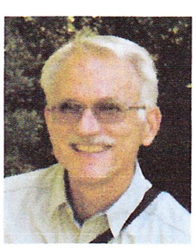
DEVELOPING LARGE-SCALE SOLAR SYSTEMS IN THE U.S.A

Where Only the Brave Venture

The U.S.A. seems to be the ideal location for large-scale solar development—there is an abundance of solar radiation, there is a robust national transmission grid to distribute the power, there are many nearby load centers, and the U.S.A. is an entrepreneurial nation. What seems to be a perfect location actually can be an exceptionally difficult one. We will discover why.

BY BOB PARKINS

A large-scale system using double axis trackers to maximize energy generation. Changes due to environmental restrictions: The trackers were elevated with dirt mounds and concrete piers to avoid flood potential; the construction cycle was shortened because of endangered species.



Bob Parkins

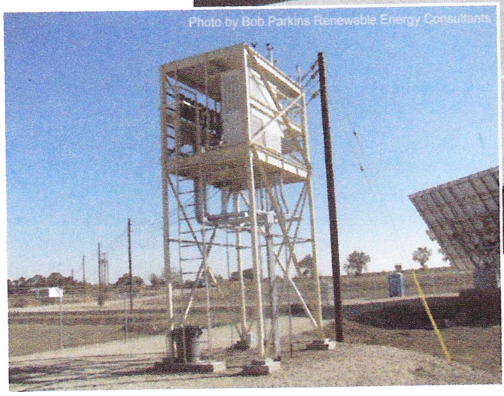
As an independent solar consultant, I am often asked by foreign and U.S. financiers and companies to help them evaluate land and develop it for large-scale solar projects of 1 MW or larger. The primary purpose is to sell the generation to electric utilities, which are mandated to generate and buy more renewable energy. The U.S.A. seems to be the ideal location for large scale solar development and eager solar champions envision a modern day Gold Rush—and why not? There is an abundance of solar radiation, there is a robust national transmission grid to distribute the power, there are many nearby load centers, and the U.S.A. is an entrepreneurial nation. Enthusiasm soon turns to frustration, however. What seems to be the perfect location actually can be an exceptionally difficult one, where only the 'brave dare venture'.

The origins of this paradox are many, but four prime candidates are government regulations, environmental restrictions, a transmission grid that was not built with dispersed and sporadic renewable energy in mind, and difficulty finding a buyer.

Government Regulations

There are over 30,000 'governments', each with regulatory and policing authority in the U.S.A. Every location has multiple government agencies with some kind of jurisdiction. They may include Federal, state, county, and city agencies or special governing districts

▲ *A 1.0 MW solar carport for a college using a Power Purchase Agreement: Government requirements were extensive but doable.*



◄ *Project inverter on elevated tower due to flood potential: Note the transmission tie line and poles which interconnect with the utility in the background.*

with specific interests, like fire protection. During the initial planning phase for a solar project, it is necessary to secure control of the land via ownership or a leasing arrangement and coordinate the proper zoning with the local planning department. Unless the site is already approved for solar, this process will require environmental studies, which may evolve into additional detailed studies. Local county and city agencies control the use of land via zoning requirements, even if the land is privately owned, and the conduct of construction through building permits and inspections.

A persistent and nagging problem is that there are no uniformly applied national technical standards to guide project design and construction. There is the National Electric Code (NEC), a nonbinding industry standard which is updated every three years. But every local planning department and permit office is like a quasi nation state—they can choose to adopt the NEC or ignore parts or all of it. Consequently, projects that may be approved in one jurisdiction may be rejected or modified in a neighboring jurisdiction.

I have experienced two burdensome problems with local agencies. First, most do not have experience with solar projects, so they do not have coherent policies and procedures. They may scramble to get advice from other agencies, but the advice may be inadequate and produce poor results. Occasionally, they may be receptive to technical suggestions from the solar developer. Because these agencies are uninformed and unprepared, uncertainty often prevails.

Second, even if agencies have policies and standards, they often do not uniformly interpret and enforce them. Most solar contactors have stories about an official inspector accepting work on one day and another inspector demanding changes the next day. This inconsistency contributes to chaos. A successful solar developer will assure that he coordinates with local authorities early and often to minimize these risks.

Environmental Restrictions

As already mentioned under regulations, unless a large solar project has been determined to be an approved use for a specific location or is otherwise compatible, it will require detailed environmental studies to get the proper zoning and/or conditional use permit. More complex sites may require additional detailed studies, which can take about 1 ½ years or more to complete and cost in the 'six figures' (I have experienced studies costing US$350,000 to US$500,000). The ideal environmental study result would be a finding of no adverse impacts. Otherwise the project could be denied, the scope could be changed, or a 'mitigation' fee could be charged to compensate for the negative impact. For two of my projects, sizeable mitigation fees were charged because 'endangered' nesting hawks were found several miles away and the project sites were designated as the hawk's hunting territory. In another project, a negative impact was declared because of evidence that an endangered fox traveled across the site. Unless a project is in an urbanized area or active agricultural area that has been extensively disturbed, project locations in the U.S. will typically have environmental issues.

An ugly aspect of the environmental process is that it is vulnerable to abuse. Opponents of a project can delay it and even cause changes during the public comment period. For one of my power plant projects, which was non-union, local union officials complained about water quality issues during the permitting process. Because of the potential for lengthy delays and expense, the developer relented and offered to exclusively use union labor. The union subsequently retracted their complaint and the project moved forward. In another case, a transmission line project I managed was stopped by a coalition of environmental groups and a Federal agency because of a claim that the construction activities 'potentially' disrupted an endangered beetle's natural habitat. No proof was offered but it was suggested that if US$500,000 was contributed to a wildlife fund, the problem would go away. Because we could not afford delays to fight the allegation, we agreed. The claim was withdrawn immediately and we continued work. Some people would assert that these cases are examples of government sanctioned extortion; others would state they are the cost of doing business. In either case, they add unexpected expense to a project.

Connecting to the Grid

Constructing a large-scale solar project is not enough to be successful—there must be an economical way to interconnect with the grid and transmit the energy to the ultimate buyer. The U.S. transmission grid is based on central thermal or nuclear generation plants, from which energy is transmitted to substations by high voltage transmission lines (e.g., 230 kVac), then re-transmitted at medium voltages (e.g., 60 and 115 kV) to unit substations, which in turn redistribute the energy to commercial and residential users at lower voltages (e.g., 12 and 21 kV). The conductors on these transmission and distribution lines (also called feeder circuits) progressively get smaller and smaller as they get farther out. Placing large generation on feeder circuits, particularly at the end of a lightly loaded line, will typically create grid problems which must be corrected. Hence, very large-scale solar systems may require a dedicated tie line to an existing or new substation to interconnect to the grid.

Any solar project that exports power to the grid will require a systems study. The study will simulate the grid with the proposed solar

A portion of a typical large-scale ground mount

system and the existing loads and generation to determine if the combination can be operated safely within established standards. Typically it will look at the most restrictive operational case when the demand is at its highest & lowest. It will, then, investigate subjects like reverse power flow, the thermal capacity of wire, potential voltage instability, high and low voltages, fault current conditions, flicker, and the overall impact on the utility's protective devices. Poorly sited solar projects may be abandoned or changed because the required grid upgrade costs to accommodate them are too high (20 to 30% of project costs). Conventional interconnection system studies in California cost from US$50,000 to US$250,000, depending on the project size, and may take one year to complete. Fast Track system studies for projects below 1.5 MW cost several thousand dollars and only take a few weeks to complete.

Besides the physical issues of connecting a solar system to the grid, another very important consideration is operating it to minimize adverse grid scheduling impacts. Utilities must balance the generation supply and load demand. To do this they monitor the demand in time increments (e.g., 15 minutes) and, then, schedule their generation resources to match the demand. If a large solar system is connected as a generator and a cloud comes overhead, there will be an immediate drop in the solar generation and the potential for grid stability problems. To avoid this problem, the utility will usually maintain standby generation (spinning reserve) that can be rapidly brought on line to make up the difference. This is a good reason not to overload the generation in a grid segment with an excessive amount of intermittent solar energy. A mitigating strategy to minimize the problem is to accurately forecast the solar system's expected generation in advance to assist in balancing the grid's supply and demand. The solar system owner will usually be required contractually to provide accurate generation forecasts in specified time increments. Failure to meet the forecasts may result in penalties based on the utility's costs to make up for the undelivered power. Distributed generation, either at load centers or as smaller blocks of distributed utility generation, can greatly reduce this problem by minimizing the portion of solar generation affected at any one time by cloud events and other intermittent problems. Solar is a great source of renewable and sustainable energy, but generation timing and consistency is highly valued by utilities.

Finding a Buyer

Finally, the entire process of developing a solar project will not be successful unless there is a buyer for the generated energy. From my experience, this is often the most difficult step. The best option is to locate a system on a buyer's property and sell the generation directly to him. These systems are usually no more than 1.0 to 2.0 MW. Otherwise, because of wheeling charges by the gird operator to transmit the energy over high voltage lines to an offsite customer, it makes more sense to sell to utilities. More than thirty states mandate that utilities generate and/or buy renewable energy up to a specified percentage of their total annual energy supply. Some states 'carve out' or reserve part of the percentage for solar PV and solar thermal plants (power towers, parabolic troughs, etc.). Hence, utilities have a big appetite and can justify large solar systems. The procurement mechanisms vary from state to state. They may be open to all renewable energy technologies or specific to solar. Typical methods include, but are no limited to: Requests for Proposals and Requests for Bids where the low bid gets the award: Feed in Tariffs where there is a predefined tariff or purchase price per kWh up to a certain project capacity; Reverse Auctions where proposers quote a price and multiple awards are made starting at the lowest price and then working up in price until a quota is achieved; and Renewable Energy Credits (or similarly defined production credits) that pay a high rate per kWh of generation for a specified time (e.g., five years).

Submitting a proposal to utilities in response to a solicitation is very time consuming and can cost in the 'five figure' range due to the extensive submittal requirements. These procurement processes can be very competitive and successful firms often have dedicated staff to write impressive proposals. Also, some module manufacturers submit proposals for the larger solicitations, using their own modules and internal financing at an obvious cost advantage to win market share. This makes it difficult for smaller independents to compete. Success breeds success and a small number of the same winners continually seem to gather awards.

There are many difficult challenges to overcome to be a successful large-scale developer of solar energy in the U.S. There are a plethora of governing jurisdictions and regulations that make planning and execution unpredictable. There are very restrictive environmental requirements that are often abused, driving up costs. Interconnection to the grid often requires expensive grid infrastructure upgrades and strict operational reporting. And finally, competing for utility buyers in a highly competitive bidding environment is very difficult.

At the same time, there are success stories. To be included among the successful, a developer must be prepared with an experienced and capable team, patient during the long delays, and willing to spend money. PV

Bob Parkins of Bob Parkins Renewable Energy Consultants (www.bobparkinsconsultants.com) is a professional engineer and independent solar energy consultant with over 35 years of engineering and construction experience, 20 years of which are in solar energy. He specializes in helping public and private clients navigate the shoals of solar energy development. He does everything from feasibility studies, technical assessments, designs, and construction services to solicitation and proposal development, special studies, Power Purchase Agreement analyses, interconnection evaluations, and utility-scale development. He has done projects throughout the world.