The SOLAR QUARTERLY

Reasons for Failure of Solar PV Companies Globally

Lessons for Investors

*In this article, **Dr Sudhir Kumar** explores reasons of the failure and bankruptcy of several SPV manufacturing companies globally during the last couple of years and suggests the dos and don'ts of how to invest in this most promising sector of the renewable energy.*

Stupendous growth of solar photovoltaic (SPV) sector all over the world discussed in several recent reports makes it hard to believe that many such companies became bankrupt or were acquired by other companies. Personally, I thought of analysing the reasons for such large-scale failures of SPV companies. To start with the analysis, Eric Wesoff's article (*Source:* http://theenergycollective.com/eric-wesoff/2165821/rest-peace-fallen-solar-companies-2014) gives an exhaustive list of failed companies all over the world, which he claims to be little incomplete.

Many reasons are given for the failures of SPV companies: (a) GTM Research forecasts 21 GW of PV module manufacturing capacity coming offline by 2015 as the global market reconciles a dire supply–demand imbalance (*Source:* http://www.greentechmedia.com/research/report/pv-supply-2012); (b) Craig Lawrence (*Source:* http://www.quora.com/What-are-some-autopsies-of-failed-solar-companies) has given many reasons for failure such as: undue favour from the government; overenthusiasm of venture capitalists; difficulty in scaling up; impatience of investors; and inability to lead the laboratory technology to commercialization. Although all these may not be tagged as frivolous, the real reason seems to be something else, which needs to be delved into for the benefit of future investors. Most of the analyses were carried out by market researchers and investment experts; thus, the technological intricacies involved in functioning and manufacturing of SPV have been missed out.

CHRONOLOGICAL STATUS

If we take a closer look at the complete list of these failed companies (from 2009 to 2014), the analysis reveals many startling facts. Let us first have an insight into the profile pattern of these companies who have become bankrupt and were either closed, acquired, exposed to fire sale, or were forced to restructure.

- Out of the total 109 failed solar companies, year-wise break up is: 10 companies in 2009–10, 11 companies in 2011, 45 companies in 2012, 31 companies in 2013, and 12 companies in 2014.
- Of the 10 companies in 2009–10, total eight used thin-film technology and majority of them were based on Amorphous Silicon (a-Si). One of them had used nanotechnology and another Gallium Arsenide (GaAs). Remaining two companies used to carry out other solar activities.
- The year 2011 saw failure of 11 SPV companies. Out of these, seven companies used thin-film technology using a-Si, CdTe (Cadmium telluride), and Copper indium gallium selenide (CIGS). Only one of them used crystalline silicon technology. The other one had Concentrated PV (CPV) technology.
- A relatively larger number, i.e., 45 companies failed in 2012. Out of these, 18 used thin film technology a-Si, CdTe, CIGS, and Organic Solar Cell (OSC). Nine of them used crystalline silicon technology. Three companies used CPV technology. Remaining were either Balance of System (BoS) suppliers or solar developers/module manufacturers.
- The year 2013 was also fatal for many SPV manufacturing companies. Out of 31 companies, 12 used thin film technology, CdTe, and CIGS. Five of them used crystalline silicon technology. Three companies used CPV technology. A new technology of Solar Combined Heat and Power (SCHP) was used by one of the companies. Remaining were BoS suppliers, solar developers, and module manufacturers.
- Fortunately, lesser failures were observed in 2014. Out of 12 companies, five used thin-film technology, CdTe, and a-Si. Two of them used crystalline silicon technology. Two companies used CPV technology. Remaining were BoS manufacturers and developers.

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ANALYSIS OF THE PROBLEM

The given data indicate that overall 48 per cent of the failed companies used thin-film technologies and majority of them were of a-Si. CIGS is the next one followed by CdTe. Only 15 per cent companies using crystalline technology were the failures. Interestingly, 2 per cent companies dared venturing into unproven new technologies such as OSC, nanotechnology, GaAs, and SCHP. Around 8 per cent were using CPV. The rest of them, i.e., 28 per cent companies were developers and equipment suppliers. The report also warns that many of the CPV companies are on the watch list in 2014.

One can understand the failures of developers and equipment suppliers due to their faulty marketing strategy and volatility of market. If we keep aside this category, majority of failures pertain to technological issues that can be analysed as follows:

- Thin-film technology attracted the attention of solar industries from 2005 onwards due to its cost effectiveness as: (a) it requires low process temperature, enabling module production on flexible and low-cost substrates; (b) the technological capability for large-area deposition; (c) very thin film has low material requirements; (d) there is low energy consumption during manufacture; and (e) there is a possibility of automation of the manufacturing process.
- Venture capitalists, with an objective of making a big kill by challenging the existing crystalline technology, supported many companies without proper technical due diligence. They were oblivious to the technical facts that any thin-film solar cell in general has the following risk factors:
  - Thin-film solar cells are always 40–50 per cent less efficient than crystalline ones, requiring comparatively 30 per cent more land for the same installed capacity and obviously, more BoS, e.g., structure, wiring, etc.
  - Thin films generally have problem of material instability on the substrate on which they are deposited.
  - Even with stable films, the efficiency degradation rate per year is faster as compared to crystalline solar cell; hence, it

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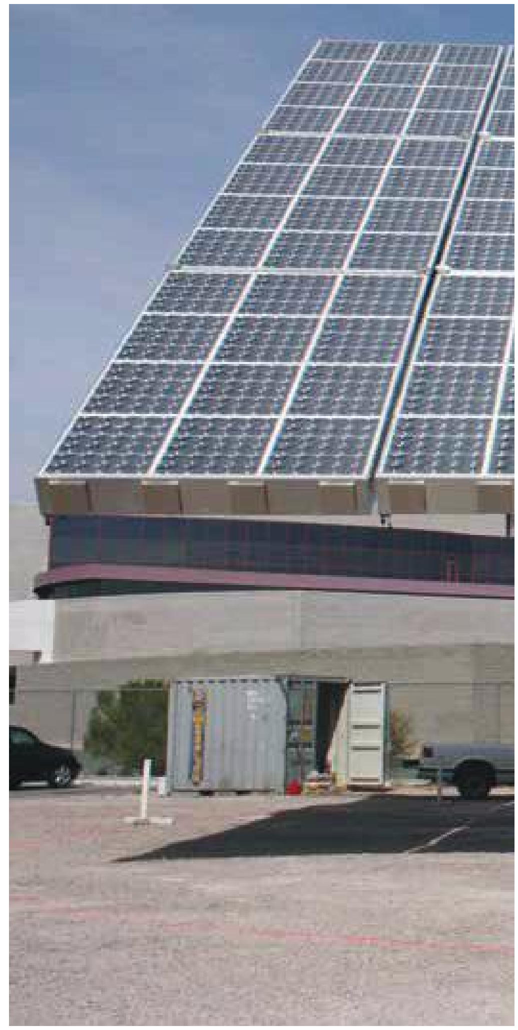
has lesser life and lesser power output during its entire lifespan. Moreover, the most used a-Si has initial light soaking degradation (in first 1,000 hours) in addition to the annual inherent degradation.

- In the case of thin-film solar cells, the thin layer of absorber material is fixed between two glass layers of around 3-mm thickness each. In the event of rise in ambient temperature, the two rigid layers of glass face severe stress due to temperature difference between top and bottom layers and due to high inherent cell temperature under illumination. This causes micro-cracks in the top glass layer, especially during water cleaning. Therefore, the thin-film power plants have to compulsorily replace 1 per cent of modules per year that leads to an additional cost.
- At the project level, thin film technology has higher environmental externalities due to the presence of heavy metals as compared to crystalline PV technologies. This is important from the societal perspective.

- In the past few years, CdTe has been claimed to have comparable efficiency and stable on substrate although uncertainty about annual degradation rate is still to be authentically verified by a third party. There has been a concern about highly poisonous Cd being used and its possible health hazard. The claim by some companies for its safe use is yet to be substantiated by an independent government agency.
- Great claims have been made about CIGS in laboratory. But on practical ground at project level, it is still to see the light of the day as good commercial venture mainly due to material instability on substrate.
- GaAs, although technically at very advanced stage, suffers from unusual high cost and its business will never survive the market with the current rock-bottom cost scenario of technologically advanced crystalline silicon technology.
- OSC and nanotechnology, although fascinating for researchers, are well known for their poor efficiency and practical efficacy. It is a big risk to go for manufacturing with these technologies at their nascent stages of development.
- Using SCHP has its own operational problems; it is yet to prove cost economics. Hence, it is not advisable to go for manufacturing before sufficient due diligence of some pilot projects.
- Mono-crystalline and poly-crystalline silicon technologies have shown far better performance in the field since many decades due to their better material stability, higher efficiency, lesser annual degradation, long-term commercial viability, etc. Thus, only 16 per cent companies based on crystalline technology have failed due to tough competition fuelled by drastic reduction in cost in recent years. Most of them have been acquired or restructured. Only very small percentage of companies using crystalline technology have been left haywire.
- The CPV technology has an interesting case. I had visited, courtesy World institute of Sustainable Energy (WISE), Pune, a reputed institute working extensively on CPV, namely ISFOC, Puertollano, Spain (http://www.isfoc.net) and found that CPV suffers from—(a) inherent problem of inaccurate focus of hundreds of lenses or concave mirrors on solar cells placed on a single large panel; (b) overheating of the cell support material; (c) moisture collection on inner surface of lenses; (d) practical difficulty in hermetical sealing, etc. Performance of CPV at commercially successful scale leaves much to be desired although some megawatt-scale plants have been installed. It is but natural that nine companies have been reported to fail. Naturally, Wesoff's report has kept all the CPV companies on watch list.



LESSON FOR FUTURE INVESTORS

So, what is the lesson we learn from these failures? We should not only depend upon the reports prepared

by the market analysts or investment experts. A thorough technological due diligence with incisive analysis is a must. In short, before jumping to any investment decision, you must have in your hand techno-economic due diligence report prepared by an expert with wide experience.

Getting good due diligence report is itself an art. The first task is to find the right consultant to prepare it. Find out the consultant who has at least 5–10 years' experience in solar sector. He must have prepared at least five detailed project reports (DPRs) for solar power projects of minimum 2-MW capacity. The most important criterion is that he must have in-depth knowledge of solar cell semiconductor physics. He should be able to differentiate one solar cell from other based on their material properties such as: band gap, efficiency, stability on substrate, fill factor, temperature coefficient, radiation performance, inherent annual degradation, potential induced degradation, Ohmic contact efficacy, weather endurance, material availability, cost of raw material, cost of production, environmental/health hazard, etc. As an investor in solar cell manufacturing company, one has to be careful in getting the due diligence report prepared, which must incorporate the following, but not restricted to the points:

Technology evaluation

This section should elaborate details of material science of the solar cell with a good literature survey of laboratory research and its latest developments. As far as possible, it should give the reference of pilot stage test results to inculcate confidence in expansion of technology for field application. An accelerated test result with respect to its material stability and outdoor sustainability with rigorous environmental/weather examination is necessary. It should predict the theoretical limits of efficiency. Possibility of efficiency enhancement needs to be analysed. Practical problems in scaling up the technology have to be examined.

Manufacturing procedure

The large-scale production needs closer look into quality control measures to be adopted for consistent performance of the solar cells. For better profit, the details of manual and automated components and their optimum ratio need to be analysed. The production rate must be compared vis-à-vis rejection rate. It is necessary to ensure good quality encapsulation-procedure and packaging system. An uninterrupted availability of raw material at reasonable cost has to be ensured. Proper study has to be done for inventory management, manpower management, delivery mechanism, etc.

Financial analysis

To ascertain it as a good business proposition, the market forecast and proposed marketing strategy has to be analysed in detail. Initial investment, projected profit-loss account, and balance sheet need to be realistically assessed with respect to detailed risk analysis. The risk analysis has to assess the impact of technical issues, market status, socio-economic condition of the country, bureaucratic environment, local political will to promote the technology, environmental aspects, any possible health hazard of the raw material, ease of availability of raw material, local industrial policy/laws/rules, etc. One of the most important criteria is the easy and low cost availability of finance.

Approvals and clearances

Approvals and clearances as per the local laws and policies before the beginning of manufacturing are the key factors, which investors generally have the tendency to overlook. It is necessary to have detailed information in advance of complete procedures, statuary fees to be paid, requirement of documentary proofs to be submitted, exact applicable forms, approving authorities, offices where forms are to be submitted, stages of approvals, etc. It has been observed that many projects fail to kick start due to undue delay in approvals and face the threat of surmounting escalation in total cost. It is, therefore, imperative that time taken in getting statuary clearances should be realistically assessed. An intelligent investor always makes it sure that the procedure of financial closure and getting statuary clearances go hand-in-hand.

CONCLUSION

All the above suggestions are indicative. These may vary depending on the project type, place, and situation. Those investors are winners who take up project not as emotional decision, but arrive at realistic conclusion based on proper techno-economic due diligence. Thus, dos and don'ts should be taken care of. The dos are—keep being solar an enthusiast; take up solar business for profit making; have a long-term vision, and go for well-established technology. The don'ts are—must see technology working before believing in it; never get trapped into unrealistic financial jargons; never venture without proper market survey; and do not go for manufacturing of new product which is not yet tested at pilot scale even after being highly successful in laboratory. EF

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