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IFC SmartLessons

real experiences, real development

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The Sun Rises on the Solar Sector

Energy from the sun is abundant and free. Solar energy is in essence electromagnetic radiation emitted from the sun. Earth's climate, hydrologic systems, and ecosystems all derive from the sun. Other forms of renewable power such as wind, wave, biomass, and hydro are an indirect function of solar radiation.

Enough solar energy reaches the Earth's surface every minute to satisfy mankind's energy requirements for an entire year.¹ It is estimated that in one year, the amount of solar energy reaching the Earth is equal to twice the amount of energy that will ever be obtained from the Earth's stock of nonrenewable energy sources.² There are opportunities to find and deploy robust, competitive solutions to convert a small fraction of this plentiful energy source into usable electric energy: Solar photovoltaic (PV) is the main solution used today, involving the use of PV panels³ that generate electricity when exposed to the sun.



Death Valley solar farm

The problem is that converting solar radiation into usable electricity is expensive, relative to traditional fossil-based energy sources, and somewhat expensive relative to some other

renewable sources (see Exhibit 1), because the solar panels themselves are expensive to manufacture and install. However, solar power offers the potential for much greater cost reduction than other renewables, based on its relative technological immaturity (see Exhibit 2). Rising to the challenge of generating solar power in a cost-effective manner would have a substantial impact. Over their life, the operation of 500 megawatts of solar panels would avoid approximately 10 million tons of CO₂ that on average would otherwise be emitted to generate an equivalent amount of energy.

IFC's strategy for solar was approved by the Corporate Operations Committee in October 2008 and focuses on:

- *investments in the solar supply chain to help reduce the cost of solar modules and installations through shifting production to low-cost countries, scaling-up manufacturing facilities, and supporting new technologies; and*
- *investments in solar farms and installations where there is suitable regulatory support (e.g., incentives, subsidies, etc.) and where solar is already competitive with traditional energy sources (e.g., for isolated systems or island systems where expensive diesel-based generation is used).*

IFC has invested in a number of companies: Nitol (manufacturer of silicon) in Russia; MBPV (the Moser Baer Group in India - crystalline silicon PV); ENN XinAo (the XinAo group in China - thin film PV); and CEPALCO PV in the Philippines (solar farm). This Smart Lesson

¹ Nathan S. Lewis, California Institute of Technology; Daniel G. Nocera, Massachusetts Institute of Technology.

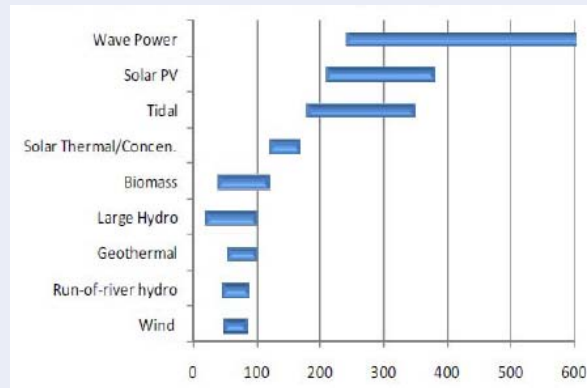
² Global Climate and Energy Project, Stanford University.

³ Also known as solar modules. Solar panels are made up of solar cells. The main technology is crystalline silicon PV, where thin wafers of purified silicon are treated such that an electric current is generated when they are exposed to the sun; in thin film PV, very thin layers of various materials are deposited on glass or metal substrates to make solar cells.

draws on IFC's experience investing in the solar industry and discusses the opportunities and challenges for IFC in this dynamic sector.

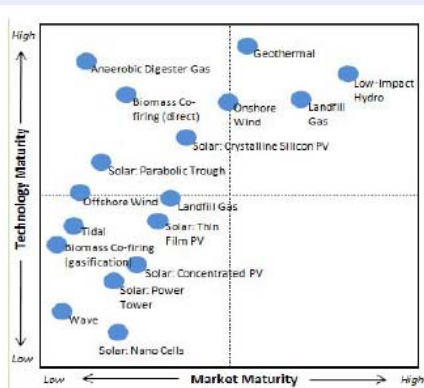
few years as silicon prices shot up due to excessive demand, but the recent industry downturn means that the long-term downward trend has now resumed. The key focus for solar industry players is achieving "grid parity," the point at which the cost of electricity from solar PV will be at par with conventional sources of power without subsidies. At current average pricing levels, solar PV still costs in the range of 20 to 40 cents per kilowatt hour. However, as the total cost of a solar installation falls over time, grid parity will be achieved progressively in various countries (or states in the United States), each characterized by different non-renewable fuel sources, prevailing electricity tariff structures, and the level of solar radiation.

Exhibit 1: Levelized Costs and Renewables (2007, \$/mWh)



Source: Hydro, Sandia National Laboratory, Idaho National Lab, Carbon Trust, Simmons Energy Monthly

Exhibit 2: Maturity of Renewables



Source: American Wind Energy Association

Lessons Learned

1) It's all about long maturities and low interest rates.

The basic characteristic of solar PV installations is that they generate electricity at almost zero cost⁴ when exposed to the sun: in particular, there is no fuel cost because the sun's energy is free. Solar installations thus represent an excellent hedge against highly variable fossil fuel prices, and this is one of the reasons that large utilities are now taking it much more seriously than in the past. However, the flip side of this characteristic is that virtually 100 percent of the cost of solar PV is capital cost, all paid up front at installation. Solar installations are very durable, with the solar panels themselves continuing to function for 25 years or more, so the up-front cost is recovered over more than two decades of essentially free electricity. This cash-flow profile makes solar especially sensitive to the availability of large amounts of long-term funding, so it is a natural fit for IFC.

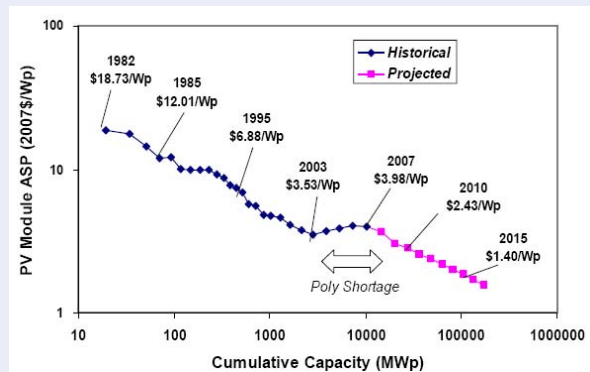
2) Solar offers more cost-reduction potential than other renewables.

The solar industry, applying technologies and manufacturing processes derived from the semiconductor industry, is the only renewable energy solution with a well-established and reasonably predictable cost-reduction curve. For example, wind is cheaper than solar today but is fundamentally based on more mature technologies and manufacturing processes and so has a lower cost-reduction potential, compared to solar (see Exhibit 2 above).

The solar PV industry has a strong track record of steady cost reduction, as illustrated in the chart above, which shows that the price per unit of output of PV modules has decreased over a long period, as capacity has expanded. The steady downward trend was reversed just in the last

⁴ Minimal maintenance is required during the life of the installation, and periodic replacement of the electric inverter is required, but this averages out to close to zero.

PV Module Learning Curve



Source: P. Minst, Navigant, 2008
From Applied Materials presentation to IFC June 2008

Industry observers project that grid parity for a large number of countries will be reached when solar PV modules are priced at about \$1.50 per watt peak (Wp)⁵. The price of solar PV modules has fallen dramatically since the 1980s, and is expected to continue to drop. The price of modules was about \$19 per Wp in 1982 (in 2007 dollars) and has fallen to around \$3 per Wp on average. Solar PV module prices have been dropping by about 4 percent per annum over the last 15 years, with some companies already beginning to offer volume discounts at about \$2 per Wp for advanced thin-film modules, and prices are projected to drop to as low as \$1 per Wp in the next four to seven years.

⁵ Watt peak, or Wp, is the direct current watts output of a solar module as measured under a standardized light test.

3) The future is in storage and hybrid solutions.

Solar panels only generate electricity when the sun shines on them. (In fact, peak solar generation corresponds closely with peak electricity demand from airconditioning in warm countries.) Without adequate storage—for example, in batteries—electricity from solar panels has to be consumed when it is being generated, and various innovative storage solutions are being developed to address this issue. In addition, hybrid approaches, such as combining solar and wind or combining solar with hydro or even with conventional electricity generation, are being explored to develop solutions that address the need for continuous power while taking advantage of the benefits of solar.

4) IFC has significant opportunities in solar as a result of the economic crisis.

The financial crisis has taken a heavy toll on the solar industry with stock prices of many solar companies falling by 80 percent or more due to uncertainty in the market as banks have reduced lending and households have cut back. IFC has been approached by the industry's top players (including Suntech, SunPower, First Solar, and Q Cells) as they seek to align themselves with a long-term partner with similar broad corporate goals and the financial capacity and long-term perspective to work with them in the emerging solar markets in developing countries. By coinvesting with such companies at this time, IFC can simultaneously help build scale, drive costs down, bring grid parity closer, and share in the upside created as the stock prices of these companies start to rise when the solar market recovers.



Commercial solar panel rooftop

The industry downturn means that solar panel prices have fallen sharply (about 25 percent so far, with perhaps another 20 percent expected in 2009), and solar companies are eager to find new markets, including developing countries, for their products. Growth in the solar industry, which had been running at 30- to 40 percent per year, has slowed significantly this year, but growth is expected to resume in 2010. As grid parity is achieved more widely, solar PV demand is expected to increase sharply, permitting greater scale and lower costs in the supply chain, thereby making

solar PV an integral component of power system supply planning for both utilities and their customers even if subsidy supports are reduced or eliminated. Furthermore, solar PV is already very economical in many developing-country rural off-grid markets where the alternative electricity source may be a diesel generator, and the falling cost trend outlined previously is expected to further improve the attractiveness of solar PV in the off-grid segment. A vibrant supply chain is expected to emerge in developing countries, along with growth in demand and the creation of many green jobs.

5) IFC has become comfortable with investing in an industry benefiting from subsidies.

IFC has a long-standing and well-founded aversion to investing in subsidized businesses. Our experience clearly shows that investing in a company in a protected market that benefits from tariff barriers is uneconomic (that is, a poor allocation of scarce resources) and represents a significant credit risk because the investment is invariably vulnerable once protections are reduced or removed (a consistent trend in a globalizing world). This aversion to subsidies was a major challenge in IFC's initial solar investments.

IFC has become comfortable with investing in the solar industry, notwithstanding the fact that it benefits from substantial subsidies in various forms.⁶ Furthermore, countries with an active solar industry also impose various regulations favoring or encouraging investments in solar (and more broadly, renewables).

IFC's comfort with these arrangements is based on a number of key considerations:

- *It is widely recognized that fossil-based electricity generation is a major contributor to global climate change through the emission of CO₂ into the atmosphere; however, agreement is yet to be reached on how to take this economic externality into account when assessing fossil fuel-based electricity projects. In effect, the playing field is tilted toward coal and gas-fired power plants, compared to solar and other renewables-based solutions. IFC's support for solar projects goes some way toward redressing this situation. But this is not a scientific approach, and a more systematic way to regulate carbon emissions remains a priority.*
- *As noted earlier, grid parity for solar in a number of locations is quite close: IFC's financing for solar projects can be seen as a necessary transitional support to help the industry achieve grid parity.*
- *In a narrower sense, the vast majority of solar panels are installed in industrialized countries (Germany, the United States, Spain, Japan, Italy, etc.) because this is where the industry benefits from substantial, credible subsidy*

⁶ These include (i) feed-in tariffs: higher electricity tariffs paid to households and others who install solar panels and sell surplus electricity to the grid; (ii) tax credits: credit for the amount spent on solar installations, deductible from taxes due; (iii) capital subsidies: grant funds or subsidized loans available to complement private capital for solar installations. Germany is the largest solar market, based on feed-in tariff support; the United States has deployed tax credits and other supports.

arrangements. Thus, in calculating the economic rate of return (ERR) for an investment in a solar company in China, for instance, the subsidies arising in Germany are not taken into account, as the ERR is calculated for the host country of IFC's investment.

- From a credit standpoint, there is now a clear understanding that:
 - the subsidy programs in major solar markets (including Germany and the United States) are based on a stable domestic political consensus so that no radical change is expected
 - IFC's investments, by building scale and supporting the shift of the supply chain to lower labor cost countries, are helping the industry achieve grid parity earlier, and that once grid parity in key markets is achieved, the risk associated with subsidies disappears; and
 - IFC is working with the largest and most successful companies in the solar industry, which are expected to survive the present downturn and emerge strengthened

Conclusion

IFC is leading the way in treating the nascent solar industry and the vast potential of the Earth's largest energy resource as a serious long-term opportunity for good business with substantial global development impact. Supporting industry players as they expand in developing countries accelerates solar's potential for cost reduction and brings closer the achievement of grid parity, while enabling IFC to benefit from the expected upturn in this dynamic industry. Investment in the solar industry coincides with IFC's goal of focusing on climate change-related projects and capitalizes on our role as an investor willing to take a long-term perspective and to help support our clients over the long haul.



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