



## **Solar Energy and Energy Storage Development**

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### **The Economics of the Modular Expandable Transportable Energy System (METES) How to Size and Price Your METES**

#### **Introduction**

When we began building solar projects in 2008, distributed (utility company) electricity in Texas was about six cents a kilowatt hour. However, a single solar panel cost over \$900 for one that was rated at 150 watts DC. The typical residential solar project capacity was rated around 5 kW/DC.

In 2022, current distributed electric rates in Texas before fees and taxes are as much as eighteen cents per kilowatt hour. In some parts of the country, electricity rates are over thirty cents per kWh (Hawaii has the highest rates at fifty cents per kWh). Although inflation and commodity shortages this year are driving up solar equipment costs, a 400-watt solar panel can be purchased wholesale at around \$200. 2022 is a year of dramatically increasing prices for everything including solar installations. Today, a 10-kW/DC sized system is common for residential installations and 100kW and larger are going on and around commercial buildings. The cost of a system can be offset by Federal and local incentives. (NOTE that incentives vary from one location to the next and the Federal Incentives decrease each year. For an up-to-date listing of renewable energy incentives, go to: <http://dsireusa.org>).

#### **Why a Manufactured System (METES) Makes Economic Sense**

First of all, the METES will not work for everyone. This is a ground-based system that requires a little bit of room to set up and operate. The Modules are eight feet wide and twenty feet long with overhanging panels that need to be far enough

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away from trees and structures so that the solar array can be in full sunlight (southerly facing) throughout a typical solar day. The METES Small Cluster family can include up to four of these enclosures in a group (or cluster). The ideal METES owner is someone who has an acreage, farm, or ranch outside of the city and who has one or more of the following needs:

- **An alternative to the high cost of extending powerlines to remote sites.**
- **Energy security to assure that there will be electricity if the grid goes down for any length of time.**
- **The need for lower electricity bills.**
- **Storage of valuable items in a clean, dry, and secure enclosure.**
- **The need for added usable work or living space.**
- **Availability of qualified and reasonably priced solar installation professionals**

NOTE: Only work with solar installation companies who employ a NABCEP (North American Board of Certified Energy Practitioners) Certified Solar Installation Professional. A NABCEP Solar Installation Professional has demonstrated they have the technical competence to design and install a quality solar PV (Photovoltaic) system, have proven their competence in the field by building these systems, and have passed a comprehensive exam.

There is a sliding scale of project types when it comes to initial costs. These project types are rooftop, ground-mounted, shade structure, and prefab (where METES fit in):

**- Traditional rooftop solar (lowest upfront investment).** This system is mounted on an existing building roof (which can be metal, shingle, flat/composite, or tile). This is especially useful when space is otherwise limited for a solar array. Although this is typically the lowest initial cost approach to adding solar, there are some drawbacks:

-- If (or more likely when) a roof requires replacement, the owner must have the solar panels and mounting system removed, then re-installed. This could cost as much or more than the original installation since it requires the uninstalls as well as the re-install of the solar array.

-- Solar panels are rectangular in shape. This presents a problem for roof designs of other shapes.

-- The size of a solar array is limited to the size and shape of the sunny sides of a roof. In addition, three feet of space just below the ridge of a roof and on each end of a roof must be left open to account for wind loading. This could make the remaining space too small for the minimum sized solar array.

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-- Shading is more of an issue for rooftops. Anything that can shade solar panels during the day, such as vent stacks, chimneys, dormers, trees, or nearby structures, can affect efficiency.

-- Roof penetrations are required that may present the possibility for leaks or for voiding roof warranties. If a rooftop system is not properly installed, extremely high winds have been known to lift not only the solar array off the structure, but also the top of the structure the solar array is fastened to.

-- Wind loads become more of an issue the higher the elevation of a solar array. The higher the roof, the stronger (and more costly) the mounting system must be.

**- Traditional ground-mounted solar.** Ground-mounted systems are the approach most commonly used for larger solar projects where adequate rooftop space is unavailable but vacant land is sufficient, and where higher levels of electricity production may be needed. These systems are most common for utility scale, or for industrial, commercial or agricultural purposes. These systems are usually more expensive than a rooftop system initially, but have a number of positive advantages over the traditional rooftop solar array:

-- The system can be as large as the need requires, with only the available vacant land and the budget as constraints.

-- These systems can operate in place for thirty years or longer (with recurring maintenance and normal inverter replacement) as opposed to roof-mounted systems that must be removed for the occasional roof replacement or repair.

-- Ground mounted systems can be placed in areas unsuitable for other purposes, such as in flood plains or on hillsides.

-- As the systems become larger, these systems benefit from economies of scale and at some point can be lower cost per kilowatt of electricity produced than the rooftop systems of comparable size.

There are some disadvantages of this type of system that also must be considered:

-- The number one constraint of these systems is the challenge of finding qualified installation professionals where these systems are typically built. The majority of solar installation companies work within 50 miles of their home base, which is typically a municipal area having a concentration of solar customers. There are several cases where large solar farms in remote areas had major failures because of incompetent installation technicians. As you get closer to a city or town, solar PV may not be the highest and best use for vacant land.

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-- The more remote a ground-based system is, the more difficult it is to logistically support them. Construction progress can come to a grinding halt for the lack of a 50-cent part that must be ordered and delivered to a remote site.

-- Systems of this type are either secured to the ground on deep concrete pillars or (if the ground is not solid rock) by machine-driven earth screws. Either way, these systems are permanently installed. This presents a problem if the system must be moved, especially for those with the concrete pillars since the upright structures may be encased in the concrete. When these systems are moved (or removed), the concrete pillars or the earth screws are either abandoned in place, or heavy equipment is brought in to remove the substructure (which then must be hauled off to a dump site).

-- The ground-based system has one purpose, and that is to produce electricity. There is no other "coincidental" usage that might enhance the value of the system.

#### **- The solar shade structure.**

-- Like the ground-mounted systems, the solar shade structure has the same benefits and disadvantages except that these systems have the benefit of using space that has other purposes, adding a dual purpose for the system. For example, one version of these systems are built over existing parking lots where they provide protection to automobiles parked underneath. In rural areas, these systems can also shelter livestock.

-- For the parking lot shade structures, the outdoor lighting can be incorporated into the structures at a lower cost than traditional parking lot lighting.

-- A smaller version of the parking lot shade structures are the outdoor cabanas that double as outdoor spaces. These are a good substitute for rooftops that might be too small, the wrong shape, or are highly shaded.

#### **- The manufactured prefab systems.**

-- The **METES** falls into this category. These systems have the same advantages of other ground-based systems but with some added benefits. An added benefit of the METES is that once the solar panels are taken out of the METES Module at the destination and installed on top, most of the inside space is available for such purposes as secure storage; conversion to usable space such as workshops, office space, temporary living quarters; space for installed equipment such as water purification systems; or other uses. The space is a valuable component of these systems not gained by traditional solar installations.

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-- These are transportable systems that have the major (and complicated) solar tasks performed at the factory. The Modules can be delivered literally worldwide, then secured and set up within a few short hours per Module (compared to months for some systems).

-- An average local electrician can connect these systems with no special training.

-- Because they are transportable, the METES can be packed up and moved quickly with very little disassembly. If transportability is essential, these systems can be trailer mounted and moved after simply taking off the solar panels, storing them inside the METES, and disconnecting a few wires plus the ground rods.

-- The METES is a fully expandable and adaptable system that can start small and grow as the needs arise. Each system begins with a Master Module (solar-only or solar plus battery backup). If more power is needed, additional Solar Slave Modules can be added to the Master Module to form a cluster of up to three slaves and one master. Larger commercial systems can be built with multiple Master/Slave clusters. Other variations allow for very large-scale systems using numerous solar slave Modules along with specialized central inverter and battery-only Modules and optional generators.

-- A METES Battery Backup or Off-grid Hybrid System costs more than a METES Grid-tied (solar only) system connected to the utility company meter. But the added costs of batteries (and/or a generator) would be offset by incentives and the added benefits of energy security, or the avoided cost of extending electric lines.

-- Most of the qualified solar installation companies are in the major cities. As you move away from these areas, there are just a limited number of qualified solar installers willing to travel more than 100 miles, and when they do, the customer's installation costs have charges added for travel costs. We have found that most of rural areas cannot get any solar company (qualified or otherwise) to even travel to these areas.

### **METES Costs and Benefits**

**METES Solar Capacity.** The METES Hybrid and Solar Modules are equipped with twenty 400 watt solar panels. These METES Modules are rated at 8 kW/DC and will produce the amount of electricity relative to your specific location. To get a good solar electricity production estimate, go to the NREL (National Renewable Energy Laboratory) PVWATTS solar calculator at:

<https://pvwatts.nrel.gov/pvwatts.php>.

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You will then make the following entries:

**Screen 1.** In the box by **GO>>** enter the closest city to your location. Then click on **GO>>**.

**Screen 2.** Your closest solar location recorded in the NREL database should show up on the map, or there may a number of alternative locations also shown. If there are multiple locations shown, you can select the one closest to you. A latitude and longitude should appear in the box near the top of the screen. If you are satisfied with the location, click on the red **GOTO System Info** chevron/arrow.

**Screen 3.** Enter the following information in the entry boxes:

DC System Size (kW):	8
Module Type:	Premium
Array Type:	Fixed Roof Mount
System Losses (%):	14%
Tilt (deg):	8
Azimuth (deg):	180

Once you've entered this information, click on the red **GOTO PV Watts Results** chevron/arrow.

**Screen 4.** Your estimated solar production will be displayed on this screen by month. To download the information, click on the "Print Results" feature then select the option to save the file as a .pdf.

To calculate the value of your solar production, pull out your monthly electricity bills for the most recent 12 months and determine your effective rate per kilowatt

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hour. This rate is the total cost of your electricity by kilowatt hour excluding charges that are fixed such as your monthly meter charges and other fixed charges that appear on your bill regardless of kilowatts used. The calculated number is then divided by the kilowatt hours used to get your effective rate. Then multiply your effective rate (Cents/kWh) times the kilowatt hours of estimated solar production on the table per month.

Finally, you will need to compare your estimated monthly solar kilowatt production to your monthly actual kilowatt usage.

There are three levels of solar sizing you will want to consider:

1. The 100% option. This option may be the best one for those who want to be energy independent. If you are planning an off-the-grid system, energy availability is the most important feature to consider in system sizing. Also important is taking measures to economize your electricity usage and budget how and when energy is expended. For this option, look at your highest energy usage month(s) and add METES Solar Slave Modules (MSSM) into the equation until your estimated solar electricity production is at or above your monthly consumption levels. You will have some months where your system will significantly over-produce but your high consumption months (with energy budgeting) should be a close match between consumption and production. (NOTE: to determine what your production would be when you add MSSMs, recalculate your output estimate in PV WATTS by adding to the kW DC system size 8 kW for each additional METES Module you are considering up to 32 KW/DC for a cluster of one Master and three Slaves.)

2. The Average Option. There is an economic sweet spot in sizing your system where you are willing to accept a few months of over-production (Fall and Spring) and a few months of under-production (Winter and Summer) to give you the best combination of energy value in relation to equipment cost. This option will give you the best return on your investment. The simplest way to estimate your system size for this option is to take the average consumption of your most recent twelve months (in kilowatt hours) and size your system to produce at approximately that level each month. This is a good option for systems interconnected to the utility company grid because the grid will supplement your energy requirements when solar production isn't enough, but may give you credit for your excess production.

3. The Starter Option (the Minimum Option). This is the system size for those who want to start out small and grow their system to meet their needs over time. This

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is a good approach for anyone on a tight budget, since the METES can be expanded with relative ease. The basic (or standard) Master Module is configured with the standard 8kW/DC of solar capacity and, in the case of the Hybrid System, can come with an initial battery setup of two 3.8kW Lithium Ion batteries (7.6kWh combined capacity). The system can also come with a Generator Ready Option so a generator can be added at any time. (NOTE: adding a generator is a good option for off-grid systems because it reduces the number of batteries and solar energy capacity required to assure coverage during multiple days of poor solar production.) If you want or need more capacity, the Master Module has room for plenty of additional batteries. If you need more solar production, you can add up to three additional Solar Slave Modules for a total capacity of 32kW/DC. And if that isn't enough, additional clusters of Master/Slave sets can be interconnected.

**The METES Solar Master Module.** This METES model is a grid-tied system secured to the ground with hurricane straps. They connect to the utility company on the owner's side of the electric meter. This is the cornerstone of the METES Solar Cluster (A cluster is one Master Module and up to three Slave Modules). The Master Module has 8 kW/DC of solar capacity.

**The METES Hybrid Master Module.** The Hybrid supports the same 8 kW/DC solar production as the Solar Master plus an additional 7.6 kWh in battery storage capacity. -There is also an option of adding a generator for extra support during periods of low solar production. The METES Hybrid is the top-of-the-line system. But considering the cost of extending power lines and the rising cost of energy, the METES Hybrid can be the best and most economical option. The METES Hybrid is the best choice for anyone wanting total energy independence.

**The METES Solar Slave Module.** Each METES Master Module can support up to three additional 8kW/DC Solar Slave Modules. The Master Module and Slave Modules are designed with conduit stub-outs and connection taps where an electrician with average training can run either underground conduits or direct burial cables between the Modules and easily connect them together electrically. The Master Module has integrated electrical access points for connecting to the Utility Company Grid, a Generator, up to three METES Slave

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Modules, and to the end loads. The Slave Modules can be used with both the METES Solar Master or the METES Hybrid Module.

## **Conclusion**

TeraVolt Energy has designed the METES Cluster System with the average rural owner in mind. As you get further away from centers of concentrated solar construction, many rural owners cannot get qualified solar installation companies to travel to their areas, and those that are willing to travel will charge exorbitant prices (or may not be qualified to build the systems). The METES are straightforward to set-up and operate and are built to last a lifetime with the best possible performance. This paper is your guide to sizing the best system for your unique situation. Your next step is to download the METES current price list, price the system you have chosen, and if the METES is your energy choice, complete (or edit if you are a returning customer) your online pre-order. You would be selecting the "Place on Reservation List" option under "Interest Level, and providing your system choice and options in the comments to start the process. We will then confirm with you the pricing and terms on an official order and provide you with your invoice. The manufacturing process begins once we have received your payment.

## **About TeraVolt Energy**

***TeraVolt Energy is an established commercial solar, energy storage, and manufactured energy system development company located in New Braunfels, Texas, with a continuous operating history dating to 2002. The company is a Texas Licensed Electrical Contractor employing a Texas Master Electrician, a NABCEP Certified Solar Installation Professional, and an engineering and sales staff.***

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