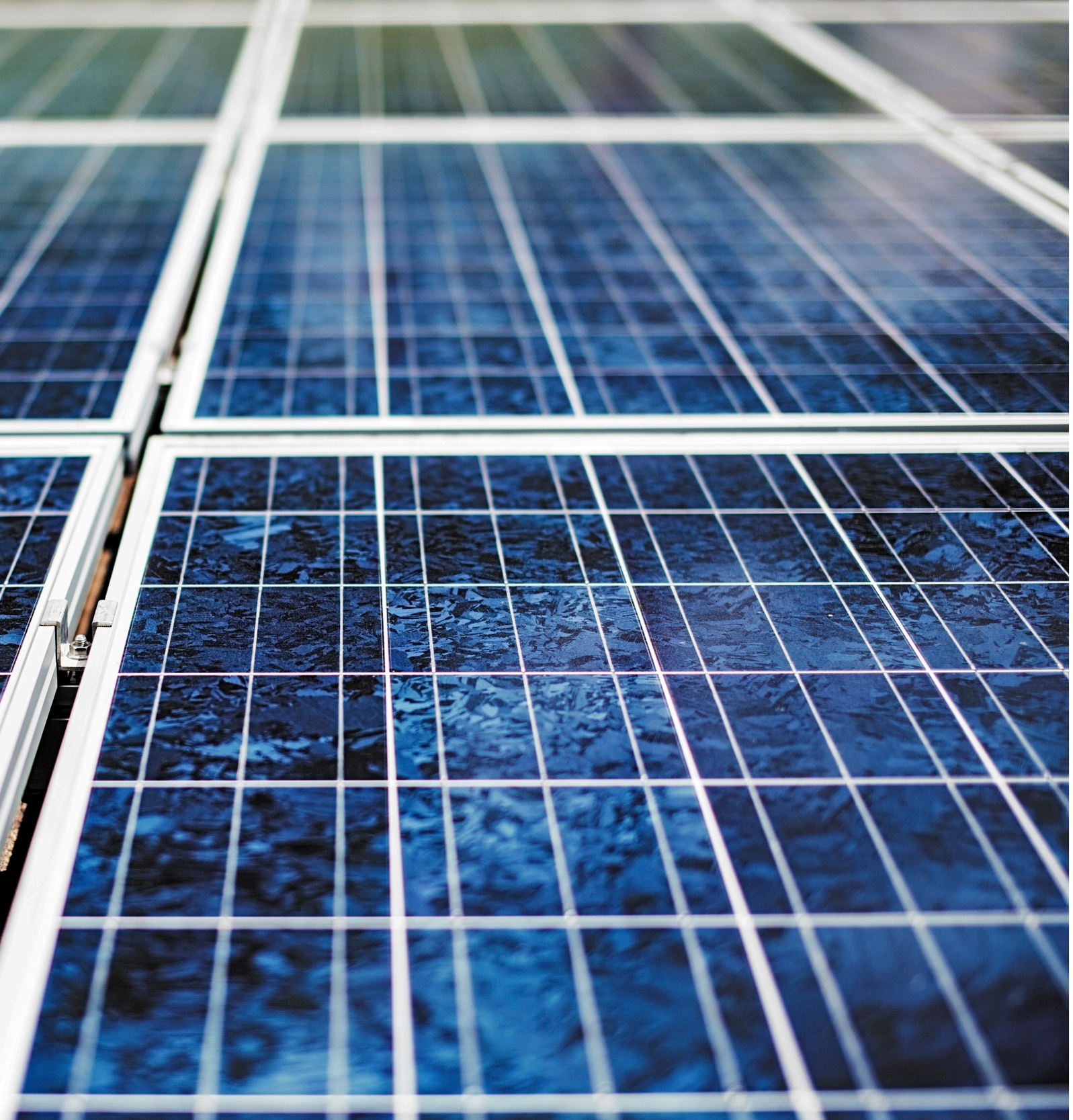
Guide to investing in Solar



MAXIMIZING RETURN ON INVESTMENT

Solar Energy

Solar installations require a significant investment. It is important to make sure your investment is sound. You want quality components, an expert installation, and an operations & maintenance contract that meets your needs. You want your solar energy company to be stable and established so that it will be around to serve you years down the road. And you want transparent, accurate energy production calculations so you can be confident in your project financials.

This short guide is intended to make it easier to understand the assumptions and calculations behind your solar energy proposal.

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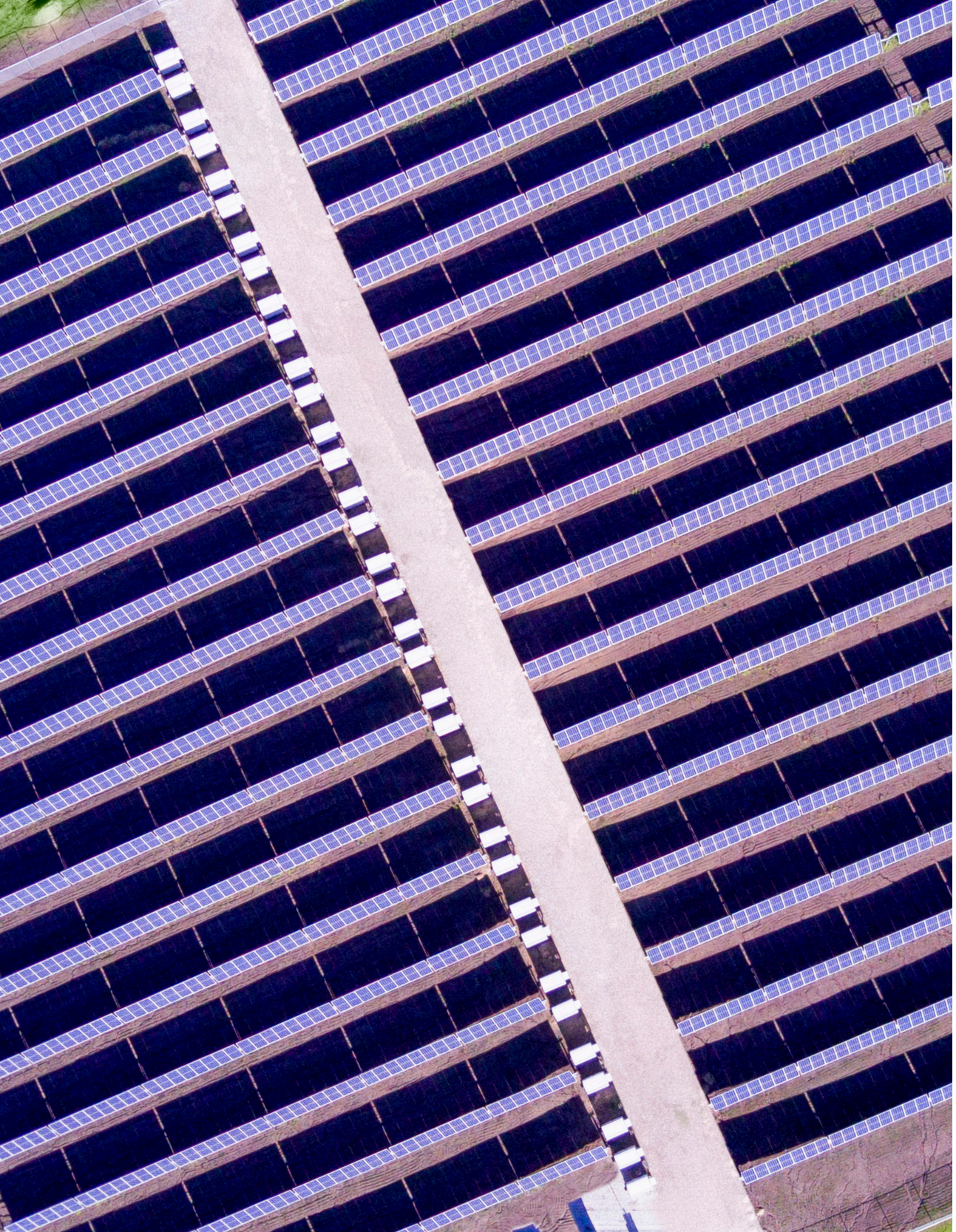


Earn the greatest ROI with solar components selected to match your property features and electrical usage profile.

Components

What type of panels will be used?

Tier 1 panels are made by the most established panel manufacturers. They are usually made from excellent materials, have great warranties, and are bankable. The tier ranking system for solar panels was developed by Bloomberg New Energy Finance[1]. It is essentially a measure of industry acceptance intended to signal to lenders that tier 1 panels are safe to loan against. As Solar Power World[2] points out, panels from other manufacturers may also be excellent, they just lack the long track record that tier 1 manufacturers have.

MONOFACIAL PANELS, which have been the industry standard for decades, have photovoltaic (PV) modules on the top side and an opaque back sheet on the underside. **BIFACIAL PANELS** have either a transparent back sheet or PV modules on both sides, and produce energy from both sides. Bifacial panels cost more and also produce more power. How much more depends on the reflectivity of whatever is beneath them. When installed on a highly reflective surface, like a white TPO membrane roof, bifacial panels can produce up to 30% more power than monofacial panels. Less reflective surfaces, like grass, pavement, or dark roofing materials, may yield a 5-10% increase in production.

What type of mounting system will be used?

A **FIXED-TILT** array is just that – fixed in place. Solar panels are attached to mounting hardware that does not move. That mounting hardware could be attached to a roof surface, to steel posts driven into the ground, or to concrete ballast blocks. Fixed-tilt arrays are robust, inexpensive, and require little to no maintenance. They have long been the standard in the solar industry.

ACTIVE TRACKING arrays follow the sun's movement through the sky. There are two types of active tracking arrays: single-axis and dual-axis. **SINGLE-AXIS** active trackers track the sun east to west. They can produce 15-30%[3] more power than a fixed-tilt array of the same size. The majority of utility-scale projects use single-axis active tracking. **DUAL-AXIS** active trackers incorporate tilt along the north-south axis, in addition to the east-west axis, to more precisely follow the sun's movement in any season or latitude. They can generate 30-45% more power than a fixed-tilt array of the same size. They also work better on undulating terrain and steep slopes.

Because they have motors and moving parts, active tracking arrays are more expensive than fixed-tilt arrays and may require more maintenance. Make sure operations & maintenance (O&M) is part of the discussion if your organization is pursuing an active tracking array.

Ideal Energy has expertise in designing and building large active tracking arrays. See our work on the Maharishi International University Solar Power Plant[4] and read our white paper[5] about the project.

[1] Bloomberg New Energy Finance – https://data.bloomberglp.com/bnef/sites/4/2012/12/bnef_2012-12-03_PVModuleTiering.pdf
[2] "What are Tier 1 Solar Panels?" | Solar Power World – https://www.solarpowerworldonline.com/2019/04/what-are-tier-1-solar-panels/
[3] What is a solar tracker and how does it work? | Solar Power World – https://www.solarpowerworldonline.com/2020/01/what-is-a-solar-tracker-and-how-does-it-work/
[4] MIU Solar Power Plant – https://www.idealenergysolar.com/miu/
[5] Solar Solutions for Universities – https://www.idealenergysolar.com/solar-solutions-universities/

What type of inverters will be used?

Inverters convert the direct current (DC) power from solar panels to alternating current (AC) that can be used in your home or business. They also track voltage, communicate with the grid, and provide emergency shutoff capability.

STRING INVERTERS are located at the end of a row of solar panels and convert power from the entire row. Smaller residential installations might need only one string inverter. The primary benefit of string inverters is cost. In a 5 kW installation – a typical size for a residential install – string inverters can save around $1,000 compared to microinverters. String inverters are durable, reliable, and can be located off the roof for easier maintenance. Downsides include less precise monitoring and less redundancy.

MICROINVERTERS sit behind each solar panel, converting power from just that one panel. The key advantage of microinverters is system efficiency. Microinverters can optimize the power output of each solar panel individually. This is especially helpful in larger arrays where shade, snowdrifts, or even cloud cover might differ from one part of the array to another. Microinverters also allow for more granular real-time performance metrics, easier expansion of the array later on, and in many cases longer warranties than string inverters. Downsides include cost, complexity, and potentially more exposure to the elements.

POWER OPTIMIZERS sit behind each individual panel, like microinverters. Unlike inverters, however, they do not convert power from DC to AC. In fact, they have to be used in conjunction with string inverters. Their purpose is to condition the power before sending it to an inverter. Power optimizers are often used along with battery energy storage systems. Conditioned power is sent to a battery while it is still DC and the string inverter is located downstream of the battery. This minimizes the number of times power has to be converted from DC to AC, while still allowing panel-level optimizing and monitoring.

TECHNICAL ADVANTAGES

Selecting the correct inverter is critical to system performance.

String inverters are the most economical type of inverter, but do not provide panel-level monitoring. Factors like shading can cause whole rows of panels to become inoperable, which can decrease system efficiency.

Power Optimizers can be added to a string inverter set-up to provide panel level monitoring and condition power before it arrives at the inverter.

Microinverters are a more expensive inverter system, but offer the most efficiency as power is converted at each panel. This reduces losses due to shading.

A successful solar investment depends realistic production targets and projections for rise in energy prices.

Calculations

What offset are your being quoted?

Solar offset is the percentage of your total annual consumption that your solar array generates every year. For example, if you use 16,000 kWh of power every year and your solar production is 12,000 kWh annually, then your system's offset is 75%.

Offset can be an important calculation for a solar investment – particularly if your organization needs to achieve net-zero (100% offset). However, it is important to note that offset can never be guaranteed by a solar company. Your annual usage is completely out of your solar company's control. Your solar company can only influence the production part of the equation.

The keys to achieving your desired offset are working with a solar company with a history of making accurate production estimates, and working within your organization to manage your energy usage.

How is production calculated? Is production guaranteed?

There are several elements in calculating solar production. There is the nameplate rating of the system, the specific yield, and the degradation rate of solar panels over time. Because several of these elements are themselves estimates, most solar energy companies do not guarantee production in most circumstances (though there are exceptions). A responsible approach to production projections is to make conservative estimates to avoid underproducing.

Underproducing power can be a significant disappointment for a customer. It will negatively impact project financials, including payback and internal rate of return. If your project goals are based on a particular offset, like net-zero, than sustainability certifications, green vendor credentialing, or even your organization's public credibility could be on the line if your project fails to achieve the required production.

Overproducing is not ideal either, but it is significantly less problematic. Depending on your utility tariff and net-metering agreement you may be required to sell back excess energy at the avoided fuel cost, which is much lower than consumption charges.

Ideal Energy takes a conservative approach. After we calculate our production estimate based on nameplate rating, specific yield, and degradation factor, we reduce that estimate by 5%. This ensures that we under promise and over deliver, rather than the opposite. We do not want customers to be disappointed by their actual production numbers.

What is annual specific yield?

Specific yield measures the efficiency of a solar installation, or how close its actual energy production is to its potential energy production. It is expressed as the actual production divided by the potential production (kWh/kWp).

Kilowatt-hours (kWh) is a measure of energy production over time. Potential production (kWp) is the electric power rating provided by the panel manufacturer. It is measured under standard test conditions – solar irradiance of 1,000 W/m2, cell temperature of 25° Celsius, wind speed of 1 m/s, and air mass of 1.5. You might also hear kWp referred to as the nameplate rating of your system.

Solar installations do not operate under standard test conditions all the time, of course. They operate in the real world where irradiance, temperature, wind speed, and air mass all fluctuate constantly. Solar companies use various resources to estimate the specific yield at a particular location, like this map [6] produced by the World Bank and its partners. The more precisely your solar company can estimate specific yield in your particular geographic area, the better.

What degradation factor is used?

Solar photovoltaics work best when new. Over time their power output declines. The degradation factor is the rate of power decline over time.

PV degradation is the subject of a burgeoning field of scientific inquiry. Researchers are still answering how climate impacts degradation, how best to model the linearity of degradation, and which mean and median values are most realistic for each solar PV technology.

Because solar photovoltaic module technology is constantly evolving, it is difficult to pin down an exact degradation factor for panels installed today. Degradation rates of first, second, and third generation solar technologies are different. Mono-silicon, multi-silicon, thin-film, and more exotic solar photovoltaics all degrade at different rates. Only a few technologies have been around long enough to study their degradation throughout their entire 25 year warranty periods. Many manufacturers are now moving to 30 year warranties on their modules as technology improves.

Two large surveys of scientific papers on the topic were conducted by National Renewable Energy Laboratory researchers Dirk Jordan and Sarah Kurtz in 2012 and 2016. Their 2012 survey[7] found an average degradation rate of 0.8%/year and a median of 0.5%/year. Their 2016 paper[8], which surveyed 11,000 studies (compared to 2,000 in the 2012 survey) found an average degradation of 0.8-0.9%/year and a median of 0.5–0.6%/year for silicon technologies. Thin-film and exotic PV technologies had degradation rates around 1%/year.

At Ideal Energy we use a 0.5% annual degradation factor. We believe this takes into account scientifically established median values as well as the progress solar module manufacturers have made in recent years.

What cost of energy escalator is being used? 3, 4, 5 % annually?

The cost of energy escalator is a projection of the increase in energy prices over time. This projection has a large impact on the economics of a solar project. A higher escalator implies a faster payback period, greater energy cost savings, and potentially lower interest payments. Overly optimistic estimates of future savings can result in customer disappointment, or even savings that are lower than project costs – a poor investment.

The U.S. Department of Energy (DOE) provides a free calculator, called the Energy Escalation Rate Calculator[9] (EERC), that uses forecasts from the DOE's Energy Information Administration (EIA). These forecasts are based on utility energy service contracts

[6] Global Solar Atlas – https://globalsolaratlas.info/map
[7] Photovoltaic Degradation Rates – An Analytical Review – https://www.nrel.gov/docs/fy12osti/51664.pdf
[8] Compendium of photovoltaic degradation rates – https://onlinelibrary.wiley.com/doi/abs/10.1002/pip.2744
[9] EERC – https://www.energy.gov/eere/femp/building-life-cycle-cost-programs
[10] Escalation Rate Best Practices –https://www.energy.gov/sites/prod/files/2015/11/f27/fupwg_fall2015_thomas2.pdf

provided to the DOE[10] by utilities. Not every utility provides service contracts to the DOE, so the EIA's forecasts should be considered estimates, not precise values.

At Ideal Energy, we believe the best practice is to use a conservative escalator. We use 2.5% for projects in the Midwest. This escalator does not inflate the payback from a solar project. In contrast, we have seen competitors using 3, 4, and even 5% escalators. These aggressive escalators set clients up for expectations that are unlikely to be met.

How well does your solar company understand your rate plan?

Your rate plan, or tariff as it is known in the industry, is your agreement with your utility that governs what you pay for electricity. It spells out your consumption charges, meter fee, taxes, as well as any other charges you may be responsible for, such as time of use fees, demand charges, etc. It also sets the parameters around net metering. Some utilities reset net metering credits every month, while others reset them annually. Some utilities, particularly rural electric cooperatives (RECs), do not offer net metering at all. Different utilities and tariffs might impose different offset limits to net metering. Make sure your solar company understands the details of your tariff.

At Ideal Energy we think our deep understanding of utility tariffs is one of the key differentiators of our service. In 2016 our staff identified tariff changes[11] proposed to the Iowa Utilities Board that could have made solar nonviable for most Iowans and crippled the solar industry in Iowa. We worked with several solar energy trade groups, environmental groups, and other solar energy companies on a campaign to lobby against these changes. In the end, we were able to preserve the viability of solar[12] for Iowa residents and businesses.

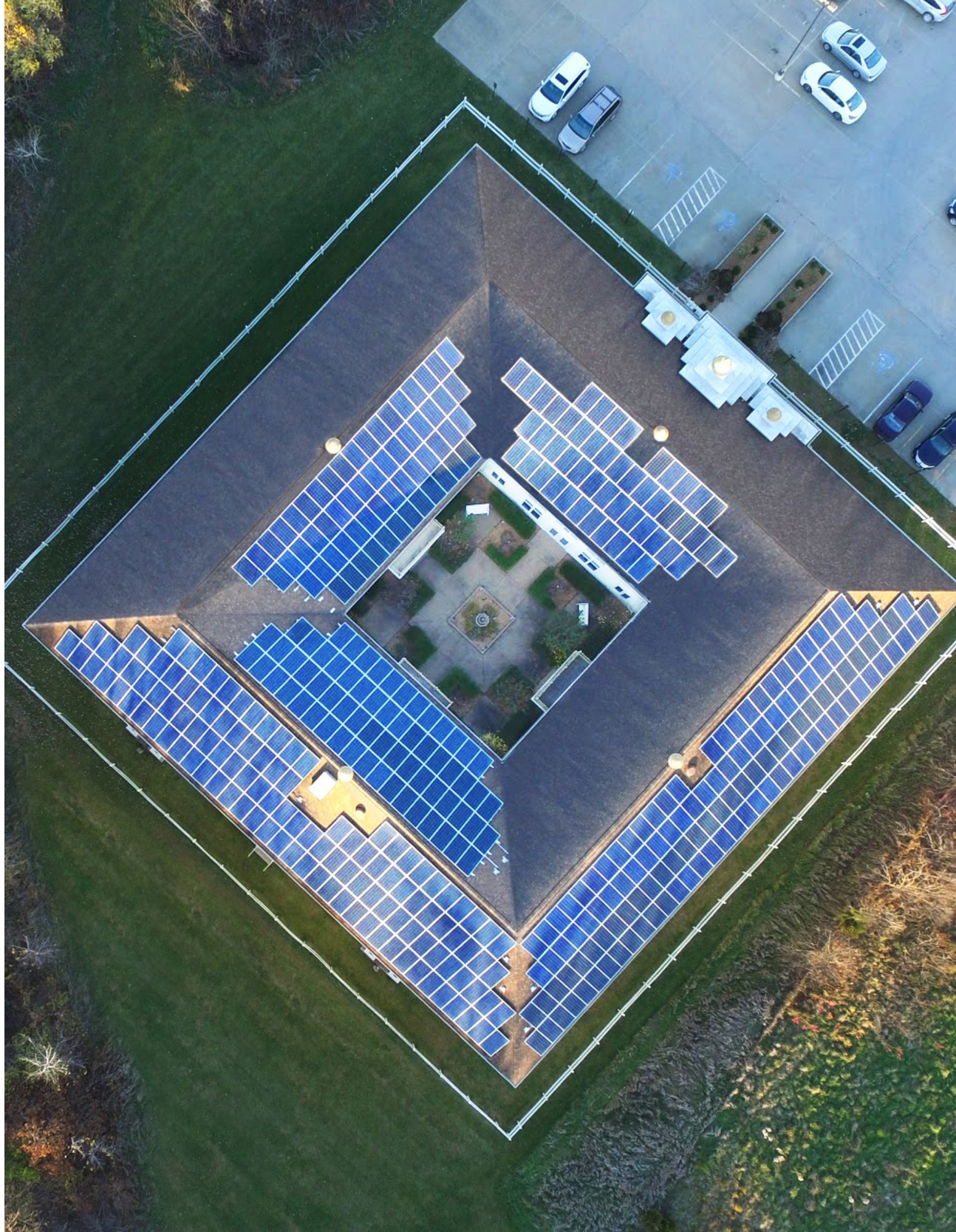
What is the national average cost per watt?

The National Renewable Energy Laboratory (NREL) gathers data on national and global solar energy trends and publishes that data in quarterly reports[13]. Their most recent report, QI 2020 Solar Industry Update[14], shows a national median cost of $2.89 per watt DC (WDC) for residential installations and a median of $0.89/WDC for utility-scale projects. Commercial-scale projects run the gamut in size – and cost – between residential (typically 4-7 kW) and utility-scale (500 kW and up).

These figures are fascinating from a macroeconomic perspective, but of dubious value when trying to figure out whether or not a bid is competitive. Cost per watt varies widely from state to state due to different average system sizes, different incentive packages, and other factors that affect the cost of doing business. The cost per watt of a residential system in California is almost double the cost per watt of a residential system in New York.

In addition, cost per watt figures do not reveal

[11] Changes Coming to Solar Net Metering – https://www.idealenergysolar.com/changes-coming-net-metering-technical-calculations/
[12] Net Metering Update – https://www.idealenergysolar.com/net-metering-calculations-update/
[13] NREL Solar Technology Cost Analysis – https://www.nrel.gov/analysis/solar-cost-analysis.html
[14] Q42019/Q1 2020 Solar Industry Update – https://www.nrel.gov/docs/fy20osti/77010.pdf



Ensuring that your solar installation performs optimally year round is critical to hitting financial targets.

Service

How will your solar company monitor the performance of your array?

Ongoing monitoring of a solar installation is important both to make sure the system is performing as intended and to identify any problems as soon as they occur.

At Ideal Energy, monitoring is baked into every system we install. We use SolarEdge inverters, which have built-in monitoring capability linked to an online dashboard. All of our customers can access their own monitoring dashboard at any time at no cost to them.

In addition, we provide proactive monitoring for five years on all systems. Proactive monitoring allows our team to quickly identify any problems that might appear. We can then either solve those problems remotely or coordinate with the customer to reach a solution. Proactive monitoring beyond the five year mark is available as an additional service.

Does your solar company have an electrician on staff? Why is this important?

Many solar companies do not have a permanent, full-time position for a licensed master electrician. These companies subcontract out their electrical work. At Ideal Energy we believe a master electrician is a key part of a solar team. We have a master electrician and several apprentice electricians on staff who work with solar full-time, day in and day out.

Subcontracting electrical work is reasonable for residential work, where service panels are similar and solar installations are routine. For commercial and industrial customers and utility-scale projects it is critical to have the expertise to perform complex service rebuilds and to perform custom, high-voltage work. Ideal Energy has deep expertise in this area, with 12 years of experience designing and building pathbreaking projects with unique electrical needs. Make sure your solar company has the technical capability to meet your needs.

How long is a quote good for? Is pricing guaranteed?

The price of solar photovoltaic modules is constantly fluctuating in response to both market forces and public policy. Import tariffs in the U.S., solar incentives in Germany, and the latest five year plan in China can dramatically influence the price of panels in short order. Recently, the solar industry saw a shortage of available panels due to Covid-19 when larges volume of panels were stuck in port in China awaiting the reopening of transoceanic shipping.

Ideal Energy bids are good for 30 days. In our experience, solar panel price fluctuations make guarantees longer than that nonviable.

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