

## Six stages of solar bankability

Solar radiation is arguably the most plentiful source of energy available on our planet. Solar electric power generation is clean, renewable, flexible, scalable and can be deployed relatively quickly to help meet increasing demand. However, solar energy is not without challenges, and in order to ensure an available budget for solar electric power generation, military and government agencies must mitigate the risks involved. Generally speaking, in the solar industry bankability is a term used to describe the degree of financial risk.

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

### The solar opportunity

The amount of solar energy reaching the surface of the Earth over a six-month period is about equal to the energy that can be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined.

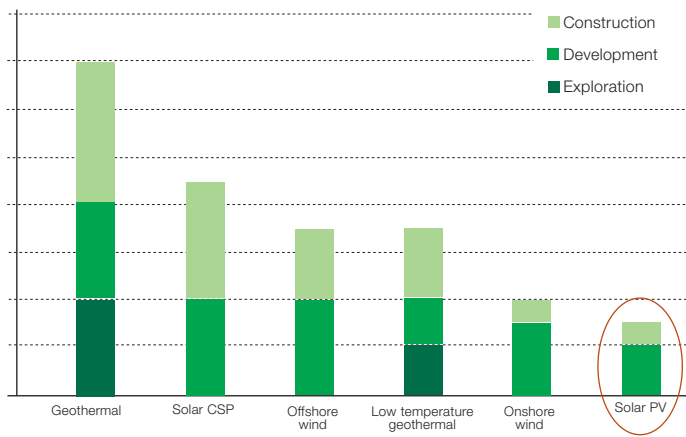


Theoretically limitless, the sun has an estimated life span of another five billion years and provides power generation with zero emissions.

Further, the scalability and flexibility of locating prospective photovoltaic (PV) power plants give this resource distinct advantages over other methods of power generation:

- It is relatively easy to assess and forecast the availability of sunshine.
- There is no cost associated with the main fuel, the sun's rays.
- Compared with other renewable sources of energy, solar PV is quick to deploy. A utility-scale solar PV plant may take 1.5 years to develop as compared with an average of two years for onshore wind and up to seven 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 federal and military entities struggling to meet their renewable portfolio goals and to keep up with increasing energy demand. In addition, utility-scale solar-electric power development does not face quite as many infrastructure hurdles as other sources of energy. Because 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 consumers also lowers the amount of energy wasted through transmission line losses.

### Challenges to success

Despite solar electric power's benefits and appeal, groups that invest in its development must weigh its ability to meet their needs by considering the following questions:

- Is the preferred technology safe and proven?
- Has the project developer (EPC) demonstrated the ability to deliver the project on-time and within budget?
- What is the anticipated benefit?
- How quickly can the project start generating the benefit?

The decisions a solar developer makes during project planning, installation and commissioning have significant impact on a project's risk and associated return. We break projects down into four phases:

- #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:

- #5 Maintenance
- #6 Customer enablement

### #1 Site and project assessment

When most people think of site assessment, they look at obvious factors such as average solar insolation for the region and local site conditions. While it is true that solar power can be developed

anywhere, utility-scale solar projects make more sense in areas where land is relatively inexpensive and the sun is stronger and generally more available, such as a desert.

However, there is more to choosing a proper site than simply finding cheap land in the desert with good insolation levels. Developers must consider local infrastructure availability and capacity. There may be a preference for solar power plants built close to substations with access to transmission lines with available capacity. And as noted above, siting power plants close to the load or consumption point reduces losses associated with long-distance transmission. This flexibility provides solar generation 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 energy in general, may have concerns about the appearance of a field of solar modules within their view. Conducting environmental studies and investigating community concerns is important to the siting decision process.

## #2 Design and optimization

Once a site has been selected, the design and optimization of the solar plant can begin. This involves developers striking 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), LCOE takes into account not only the capital cost of building the 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 projects as it is often used to compare the cost of solar energy with other sources. It's LCOE that determines the long-term viability of a power plant.

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

**Product design and selection** – Transformers are a significant capital equipment investment and an excellent example of the tradeoffs developers must make between first costs and TOC. 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.

ABB manufactures distribution type transformers with both traditional grain-oriented electrical steel cores as well as





**System optimization** – Even with wise choices to minimize first costs while balancing total operating costs, a solar plant may not be optimized to provide the greatest benefit. One illustration of this is a concentrated solar power (CSP) pump optimization project where ABB was able to identify design changes to provide substantial first cost and TOC savings.

### #3 Procurement

Solar projects can be complex and funding sources fickle. Developers must be able to complete the solar project while funding is available and able to ensure the project will operate as planned. Supplier reliability is critical. Selection considerations, whether for an equipment supplier or an EPC, include:

- 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 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.

amorphous cores. An amorphous core transformer has superior no-load loss performance when compared with 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 three-to-five 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 which increases the importance of the no-load loss performance of the transformer.

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

Instrument transformers are another of the many product choices that can have an impact on TOC and LCOE. Extended range and accuracy are both cost-effective features of an instrument transformer, and ABB is one of the few companies to offer both in one product.

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 TOC over the expected life of the transformer for use in payback models.

Once the TOC of various designs have been calculated, developers can use ABB's 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.



While few suppliers provide 100 percent 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 large numbers of fragile components that require special care and handling, including coordinated shipping and delivery. If components arrive too early, the risk of damage increases 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 generation sources, but the average power purchasing agreement for a PV plant is 20 to 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 maximize plant performance and their return on investment.

To maximize performance of the solar plant, the developer must:

- Maximizing uptime
- Maximizing output and revenue
- Extend the life of the plant through careful 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 equipment 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 condition monitoring, asset maintenance helps ensure regularly scheduled preventive maintenance occurs as

needed. ABB has found utilities that have deployed its Ventyx Asset Management applications can reduce downtime by 20 percent while reducing maintenance costs by 30 percent.

**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 with roughly three hundred in traditional spring-charged breakers, increasing reliability and durability. In addition, suppliers that 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 downtime and lowering 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 users. However, enabling consumers to choose solar over other energy sources is a key to the technology's success.

Demand response capabilities allow consumers to manage their energy use by shifting demand loads to non-peak periods or off-grid sources. These systems help utilities encourage the use of solar power, and ABB enables demand response through the Ventyx Virtual Power Plant (VPP). The VPP coordinates solar plants with other forms of energy and allows a utility to supply energy based on factors such as renewable energy portfolio targets. In addition, the VPP allows a customer to set preferences such as energy supplied from solar power regardless of other factors, putting choice in the hands of energy users.







For more information on solar technology:

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## Conclusion

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

Making solar power viable 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 also focus on minimizing total operating costs. Developers must also reduce the risk of solar power projects in order to encourage the funding of 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 millions of dollars in first costs and total operating costs, as well as dramatically impact the time it takes for the solar plant to begin returning benefits.

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 to provide leadership and stability. ABB is committed to solar and offers new technologies and solutions that improve the efficiency, reliability, safety and performance of modern solar power systems, which in turn, improves their viability and long-term bankability.

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