Letting The Sun Shine In:

The Role of Development Finance Institutions in Catalyzing Investments in the Indian Solar Industry

Master of Arts in Law and Diplomacy Capstone Project

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Table of Contents

Introduction

Access to energy is a fundamental building block of economic development, yet many developing country power sectors face acute challenges with insufficient and expensive generation compounded by limited and ageing distribution infrastructure. India is no exception to this trend. About 100,000 villages in India (17 percent) remain un-electrified, and almost 400 million Indians are without electricity coverage. Untold numbers of businesses suffer from lack of reliable power for industrial processes or because they cannot get their goods to the market.

Solar energy is the largest renewable resource available and solar photovoltaic is the fastest growing energy source in the world. Consequently, massive investment has been occurring globally right across the solar supply chain. A massive drop in the installed costs of solar photovoltaic and the increasing cost of fossil fuels is making solar increasingly more competitive with traditional sources of electricity. Solar photovoltaic is particularly well suited to off-grid applications, making it ideal for rural electrification.

In this paper, I outline the opportunity that solar power represents for India to address its energy deficit and how fostering private sector participation is pivotal to ensure that the capacity of renewable energy is harnessed for development in India.

I begin by reviewing the development of different renewable sectors in India to compare the solar sector with wind, hydro and biomass and extend the comparison to analyze the economic viability of solar energy relative to other energy sources available to India. I conclude that although costs for generating solar power have decreased significantly in recent years, the technology still requires policy support to grow.

In light of this conclusion, I examine the feed in tariff regimes that support renewable generation in India and specifically analyze the incentive structures put in place under the National Solar Mission to encourage private investment in the solar sector. This is followed by a brief primer of the technologies that are being supported by this policy to illustrate their similarities and differences with more conventional, non-renewable power technologies which are more familiar to domestic investors and lenders.

The second part of the paper delves into the role of development finance institutions in catalyzing growth in this sector. IFC, a leader in emerging market renewable energy finance, is uniquely positioned to help countries transition to a low carbon future. As part of a wider program to help mitigate climate change, IFC is investing in and providing advisory services to private enterprises in the renewable energy sector, throughout emerging markets, and across all parts of the supply chain. In 2011, renewable energy projects represented nearly 70% of IFC's commitments in the power sector, in terms of number of investments and dollars invested. Since 2005, IFC has financed more than $2.3 billion in renewable energy projects and between FY'09-11, it has committed to providing a further $3 billion in financing for renewable energy and energy efficiency projects.

Using case studies of IFC's solar investments in India, the paper concludes that IFC's involvement has encouraged private sector participation in three key ways

- Project Appraisal: IFC's due diligence helps uncover the information about the project, as well as sponsors and governments involved, which may not be readily available to lenders. It is arguably better qualified to do sovereign risk analysis given its development experience and relationships with governments and has the ability to act as a mediator between the governments and sponsors to ensure all issues are addressed and handled properly.

- Structuring the project: The IFC has a reputation of being an 'honest broker' with significant experience in mediating large and diverse groups and resolving complex legal issues. IFC pays attention to structure fair deals that would benefit the governments and private sector interests and then monitor them to preclude short-term opportunistic behavior. By virtue of being a World Bank affiliate, it receives preferential treatment from the governments in terms of debt obligations, and hence provides indirect protection for lenders.

- Providing long-term capital: The IFC is an important as a capital provider, willing to lend senior debt and subordinated debt with longer maturities compared to bank loans. Compared to commercial banks, it has a willingness to bear higher risks for the same return because of the developmental aims it attaches to projects.

Chapter 1: Role of Renewable Energy in India

India has a severe electricity shortage. It needs massive additions in capacity to meet the demand of its rapidly growing economy. The country's overall power deficit—11 percent in 2009—has risen steadily, from 8.4 percent in 2006. About 100,000 villages (17 percent) remain un-electrified, and almost 400 million Indians are without electricity coverage. India's per capita consumption of electricity (639 kWh) is one of the lowest in the world.[1]

Renewable energy can be an important part of India's plan not only to add new capacity but also to increase energy security, address environmental concerns, and lead the massive market for renewable energy. More than three-fourths of India's electricity production depends on coal and natural gas. At current usage levels, India's coal reserves are projected to run out in 45 years.[2]

Like coal, gas and oil have witnessed considerable price volatility in recent years. Development of renewable energy sources, which are indigenous and distributed and have low marginal costs of generation, can increase energy security by diversifying supply, reducing import dependence, and mitigating fuel price volatility. Accelerating the use of renewable energy is also indispensable if India is to meet its commitments to

[1] World Bank, 2010. "Energy intensive sectors of the Indian economy: Path to low carbon development." South Asia Sustainable Development

[2] National Sample Survey Organization, Ministry of Statistics and Program Implementation 2007.

reduce its carbon intensity. The power sector contributes nearly half of the country's carbon emissions.

Renewable energy development can also be an important tool for spurring regional economic development, particularly for many underdeveloped states, which have the greatest potential for developing such resources. It can provide secure electricity supply to foster domestic industrial development, attract new investments, and hence serve as an important employment growth engine, generating additional income.

Renewable energy is seen as the next big technology industry, with the potential to transform the trillion dollar energy industry across the world. China seized this initiative to become a world leader in manufacturing renewable energy equipment. India's early and aggressive incentives for the wind sector have led to the development of world-class players. Investing in renewable energy would enable India to develop globally competitive industries and technologies that can provide new opportunities for growth and leadership by corporate India.

Development of the Renewable Energy Sector in India

India ranks fifth in the world in terms of installed renewable energy potential, with more than 5 percent of the world's capacity in 2008. India's renewable energy installed capacity has grown at an annual rate of 31 percent, rising from about 2.5 GW in 2003 to about 15 GW in December 2009.[3]

[3] Central Electricity Authority 2009.

Wind

Wind energy dominates India's renewable energy industry, accounting for 70 percent of installed potential. The sector has received more support than any other renewable energy sector to date. Wind continues to be the biggest renewable energy sector in India, in terms of both current installed capacity (11 GW) and total known potential (45 GW). Significant tax incentives––offering up to 100 percent accelerated depreciation in the first year—have induced substantial investments by corporations and high net worth individuals in wind energy projects.[4] State-level actions, such as preferential tariffs and special directives for wind, have also accelerated the development of the industry.

Small Hydropower

Small hydropower—one of the least expensive and most attractive forms of renewable energy—lies largely untapped. It is a very attractive renewable energy source because it uses mature and largely indigenous technology and its maximum power production is in the summer, which coincides with peak seasonal demand in India. India has an estimated small hydropower potential of about 15 GW, of which about 2.5 GW has been developed.[5] Development has been relatively slow because of long delays in getting clearances and acquiring access to evacuation infrastructure, lack of clear policy for private sector participation in some states, and issues associated with land acquisition. Small hydropower–rich north and northeastern states have lagged in tapping this

[4] Bussolo, Maurizio, and D. O'Connor, 2001. Clearing the Air in India: The Economics of Climate Policy

[5] World Bank, 2010. "Energy intensive sectors of the Indian economy: Path to low carbon development." South Asia Sustainable Development.

resource. With their perennial Himalayan rivers, Himachal Pradesh, Jammu and Kashmir, and Uttarakhand have 65 percent of India's small hydropower resource and among the lowest generation costs. Despite these advantages, resource utilization is only in the low to mid-teens. Raising the utilization rate requires immediate attention.

Biomass

Biomass has huge potential in an agrarian economy like India. Generation costs for biomass are similar to those of wind. India has nearly 700 million tons a year of biomass agri-residues, of which about a fifth can be used for electricity generation. This biomass could produce about 17 GW of power. Despite these resources, the sector is the least developed in India, with only about 0.8 GW (less than 5 percent) of potential realized to date.[6]

Biomass plants require large quantities of fuel input for operations (biomass feedstock), which requires a well-developed supply chain. However, the presence of multiple middlemen, difficulties in administering and enforcing agricultural contracts, and the development of wastelands have led to underdeveloped fuel supply chains. Hence, the sector suffers from lack of reliable resource assessment.

Co-generation

Co-generation is a highly cost-effective and industrially attractive generation source that is gaining industry attention. With the ready availability of low-cost and abundant fuel supply, the levelized costs are lower than those of even small hydropower. The potential

[6] World Bank, 2010. "Energy intensive sectors of the Indian economy: Path to low carbon development." South Asia Sustainable Development.

to reach higher efficiencies in heat recovery and usage also make it an attractive energy source. India has about 5 GW of estimated co-generation potential from sugarcane, paper making, and other agri-processing industries. Interest in this source has been growing.

Solar

Solar power represents a strategic long-term solution for India. On average, the country has 300 sunny days per year and receives an average hourly radiation of 200 MW/km2. The India Energy Portal estimates that around 12.5% of India's land mass, or 413,000 km^2, could be used for harnessing solar energy. There is a huge potential for solar energy applications in grid-interactive solar power generation plants, solar thermal industrial applications, rural electrification, roof top–based applications and mobile towers in off -grid areas, and domestic water heating.

Chapter 2: Economic Viability of Renewable Energy in India

India's renewable energy potential is both large and varied. However, the high up-front cost of renewable energy generation compared with conventional energy sources has often posed a barrier to their development. A more economically competitive picture emerges when an environmental premium is imposed on the cost of conventional sources.

The trends in international fuel and equipment markets are likely to favor renewable energy technologies. Fuel costs constitute the largest proportion of total economic costs for thermal generation, which is therefore exposed to future input inflation. Given the structural changes in global oil markets in the past decade and the accelerating global demand and shrinking supply of known fuel sources, fuel costs are projected to increase consistently in the coming decades. According to the International Energy Agency, demand for fossil fuels in the base reference scenario is expected to increase by 77 percent by 2030. The average real price of coal is projected to rise to $100/ton by 2020 and $110/ton by 2030 in real terms. Oil is expected to follow a similar trend, with the average price projected to rise to $100/barrel by 2020 and $115/barrel by 2030 in real terms.[7]

In contrast, the costs of capital equipment for renewable energy have been decreasing and are likely to continue to decline as technology advances. The cost of solar photovoltaic systems is projected to fall from about $4/W in 2009/10 to $1.9–$2.2/W

[7] Awerbuch, S., 2006, "The Value of Renewable: Portfolio Diversifi cation, Energy Security, and Free Hedging." Paper presented at the International Grid-Connected Renewable Energy Policy Forum, February 1–3 Mexico City

in 2020 and $1.07–$1.23/W in 2050. Electricity generation costs are projected to be in the range of $0.05–$0.07 kWh at sites with good irradiation. In India, these cost decreases are expected to put solar power at parity with grid electricity. These trends in the cost of conventional and renewable power are expected to make renewable energy sources more cost competitive than conventional sources. [8]

Furthermore, fossil fuels are also exposed to frequent market shocks and high price volatility. Although domestic coal and gas prices are controlled by the government in India, a significant share of fuel supply is imported, which increases the risks associated with supply and price. For example, the average price of steam coal imported by OECD countries jumped from $74/ton in 2007 to $121/ton in early 2009; by mid-2009 it had dropped back to $90/ton.[9] Price volatility is one of the major market risks of fossil fuels. Fossil fuel volatility also hurts employment and GDP growth in oil-consuming and -producing nations. In the United States, for example, oil price volatility imposed $7 trillion in additional costs between 1970 and 2000. In India, spending on oil and gas imports is expected to increase from 4 percent of GDP in 2010 to 6.9 percent of GDP in 2020.[10] It can be mitigated by using financial instruments (hedging) or diversifying the portfolio with renewable energy. However, hedging solutions are from costless. Renewables are the only free hedging mechanism against price volatility of fossil fuels. The risk-adjusted cost of renewable energy is lower than that of fossil fuel–based fuels,

[8] Awerbuch, S., 2006, "The Value of Renewable: Portfolio Diversifi cation, Energy Security, and Free Hedging." Paper presented at the International Grid-Connected Renewable Energy Policy Forum, February 1–3 Mexico City

[9] Bloomberg

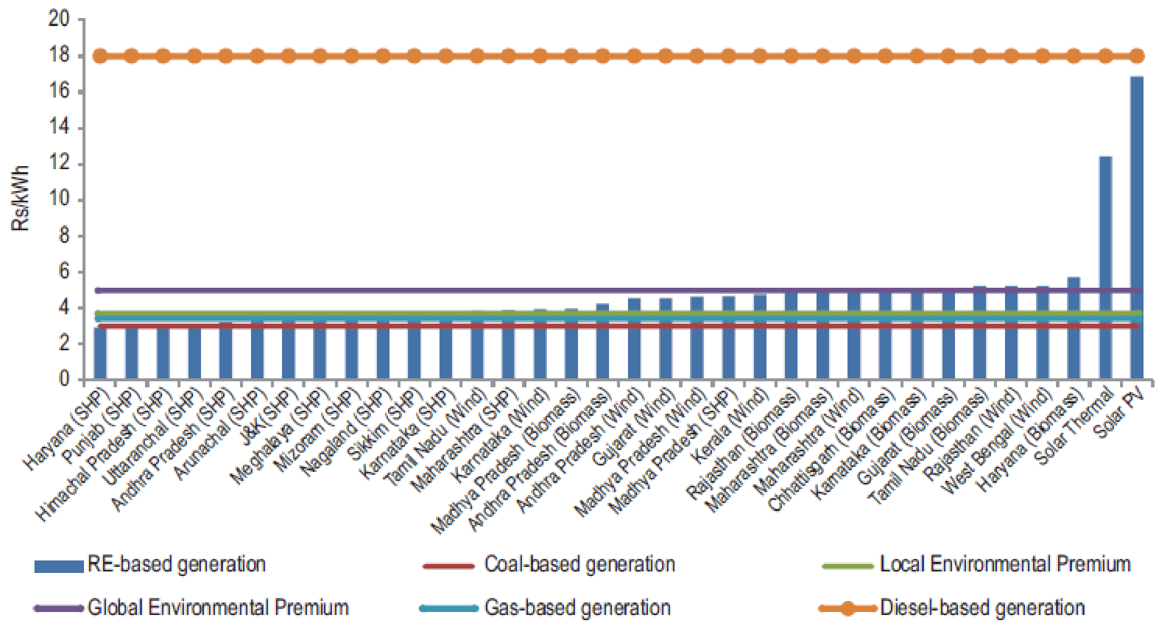
[10] CERC 2010, Annual Report: Short-Term Power Market in India, New Delhi

and their use enhances the price certainty of the energy portfolio of a country and increases energy security.

The availability of indefinite quantities of coal is also being challenged in India. Traditionally, it was believed that all proven reserves were extractable and that India had enough coal for 200 years. The Integrated Energy Policy (2006) suggests that if India continues to extract domestic coal at the rate of 5 percent a year, total extractable coal reserves will be exhausted within 45 years. One of the major reasons for the shortfall in electricity supply in India over the past five years has been the shortage of coal and gas. In July 2005, 22 of 75 coal power stations (with a total capacity of 61,000 MW) faced severe coal shortages, even though all stations are required to maintain 15–30 days of coal stocks for emergencies. The NTPC Ltd., India's largest thermal power generator, ran short of gas to power its plants and had to resort to more expensive naphtha to operate some plants. In 2008, its 1,000 MW Simhadri project, in Andhra Pradesh, faced similar shortages of coal, with stocks falling to only 4 days against a norm of 25. [11]

[11] CERC 2010, Annual Report: Short-Term Power Market in India, New Delhi.

Exhibit 1: Economic Cost of Renewable Power Generation



The World Bank, in a recently published study[12], has estimated the economic cost of renewable power generation in India. The economic benefit of renewable energy is measured by opportunity or avoided cost. The cost of building the marginal coal power plant is considered the economic value of developing renewable energy. In addition to the base cost of building a coal-based power plant, there are associated local and global environmental effects because of the increase in carbon emissions at the global level and the contribution to local environmental damage. Reducing such damages through renewables raises the avoided cost of generation and represents the competitive advantage of renewable resources. Assessing the competitiveness of renewable energy involves comparing the economic cost of coal-based generation with and without

[12] Gevorg Sargsyan, Mikul Bhatia, Sudeshna Ghosh Banerjee, Krishnan Raghunathan and Ruchi Soni; Unleashing the Potential of Renewable Energy in India, World Bank Group

environmental premiums. The other avoided fuels considered are gas and diesel, which are used on a long-term basis to generate power.

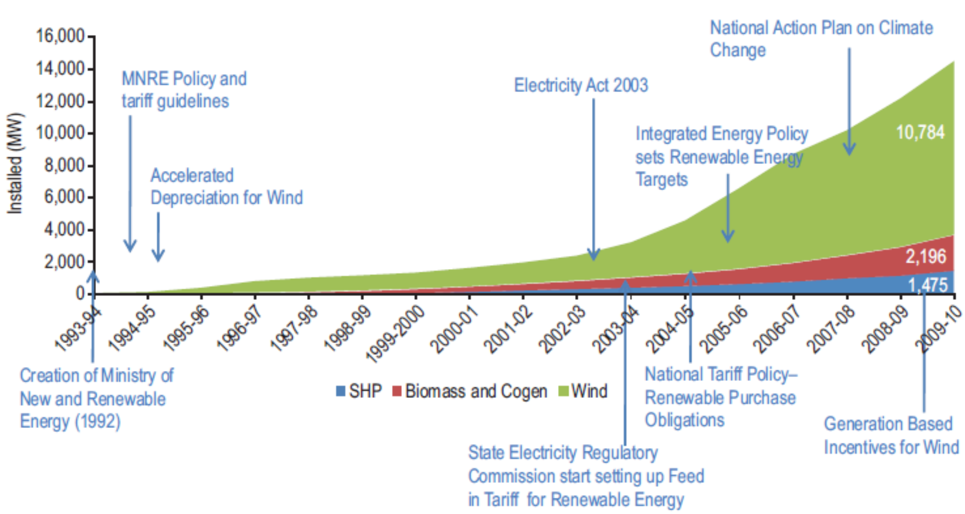
Unit costs of production associated with solar power are estimated to be Rs 12/kWh for solar thermal and Rs 17/kWh for solar photovoltaic—comparable to or lower than the cost of diesel-based generation. Solar technologies become even more competitive when the associated environmental externalities of diesel-based generation are taken into account. The high cost of production reflects the high capital cost and low plant-load factor compared with other renewable technologies. The capital costs of generating 1 MW of power are Rs 170 million (with a plant- load factor of 19 percent) for solar photovoltaic and Rs 130 million for solar thermal (with a plant-load factor of 23 percent). However, the economics of solar power are expected to improve significantly over the next two decades. In the short term, the development of the industry depends crucially on industrial policy support.[13]

[13] Gevorg Sargsyan, Mikul Bhatia, Sudeshna Ghosh Banerjee, Krishnan Raghunathan and Ruchi Soni; Unleashing the Potential of Renewable Energy in India, World Bank Group

Chapter 3: Creating an Enabling Policy Environment for Renewable Energy Development

India has already put in place significant policy, regulatory, and financial incentives to encourage renewable energy development. The landmark Electricity Act 2003 aimed at fostering competition, private investment, and power for all. De-licensing generation and allowing open access probably had the greatest impact on jump-starting renewable energy development. The act explicitly recognized the role of renewable projects for supplying power to the utility grid as well as in stand-alone systems. It provided an overall framework for preferential feed-in tariffs to incentivize supply and renewable purchase obligations for different states (quotas for renewable energy) to incentivize demand. It also introduced a host of important reforms, such as allowing captive generation, establishing provisions for power trading, and allowing phased open access to both transmission and distribution. All these steps had a substantial impact on attracting private investment into the power sector. As a result, renewable energy capacity grew dramatically.

Exhibit 2: Timeline of Policy Development



A number of dedicated institutions were created to facilitate development of renewable energy. On the institutional side, the Ministry of New and Renewable Energy (MNRE) has been playing a key role in catalyzing all aspects of renewable energy development, from resource mapping to R&D investment and promotional projects. The Central Electricity Regulatory Commission (CERC) along with the State Electricity Regulatory Commissions (SERCs) set guidelines for feed-in tariff design. On the financing side, the India Renewable Energy Development Agency (IREDA) has a long track record of providing financial support to renewable energy projects. Agencies for promoting renewable energy have been set up in most states as well.

Exhibit 3: Key Roles and Responsibilities of Government Agencies Dedicated to Renewable Energy Policy

Level	Central government (Ministry of Power/ Ministry of Finance)	MNRE	CERC
Central	• Develops national electricity tariff policies, which also cover renewable energy • Provides fiscal incentives for promoting renewable energy	• Develops national renewable energy laws • Sets technical standards for renewable energy • Conducts resource assessments for renewable energy; supports R&D in renewable energy technologies • Promotes effective use of information technology for renewable energy, manages database • Reviews renewable energy programs to understand their effectiveness and efficiency	• Sets guidelines for feed-in tariff design for different renewable energy technologies • Regulates the regional electricity corporation mechanism • Regulates interstate open access, and third-party sales
State	**State government**	**State nodal agency**	**SERCs**
	• Develops state- level renewable energy policy • Provides fiscal incentives for promoting renewable energy sources	• Conducts resource assessments for various renewable energy sources • Allocates renewable energy projects and progress monitors • Provides facilitation services to project developers —IREDA personnel escort project developers to various government departments with the objective of facilitating and streamlining clearances • Facilitates clearances and land acquisition • Creates awareness and educates the masses about adoption of renewable energy • Maintains database on renewable energy sources	• Develops feed-in tariff methodologies for different renewable energy technologies • Determines RPOs and enforcement mechanism • Sets regulations on intrastate wheeling, open access, and third-party sale

Although there are gaps in these institutions like inadequate capability at state nodal agencies and lack of adequate renewable energy financing, a nascent institutional infrastructure does exist for renewable energy on which future development can be built.

Jawaharlal Nehru National Solar Mission, 2010

The Jawaharlal Nehru National Solar Mission (the "NSM") of the Government of India came into force on January 11, 2010, and would remain in operation until 2022. The objective of the NSM is to expand solar power generation in India through large scale grid-tied plants across both PV and solar thermal technologies, by creating the policy conditions for its diffusion across the country as quickly as possible.

The policy has a 3-phased deployment timeline targeting a cumulative 20GW of solar installations by 2022. NTPC Vidyut Vyapar Nigam ("NVVN") has been deployed as a nodal agency to purchase the power developed by the solar power plants through 25 year Power Purchase Agreements (PPAs) with power developers. Power produced by solar plants will be bundled in a ratio of about 1:4 (4 parts of thermal) with thermal power and sold on to state electricity boards (SEBs) through Power Sale Agreements (PSAs) at a price of Rs. 4 – 5 kWh which is lower than peak power prices in most states.[14]

[14] Gevorg Sargsyan, Mikul Bhatia, Sudeshna Ghosh Banerjee, Krishnan Raghunathan and Ruchi Soni; Unleashing the Potential of Renewable Energy in India, World Bank Group

Tariff is to be determined by competitive bidding. PPAs have so far been signed with 36 power developers for 145 MW Solar PV and 470 MW solar thermal with tariffs ranging from INR 10.9 to INR 12.8 per kWh.

Exhibit 4: Development Targets for the National Solar Mission

Application Segment	Targets		
	Phase I (2010-13)	Phase I (2014-17)	Phase I (2017-22)
Solar Thermal Collectors	7 million sqm	15 million sqm	20 million sqm
Off grid solar applications	200 MW	1000 MW	2000 MW
Grid power, including roof top and small plants	1100 MW	4000–10000 MW	20000 MW

As per the Electricity Act 2003, every State Commission must mandate a percentage of the total consumption of electricity, for power utilities, as purchased from renewable sources, termed as Renewable Purchase Obligation (RPO). This obligation, fixed by the state regulatory authority and ranging from 1% - 14% of total state energy purchases, is the key driver for promoting renewable energy.[15]

While some states in India have very high renewable energy potential, others have little renewable energy potential. While renewable energy abundant states have no motivation to produce renewable energy based power more than that required to satisfy the RPO mandate within the state, renewable energy scarce States would not be able to procure renewable energy generated from other states. Hence a mechanism which will

[15] Gevorg Sargsyan, Mikul Bhatia, Sudeshna Ghosh Banerjee, Krishnan Raghunathan and Ruchi Soni; Unleashing the Potential of Renewable Energy in India, World Bank Group

enable and recognize the inter-state renewable energy transactions is critically required for further promotion and development of renewable sources. The Renewable Energy Certificate (REC) mechanism is such a market-based instrument which is used in India to promote renewable energy and facilitate renewable energy purchase obligations amongst various stakeholders.

Chapter 4: Understanding the Technology - Solar Photovoltaic Power Generation

Solar energy has been converted to power for over a century. However, it can only be produced when the sun is shining and a very small percentage of the world's utilized power is generated directly from solar energy. It is one of the most expensive forms of renewable power generation today. Yet the press, researchers, governments, and the financial community give solar power more consideration than other forms of renewable power and solar funding has significantly outpaced other forms or renewable power and clean technology silos.

This is largely because of the potential market of solar power, which outstrips other sources of renewable and non-renewable power. Every minute, enough solar energy reaches the earth's surface to satisfy global energy requirements for an entire year.[16] In one year, enough solar energy reaches the earth's surface to equal twice the amount of energy that will ever be obtained from the Earth's stock of non-renewable energy sources.[17]

Photovoltaic (PV) is a field dedicated to harnessing the energy in the sun's rays and converting it into useable power through the use of a solar cell. A solar cell is often classified by its conversion efficiency. This is the ratio of power generated to the light incident that falls onto a cell's surface.

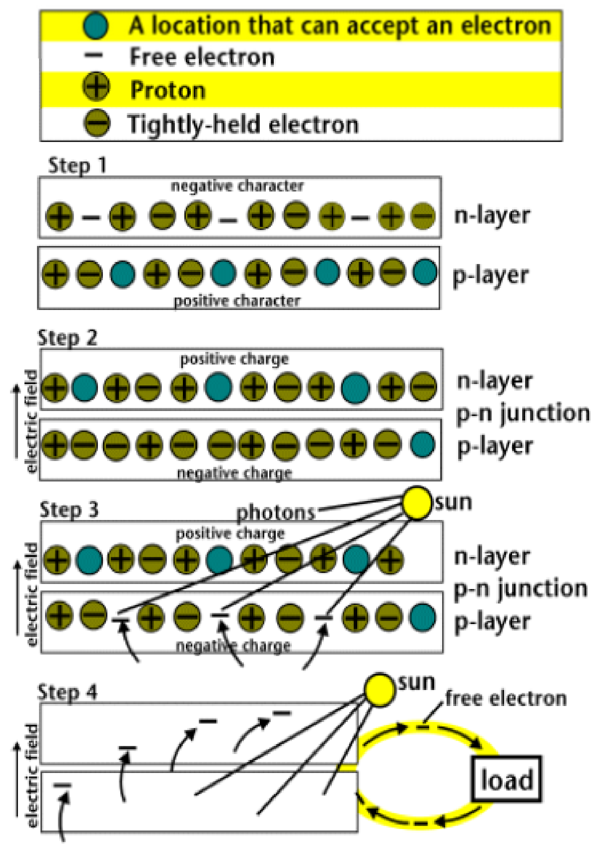
[16] Nathan S. Lewis, Daniel G. Nocera; Solar Energy Technology Primer, Massachusetts Institute of Technology

[17] Global Climate & Energy Project, Stanford University

Photovoltaic Effect

The core of a simple solar cell contains two layers of semiconductors. The p-layer is positively charged, while the n-layer is negatively charged. The n-layer is doped with a substance such as phosphorous to give it extra electrons. Electrons are subatomic particles with a negative charge.

Exhibit 5: Photovoltaic Effect



Source: US Department of Energy

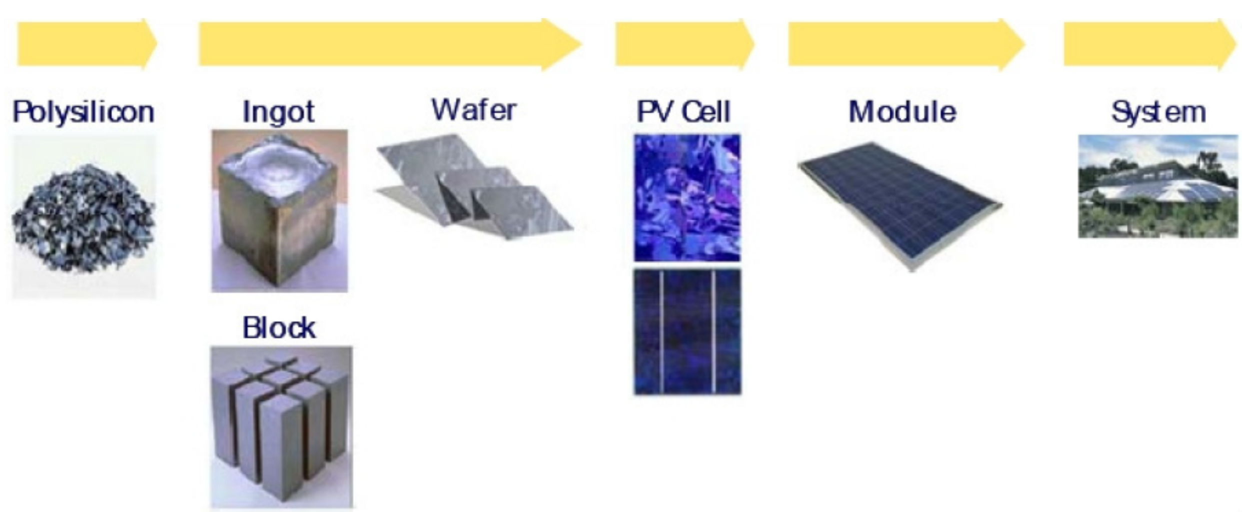
The p-layer is doped with another substance such as boron to give it a deficit of electrons. The surplus or deficit of electrons determines the overall charged character of each layer. An electric field forms from the opposing charges when the two layers are joined. This field is found in the p-n junction between the two layers as shown in Step 2 of the diagram alongside. This field causes positively charged particles to move one way, while negatively charged particles move in the opposite direction. The electrons move towards the p-layer, while the holes move towards the n-layer. This results in charged properties of each layer being reversed. This also creates a reverse electrical field.

Sunlight is made of photons; small particles of energy. When photons enter the p-n junction, their energy is taken by some nearby electrons traveling through the junction. The now "excited" electrons are impacted by the reverse electrical field and travel to the p-layer. This movement of excited electrons is an electric current. The electrons ultimately move out of cells through contacts near n-layer. Once a current is produced in an external circuit, the electrons return through another contact near the p-layer to recombine with waiting holes. This is known as the photovoltaic effect.

The Solar PV Supply Chain

The solar PV supply chain contains a number of distinct stages. The diagram below shows the supply chain for polysilicon solar panels. This is the most common type of PV product on the market today. Equity investors can get direct and often pure play exposure to any portion of the supply chain through the public markets.

Exhibit 6: The Solar PV Supply Chain



Source: *European Photovoltaic Technology Platform*

Polysilicon Production: The first step of the process involves converting naturally occurring quartz sand into silicon via a metallurgical process. Until recently, there were 7 primary companies supplying the vast majority of global polysilicon. Until recently there had been a silicon shortage in the market going back to 2004. This coupled with a small number of producers means that high margins can be made at this stage of the solar supply chain.

Processing Cell Components: In comparison to the first stage, there are more equally sized companies processing silicon into ingots and wafers. Larger numbers mean lower margins at this stage.

Cell Manufacturing: The PV cell stage requires highly automated equipment and is very costly. This stage has a modest number of large manufactures along with a few promising startups. Each manufacturer tries to differentiate its products based on the proprietary techniques and technology employed at this stage. A handful of large companies dominate the supply of cells.

Module manufacturing: This is a less capital intensive process. There is more manual labor involved in this assembling step. There are a large number of companies in this stage offering a very similar service. But there are also a select group of companies innovating in panel design to lower costs and increase efficiency. Production can often be located in low labor cost locations. The industry is trying to increase automation to cut costs at this step.

System Integration: The system integration step is highly fragmented. Typically, local contractors operate in small geographic locations and are technology agnostic.

The Evolution of the PV Cell

Since their development in the 1940s, the first generation of PV cells has used silicon as a semiconducting material. A second generation of solar PV cells has been developed to dramatically lower the costs associated with the first generation. This is accomplished through the use of less silicon, new manufacturing techniques, and the use of alternative materials. The recent shortage of silicon supply has greatly spurred this generation's development and deployment. The lower costs are also associated with lower efficiencies than first generation crystalline cells. Currently, research is being directed towards achieving high conversion efficiencies and improving on the cost profile of PV cells.

Exhibit 7: Conversion Efficiencies (%) of Commercial PV Technology

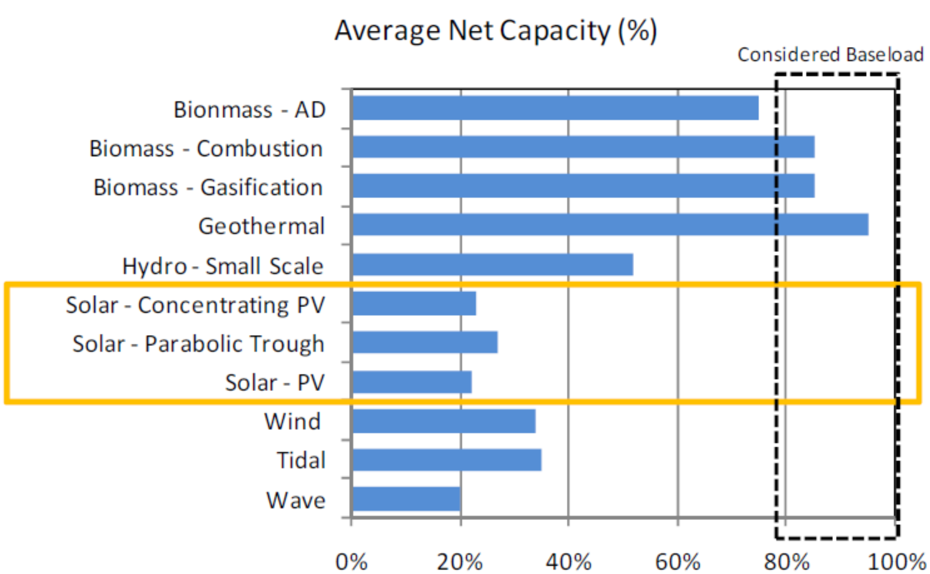
PV Technology	2006	2010	2015
Crystalline Silicon (1st Gen.)			
Monocrystalline Silicon (c-Si)	14-19	16-22	22-25
Polycrystalline Silicon (poly-Si)	13-17	16-18	20+
Crystalline-Based Silicon (1st Gen.)			
Ribbon	14-16	16-18	20+
Non-Crystalline Silicon (2nd Gen)			
Amorphous Silicon (a-Si)	6-8	9-10	12
Non-Silicon (2nd Gen.)			
Cadmium Telluride (CdTe)	9-10	11	12
Copper Indium Gallium Diselenide (CIGS)	8-11	10-12	14

Source: PV Energy Systems

Currently, 1st generation cells represent about 90% of the PV market and 2nd generation cells represent the balance. The advantage of the 1st generation is higher efficiencies, larger manufacturing capacity, and a predictable long-term track record of performance. In terms of conversion efficiency, the comparison across commercially available PV technology is given in the diagram alongside. The 1st generation is currently near 20% and will likely tap out near 25%. The greatest improvements are likely to come in terms of costs as production volumes increase. In terms of the 2nd generation, the efficiencies are not likely to exceed 20%, but they have a significant cost advantage. This advantage should influence market share as the technology matures.

The various solar technologies are not likely to approach the conversion efficiencies found with other forms of renewable power generation as show in the diagram below. Geothermal and certain types of biomass generation can be run all day. This round the clock operation coupled with high capacity factors allows them to operate as base load power generators.

Exhibit 8: Capacity Factors for Renewables



Source: Navigant Consulting

The value of solar power lies in the fact that it is only generated when the sun is shining and hence coincides with peak electricity demand during the day. Power demand tends to peak around 4 or 5 pm on a weekday. At this time people are returning home from work and appliances and air conditioners are turned on in the house. Demand builds up and tapers off over 3-4 hours in both directions. In the summer months, there can be a wide swing in wholesale energy prices with prices increasing from a few cents to over $1.00 per kWh when the grid is choked by a demand supply imbalance.[18] There are specialized peaker/peaking plants that only operate during peak hours. These plants have comparatively lower fixed costs, but much higher variable costs in the form of fuel. They can only be economically run during the periods of higher electricity prices.

Solar power costs are often measured against average generation costs. However, a more appropriate measure would be against the type of power it is providing. Solar power is only generated when the sun is shining. In the absence of viable storage options for solar PV generation (primarily at the utility and commercial scale), it has to be consumed during the part of the day it is generated. Many electricity markets, including India, employ a marginal pricing standard to establish the market clearing price. During peak hours, the next price accepted (the marginal cost to produce the next unit of power) will be the price charged for all electricity sold in market. In other words, solar costs should be compared to the cost of electricity generated during peak hours.

Another benefit which is unique to solar PV technology is that it lends itself to distributed power generation. Distributed generation is associated with generation near

[18] Bussolo, Maurizio, and D. O'Connor, 2001. Clearing the Air in India: The Economics of Climate Policy

an end user's location. Systems are usually less than 5MW in size. Solar PV is inherently the most appropriate renewable power technology for this type of generation. PV panels can be easily integrated into a residential or commercial building's roof. Moreover, PV cells are solid state devices that require very little of the maintenance & repair that is associated with centralized power generation.

The most significant advantage in terms of cost and logistics is the lack of a transmission and distribution system. The electricity transmission grids in most countries are very expensive to build and maintain. These grid systems are also aging in most cases and in need of significant upgrades that are becoming more expensive every year. Transmission and distribution typically represent about 30%-50% of the final electricity cost to an end user.

Chapter 5: A Primer on Financing Solar Energy

The financing of solar PV projects is typically arranged by the developer or sponsor. It comprises two parts: an equity investment and project financing to cover the debt portion.

Project finance is the long term financing of infrastructure and industrial projects based upon the projected cash flows of the project rather than the balance sheets of the project sponsors. Both the equity partners and project finance partners typically conduct an evaluation of the project covering the legal aspects, permits, contracts (EPC and O&M), and technical issues prior to achieving financial closure. The project evaluations (due diligence) identify the risks and methods of mitigating any risks prior to investment. Where the project has inherent risks, the exposure to these risks will be negotiated between the parties and reduced wherever possible with insurance.

Equity partners may be individual firms, developers or equity funds managed by management firms, bank equity fund managers or pension fund managers. The equity funds can be used as the seed capital to start the construction of the project. The equity is typically around 15-20% of the total project investment cost.

It is quite normal to see equity partners and developers form a special purpose vehicle (SPV) to develop the project. This is the equity vehicle which owns the project and plant when constructed. The SPV signs the EPC and O&M contracts, and the project revenues are paid to the SPV. The working capital requirements and debt servicing are taken from the revenue to determine the returns for the equity partners from the projects, typically in the form of dividends. In some cases, the equity partners will not commit equity to projects unless they have received firm commitments of debt project finance. The debt portion is typically provided by an investment bank providing project finance or leasing finance. The debt portion is the larger investment, which is typically 80-85% of the total project cost.

Individual projects from smaller developers may receive financing with a loan to value (LTV) ratio of 80%, whereas portfolios of solar projects from experienced developers may be financed with a LTV ratio of 85%- The usual term of a project finance loan is approximately 18 years. Large corporations and utilities may develop solar plants without the need for project finance; these projects are financed from the corporate balance sheet.

Evaluating the Project

Both equity and debt finance investors typically evaluate the legal, permitting, consent and technical due diligence areas of the project. The due diligence conducted at the equity stage may be based on preliminary technical information. On the other hand, the due diligence for project finance is conducted at a later stage and is often supported with detailed technical information and designs.

The due diligence phase of evaluating a project takes three main forms:

• Legal due diligence - assessing the permits and contracts

• Insurance due diligence - assessing the adequacy of the insurance policies and gaps in cover.

• Technical due diligence - assessing the technology, integration, energy yield assessments and technical aspects of the permits and contracts.

The process of due diligence can require considerable effort from the developer to satisfy the requirements of the lenders. It is important that the developers have realistic financial models with contingencies clearly shown. Alongside, it is also imperative to have a sensible construction programme, which takes contingencies into account. Such a programme will clearly show that the target deadlines are realistic and achievable.

The due diligence process is likely to identify risks, and help develop solutions to mitigate the issues found. It may result in changes in the design or use of components in the plant to make the project "bankable" for the lenders.

Mitigating Project Risks

Investors and developers should satisfy themselves that the level of risk attached with any development is appropriate to their investment criteria and should make every effort to mitigate the risks where possible.

<u>Financing Risks</u>

Interest Rates: Interest rate risk (variability in rates) is the risk borne by an interest-bearing loan. It can be beneficial to finance projects on long term fixed interest rate loans, as opposed to variable rate loans. A fixed rate loan is a long term loan that carries a predetermined interest rate with tenure usually of 15-20 years. Ideally, the plant should pay back the loan in 10 to 12 years. But spreading the loan over a longer period allows for smaller annual payments. This allows the developer the scope to build a reserve and to return a profit in the first years.

Leverage: In cases where projects are to be financed through a mixture of equity and non-recourse debt finance, leverage may potentially increase the total return of the equity investors. But it may also lead to increasing losses in adverse market conditions.

Technical Risks

Solar Modules: It is important to consider the quality of modules (for example, checking whether degradation of the module will occur faster than expected) and the strength of the module manufacturer's warranties. Given the long term nature of the project, choosing the right technology is essential in achieving consistent results and maximizing power output over the life of the project. A productive and viable PV power plant will automatically become an attractive proposition to potential buyers in the future.

Inverters and Cabling: Besides considering quality and warranties, the overall configuration of the PV power plant must be designed correctly. This will ensure that the maximum power reaches the grid based on the gross irradiance reaching the modules.

The technology and manufacturer choice for the inverters is also important for ensuring trouble-free operation suited to the environment and design of the PV plant. Warranties and maintenance activities for the inverters need to be carefully assessed to ensure that the risk of inverter failure is minimized.

Technology Failure: Generation of electricity involves mechanical and electronic processes. These may fail under certain conditions, leading to loss of revenue and repair or replacement costs. Selection of modules and inverters should be based on the track record of manufacturers—and the warranties they offer. These warranties help reduce the risk of technology failure in the initial years of the PV plant's operational life.

Solar Irradiation Risk: One of the key factors in determining the energy yield of a solar plant is the solar irradiation at the site. Changes in weather patterns such as cloud cover, rainfall and heat waves could reduce the energy output and, consequently, investor returns. However, meteorological assessments and long term averaging show that inter-annual variation over the lifetime of a PV plant is generally quite low, generally in the order of 5%, depending on location.

Solar Module Degradation: The efficiency of solar modules as well as their degradation (loss of performance) has a direct effect on the yield of a solar plant. The degradation is indicated by the supplier (usually less than 1% per year). Any unexpected loss of performance could have an adverse effect on the business. Module manufacturer's power warranties generally cover larger losses of power due to degradation. However, the warranties need to be reviewed carefully for exclusions. The financial strength and backing of the module manufacturers should be assessed to verify that the manufacturer can support any claims against their warranties. In some cases, insurance policies may be taken out by the manufacturers to cover warranty claims.

Pre-Completion Risks

Cost Overrun: Exposure to changes in the prices of components can account for a cost overrun. A change in prices for certain key components, in particular modules and inverters, may have an adverse effect on the bottom line.

Delay in Completion: Delay in completion occurs when there is a reliance on third party contractors for installation. In the construction phase of a project, developers and SPVs enter into agreements with third-party professionals, independent contractors and other companies to provide the required construction and installation services. If such contracted parties are not able to fulfill their contractual obligations, the developers may be forced to provide additional resources or engage other companies to complete the work. Any financial difficulty, breach of contract or delay in services by these third-party professionals and independent contractors could have an adverse effect on the business.

Permits, Grid Applications and Feed-in Tariff: Permits and grid applications need to be secured for all project sites. Any project will carry the risk that all approvals will not be finalized and approved by the competent authority or party within the expected timeline. Any delays may have an effect on the income stream from the corresponding project.

Grid Connection: The connection to the third party distribution or transmission network is often non-contestable. Therefore, the final grid connection is reliant on the works of the third party network operator or their contractor. Grid connection contracts and deadlines should be finalized to mitigate this risk.

Post-Completion Risks

Market Risk: Every developer should also keep in mind that government policy towards renewable energy may change unfavorably. Changes with respect to legislation concerning renewable energy policy could reduce the forecast revenues and profits of new projects. As importantly, a global consensus on taking action on climate change may positively influence government policy.

Change of Legislation: Legislation gives qualifying PV power plants the right to receive a levelised tariff which takes into account depreciation benefit. In India, under the National Solar Mission this tariff is guaranteed for all electricity produced for 25 years. Under Indian law, the government cannot retrospectively change the tariff issued. However, once a project is connected, there may be a residual risk that individual state governments may ask grid operators to retrospectively adjust the tariff levels.

Operational Considerations: Every operational solar power station engages an O&M Contractor to carry out the day-to-day maintenance of the solar power station. Inefficiencies in the operation and management of the project could reduce the energy output. This can be reduced by adding performance clauses within the O&M contract, based on the availability of the PV plant and targets for energy yield or performance ratio.

Insurance and Risk Mitigation

At present, the insurance industry has not standardized the insurance products for PV projects or components. A number of insurers are providing PV insurance policies, but underwriters' risk models have not been standardized. The data required for the development of fair and comprehensive insurance policies are lacking as insurance companies often have little or no experience with solar projects. However, demand for PV insurance is increasing. In general, large PV systems require liability and property insurance, and many developers may also opt to add policies such as environmental risk insurance. Though PV insurance costs can be quite high, it is likely that rates will drop as insurers become familiar with PV plants and as installed capacity increases. A recent study conducted by IFC showed that insurance premiums can make up approximately 25% of a PV system's annual operating expense. Annual insurance premiums typically range from 0.25% to 0.5% of the total installed cost of a project, depending on the geographic location of the installation. PV developers report that insurance costs comprise 5% to 10% of the total cost of energy from their installations, a significant sum for a capital-intensive technology with no moving parts.

Typically, developers of PV projects use the following insurance products to mitigate risks associated with ‘force majeure’ events:

- General Liability Insurance: General liability insurance covers policyholders for death or injury to persons or damage to property owned by third parties. General liability coverage is especially important for solar system installers, as the risk to personnel or property is at its greatest during installation.

- Property Risk Insurance: The PV system owner usually purchases property insurance to protect against risks not covered by the warranty or to extend the coverage period. The property risk insurance often includes theft and catastrophic risks. Property insurance typically covers PV system components beyond the terms of the manufacturer's warranty. For example, if a PV module fails due to factors covered by the warranty, the manufacturer is responsible for replacing it, not the insurer. However, if the module fails for a reason not accounted for in the warranty, or if the failure occurs after the warranty period, the insurer must provide compensation for the replacement of the PV module.

- Environmental Risk Insurance: Environmental damage coverage indemnifies PV system owners against the risk of either environmental damage inflicted by their development or pre-existing damage on the development site.

- Business Interruption Insurance: Insurance against the risk of business interruption is often required to protect the cash flow of the solar project. This insurance policy can often be a requirement of the financing process.

Chapter 6: IFC’s Role in Financing Solar Projects in India

IFC is the largest global development finance institution focused exclusively on private sector development, and is uniquely placed to provide innovative solutions for individual clients needs and help shape the field for sustainable and inclusive private sector development. IFC has demonstrated its global leadership, standard-setting, and innovation in many areas, including environmental and social (E&S) sustainability and corporate governance, as well as its broad range of investment and advisory products.

Relative to commercial funders, IFC has many comparative advantages. Synergies exist across the World Bank Group (WBG), and being part of the WBG enhances IFC‟s convening power on critical development challenges, and allows it to frame solutions that require close public-private collaboration. IFC can also invest in markets where private finance would not go alone, and take a longer-term view than other market participants.

IFC’s comparative advantages also include its global reach – allowing it to leverage lessons of experience across regions while diversifying risk - and its ability to craft client solutions drawing from combinations of three complementary and strategically aligned lines of business - Investment Services (IS), Advisory Services (AS), and the IFC Asset Management Company (AMC).

IFC‟s strategic pillars in South Asia are: (i) inclusive growth; (ii) climate change; and (iii) global/regional integration. These pillars respond to the critical issues facing the region--extreme poverty, with more than 900 million people living below $2 a day; extreme vulnerability to climate change; and lack of economic integration. The climate change pillar emphasizes renewables (hydro, solar, biomass, and wind), energy efficiency, and agricultural and irrigation efficiency activities, which are expected to result in lower carbon footprints. IFC supports investments in energy generation, distribution and transmission infrastructure to support India's growing energy demand and security needs, critical to sustaining GDP growth at current or higher levels.

The renewable energy sector globally as well as in India has traditionally been a less attractive area for the private sector. One of IFC's strategic objectives is to catalyze investments in this area. In the Indian market, IFC plays an important role by providing direct financing (debt as well as equity) to sponsors that have a good track record and a long term commitment to the renewable energy business. IFC's support, provided to developers at a critical stage in their growth, in turn encourages other financiers to provide support for renewable energy projects. Thus, companies supported by IFC are able to broaden and diversify their sources of funding. Over time there is a strong demonstration effect of the viability of investments in the sector, resulting in a crowding-in of other investors.

Chapter 7: Green Infra - Project Financing

Background

Green Infra Ltd (GIL) is a renewable energy venture fund, founded in 2008 by IDFC Private Equity to develop renewable energy projects across sub-sectors such as wind, solar, hydro and bio-mass. In the last two years, GIL has established a track record of developing projects and has an operational capacity of 238.7 MW spread across Maharashtra, Tamil Nadu, Karnataka, Rajasthan and Gujarat. The company aims to expand its portfolio to 3.5-4.0 GW in 4-5 years.

GIL is constructing a 20 MW and a 5 MW solar photovoltaic plant located in two separate locations in Jodhpur district of Rajasthan. Each of these projects is housed in a separate Special Purpose Vehicle. The company was awarded their licenses through a process of competitive bidding under India's National Solar Mission. The two projects were awarded tariffs of approximately US$0.17/kWh. The projects will both utilize thin film modules. The projects will sell power under a 25-year power purchase agreement to NTPC Vidyut Vyapar Nigam Limited (NVVN), a public agency designated for the purchase and resale of solar power under the National Solar Mission. Under this arrangement, NVVN (the power trading subsidiary of NTPC, India's largest state-owned thermal power generation company) will source solar power from various developers including the Companies, and bundle it with electricity from NTPC's thermal power plants. This bundled power will be sold to various state-owned distribution companies at a blended rate that is in line with their cost of peak power. The National Solar

Mission provides regulatory and financial support to solar power developers without requiring an explicit solar subsidy due to the concept of competitively priced bundled power.

IFC's Role

IFC is among the few long-term financiers of the emerging solar sector in India. IFC is seen as a leader with good in-house expertise on solar technology and an understanding of the implementation risks of solar in the country. IFC also has provided lines of credit targeted to solar to encourage local financial institutions to start lending to this sector. Given its growth plans, GIL is seeking a long-term partnership with IFC for project finance as well as mobilization of additional financing for its future projects. IFC's additionality is expected through the following:

- Longer Tenor: IFC will provide a 14-15-year loan with a debt repayment profile that matches the cash flows of the Project. Other lenders are not willing to provide loans with maturities longer than 10-12 years.
- Fixed Rate INR Financing: The interest rate on the IFC loan will be fixed for the lifetime of the loan. In contrast, the interest rate offered by domestic banks can be reset annually after 3 years, exposing the Company to interest rate risk.
- Environmental and Social Standards: IFC will help the company establish a social and environmental management system for its entire pipeline in accordance with IFC's Performance Standards. This is expected to improve the sponsors' ability to raise financing from international investors for future Projects.

Transaction Structure

The IFC supported the project through a USD 8.2 million loan, payable over 15 years with an average maturity of 9.5 years. The loan would charge a fixed interest rate of 12.00%. The interest rate was benchmarked to the INR swap equivalent of the 6-month LIBOR rate. The transaction would additionally require up-front fees of 1.0% of the IFC loan, a commitment fee of 0.5% per annum and a prepayment fee of 2%. Loan covenants required the project to maintain a minimum DSCR of at least 1.3x, current ratio of at least 1.2x, maximum liability to tangible net worth ratio of 2.5x. As security, IFC wanted a first ranking security over movables, immovables, land, contracts, cash flows and a pledge on 100% of paid up equity share capital till the physical completion of the project.

Uses	INR	USD	%
Project EPC Cost	1,595.9	29.0	89%
Land Cost	14.9	0.3	1%
One time development costs	108.7	2.0	6%
Working Capital	7.1	0.1	0%
Financing Cost	74.1	1.3	4%
Total Uses	**1,800.6**	**32.7**	**100%**

Sources	INR	USD	%
IFC A Loan	450.2	8.2	25%
Other Lender - I	360.1	6.5	20%
Other Lender - II	450.2	8.2	25%
Total Debt	**1,260.4**	**22.9**	**70%**
Equity	540.2	9.8	30%
Total Sources	**1,800.6**	**32.7**	**100%**

Development Impact

The Project is expected to have the following beneficial impacts:

- Increase Power Generation: The Rajasthan Project is expected to generate 45.5 GWh of electricity per year, which will help meet the country's power needs.
- Avoided Greenhouse Gas Emissions: The Rajasthan Project is expected to avoid approximately 41,000 tCO_2e annually by utilizing solar energy for the production

of electricity instead of fossil fuels that comprise the majority of India's electricity generation.

- Introduce High Environmental, Social, Health and Safety Standards: IFC is working closely with GIL and the companies to establish an environmental management system in line with IFC's Performance Standards.
- Employment Generation: As a result of the Rajasthan Project, direct employment is expected to be created for approximately 600 workers during construction.

Chapter 8: Applied Solar Technologies – Providing Growth Equity to a Distributed Solar Product Company

Background

India has about 300,000 telecom towers, almost all of which have diesel back up to ensure continued operations. It is estimated that about 20% of India's telecom towers are off-grid and completely powered by diesel power which is inefficient and causes environmental harm. The proposed project addresses the power needs of such off-grid and grid connected telecom towers (which rely on DG power for a majority portion of the day) through a solar based hybrid power solution which greatly reduces the reliance on diesel, thereby reducing GHG emissions while providing cheaper power. This is an innovative distributed generation project which has immense potential for replication in various applications and could potentially be an important source of power in off-grid areas.

Founded in December 2008, Applied Solar Technologies (AST) provides a hybrid solar based renewable power solution to telecom tower sites which primarily rely on diesel power (for 16 to 24 hours a day). AST's solution optimizes the usage of various energy sources (solar, battery and diesel) through a proprietary controller which maximizes the usage of solar and battery and reduces the usage of diesel. AST has developed an innovative business model wherein it takes over the entire power supply management of each telecom site and commits to a maximum number of diesel hours (maximum 8 hours a day) thereby resulting in a significant 20% power cost savings for its customers (for a typical tower, total energy related expenses are brought down from about

US$1100 per month to about US$900 per month). Energy costs constitutes a major 30 - 40% share of total expenses for typical telecom tower companies in India which are under tremendous pressure to reduce costs due to falling telecom tariffs and revenues. In addition to operating cost savings, AST's solution is also attractive to its customers since AST bears the entire capital expenditure of its installation on its own and provides cheaper 'green power' to telecom companies.

At each tower site, AST installs 3 - 6 kW solar PV panels, a battery pack and its proprietary controller and utilizes the existing DG of each tower site. A typical installation costs about US$20,000 - 25,000 depending on site load and solar/battery size. AST's first customer is Bharti Infratel, the tower company of India's leading telecom company, Bharti Airtel. AST has signed and is executing a 10 year contract with Bharti Infratel to provide its solution for 500 tower sites in the state of Bihar. With an addressable market of over 60,000 towers in India alone, AST is targeting to implement 5000 installations by the end of FY12 which will cost about US$100 million. AST is also working to expand its solution to other applications such as off-grid gas stations and community power.

IFC's Role

Mainstream equity fund raising for early stage clean energy companies in India has been challenging, particularly for the nascent solar industry. By supporting this Project, IFC expects to play a pivotal role in addressing this critical funding gap. AST currently has no significant local banking relationship.

This coupled with AST's unique and new business model makes it difficult for the Company to raise loans from the local Indian banks. IFC's long term funding in local currency helps the Company meet its capital requirements for expansion. IFC's participation is expected to catalyze the development of mainstream financing for such innovative solutions for cleaner energy.

The sponsors have welcomed the benefit of IFC's experience and knowledge in the power sector and particularly the solar value chain. The sponsors expect to leverage IFC's relationships with various stakeholders like solar equipment manufacturers, telecom companies, banks and financial institutions as they move forward in their business.

Transaction Structure

IFC invested up to US$6 million equivalent in Rupees in compulsory convertible preference shares ("CCPS") and 100 common equity shares of the Company and provided a loan of up to US$15 million equivalent in Rupees to AST. Capricorn Fund and Bessemer Venture Partners co-invested alongside IFC with a total of about another US$6 million.

Development Impact

- Off-grid renewable power solution: AST's solar based hybrid power solution will drastically reduce diesel generation which is extremely inefficient and causes environmental havoc. This solution, which reduced GHG emissions, has great potential for replication and become a preferred source of renewable power to large number of off grid commercial and community power consumers. This power solution, when expanded to residential services as well, has the potential for providing basic access to energy to large number of households in rural India and other countries.

- Employment generation: AST plans to establish about 5000 sites in the next 3 years, and is expected to be an active source of permanent and local employment during both the construction and operational phase.

- Focus in Low Income States: AST's power solution directly results in 20% savings for telecom companies' power expenses which will increase their viability in rural and off grid areas. This is especially important for India's low income states which currently have low telecom penetration and have large off grid areas. AST has started its operations in Bihar which is the poorest of India's low income states and expects to have most of its future business from such low income states and areas which have low grid penetration.

Chapter 9: Gujarat Rooftop Solar – Advising a Public Private Partnership Framework

Background

The state of Gujarat, located in western India, has embraced the idea of renewable energy. With over 300 sunny days per year, the government of Gujarat plans to develop 500 MW of solar power capacity by March 2014 to meet its energy needs. It also plans to make its capital, Gandhinagar, a model solar city. The government of Gujarat needed assistance in selecting the most appropriate technology, and suitable agreements between government, private investors, and the power procurer had to be concluded.

To pave the way for large-scale solar power development, the government sought private sector participation to finance and build two 2.5 MW pilot solar projects in Gandhinagar that will generate a total of five MW annually through rooftop solar panels. Although modest, the project will address issues constraining the adoption of solar power, provide extra power capacity to the grid, and contribute to the reduction of greenhouse gas emissions.

IFC's Role

IFC was appointed lead transaction advisor to execute the pilot project by Gujarat's Department of Energy and Petrochemicals. Besides providing transaction advice, IFC's role included technical, legislative, analytical and marketing support. IFC's support included:

- Analyzing the technical options for solar panels, for example, using concentrated solar power or photovoltaic solar panels; resolving connectivity issues, and determining maintenance requirements. IFC recommended using solar panels mounted on rooftops;
- Reviewing social, legal and commercial issues related to renting rooftop space from residential and commercial buildings, and then developing terms for the rental agreements;
- Organizing an investors' conference to discuss the project with potential investors and obtain their feedback. Over 40 firms attended, demonstrating strong interest in the project;
- Leading discussions with the client and the local private distribution company, Torrent, on the power purchase agreement. IFC helped broker the terms so that Torrent would purchase electricity generated by the rooftop panels.
- IFC also recommended a transaction structure and managed the bidding process, including preparation of bidding documents and evaluation of bids.

Transaction Structure

IFC recommended a 25-year build, own, operate (BOO) concession. Under the agreement, the winning bidders will place thousands of solar panels on rooftops throughout the city divided into two clusters, each with 2.5 MW of installed capacity. Most of these will be on public buildings, such as schools, hospitals, and offices.

The remaining panels will be placed on private residences, which will receive rental income for hosting the panels. The developers will then connect power generated by the panels to the city grid.

Total project cost is estimated to be $15 million, all of which will be provided by the winning bidder. The government of Gujarat will provide access to roofs of buildings it owns, facilitate purchasing agreements with the power procurer for the electricity generated, and guarantee a subsidy if required. The developer will be responsible for identifying private buildings that will participate in the project, producing solar power and delivering it to the grid.

Interest in the project was strong, with 38 firms submitting expressions of interest. The winning bidders were those quoting the lowest tariff. Azure Power and SunEdison each won one of the two 2.5 MW projects. The project agreements, including the power purchase agreements (PPAs), were signed on April 20, 2012.

Developmental Impact

- Improved access: 12,000 people will benefit from improved energy services at affordable prices with virtually no state subsidies.
- Mobilization of private sector investment: the transaction will attract $15 million in private investment to the region.
- Public revenue: provides the government with a net annual revenue stream of $400,000 for 25 years.
- Climate change: reduces carbon emissions by 6,000 tons annually.
- Proof of concept: demonstrates the technical, regulatory, and financial viability of rooftop solar panels, which will enable the expansion of solar power in

Gandhinagar and elsewhere in India. As a result of this initiative, IFC has already signed mandates to advice on similar initiatives in five other cities in Gujarat.

Chapter 10: Conclusion

India is well placed to benefit from the successful development of a solar energy industry. The solar industry in India has gone from a mere 22MW of installed capacity in January 2011 to over 1 GW at the end of October 2012. Until now, the main drivers for capacity addition in India have been the Gujarat Solar Policy and the National Solar Mission (NSM). Projects under these two policies accounted for 80% of India's installed capacity until October 2012.

India, with liberal policies for the power sector, a high potential for solar power and a variety of central and state-level incentive schemes presents a particularly good opportunity for the solar industry. The market is supported by feed in tariffs to provide an initial thrust. Further, by introducing the renewable energy certificates and renewable purchase obligations, the government is keen to create a demand-driven market for solar power in India. Even though it is currently depending on government incentives and subsidies for the initial thrust, the country's long term strategic aim is for the solar industry to be led by market mechanisms.

Financing of solar projects in time continues to be a critical challenge for project developers. Banks are weary of lending to the sector and show concerns over factors like: bankability of PPAs, lack of experience in the sector, uncertainty on implementation of regulatory mechanisms and absence of reliable irradiation and plant performance data among other factors. Interest rates in India have been at an all-time high. This has a significant downside on the margins for project developers who are already working with some of the lowest solar tariffs in the world.

Unlike many of their international counterparts in mature markets, Indian banks still perceive solar PV plants as being technologically risky. The primary reason for this perception is the lack of performance data from solar plants operating in India. As the clarity on the performance of projects begins to emerge, Indian banks are expected to play an increasing role in financing future projects.

Hence, development finance institutions such as the IFC has emerged as a key financing and advisory institution in the Indian solar market. The IFC has been actively involved in financing at the project level. It has provided financing for projects by developers such as Green Infra, Mahindra Solar, Azure Power and Sun Edison. Apart from that, IFC has also invested on a corporate level in solar companies focusing on the off-grid market. As part of its advisory and investment support, IFC has been involved with advising public private partnership frameworks to build rooftop solar capabilities with the Gujarat government.

Such interventions are playing a pivotal role in catalyzing financing and expanding financial market access for the nascent solar industry in India.