outage, you'd need to add a battery backup system like a Tesla Powerwall. This will store the energy your system produces in the battery so you can continue to power your home off stored energy. During the day, the solar power you will recharge your battery. Learn more about battery storage and everything you need to know about the Powerwall in our Tesla Powerwall Guide.

QUIZ YOURSELF

1. Solar panels absorb sunlight and create _____ electricity.

a. Alternating Current (AC)
b. Direct Current (DC)
c. Recurring Current (RC)

2. When the sun is not shining you will draw electricity from:

a. The utility's grid
b. Battery storage (if you have it)
c. Either A or B

3. When the power goes out, your solar panels will store energy for you to use.

a. True
b. False

Answers: b, c, b

Solar System Components

What are the parts of a solar system?

Panels (aka Modules)

Solar panels absorb energy from the sun to generate power. There are many options when it comes to choosing a panel that can impact both appearance and performance. We'll take a closer look at this in the next section.

Inverter

Solar panels produce DC (direct current) electricity while your house runs on AC (alternating current) electricity. Your solar system will come equipped with an "inverter" which is the brain that will turn that DC into AC power to be usable in your home. The inverter also performs a lot of other important functions, like managing the power from the panels and making sure the right voltage is flowing into your home or back to the grid.

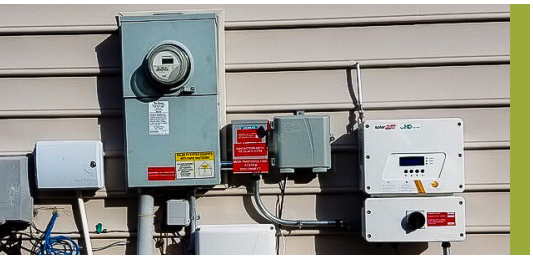
Racking

Solar racking, or mounting, is what holds the panels in place. On a roof mounted system, racking can be added to new homes during the construction process or retroactively to existing homes. The racking system we use involves installing clamps on the roof which clip into the panel's frame and are anchored to your roof rafters. Ground mounted systems require a racking frame to be engineered and securely anchored into the ground.

Optimizer

Optimizers are installed on the back of each solar panel to ensure that each solar module is able to produce at its maximum power even if another panel is shaded or has bird poop on it. They also help track performance so you can see how each panel is functioning which makes it easier to identify and troubleshoot any production issues. When the system is down, optimizers also automatically shut off power as a safety measure.

Optimizers perform a similar function to micro-inverters, but they stand up much more reliably to North Carolina's heat and humidity.



Meter

Once your solar system is installed, your utility will come out to switch your old meter with a fancy new bi-directional meter. The new meter will allow you to be properly credited for the solar energy you send back to your utility.

Monitoring

The final component, and arguably one of the most important, is your solar system monitoring. The systems we install come equipped with production **and** consumption monitoring so you can compare how much energy your panels are producing to how much energy you are using. See Page 17 for more info.

What are the parts of a solar panel?

After being in the solar industry for nearly 20+ years, we can tell you just how far solar panels have come in both efficiency and looks. There are three primary components of a solar panel: **solar cells, backsheet, and frame**. Each of these elements can come in different styles and be mixed and matched to achieve different looks at varying price points.

Solar Cells

There are two primary types of solar cells: polycrystalline (poly) and monocrystalline (mono).

Polycrystalline (Poly) Cells

Poly cells are instantly recognizable by their space-age blue hue. Until a few years ago, poly panels dominated the market because they were significantly less expensive to produce. Today, however, mono panels have fallen in price and have taken a rise in popularity. Poly panels are now most prevalent in commercial and utility scale solar projects where their distinctive appearance is less of a consideration.

Monocrystalline (Mono) Cells

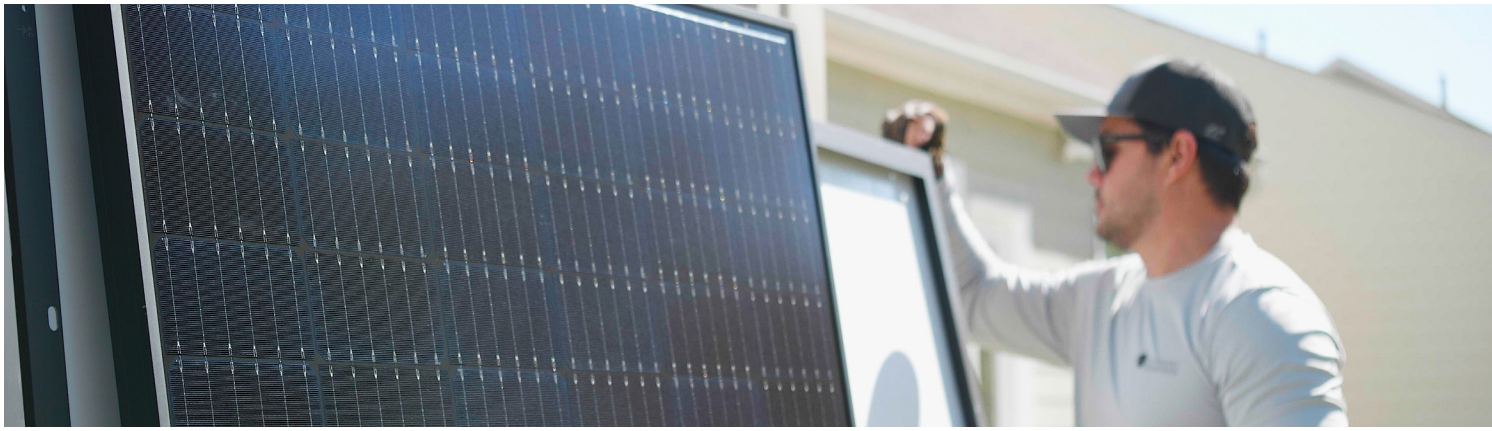
Mono cells are made from a single crystal which gives them their characteristic uniform black color. Not only are mono panels more sought after because of their sleek appearance, they are also more power dense and degrade less over time. The price of mono panels have dropped greatly over the past decade and they now make up the majority of our residential solar installations.

Frame

Much like a picture frame, a solar panel's frame is what holds the sandwich of glass, silicon cells, and back sheet together. Solar panel frames are made of light-weight and durable aluminum and come in two colors: black and silver. Both styles perform the same, so it all comes down to aesthetic preference. Silver frames are typically paired with a poly cell and come in at a lower price. Black frames are definitely more popular for residential solar systems and pair nicely with poly or mono cells.

Back Sheet

Beneath the silicon cells in a solar panel is a layer called a back sheet. The primary function of the back sheet is to protect the components inside the panel, however, it does impact their appearance as well! Solar back sheets come in black or white. Most homeowners prefer a black back sheet with black cells and a black frame so their panels blend in better with their asphalt roofs.



QUIZ YOURSELF

1. Polycrystalline (poly) cells have a recognizable _____ hue.

a. Blue
b. Black
c. Grey

2. Which type of cells are more power dense and degrade less over time?

a. Monocrystalline (Mono) Cells
b. Bicrystalline (Bi) Cells
c. Polycrystalline (Poly) Cells

3. Which component is the brain of your system that will turn that DC into AC power to be usable in your home?

a. Panel (Module)
b. Inverter
c. Meter

Answers: a, a, b

Types of Solar Systems

Solar systems are either installed on a roof or on the ground. Which location is right for your home depends on a host of factors like shading, HOA restrictions, size of your yard, orientation of your home, your roof line, and more.

Roof Mount

A roof mount system is just as it sounds — panels are attached to the roof and framing with racking hardware. There are 3 basic factors that determine whether a roof will be good for solar.

What Makes a Good Roof For Solar?

Space. We need a reasonable amount of unshaded space to put the system on your roof. An average 4-6 kW system (16-24 panels) will need 200-400 square feet.

Orientation. Roof space also needs to be oriented well to capture the maximum sunlight over the course of the year. South-facing is best, but east and west-facing roofs will work as well. We only really start to lose production when facing north.

Low Shading. Our design specialists conduct a shading analysis to make sure there aren't too many shadows from trees. We use a tool called a Suneye that measures and calculates the available solar energy of the site by day, month, and year.

Ground Mount

For a ground mount installation, a racking system is engineered, constructed, and anchored into the ground. The electrical wiring runs in an underground trench to the house and the system is connected to the meter. There are several pros and cons when considering a ground mount.

Pros

+ **Customization**
  Can be positioned due south for maximum solar exposure and can be designed as a carport or other custom structure
+ **Space**
  Not limited by roof space allowing a larger system size for maximum solar production
+ **Aesthetics**
  Great for customers concerned with home look, do not want it on their roof, are involved with a historical development/district that does not permit exterior changes, or have certain HOA restrictions

Cons

+ **Material Cost Increase**
  More material is needed to mount and run the ground mount to the meter on the home, there are also additional costs for trenching to your meter

Solar Shingles

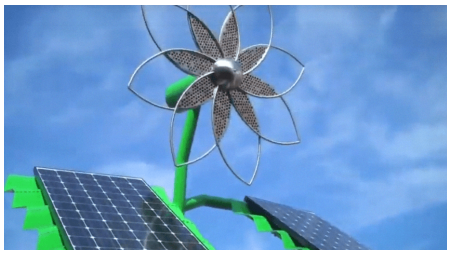
Solar shingles have been powering in and out of the headlines for the past few years after Tesla debuted their solar roof product. Although still in limited production, the future of solar is definitely S3XY with options that camouflage the appearance of rooftop solar. We hate to rain on this solar party, but when compared to a traditional system, there are few pros among even more cons to this technology in its current form.

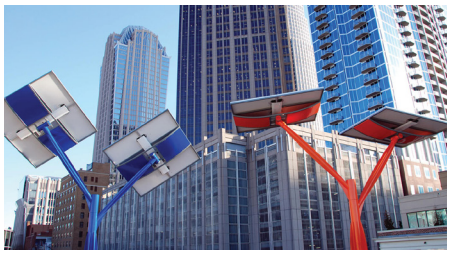
Solar shingles aren't a new concept, in fact we installed Dow's version of solar tiles in 2014 and a few predecessors even earlier. Although we dream of a beautiful future where solar is fully integrated into the design and build of a home, and HOA's have nothing to object to, our main concern is the savings potential of the solar shingles that are currently on the market.

Right now, solar shingles are much less power dense than their cousin the PV module. On top of that, a full roof replacement is required when switching to a solar roof so there is also a large increase in material and labor cost. This is why the payback on a solar roof is much longer than a traditional solar system. Check out our article Tesla Solar Roof: To Wait Or Not To Wait to learn more about the pros, cons, payback, and whether you should get in line for a solar roof in NC.

Custom Solar Structures

We love exploring creative options to integrate solar in the landscape and architecture of homes and businesses. Based upon your goals, custom solar structures can be as unique or as functional as you'd like. On the more practical end of the scale, awnings and parking lot shade shelters made from solar panels are a popular choice. We've designed and installed several of these systems including a beautiful porch roof constructed with frameless, glass-on-glass panels. Charging stations with solar umbrellas are an attractive alternative where form meets function. If you're looking for wow factor, custom structures like the power flower we installed at Marbles Kids Museum in downtown Raleigh or the solar tree we did at Charlotte Discovery Place are both eye-catching and educational.





Off-Grid Solar Systems

One of the most common goals we hear from solar curious people is “going off-grid”. In a true off-grid scenario, your home would not be connected to a utility company’s electric grid. You would produce all the electricity your home and family needs through your solar system during the day while also having a large battery storage system to hold enough energy to power you through the night. To maintain the average family’s lifestyle, this would mean a much larger financial investment.

Additionally, for a home that is already connected to the grid — or for a new home that can easily connect to the grid — going off-grid provides little to no practical benefit. It’s much less expensive and less complicated to reach annual net-zero energy usage (or even net-positive) by investing in a solar system while still maintaining your connection to the utility grid as a secondary source of power.

Energy independence and reaching a net-zero electricity use are definitely achievable — we just don’t typically recommend trying to go off-grid due to higher costs.

Alternative Solar Applications

There are many wonderful ways that solar can be used to power different parts of daily life. From solar powered weeding robots to powering vaccine refrigerators on the go, new and sometimes unusual solar technologies are always popping up. Two applications we are constantly asked about are solar pool heating and solar-thermal hot water systems.

Solar Pool Heating

Solar pool heaters work in a similar fashion to solar hot water heaters by cycling cold pool water through solar collectors which heat the water before it is returned to the pool. We do not install solar pool heaters because of how specialized the technology is. Instead, we advocate that a similar outcome can be achieved by offsetting the energy consumption of an electric heat pump with a traditional solar PV system while also being able to power other aspects of your home with clean, renewable energy.

Solar-Thermal Hot Water System

Solar thermal systems come in several varieties which all function slightly different. In general, a solar-thermal system heats water by transferring heat from the panels on the roof (known as the collector) to water that circulates through a series of pipes that run through the tank (known as a heat exchanger). This creates a circuit where cool water is pumped to the collector, heated by the power of the sun, then flows through the heat exchanger to the tank. As the water passes through the tank, it transmits its heat, cooling down to cycle through the process again.

Many years ago we installed these systems for solar hot water. However, as PV technology has advanced and prices have fallen, we've found that it is actually more economically viable for our customers to invest in whole home solar instead of focusing on solar water heating. If you are still interested in a solar hot water system, contact us for a recommendation.

QUIZ YOURSELF

1. Which direction should a roof face for optimal solar orientation?

a. North
b. East
c. South

2. Solar shingles are more power dense and less expensive than traditional PV solar systems.

a. True
b. False

3. All homes that have a solar system are "off-grid".

a. True
b. False

4. You can reach net-zero energy use without going "off-grid".

a. True
c. False

Answers: c, b, b, a

Connecting to Your Electric Utility

Types of Utility Interconnection

Each electric utility has its own solar policy for connecting your solar system to the electric grid, known as utility interconnection. Most of the time, solar homeowners will be generating more electricity than they can use when the sun is up, so knowing how the utility compensates for excess power sent to the grid is crucial for determining the economic benefit of a project.

Net Metering

In North Carolina, net metering is the best way to hook up a residential solar system to the grid. In a true net metering scenario, all excess electricity you produce is credited back to you on your account at the same rate as charged.

For example, if you are net metered, the power from your system will first flow into your home to power whatever is being used at that time. Any extra power will be sent back out to the utility for a **1:1 credit** to be used later. Depending on your utility, if you produce more electricity than you consume for an entire month, you can roll your credits forward to the next month. We dive deeper into how Duke Energy handles rollover on page 42.

Sell-Excess

Many co-op and municipal utilities require you to sell your solar energy back to them. Sell-excess interconnection is very similar to net metering except for one key difference — **any excess electricity you send back to the grid is purchased at a lower wholesale rate** instead of at the same retail rate you pay when you purchase power from the utility. Because of this, we generally design sell-excess solar systems to minimize the amount of solar production sent back to the grid to maximize your investment.

Buy-All-Sell-All

This is the most archaic and disappointing to solar dreams of the 3 interconnection types. This interconnection policy requires homes with solar to sell all of the electricity their system generates, typically at a low wholesale rate, while having to purchase all their power at the full consumer value. Under this model, there is a very low return on investment for solar unless a battery system is involved. This is how all solar used to be installed in NC, but luckily that is not the case anymore.

QUIZ YOURSELF

1. Which of the following is the most solar friendly interconnection policy?

a. Net Metering
b. Sell-Excess
c. Buy-All-Sell-All

2. In a true net metering scenario, _____ of the excess electricity a solar system generates will be sent back out to the utility for a 1:1 credit to be used later.

a. All
b. Some
c. None

3. Sell-excess requires you to sell all of the electricity your system generates, typically at a low wholesale rate.

a. True
b. False

Answers: a, a, b

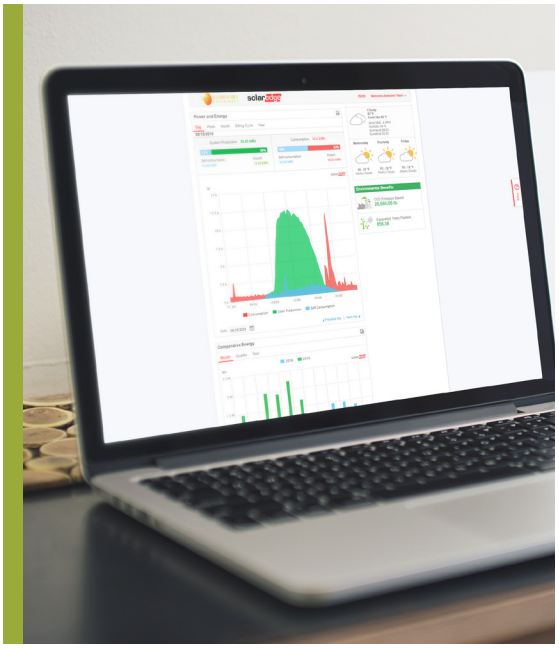
Solar Production Basics

What is a kilowatt hour (kWh)?

One of the first terms that will be critical to understanding and talking about solar production is the term kilowatt hour or kWh. A kilowatt hour is the measure of energy consumption of 1,000 watts for 1 hour. If you use a 100-watt light bulb for ten hours, you would use one kilowatt-hour (kWh) of energy. To gauge your average energy needs, you can find your kWh consumption amount typically under “Usage” on your electric bill.

Energy Monitoring

For you to get the most out of your solar system, it’s important to know how much energy you are using in relation to how much power your system is creating. Energy monitoring also allows you to track and make sure your system is performing optimally.



Most systems come with production monitoring, to show you how much power your solar system is producing. Consumption monitoring is equally as important, which is why we include it with our systems. Consumption habits have been proven to change when there is greater visibility and more awareness – just like how some people drive differently once they see their miles per gallon on their dashboard. By producing your own power and using energy more efficiently, you will be able to maximize your investment and increase your savings.

How does weather impact solar production?

As sun lovers, we're over the moon (and sun) that North Carolina sees an average of 214 sunny days per year. But what happens to solar production on those cloudy, rainy, and snowy days in between?

Clouds & Rain

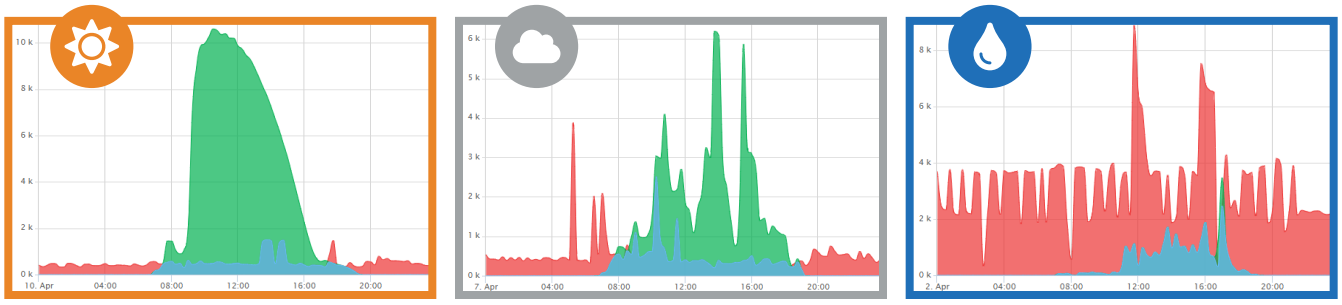
On gloomy days you can expect your solar production to dip, and when rain rolls in your production will dampen — just like our team's spirit. However, not all hope is lost! Your panels will still produce some energy when it's not so sunny and the rain will clean your panels for you.

Snow

When it snows, your solar production will grind to a halt as snow accumulates on your panels. Luckily for us sun-loving North Carolinians, we don't see very many snow days. Once the flakes stop falling, the snow on your system will either melt or slide off — no need to sweep off your solar panels! Up north where the skies are greyer and snowfall is heavier, snow loads have to be accounted for when engineering the structural design for solar panel systems. Fortunately for us, that's not an issue here!

What You'll See On Your Monitoring

The graphs below show the types of production and consumption patterns you might see on your energy monitoring depending on the weather.



Fun Fact – After the snow storm passes, you'll get great solar production because your system will be nice and cold which means there will be less resistance in its wires, allowing the electricity it generates to flow more easily from your panels to your home.

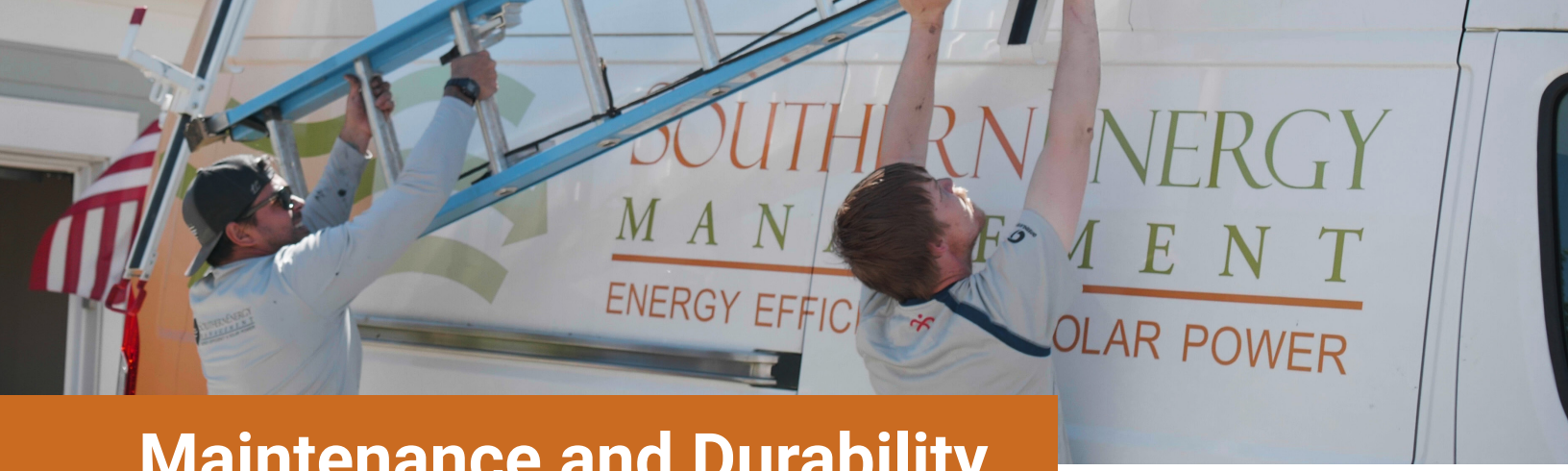
Battery Storage

What's the deal with battery storage?

Whether you're looking for energy security to keep your power on when power outages happen, or if you want to power more of your home with clean solar energy, battery storage will help you reach those goals. Batteries store the extra power your solar system produces to be used later by your home.

When the power goes out, batteries like Tesla's Powerwall or Generac's PWRcell will still operate and the home will automatically switch over to the batteries to draw power. On top of that, the solar system will keep recharging the batteries so you can keep the lights on and ice cream chilled while the utility is fixing its issues.

Beyond backup power, battery storage can also be used to capture a higher value for solar in areas served by utility providers that don't offer net metering or have more expensive rates during certain times of the day. In these scenarios, homes are able to maximize their solar savings potential by programming the battery system to store energy when rates are low to then be used when rates are high.



Maintenance and Durability

Do solar systems require maintenance?

Solar panel systems in North Carolina require little to no maintenance or cleaning. In areas like Arizona that have high dust and little precipitation, cleaning your solar panels is a thing. However, here in the South-East, our temperate climate and relatively frequent rainy days means dust and dirt don't really build up so cleaning your panels is not something you need to have on your to-do list. At most, homes with heavy tree coverage might experience some tree sap buildup. But if there is a significant amount of sap on your panels, you probably have trees too close to your home. We recommend that homeowners do not attempt to get on their roof to clean their panels — safety first!

For our friends at the coast, there is an official salt mist resistance test (IEC 61701) applied to solar panels. Any module that has this certification is rated to be installed along the coast. There are different levels to this test that give better protection the closer you get to the ocean, but most panels have at least level 1 certification.

Pollen

As for the NC pollen surge each year, there's no need to add your solar system to your spring cleaning list. We model in the production loss from soiling (pollen, leaves, dust, water, deposits, etc.) when we design your system. One of our customers actually put their system to the test by tracking the impact of pollen on their solar system's production. Based on what they tracked and calculated from their monitoring data, there was an insignificant decrease in production during pollen season. Ultimately, the lost production value is minimal and not worth a pricey cleaning service fee. You're best to tap into mother nature's free cleaning service by waiting for the next rain to come through.

How durable are solar panels?

In North Carolina, knowing how your solar system will hold up to hurricane force winds is important. Luckily, this isn't something you need to spend any time worrying about.

Through our design and permitting process, the solar systems we install are specifically engineered to endure high wind-speeds and are tested by manufacturers to ensure they can survive hurricane conditions. Solar panels are certified to withstand winds of up to approximately 140 miles-per-hour. As long as your roof is in place, your panels will be right there with it. Additionally, the typical aluminum and glass casings that hold solar cells are highly waterproof, even during extreme rain. As for hail, panels are also engineered to bear the impact of hail 1" in diameter.

With that said: trees, falling limbs, and other debris could damage your solar system or the surrounding roof may be damaged. The good news is that the racking system we use allows us to easily remove the panels so that the roof can be repaired. If either of these events occur, the damages should be covered by your homeowners insurance and we will work with you to make sure you have all the information you need to file a claim.

Solar System Warranties

Most panels typically carry a 12 year product warranty and a 25 year power output warranty. The power output warranty guarantees that, in 25 years, each panel will produce approximately 85% as much electricity as it does when it's first installed (the exact percentage varies by manufacturer). Note — after year 25, your panels will still continue to produce energy and will continue to degrade at the same rate. If a panel's production level drops below the linear degradation rate defined in its warranty, the manufacturer will replace the panel! The inverter also has a standard 12 year warranty, while the optimizers will come with a 25 year warranty.

Process of Going Solar

Every solar company's process for helping you go solar is a little bit different, so we can only speak to how we do things.

Get Started

Here at Southern Energy Mangement, your solar journey begins as soon as you let us know you're ready. Just fill out a free quote request online, give us a call, or even stop by our office!

Solar Education

Once you've reached out, one of our solar educators will be in touch to answer any questions you might still have about solar power and provide you with a preliminary site assessment to determine if solar is a good fit for your home.

Site Visit

If your home checks all the boxes for solar, and you're ready to continue on your journey, your educator will schedule a site visit for one of our solar designers perform a shade analysis, review your energy use, and go over your goals for going solar.

Custom Design

Your designer will use this data to design a custom solar system for your home and goals with a detailed breakdown of your installation costs and solar savings. We'll work with you to modify our proposal as many times as you want to make sure we've built the perfect solar energy system for you.

Sign Up

Now your solar journey really kicks into gear. Once you're happy with your proposal and have signed your contract to partner with us, our in-house team springs into action to make your on-paper solar energy system a reality on your roof (or ground).

Pre-Install

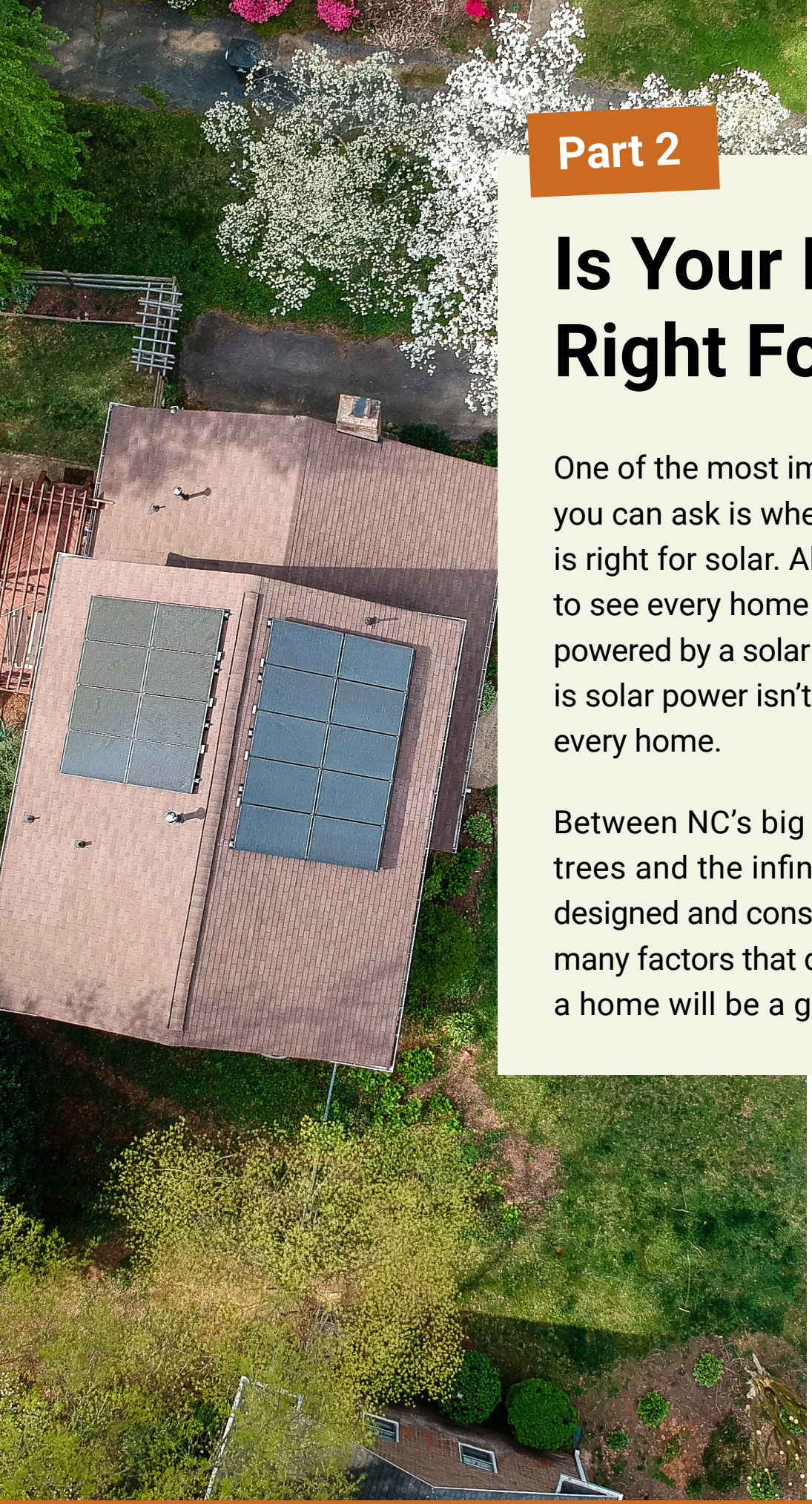
Our solar dream team gets to work securing the right permits from your utility and local inspections department and ordering all the equipment for your solar project. This phase generally lasts **30-60 days**, depending on the permitting requirements.

Solar Installation

This is the fun part! We'll work with you to schedule a time to install your solar system and then knock out all of the required follow-up inspections. All this happens without you lifting a finger (unless it's summer and you decide to make our field team some ice cold lemonade). Our average residential install takes 1-5 business days.

Start Saving!

Your solar journey is complete! Your system is up and running generating clean solar energy everyday. You can sit back and enjoy the financial and environmental benefits of solar for the next 30+ years!



Part 2

Is Your Home Right For Solar?

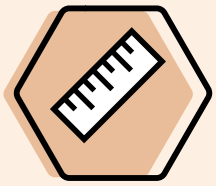
One of the most important questions you can ask is whether your home is right for solar. Although we'd love to see every home in North Carolina powered by a solar system, the reality is solar power isn't a good match for every home.

Between NC's big beautiful pine trees and the infinite ways homes are designed and constructed, there are many factors that determine whether a home will be a good fit for solar.

Evaluating Solar Potential

What factors do we look at to determine a home's solar potential?

While some of these factors have stronger solar implications than others, finding the right balance between how each of these six areas impact the other is important for maximizing your solar savings.



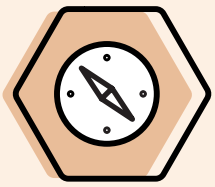
Space

Shading

Location

Tilt

Roof Age



Orientation

Space

We need a reasonable amount of unshaded space to put a solar system on your roof. An average 4-6 kW system (16-24 panels) will need 200-400 square feet. Beyond shading, vents, dormers, and other elements of your roof structure can limit the amount of space we have to work with when designing a solar system for you. There are also several other criteria that we look for in a roof to capture the maximum sunlight over the course of the year. We'll dive deeper into these in a moment.

If your roof has limited or shaded roof space, don't worry! We can install a ground mount solar system as well. The biggest benefit of going with a ground mount system is that shading can be avoided. Since ground mounts are not limited by roof size or orientation, you may have more options when it comes to designing a system to meet your solar goals. We have some creative install methods, so you will have plenty of choices for how the system looks whether it's a carport, pergola, low ground-mount, or something else!



Shading

Shading is public enemy #1 when it comes to solar production. While solar cell technology has evolved to produce energy from the diffused light present on overcast days, energy cannot be generated in *complete* shade. Shade can come from many sources but when it comes down to it, the real MVP of shading is trees.

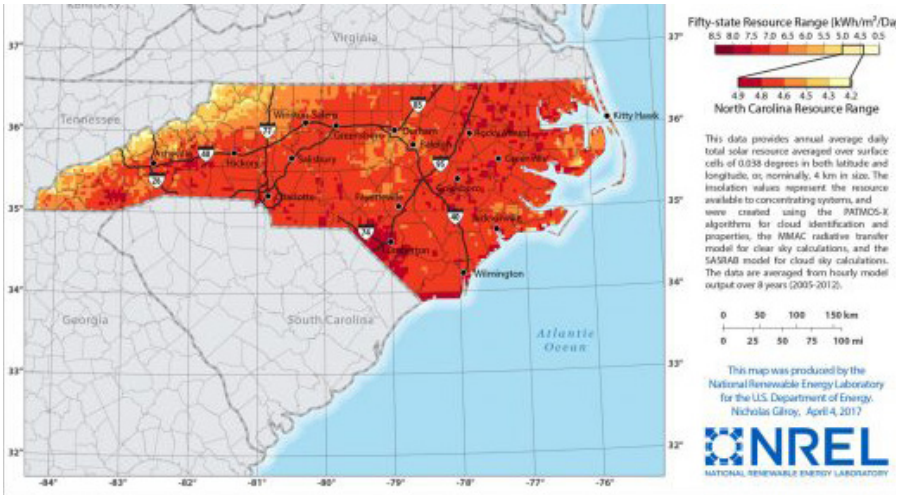
This is why an in-depth assessment of your home (and trees) is so important when going solar. The best way to gauge exactly how shading will impact your solar potential is by having a solar technician assess your home to evaluate whether we can position your solar array to avoid shading or if you'll have to cut back or remove trees to make solar feasible. We typically do not like to recommend tree removal (we love trees!), but we also want you to have optimal solar production and will list it as a potential solution.

SunEye Shade Analysis Tool

How does a solar designer know how much shading your home will have? The answer is simple and reliable. We use a device called a SunEye that allows us to determine the solar potential of a roof. Its name is fitting as it has a fish-eye lens that assesses the total solar production of a site based on the shading of the area. This includes simulating if shading elements are added or removed in addition to giving information about the roof pitch and azimuth angle. The SunEye can also take into account the tilt and orientation of possible solar panels for a full scope of your solar potential.

Location

The amount of solar energy that hits an area (also called solar irradiation) depends on its distance from the equator and local weather conditions. For example, according to the National Renewable Energy Laboratory (NREL), North Carolina averages around 4-5 kilowatt hours of solar energy per square meter. This is more than the < 4 kilowatt hours per square meter that Alaska receives since Alaska is further from the equator. But this is also a little less than the American Southwest — which averages 5-6 kilowatt hours per square meter — despite the fact that we are similar distances from the equator since the Southwest has less precipitation throughout the year. **Basically, the sunny Carolinas are great for solar!**

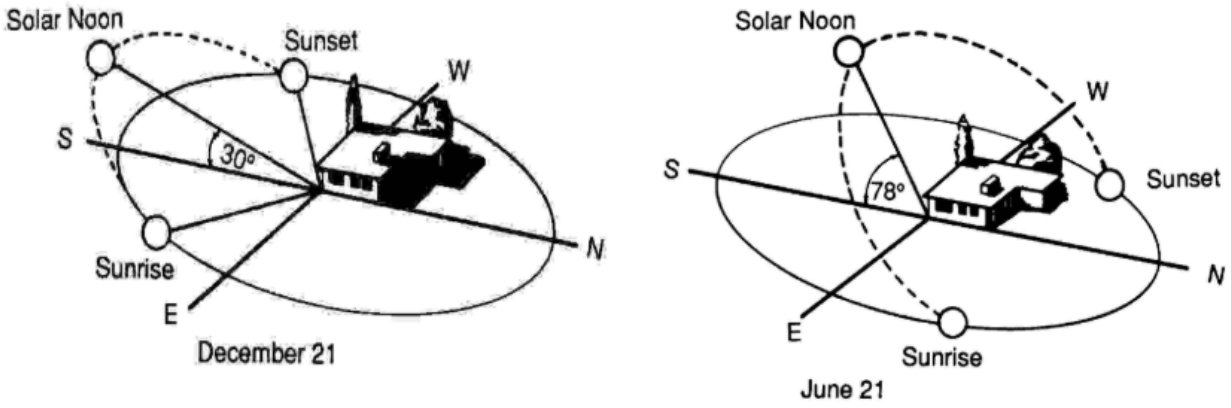


As you can see in NREL's North Carolina specific map, solar irradiation is fairly constant across our state with the Great "Smoky" Mountains really being the only place where solar potential drops a little.

Source: www.nrel.gov/gis/images/state-level-resource-maps/dni/North-Carolina-DNI-2017-01.jpg

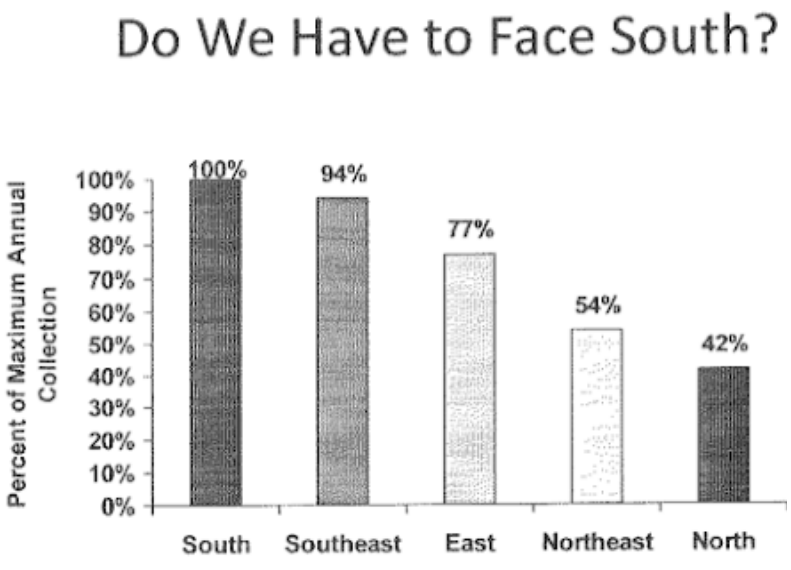
Orientation

Azimuth (pronounced az + uh + muhth) is the fancy solar industry term we use when referring to the cardinal orientation (north, south, east, west) of your solar system. Because North Carolina is in the Northern Hemisphere, sunlight hits from a southern angle. As a result, a solar system needs to be installed facing south to be optimized for solar production. You can see how the sun remains in the south, even as its position in the sky changes throughout the year, in this diagram:



Source: www.nrel.gov/docs/fy04osti/35297.pdf

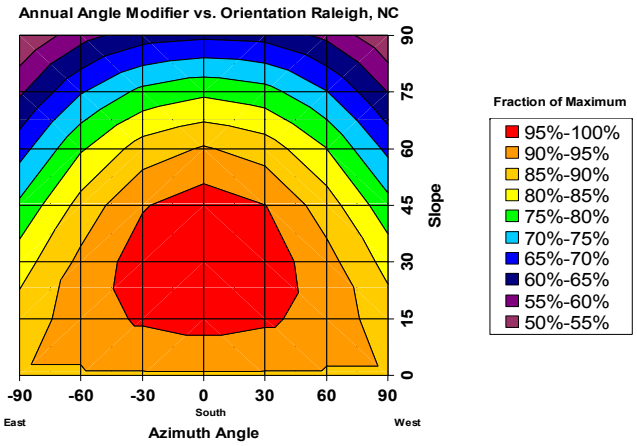
A perfectly south facing system would have an azimuth of 180° south. While south facing systems are optimal, the azimuth angle can range by 90° east or west and still receive a highly productive amount of sunlight. Production only really starts to drop off when we face panels northward (so we avoid that in 99% of cases). Check out the differences between azimuth angles in this chart.



Source: www.nrel.gov/docs/fy04osti/35297.pdf

Tilt

A solar panel's tilt is its angle relative to the ground. For a roof mounted solar system the tilt will equal the roof's pitch (unless it's a flat roof). Roof pitch is commonly measured on a rise-over-run ratio, so your roof pitch may be 6/12 or 7/12. Most homes typically range around 4/12 to 9/12 which translates from 19° to 37°. The ideal pitch for a solar system in North Carolina with an azimuth of 180° is between 30° and 35° or a 7/12 to 8/12 roof pitch. As a solar system's azimuth gets further away from south, flatter tilts are more advantageous. This psychedelic graph from Solmetric (the company that makes Suneye) shows the impact of tilt and azimuth on optimal solar production for Durham, NC.



For ground mount solar systems we aren't tied to a predetermined roof pitch so we can set the tilt to the optimal 30°-35°. For flat roofs systems, however, we generally limit the tilt to below 15° in order reduce the array's exposure to wind. You can check out the optimal azimuth and tilt for your location with Solmetrics' calculator.

Roof Age

If you think you will need to replace your roof in the very near future, we recommend doing that before installing solar panels. But if your roof can hang on for another 2-3 years you might consider installing solar now to take advantage of the 26% Federal Investment Tax Credit for solar before it starts to sunset.

When you do need to re-roof, give us a call and we'll simply take the panels down but leave the racking up. The roofers will re-flash all the feet, and then re-shingle. Afterwards, we'll put the panels back up and you'll be capturing your solar savings again!

If your roof is fairly new or in good shape, now is a great time to go solar. The panels will actually protect the roof, and when it comes time to re-roof we may not have to take down the modules and you can replace shingles around it. Should you have any questions about your roof, our solar designers will take a look at it during your on-site assessment and give you a recommendation.

A Note About Online Solar Estimate Tools

There are plenty of online solar estimate tools and calculators out there like Google's Project Sunroof and Solar-Estimate. These are great tools to give you a general idea to get started on your solar journey, and many of them will connect you with nearby solar professionals. However, designing a solar system based on limited factors like home's square feet will not give an accurate representation of what size system is needed to meet that home's energy needs.

Ultimately, a personalized solar assessment is really the best way to get an accurate estimate of your home's solar production potential and what the savings will look like for you based on your specific site and historic energy use.

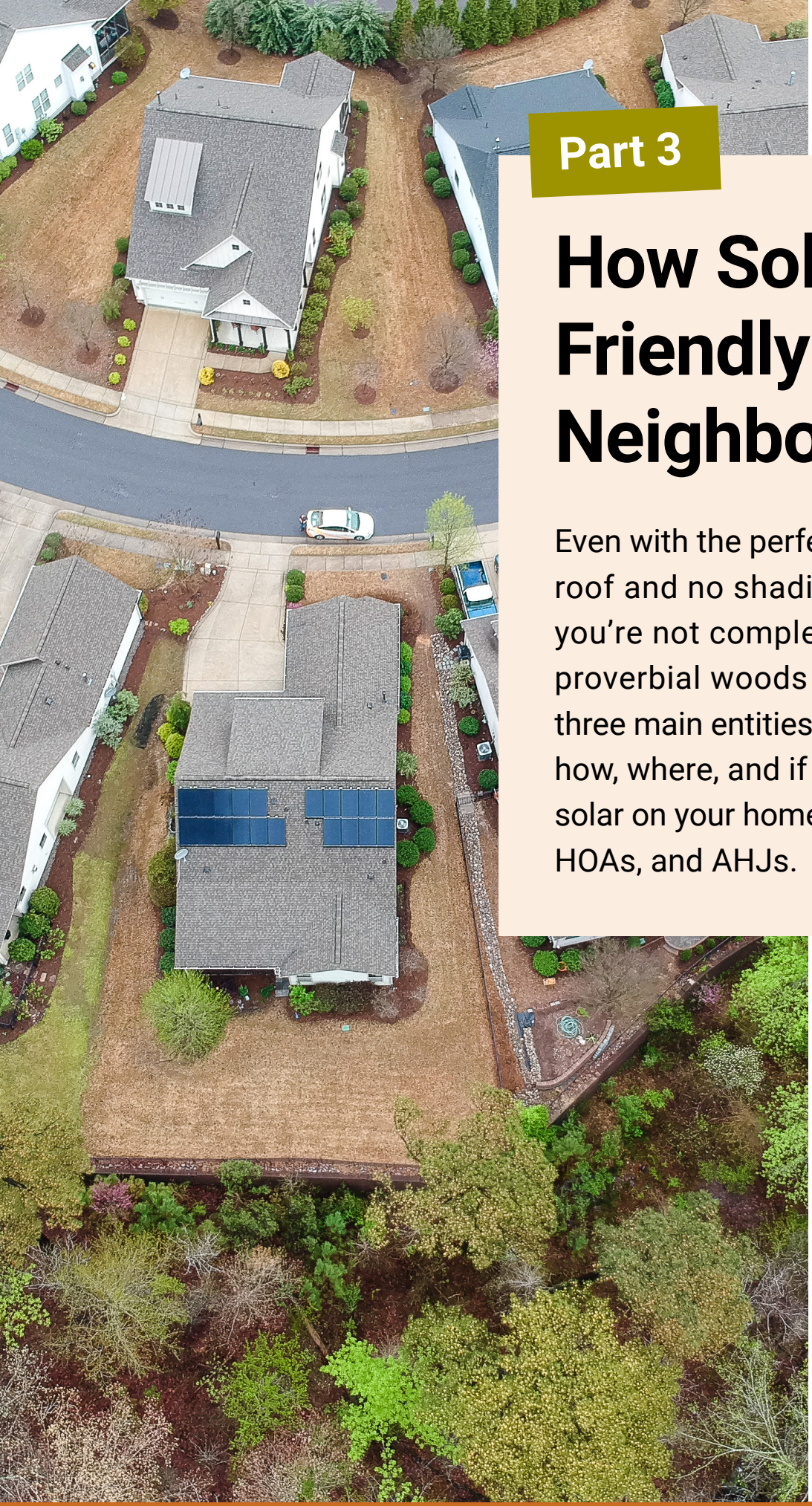
QUIZ YOURSELF

1. **_____ is the fancy solar industry term we use when referring to the cardinal orientation (north, south, east, west) of your solar array.**
   a. P-N Junction
   b. Solar Irradiation
   c. Azimuth

2. **While south facing systems are optimal, the azimuth angle can range by 90° east or west and still receive a highly productive amount of sunlight.**
   a. True
   b. False

3. **Once a solar system is installed, it cannot be taken down to replace the roof.**
   a. True
   b. False

Answers: c, a, b



Part 3

How Solar Friendly Is Your Neighborhood?

Even with the perfect south facing roof and no shading from trees, you're not completely out of the proverbial woods yet. There are three main entities that can restrict how, where, and if you can install solar on your home: Electric Utilities, HOAs, and AHJs.

Solar Friendly Neighborhood Policies

These are the top barriers that you should look out for when figuring out if where you live is solar friendly, in order of importance:

- **Electric Utility**
- **Homeowners Association (if you have one)**
- **Local Permitting and Inspections Department aka Authority Having Jurisdiction**

All solar customers in NC have to get the proper permits and approval through their utility and local jurisdiction and many also have the added burden of their Homeowners Association. Luckily, we handle all of the onerous paperwork and hoop jumping on our customers' behalf.

We have lots of experience dealing with these entities, which makes the process smoother and more efficient – but this is still one of the biggest barriers to solar cost and install speed in the US. This is especially true when compared to other countries with high solar adoption like Germany — where the permitting and interconnection process is more streamlined and standardized.

Electric Utility

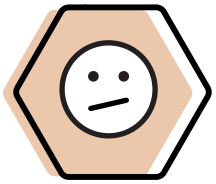
Your utility is the most important 3rd party entity influencing your ability to make the switch to solar. Each utility can set their own rules for how you interconnect to their electric grid and how they credit you for your solar production. How your utilities handle these factors can make or break the viability of your home solar system.

Types of Interconnection

Most of the time, homeowners with solar will be generating more electricity than they can use when the sun is up. Understanding how the utility compensates for the extra power you send to the grid is crucial for figuring out if solar will be beneficial for you.

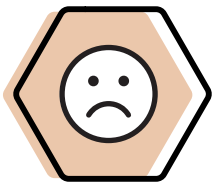
Net Metering

In a true net metering scenario, all excess electricity you produce is credited back to you on your account at the same rate as charged.



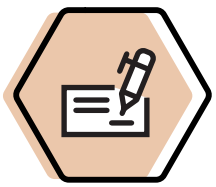
Sell-Excess

This allows you to use the electricity created by your solar panels to power your home during the day, but you are forced to sell back any excess at a lower rate than what you pay. It can work out pretty well if you have a high daytime electric demand, especially since we can size the system to minimize how much you export.



Buy-All-Sell-All

This super lame and archaic policy requires you sell all electricity back to the utility at a low, wholesale rate.



Other Fees

For example, these can include interconnection fees, pesky admin fees, etc.

Types of Utilities

There are more than 100 unique utility providers across North Carolina. NC Utilities are broken into 3 main groups:

Investor Owned Utilities (IOUs)

- **Have net metering in NC**
- **These are the big guys. They are regulated monopolies which have all aspects of their service and electric rates overseen by the North Carolina Utilities Commission.**
- **Examples**
  Duke Energy, Duke Energy Progress, and Dominion Power

Electric Membership Cooperatives (EMCs)

- **Probably have net metering or a modified version of it**
- **These utilities serve historically rural areas and were established during the New Deal to bring electricity to rural areas. Thanks FDR!**
- **Examples**
  Piedmont EMC, Central EMC, South River EMC, Wake EMC

Municipal Utilities

- **Not Net Metering, probably Buy-All-Sell-All around 4 cents per kWh**
- **These are utilities administered by local municipalities. They generally have the highest rates for electricity in the state and the worst solar interconnection policies. This means that the customers who could benefit from solar the most (those with the highest bills) are prevented from doing so because of their local government.**
- **Examples**
  Rocky Mount, Wilson, Wake Forest Power, Fayetteville PWC

What are your options if your utility is not solar friendly?

The best solution to this issue is a solar PV system with battery backup. This way, all excess electricity is stored in your home battery (Tesla Powerwall or Generac PWRcell) and each day after the sun goes down, your batteries provide electricity until they run out. After your batteries are drained, you would buy electricity from the grid at the same rate you do now. If solar + storage isn't a viable option for your home at the moment, you can still take action toward getting solar into your community.

Reach out. Double check with your utility company, see if their policy will be changing anytime soon.

Learn more. Contact North Carolina Sustainable Energy Association to find out how you can advocate for Net Metering options with your utility and make solar an option for you and your home.

Become a solar advocate! Urge your utility to join the 21st century by adopting net metering, especially if you are in a co-op!

Homeowners Association (HOAs)

After the utility, Homeowners' Associations are the biggest 3rd party roadblock to going solar. If you don't have an HOA then 1) count your blessings, and 2) feel free to skip this section. In 99% of cases, HOAs are not hard barriers for solar, but they can slow the process down and might impact your system design.

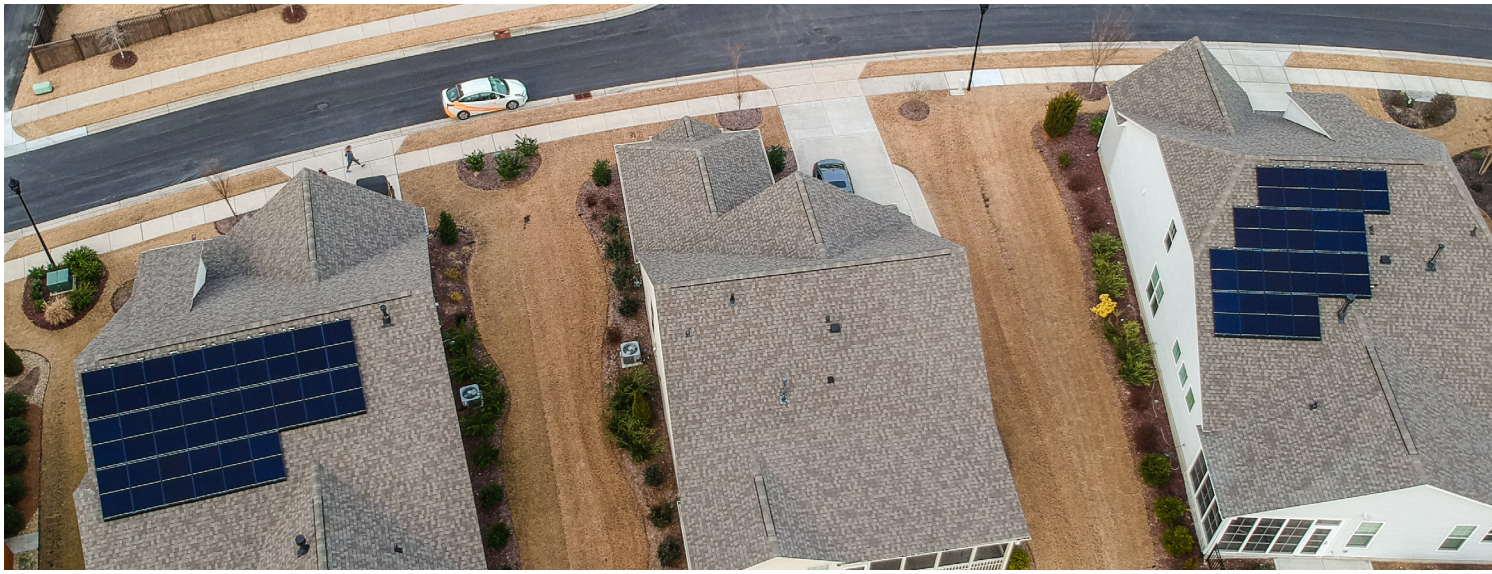
Solar Access Law

In 2007, North Carolina passed a solar access law (N.C. Gen. Stat. 160A-201) which prevents an HOA from establishing rules that outright prohibit solar after Oct 1, 2007. However, The law does allow HOAs to create restrictions and regulations on solar installations on the front of a home and on roofs that face common/public areas.

Getting Your HOA On Board

In cases where an HOA regulates front of roof installs, we work with homeowners to present their case for approval to the HOA. To support our argument, we equip homeowners with custom 3D renderings of what the panels will look like on their roof and with pictures of solar systems we have installed on comparable homes in similar communities in the past.

Most of the battle with HOAs is a lack of familiarity with solar. Once we show them examples of solar in the 21st century, the HOA typically becomes more comfortable with the look and feel and their fears of bright blue Carter-era roof monstrosities disappear. In some cases, though, we do have to modify our system design by moving the panels to side roofs which might result in less solar production.

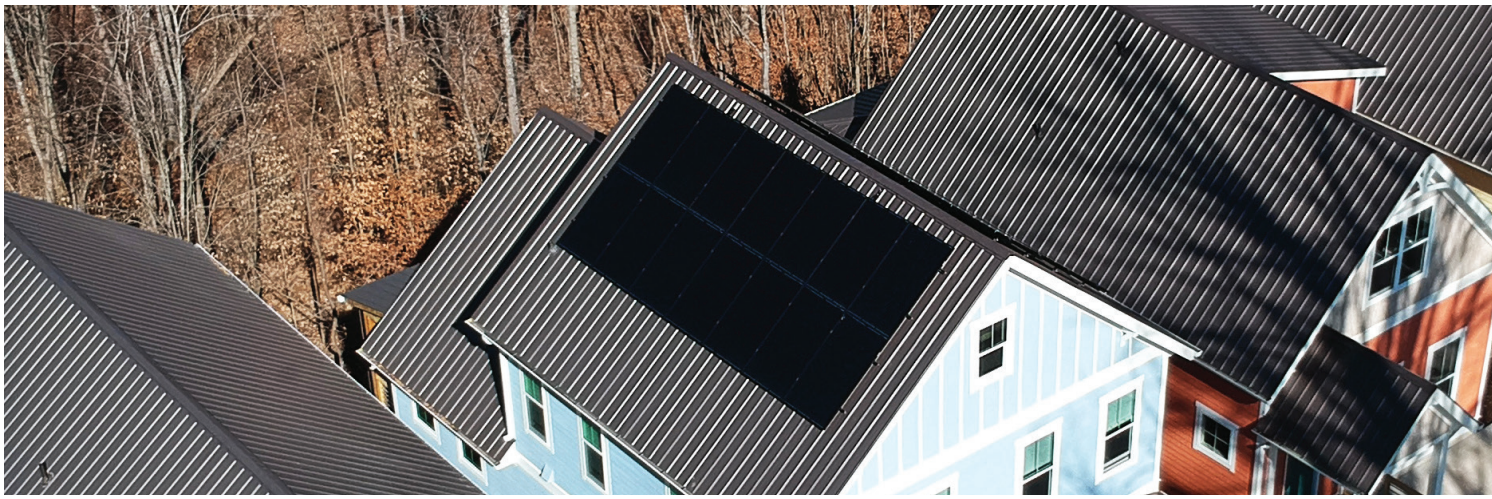


Local Permitting and Inspections Departments

Last on our list of 3rd party stakeholders is your local permitting and inspections departments or Authority Having Jurisdiction (AHJs). AHJs do not restrict you from going solar, but they can impact the timeline of your project. There are over 900 unique local jurisdictions in North Carolina, each with the ability to enforce different standards and requirements for solar, and each with a group of inspectors with differing familiarity with how solar works. The result is a large degree of variability in what it takes to get a permit to install solar across North Carolina.

Luckily we handle all the permitting and interconnection paperwork for our Shine customers, but to get a sense of what we're up against here are a few examples:

- To install a residential rooftop solar system in Wake County's jurisdiction, only an electrical permit is needed and no engineered designs are required to be submitted with the permit application. There is no plan review, and the permit will normally be issued within one day of the application's submittal.
- For the same exact project in the Town of Cary's jurisdiction, the permitting process would look very different. In this case, both a building and electrical permit would be required, the permit application would need to be supported by electrical and structural engineered designs, and the application would undergo a plan review normally spanning 2 weeks.
- In an extreme example, Perquiman's County Planning and Zoning department required us to send a letter to a multinational corporation headquartered in California, who happened to own the 2 tracts of wide-open farm land adjacent to one of our customer's lots (pictured above). We were tasked to ask them to attend a formal architectural review for a rooftop solar system to make sure the company would not be bothered by the [non-existent] glare from our system. Predictably, this mega-corp did not respond to our letter or attend the county's review meeting to speak on behalf of their empty fields to protect them from the deadly "solar glare" from the homeowner's system. The homeowner was able to go solar at the end of the day, so all's well that ends well– even if it was ridiculous approval process.



Again, at the end of the day, your local jurisdiction will only affect your project timeline and will not stop you from going solar, so it doesn't need to be a consideration when you're making the decision to power up with clean energy. After two decades of experience working in NC, we have developed familiarity with many of NC permitting jurisdictions and know exactly how to navigate their unique requirements and quirks on behalf of our customers. Ultimately, if we can check off your utility as solar friendly, we'll make sure the other two get on board as well.

QUIZ YOURSELF

1. Which type of utility is most solar friendly in North Carolina?

a. Investor Owned Utilities (IOUs)
b. Electric Membership Cooperatives (EMCs)
c. Municipal Utilities

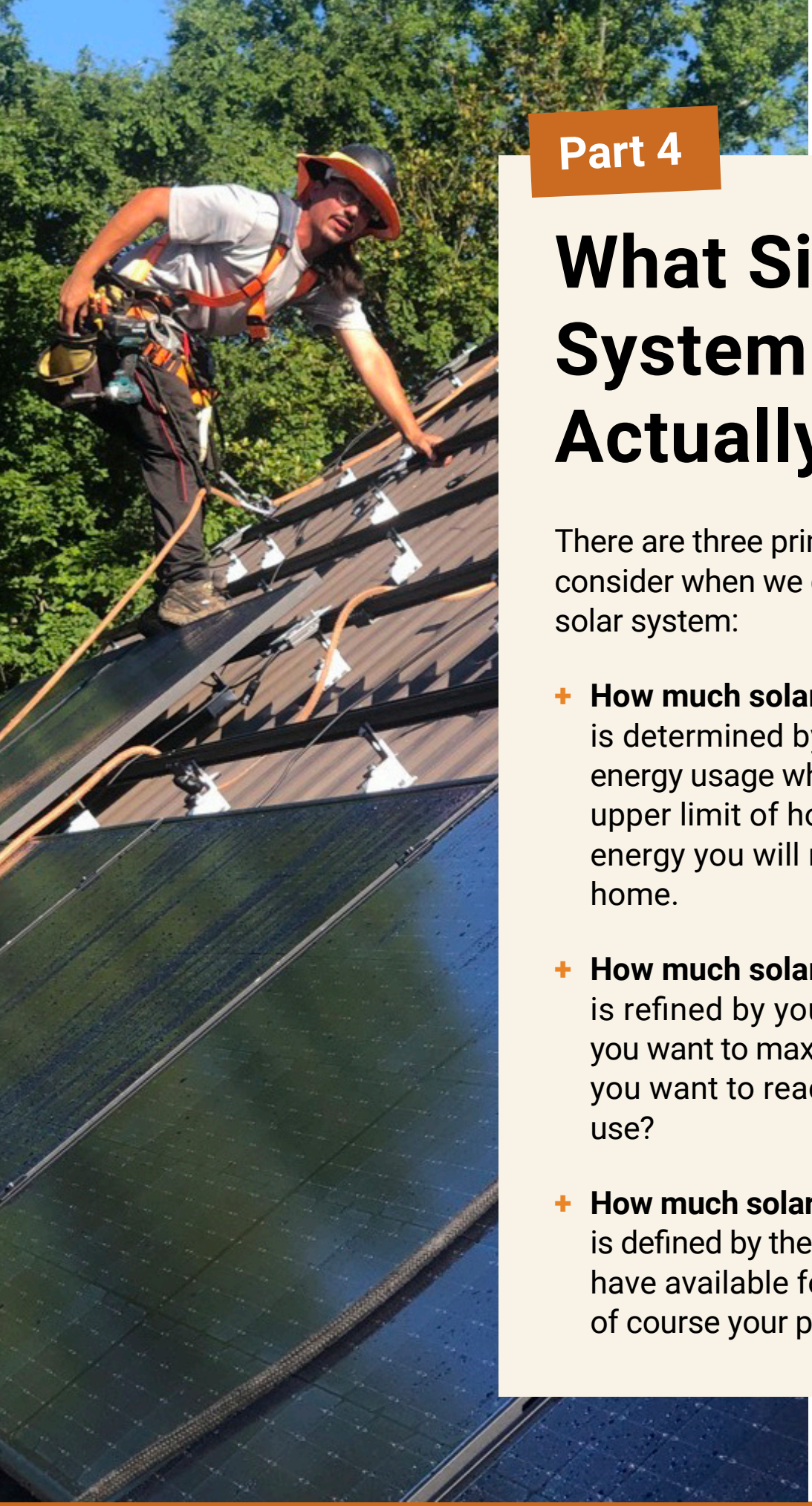
2. The Solar Access Law allows HOAs to establish rules that outright prohibit solar after Oct 1, 2007.

a. True
b. False

3. You do not need a permit to have a solar system installed on your home.

a. True
b. False

Answers: a, b, b,



Part 4

What Size Solar System Do You Actually Need?

There are three primary factors we consider when we design your custom solar system:

+ **How much solar you NEED** is determined by your home's energy usage which tells us the upper limit of how much solar energy you will need to power your home.

+ **How much solar you SHOULD get** is refined by your savings goal. Do you want to maximize your ROI or do you want to reach net-zero energy use?

+ **How much solar you CAN get** is defined by the eligible space you have available for a system — and of course your project budget.

Calculating Your Solar Needs

ENERGY USE =

How Much Solar You NEED

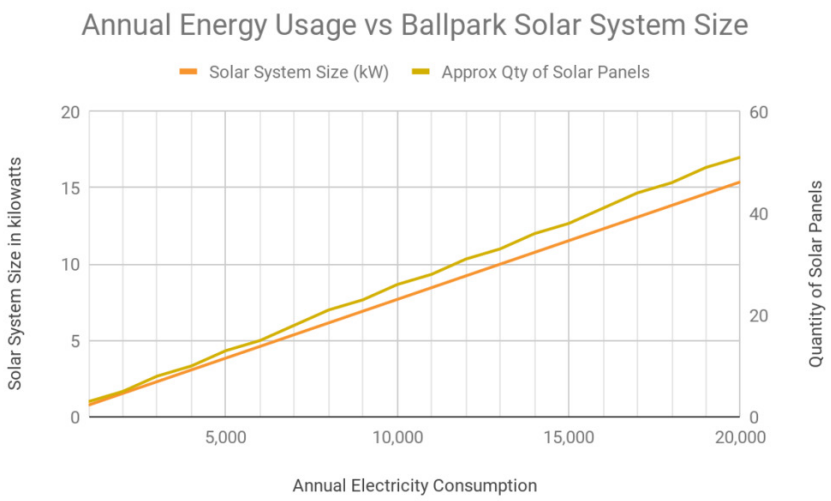
We always start with energy usage when sizing a solar system. For existing homes we prefer to look at your previous 12 months of electric bills so we can establish a good sense of your energy usage patterns over the course of a year. If we aren't able to get a full 12 month view of your bills, we can estimate your monthly usage based on your peak winter and peak summer usage while factoring in whether you use natural gas or electricity for heating.

For new construction homes, our building science team can create an energy model for your home that predicts your future energy usage (if you are building your home with one of our 200+ NC Builder partners, then we've probably already generated this model).

Once we have a sense of your electric consumption needs, we'll talk with you about any events on the horizon that might impact your usage. Are you thinking about getting an electric vehicle? Are your kids moving out soon? Are you going to get a pool with your Christmas bonus? Are you contemplating mining Bitcoin or starting a hydroponic farm? We'll take all of these changes into account to appropriately size your system up or down.

Ballparking A Solar System Size With Your Annual Usage

From your annual electricity and monthly consumption pattern, we can ballpark a general system size for you. To do this, we use a rule-of-thumb number for solar production in NC to estimate your needed system size. Based on our experience, our rule of thumb is that 1 kilowatt (kW) of solar installed in NC will produce 1,300 kilowatt hours (kWh) per year. So if your home uses 12,000 kWh per year, we'd estimate you need around a 9.2 kW solar system to meet 100% of your energy needs (12,000/1,300 = 9.2).

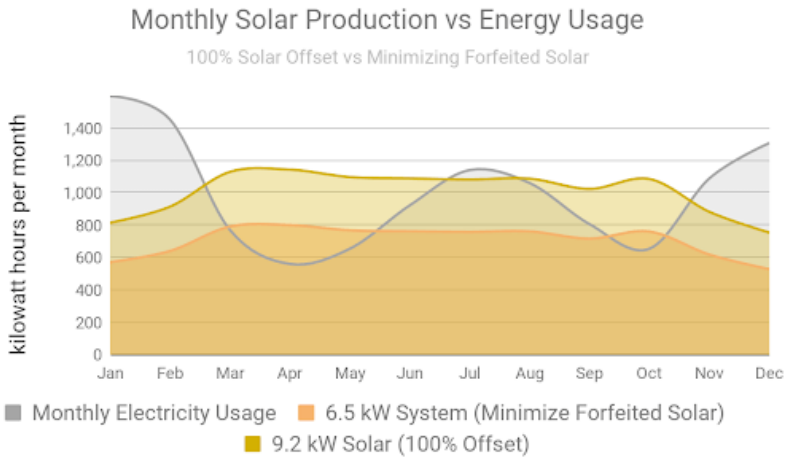


Remember, this is just an initial rough estimate. We always refine your system size with more accurate annual production estimates based on the exact solar potential of your site after we perform a full evaluation of your home, discuss your goals of going solar, and work through any limitations if encountered. With that said, this graph shows how this rough estimation translates to solar kW and number of solar panels.

SAVINGS GOALS =

How Much Solar You SHOULD Get

This graph shows the balance we are trying to reach between monthly usage for an average NC home using electric heating (a home with natural gas heating would not have a winter spike in usage) and monthly solar production. Overlayed on top of the home's energy usage is the production from two solar systems — one that offsets 100% of the home's annual usage and one that minimizes the amount of energy that will be forfeited to Duke Energy (any excess solar production from your solar system accumulates as credits that go toward your electric bill until the end of May, when it is zeroed out by Duke).



Based on our more detailed comparison of monthly usage vs solar production we might refine our recommended system size for this home from 9.2 kW to 6.5 kW if maximizing your ROI is your main goal. I say might, because our solar designers will weigh your cost of forfeiting some production to your utility vs the cost efficiencies of having a larger system which produces more total savings.

LIMITING FACTORS =

How Much Solar You CAN Get

There's not much we can do about overcoming set constraints and we'll never push you beyond what you are comfortable with, but there are a few ways we can work around specific limitations when it comes to available area for solar and your budget.

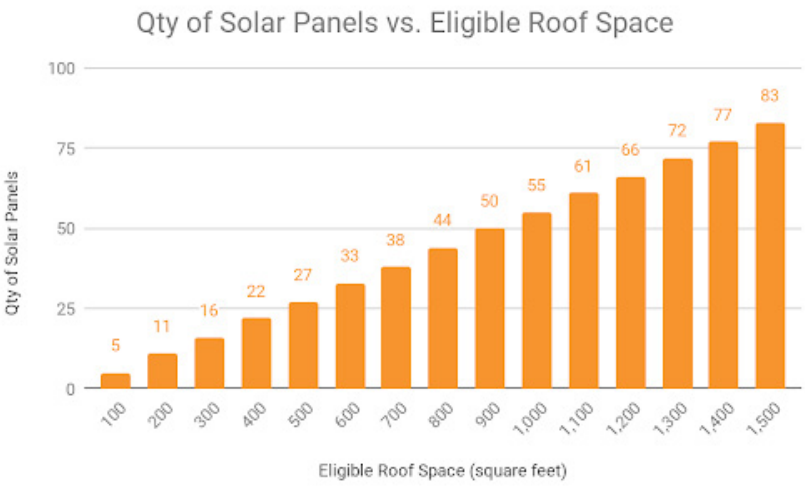
Available Area for Solar

Without enough eligible space to install solar panels, your solar savings will remain theoretical. We define eligible space as an area that:

Is free from obstructions like vents and dormers

Doesn't have significant shading

Is not facing northward



If a space meets all those criteria, then it is ready to shine. For a roof mounted solar system, each panel takes up an area of approximately 18 square feet. So for the 100% energy offset and 9.2kW solar system we have been using as an example, we would need 31 panels (if we assume 300 watts per panel) or 560 sq feet of eligible roof space.

Ground Mount Solar System Requirements

For a ground mounted solar system, an eligible space is one that is free from significant shading and close enough to your home or electric meter that trenching is feasible and cost effective (i.e., within approx 500 ft). Ground mounted panels can take up more area than roof mounted panels if there are multiple rows because we have to account for shading created between rows of panels (this is creatively called inter-row shading). For a south facing system, tilted to 30 degrees (to optimize for production), the effective area taken up by the panels (accounting for inter-row shading) would be close to 60 square feet for the same 18 square foot panel!

Budget

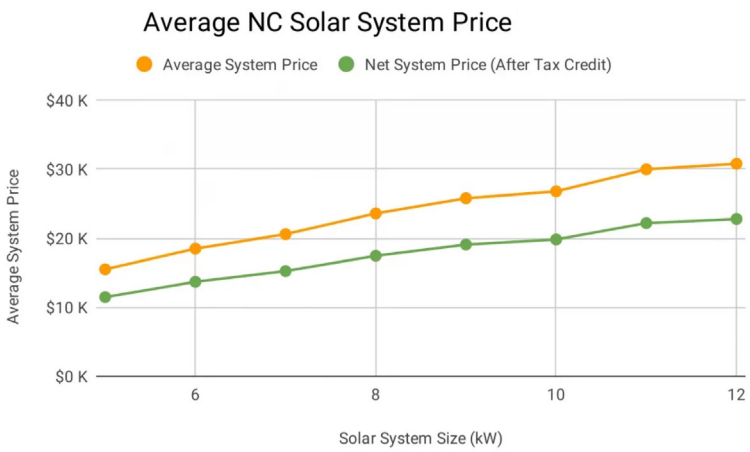
Your budget is an obvious and important criteria for your solar system size. We'll work with you to find a system that balances what you can spend with your optimal system size. The good news is that there is some flexibility in price and how we design your system to maximize your budget and your home's solar production.

For example, if you are limited by space you might need more efficient, higher wattage panels that take up less room. However, while you will need less panels to reach the same system size (and production output), these panels are more expensive. On the flip side, you might have more than enough space allowing you to opt for a higher quantity of lower wattage and lower cost panels to reach the same production numbers. So while there is flexibility between these options, by far, the biggest driver of your system's price is the overall system size. For a full breakdown of how much solar costs and the variables that can impact the bottom line, check out our guide to home solar cost.

Example Solar System Cost Breakdown

For simplicity, let's look at some averages for solar system cost and size. Our average residential solar system size is around 8.5kW which has an average price of $27,000 before incentives and $17,000 - $20,000 after incentives. This graph will give you a reference for how that average price scales up and down as system size changes. As a note, this illustration represents solar system pricing without battery storage.

So if your energy needs call for an 8.5kW system, but your budget is closer to $15k, we can work with you to scale your system down to closer to 7kW — and we're more than happy to show you all of the different panel options and quantities combinations we can use to land at your budget.



QUIZ YOURSELF

1. Which factor determines how much solar you NEED?

a. Budget
b. Energy Use
c. Roof Space

2. Based on our experience, our rule of thumb is that 1 kilowatt (kW) of solar installed in NC will produce _____ kilowatt hours (kWh) per year.

a. 130 kWh
b. 1,300 kWh
c. 13,000 kWh

3. It is always best to design a system to offset 100% of the home's energy use.

a. True
b. False

Answers: b, b, b

Notes

Pheeeew...

Congrats you made it to the end! That was a ton of info. By now you know more about solar than 99.963% of the world's population!

However, if you still have some questions our solar educators are standing by with the answers.

Give us a call to take the next step on your solar journey.

Dave Anderson

Solar Educator
(919) 924-8862

P.S. We've also included a few nifty note sheets to jot down your thoughts!

DISCLAIMER: WE ARE NOT DUKE ENERGY

Duke Energy or Duke Energy Progress ("Duke Energy") administers the Duke Energy NC Solar Rebate Program. Southern Energy Management is not Duke Energy and does not represent its views or opinions in any way. Southern Energy Management is not affiliated, associated, endorsed by, or in any way officially connected with the Duke Energy NC Solar Rebate Program. Our only involvement with the NC Solar Rebate program is as a solar installer that seeks to guide, educate, and support our customers to make the best solar decision for their home and/or business.

Any facts and statements on our website or digital content about the Duke Energy NC Solar Rebate program are based on publicly available information on Duke Energy's website and our own experience in working with the program. This content is updated on a regular basis as new information is released and any inaccuracies or outdated information should be brought to our attention immediately so that we can correct it.

Notes

Leading the Change Since 2001

SOUTHERNENERGY
MANAGEMENT

southern-energy.com

5908 Triangle Drive
Raleigh NC, 27617

Free Quote

Southern Energy Management, headquartered in Raleigh, NC, is a team of solar designers and installers, building scientists, and entrepreneurs dedicated to leading the change. Founded in 2001, we've worked for more than a decade to improve the way homeowners, businesses, builders, and developers create, consume, and conserve energy.

We're firm believers that businesses have the power to change the world for the better, and we're committed to working toward that goal each and every day. We believe what you do is important, and we also believe how you do it matters just as much. Because of that, we're proud to be a B corporation in NC.

Certified B Corporation | BEST for THE WORLD ENVIRONMENT

TESLA POWERWALL CERTIFIED INSTALLER

TRIANGLE BUSINESS JOURNAL BPtW BEST PLACES TO WORK

What's Next?

Our solar educators are happy to answer any questions and help you get started on your solar journey!

Dave Anderson
(919) 924-8862
danderson@southern-energy.com