White paper

Six stages of solar bankability

Solar radiation is arguably the most plentiful source of available energy on our planet. Solar electric power generation is clean, renewable, flexible, scalable and can be deployed relatively quickly in order to help meet increasing demand. However, solar energy is not without challenges, and in order to ensure the availability of capital for solar electric power generation, developers need to mitigate the risks involved.

In this paper, we will examine the first five stages of solar development to see how the decisions made during the development process affect a project's bankability. We will then take a look at a crucial sixth stage, customer enablement. This stage provides energy conscious consumers with the ability to choose solar electric power and other renewable sources of electricity over more traditional sources.

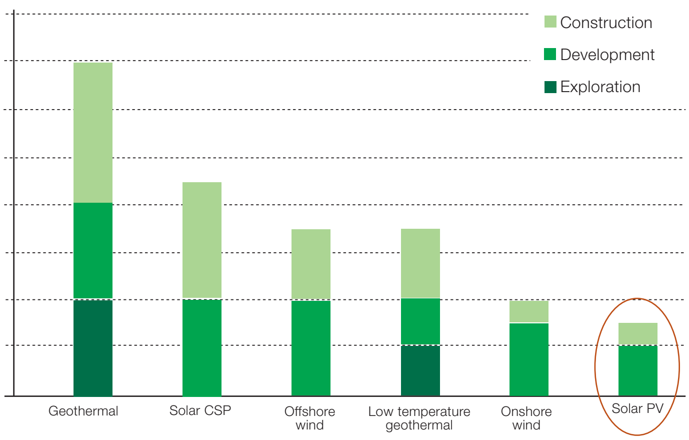
The solar opportunity

The amount of solar energy reaching the surface of the Earth is so great that in 6 months it is about equal to all of the energy that can be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined. Theoretically limitless, the sun has an estimated life span of another five billion years, and is one of the most passive forms of power generation with zero emissions.

Solar electric power has a great deal of appeal for investors looking at opportunities in the renewable energy market. The scalability and flexibility in locating a prospective PV power plant give it distinct advantages over other methods of power generation:

- It is relatively easy to assess and forecast the availability of the resource.
- There is no variability associated with the cost of the main fuel, sunshine.
- Compared to other renewable sources of energy, solar PV is quick to deploy. A utility scale solar PV plant can take 1.5 years as compared to an average of 2 years for onshore wind and up to 7 years for a geothermal power plant, according to IHS Emerging Energy Research.

Dependence on costly, time-intensive transmission build-out



Source notes: IMS Emerging Energy Research

Rapid deployment makes solar an attractive solution for states and utilities scrambling to meet their respective renewable portfolio standards and keep up with increasing energy demand. This in turn provides an opportunity for investors and developers.

Utility scale solar electric power development does not face quite as many infrastructure concerns as other sources of energy. Since the sun shines to some degree everywhere on the planet, solar power plants can be placed relatively close to the point of consumption, leveraging substations with excess capacity. Locating power generation close to the load results in lower losses due to transmission.

Bankability: the challenge for solar developers

However appealing solar investment is, developers still need to assess investment risks by considering the following questions:

- Is the technology proven?
- Has the EPC demonstrated the ability to deliver the project on-time and within budget?
- What is the anticipated ROI?
- How quickly can the project start generating a return?

Generally speaking, in the solar industry, bankability is a term used to describe the degree of financial risk. The degree of bankability of any project, solution, technology or supplier will affect the availability and cost of capital.

The decisions a solar developer makes during project planning, installation and commissioning can have a significant impact on a project's risk and associated return. In this paper, we will break the project down into four stages:

#1 Site and project assessment
#2 Design and optimization
#3 Procurement
#4 Installation and commissioning

We will also look at two critical post development stages that continue to impact the project's total operating costs and return:

#5 Maintenance
#6 Customer enablement

#1 Site and project assessment

When most people think of site assessment, they tend to look at obvious things such as average solar insolation for the region and local site conditions. While it is true that solar can be developed anywhere, utility-scale solar projects make more sense in areas such as a desert where the land is relatively inexpensive and the solar resource is stronger and generally more available.

There is more to choosing a proper site than simply finding cheap land in the desert with good solar insolation levels. Developers also need to consider local infrastructure availability and capacity. Solar power plants can be built in relatively short order close to substations with access to transmission lines with available capacity. Siting power plants close to the load or consumer, reduces losses associated with long distance transmission. This flexibility is an advantage over other rival renewable energy technologies.

As with any project, it is crucial to consider environmental and community concerns. Environmental groups have tied up more than one power project in costly legal battles. And local residents, while supportive of solar in general, may have concerns about the appearance of a field of solar modules within their view. Before final site selection, it is important to conduct environmental studies and investigate community concerns so the project is not blocked before it even begins.

#2 Design and optimization

Once the site has been selected, design and optimization of the solar plant can begin. Things can get complicated as developers try to strike a balance between first costs, Total Operating Costs (TOC) and Levelized Cost of Energy (LCOE).

First costs - the costs to acquire equipment as well as build and commission the solar power plant.

Total Operating Costs (TOC) - the sum of all direct and indirect costs that go into operating a solar plant. Both first costs and operating costs affect when a plant ultimately becomes profitable.

Levelized Cost of Energy (LCOE) – expressed in cents per kilowatt hour (kWh), takes into account not only the capital cost of building a project, but also operating and maintenance expenses over time, such as the length of a power purchase agreement, the cost of the fuel, etc.
LCOE is a crucial metric for solar investors as it is often used to compare the cost of solar energy to other sources. It's LCOE that determines the long term profitability of a power plant.

Here are three ways decisions made during the design phase can impact first costs, TOC and LCOE.

Product design – Transformers are an important capital item and a critical piece of equipment in a solar power plant. Proper consideration should be given to selecting an appropriate transformer; they are an excellent example of the tradeoffs developers must make between first costs and total operating costs. Variables such as the cost and/or price of energy either

generated or consumed, as well environmental and load factors aid in the selection of the ideal transformer.

For example, ABB manufactures distribution type transformers with both traditional grain oriented electrical steel cores as well as amorphous cores. An amorphous core transformer has superior no-load loss performance when compared to a more traditional grain oriented core transformer. The grain oriented transformer has superior load loss performance to that of an amorphous core transformer.

An amorphous core transformer has a higher first cost than a traditional grain oriented core transformer. However, in many cases, a properly designed, amorphous core transformer will deliver a 3-5 year payback. Due to the nature of PV solar power, the transformer spends a great deal of time at no-load or lightly loaded conditions, increasing the importance of the no-load loss performance of the transformer.

In addition, ABB leads the way in developing innovations such as BioTEMP®, a 97% biodegradable, non-toxic transformer fluid that can hold up to 10 times more moisture than mineral oil. Using BioTEMP in solar applications makes even more sense due to the intermittent nature of solar power generation. BioTEMP allows a typical transformer to be overloaded by approximately 10% and still achieve the same life expectancy.

To help developers balance first costs vs. Total Ownership Cost, ABB has developed a TOC calculator to determine the present value of a transformer's no-load losses ($/watt) and load losses ($/watt) over the expected life of the transformer. Added to the transformer purchase price, this gives the buyer the total ownership cost over the expected life of the transformer for use in payback models.

Once the total ownership costs of various designs have been calculated, developers can use the Payback Calculator to help select the optimal transformer design based on shortest payback period, taking into account transformer purchase price, losses and cost of energy.

Product selection – Instrument transformers are another one of the many product choices that can have an impact on Total Ownership Costs and Levelized Cost of Energy. Extended range and accuracy are both important features of an instrument transformer, and ABB is one of the few companies to offer both in one product.

Accuracy is crucial to payback as it allows the utility to capture revenues that might otherwise be lost. For example, if the accuracy of an instrument transformer is off by even 1%, the effect on just one large industrial customer's annual bill could be as much as $23,000. If a utility has 50 customers of this size, that 1% error can translate into as much as $1,150,000 in lost revenues in just one year.

Safety should also be a consideration during the design phase, and product selection has a big impact. For example ABB's arc-resistant medium voltage switchgear reduces equipment damage due to internal faults, increasing equipment reliability and preventing tragic injuries to employees.

System optimization – Even if the solar developer makes wise choices to minimize first costs while balancing total operating costs, the solar plant may not be optimized to provide the greatest return. One illustration of this is a Concentrated Solar Power (CSP) pump optimization project where ABB was able to identify design changes that would provide substantial first cost and total ownership cost savings.

The original design of the CSP plant called for sixty-four inch pipes, 2 supply pumps, 3 boosters and 5 injection pumps. The team was able to optimize the system design by reducing pump size and wall thickness and eliminating the boosters. They even managed to increase capacity of the system by another 10,500 gallons per minute.

The results? The company saved $101 million on first-costs, $3 million in energy costs over the estimated life of the plant and $104 million in total costs.

#3 Procurement

Solar projects can be complex and funding sources fickle. It is important for developers to complete the solar project while funding is still available and to ensure investors the project will operate as planned. Therefore, developers must select suppliers that can deliver as promised.

Here are a few things to think about when selecting a supplier, whether it's an equipment supplier or an EPC:

- What is their experience in the market? Do they have the references to support their claims?
- What is the supplier's relationship and experience with utilities and off takers of power to ensure grid integration is successful and efficient?
- What is the financial strength of the EPC? How deep is their balance sheet and do they have the financial strength to deliver even in tough times?
- Are their products designed for the harsh solar environment? Sand, wind, dust, salt and other elements can wreak havoc on sensitive equipment.
- Could supply disruptions and shortages cause problems, or does the supplier have the capacity to minimize these? For example, ABB is the largest buyer of copper in the world, making it less vulnerable to potential shortages.
- What are their testing procedures? Do they test equipment before it reaches your site? ABB provides 1MW pre-tested solar plant modules, making it easy to scale solar development and reducing delays in site commissioning.

While few suppliers provide 100% of the solar solution, developers do well to minimize the number of suppliers they work with in order to reduce the number of moving parts in any solar project.

#4 Installation and commissioning

Installing and commissioning a solar plant is different from other types of power plants, with each particular type of solar having its own challenges. One commonality is that solar plants contain a large number of components. When installing in harsh environments, special care needs to be given to the handling of these components so they are not damaged during the process. In addition, shipping and delivery of these components needs to be coordinated so they are available when needed. If they arrive too early in the process, the risk of damage increases as they can be exposed to the elements while awaiting installation.

Solar developers should ensure all contractors working on the job are solar-trained. It helps to ensure the vendor in charge of the project has extensive solar project management experience and that project managers are well-versed in managing solar projects. It also helps if they've been certified by organizations like the Project Management Association.

#5 Maintenance

Solar PV power is faster to deploy than other types of power plants, but the average PPA of a PV plant is 20-25 years based on the design life of a solar module. This means the solar developer has a shorter window of time in which to achieve and maximize profitability of the plant.

To maximize profitability of the solar plant, the developer needs to think about three things:

- Maximizing uptime
- Maximizing output and revenue
- Extending the life of the plant

Asset maintenance – Asset maintenance is a discipline that can help maximize uptime and extend the life of the plant. A key component of asset maintenance is asset monitoring to predict potential failure. For example, ABB offers TEC Monitoring™, an online power transformer monitoring service that detects gassing and other signs of potential transformer failure.

In addition to asset condition monitoring, asset maintenance helps ensure regularly scheduled preventive maintenance. ABB has found utilities that have deployed its Ventyx Asset Management applications can reduce downtime by 20% while reducing maintenance costs by 30%.

In-field servicing – Technology that allows in-field servicing can also improve uptime. Using the example of power transformers again, the challenge in transporting these large machines can make them costly to repair. In-field services, such as oil reclamation and low frequency heating to dry the insulation can decrease downtime, cut costs and extend the life of the equipment.

Component selection –The equipment you choose plays a significant role in maximizing uptime. When selecting components, ask about ratings such as Mean Time to Repair (MTTR). Of course, requiring less maintenance is a great way to improve uptime. For example, ABB's AMVAC magnetic actuator circuit breakers contain only one moving part as compared to roughly three hundred in traditional spring-charged breakers, increasing reliability and durability.

In addition, suppliers who manufacture and stock components that don't have to be shipped overseas can decrease downtime

significantly. Innovations such as the extended range instrument transformer can be used as a universal spare, decreasing your downtime while lowering your inventory costs of components on hand.

#6 Customer enablement

Solar energy, at least at this stage of its development, is not a primary energy source for most consumers. However, one of the industry's keys to success is to enable consumers to choose solar over other sources.

Demand Response is a technology that helps utilities encourage the use of solar power, and ABB enables this through the Ventyx Virtual Power Plant (VPP). The VPP coordinates solar plants with other forms of energy and allows the utility to supply energy based on factors such as renewable energy portfolio targets. In addition, the VPP allows the customer to set preferences such as energy supplied from solar power regardless of other factors, putting choice in the hands of energy-conscious consumers.

Conclusion

If solar electric power is to become an important source of energy in our future, the industry needs to work together in order to make it affordable for everyone. Lowering costs and increasing the safety and reliability of solar electric power will make it easier for utilities and consumers to select solar power over other forms of energy.

Making solar electric power affordable begins with developing solar electric power plants that have a competitive Levelized Cost of Energy. In order to obtain a low LCOE, a developer must not only control first costs, but focus on minimizing Total Operating Costs. Developers must also reduce the risk of solar power projects in order to attract more investors and lower the cost of capital for those who are interested in funding renewable energy projects. In other words, bankability is key to the future of solar power generation.

Solar project bankability doesn't happen by accident. It takes careful planning during every stage of the project and assistance from experts who have the experience to navigate each stage of a complex project, steering around hurdles like local regulatory, environmental and public concerns. Suppliers with experience in developing products and solutions for optimizing solar projects can save developers, utilities and consumers millions of dollars in first costs and Total Operating Costs, as well as dramatically impact the time it takes for the solar plant to achieve profitability.

This is an important period in the development of the North American solar power market. The demand for safe, clean, reliable renewable power is growing at an ever increasing rate. The market is looking for large global players like ABB to provide leadership and stability. ABB will be demonstrating its commitment by introducing new technologies and solutions that improve efficiency, reliability, safety and performance of modern solar power systems, and will continue to invest in solar electric power solutions in order to improve its viability and long-term bankability.

For more information please contact
www.abb.us/solar

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