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Renewable Energy Assets in India: A Project Finance Perspective

Analysing the Feasibility of Renewable Energy Projects in Light of Current Sectoral Headwinds

Executive Summary

The growth of India's renewable energy sector is among the most successful energy transition efforts globally. In the early years of the renewable energy sector's evolution, stakeholders perceived almost all business risks to be high. The equity returns for the initial projects were at a higher threshold – and >18% return on equity (ROE) expectations were commonplace. As business risks eased over the last decade, renewable energy technologies emerged as India's lowest cost energy source.

Figure 1: Global Levelised Cost of Energy Benchmarks for Bulk Power, 2014-2021 (US$/MWh)

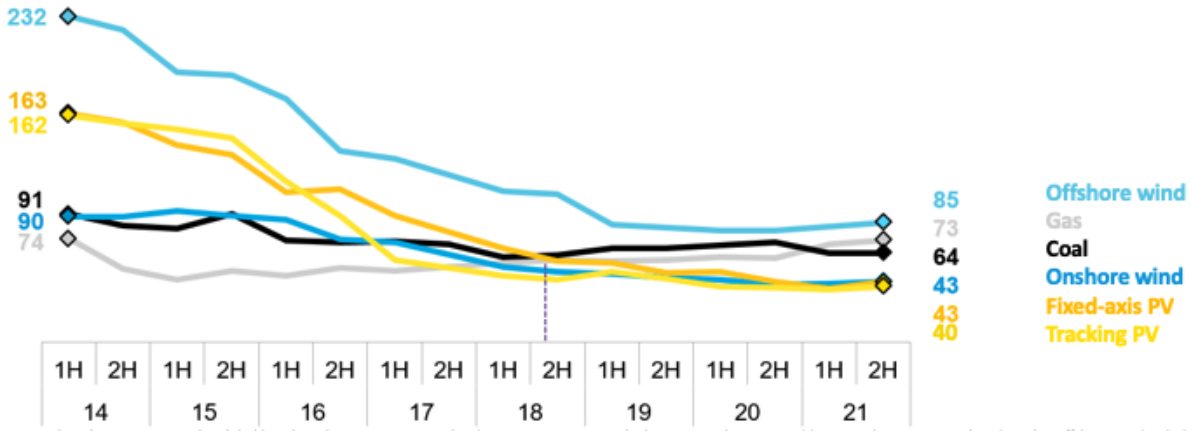

Figure Source: BNEF

Falling tariffs have resulted in renewable energy capacity in India increasing by nearly 10-fold in the last decade from ~12 gigawatts (GW) in 2010 to around 110GW in March 2022.[1] Over the years, alongside tariffs, ROE expectations have also fallen. From a must have 18% threshold, the ROE expected now hovers around the 12% mark.

[1] CEA. All India Installed Capacity. March 2022.

However, fresh challenges have emerged for the sector. Global supply chains have been in tatters lately due to the disruption caused by the pandemic and, more recently, the Russia-Ukraine war. Both wind turbine generator producers and solar module manufacturers have been hiking prices as materials, freight, labour needs coming out of the pandemic, and geopolitical risk weigh down on critical raw material prices. Fresh trade barriers have emerged with the imposition of a basic customs duty (BCD) on the import of solar modules and cells in India.[2] To top it all, the sharp, seemingly uncontrollable inflation is making global central banks suck out the system's liquidity, leading to a steep increase in interest rates.

In this context, a natural question is whether India will be able to continue its renewable energy capacity addition trajectory as witnessed in the past? We believe it will because current challenges will ease in the short-to-medium term, and the industry has enough cushion to absorb these downside risks. Interest in renewable auctions from the large sector players should not wither, even in these unprecedented times.

Module Price Hike – An Aberration in the Long-Term Deflationary Trend

Landed costs of solar modules in the country halted their downward trajectory, rising for the first time (on a sustained basis) in more than a decade. Module costs form ~65% of initial capital expenditure for a typical solar project, hinging project viability on their trajectory.

Industry belief is that these are aberrations due to the Ukraine war and COVID-19 related supply chain disruptions, especially in China. It would be fair to assume that long term average prices should revert to sub US$0.20 level (before taxes).

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In the short-to-medium term, the presence of non-BCD stock of imported modules, importing cells that attract lower BCD (25% versus 40% on modules) and assembling locally, framework agreements with domestic suppliers, and backward linkages into module manufacturing will provide a good grip on capital costs. Further, even as BCD kicks in, domestic manufacturing capacities buoyed by policy initiatives such as PLI schemes will grow multifold, softening domestic prices.

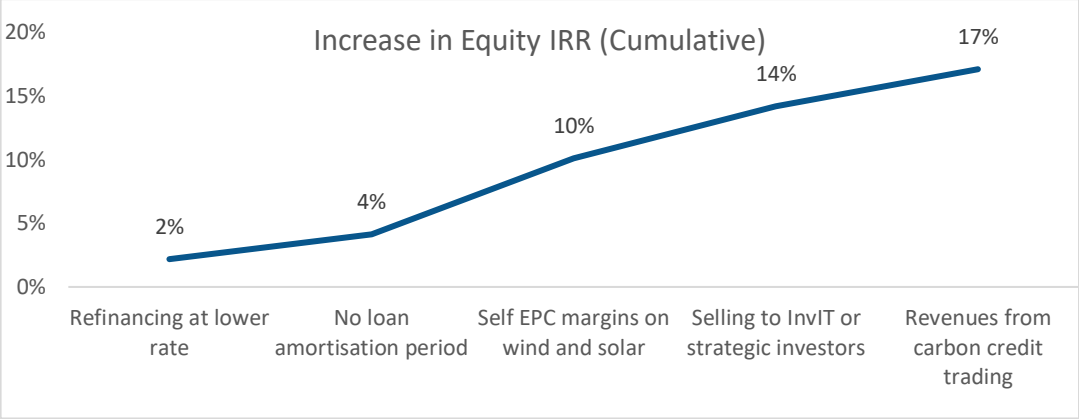
[2] Mercom. Basic Customs Duty of 25% on Solar Cells and 40% on Modules to Take Effect from April 2022. March 2022.

Multiple Levers Remain with Renewable Energy Players to Enhance Returns and Provide Cushioning Against Any Downside Risks

While the "nameplate" return expectations for renewable energy infrastructure assets remain in the ~12% ROE range, several developers have in the past jacked up equity returns through prudent financing improvements (or financial engineering) and capital management practices.

Besides the obvious gains to equity returns through procuring modules at lower rates (through any of the avenues listed above), several other returns enhancing practices cushion against downside risks.

Figure 2: Equity Return Kickers for a Model Wind-Solar Hybrid Project



Source: IEEFA Analysis

Bond market refinancing: Refinancing of project debt post commissioning is commonplace as construction risks subside and the project operationalises. Further, a non-amortising period of 3-5 years often accompanies a bond market refinancing, especially in offshore market issuances.

EPC margins: Most of India's large renewable energy companies currently have their engineering, procurement and construction (EPC) divisions. Even when competitively considered, EPC margins of 10% (on non-module costs for solar) are a fair assumption in renewable energy projects today.

Stake sale in operational projects: Just as the cost of debt reduces for operational and de-risked projects, the cost of equity also reduces. India has been witnessing this churn with stake sales in operational projects to strategic and financial investors for a long time now. With the recent success of InvITs, much larger pools of such lower cost equity are accessible to developers today.

Carbon credit trading: Several players have started considering the revenues they earn from selling carbon credits as an important source of income. The carbon

prices in India have ranged from US$1-10/tonne in the recent past.[3] Currently, about 98% of the carbon credits generated in India go to developed economies. The government is trying to create a domestic marketplace.[4] Carbon credits trading is one of the only enhancements that generate additional revenue for the project and improves equity IRR as well as project IRR, thereby making it more viable.

To be fair, these "return enhancements" might be available with only the top rung being able to push returns to higher levels. Still, the reality is that a large proportion of India's renewable energy capacity will be added by the largest players already operating in the industry, given the capital-intensive nature of the business and competition the sector.

[3] Saur Energy. EKI Energy Services Races To Make The Most Of Its Headstart In Carbon Credits. December 2021.
[4] BNEF. Indian IPO Darling Sees National Carbon Market in Three Years. January 2021.

Table of Contents

Table of Figures

Retrospective View of the Renewable Energy Sector

The growth of India's renewable energy sector is among the most successful energy transition efforts globally. India is one of the few countries on track to achieve its climate goals and nationally determined contributions (NDCs) defined under the Paris Agreement.[5] Over the years, investors and business owners from varied fields have entered the sector, attracted by the improving return profile of renewable energy assets.

Stakeholders perceived business risks to be high in the initial years of the renewable energy sector's evolution. As a result, equity returns for the initial projects were at a higher threshold. Expectations of return on equity (ROE) being more than 18% were commonplace.

However, the risks have panned out over the past decade or so. Evolution of technology, plummeting module prices, simplicity of designs, timely commissioning of projects, accommodative regulatory stance and offtaker risks/working capital issues have helped stabilise project behaviour.

Lower risks also resulted in intense competition. Today, the Indian renewable sector has investments from the biggest investors globally. A combination of these parameters has led to a sharp decline in return expectations. From a must have 18%, the returns expected now hover around the 12% mark.[6]

Figure 3: Major Impediments to Renewable Energy Sector's Initial Growth

Source: IEEFA Analysis

[5] Hindustan Times. India only G20 nation to meet climate goals. August 2021.
[6] IEEFA Analysis; Industry insights.

Falling Tariffs and Increasing Bid Sizes Underscored the Sector Transformation

The first open bids for solar power projects of megawatt (MW) scale, between 2010 and 2012, attracted tariffs ranging from Rs12/Kilowatt-hour (kWh) to Rs18/kWh[7] (US$0.16/kWh to US$0.24/kWh). The majority of bids were for a capacity of less than 5MW. Projects of 20MW were rare and sought by large players with deep pockets and high-risk taking appetites. The tide has turned completely, and the lowest bids for solar projects came at Rs1.99/kWh (~US$0.03/kWh).[8] Even if we consider Rs1.99 per unit as an aberration, a steady state tariff of Rs2.2-2.5/kWh (~US$0.03/kWh) has become a reality for most solar projects.

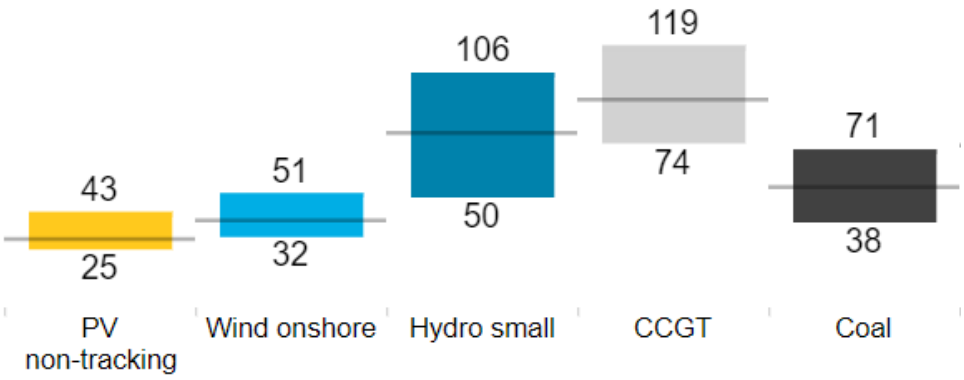
The wind sector has evolved differently. The market started on a return on equity (ROE) guarantee model whereby large Wind Turbine Generator (WTG) manufacturers executed a lump sum turnkey project – from site identification to project completion. Under the FiT (feed in tariff) regime, WTG manufacturers often back calculated the project cost to provide a 15-18% return on equity to the wind developers/investors. Over time, as the FiT regime made way for open bids, the sector started innovating both technologically and financially. Negotiations deepened, margins shrunk and indigenisation picked pace. Wind power developers often split the contract between them and WTG manufacturers into equipment and balance of plant (BOP) works. As developers competed for increased market share in the open bid regime, record low tariffs of Rs2.54 to Rs2.59/kWh (~US$0.03/kWh)[9] won the Solar Energy Corporation of India (SECI) III and SECI IV bids. The tariffs seem very aggressive, and factoring for increased risks of wind compared to solar, the SECI III and SECI IV projects' viability is questionable. The sector is facing interim challenges, but even so, sub-Rs3/kWh tariffs seem to have become the norm.

Technology Played a Key Role in Making Renewables Competitive

Solar and wind rank as the lowest priced sources of electricity generation in the country today, a trend seen globally. The trajectory of input price deflation in key solar and wind technologies and government impetus to grow the country's renewable energy sector have led to a nearly 10-fold increase in installed capacity over the last 12 years. From ~12 gigawatt (GW) (of which 11.8GW was wind and 15MW was solar) in 2010,[10] capacity rose to nearly 110GW in March 2022.[11]

[7] Bloomberg New Energy Finance (BNEF). Global Auction and Tender Results and Calendar. Extracted on 29 April 2022.
[8] Financial Express. Solar auction tariff hits new low of Rs 1.99 per unit. December 2020.
[9] Bloomberg New Energy Finance (BNEF). Global Auction and Tender Results and Calendar. Extracted on 29 April 2022.
[10] NREL. Indian Renewable Energy Status Report. October 2010.
[11] CEA. All India Installed Capacity. March 2022.

Figure 4: Current Levelised Cost of Energy Range (US$/MWh, nominal) in India



Source: Bloomberg

Policy Support Provided Backbone for the Thriving Sector

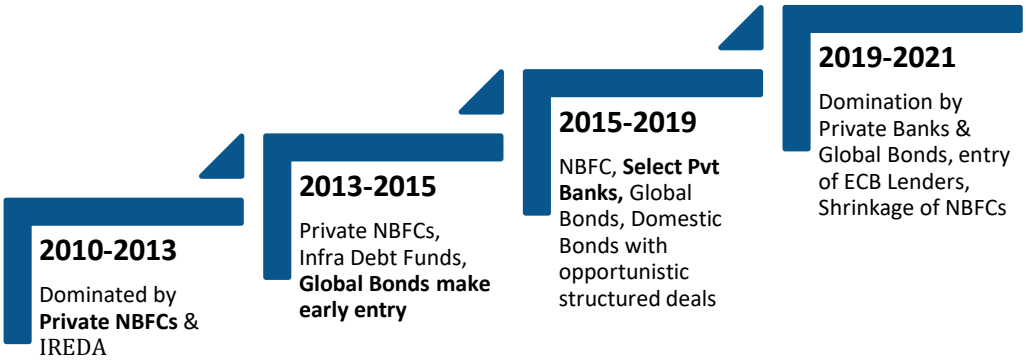
The Ministry of New and Renewable Energy (MNRE), Government of India and several state governments have been at the forefront of providing the necessary policy support and a facilitative regulatory system for the fast and orderly growth of the renewable energy sector. During the early days, when technology was still at a nascent stage, government support for wind and solar in the form of fiscal and financial incentives helped channel private capital and gave confidence to financiers.

Some of the regulatory steps that helped remove revenue risks for projects included providing a "must run" status to the projects. Further, generation-based incentives (GBI) ensured sovereign risk for a part of the revenue while waiving Inter-State Transmission system (ISTS) charges made the sector more cost competitive than other energy sources. Finally, accelerated depreciation provided a tax cushion in the initial years. Such steps lowered return expectations from these projects.

Investing and Financing Scenario Altered as the Sector Grew

As the renewable energy sector grew, so did the sources of financing. What started with just private Non-Banking Financial Companies (NBFCs), when capital from other conventional sources such as banks, private or public, found it best to avoid exposure to a nascent and evolving technology, soon expanded into various sources.

Figure 5: Renewable Energy Financing Landscape



Source: IEEFA Analysis

On the equity side, sizeable investments came from sovereign entities, global private equity players, oil and gas majors and national conglomerates like the Adani Group, Tata Group and most recently, Reliance Industries.

Capital Recycling Led to Better Utilisation of Resources

The evolution of financial structures led to further aggression in ROE expectations for renewable energy projects. For instance, with infrastructure investment trust (InvIT), the profit at InvIT level is tax exempt.[12] This boosts the returns of projects by up to 30%. Therefore, issuing an InvIT or selling operating assets to an existing InvIT provides an attractive exit to a renewable energy developer.

For a renewable energy developer with limited capital to deploy, this also provides a reliable way to exit older investments at a profit and grow further in new investments. A developer with limited capital and high execution skills will use a churn model. Under such a model, a developer creates an asset base, pools it and then sells/dilutes it to an InvIT or other such instruments. The developer can redeploy the capital to another asset.

The Finance – Refinance Story

Lenders funded the first solar public-private partnership (PPP) projects in Gujarat at 12-14% interest rates owing to their limited track record and unproven technology. The lenders also kept sufficient cushions in debt service coverage ratios (DSCRs), with transaction closures happening at DSCRs of 1.3x to 1.4x on conservative assumptions. Hence, the debt-to-equity split was often near the 50-50 or 60-40 mark.

Over time, this has changed substantially. Today, renewable energy projects, specifically solar projects, get some of the most competitive structures in long-term

[12] PGInvIT. Frequently Asked Questions on Taxation – PGInvIT.

financing. Financing costs have come down by ~50-60% from the highs of ~13% interest rate. A majority of the changes came post COVID-19, as central banks across the globe followed an easy money policy. Financing for under construction projects often have 20-year tenors, while the DSCRs are close to 1.2x. This structuring superiority leads to a significant enhancement of ROE.

The advent of international bond issuance has further enhanced equity returns. Bonds are often structured with nearly no debt amortisation for 3-5 years, allowing further capital deployment (equity contribution) of the free cash flow. This, in turn, has a cascading positive effect on ROE.

The advent of international bond issuance has further enhanced equity returns.

Economies of Scale at Play

Economies of scale play out perfectly when it comes to operating expenses for renewable energy projects. In the case of solar projects, a majority of operating expenses are for the cleaning of solar panels. With larger projects (100-1000MW DC), labour utilisation is much more efficient. Automation is also possible as the operations are simple. Robotic arms are now doing automatic clean-up. As a result, pure play operating expenses have come down from ~Rs0.4-0.5mn/MW DC (~US$ 6,000/MW DC) to ~Rs0.15-0.2mn/MW (~US$ 2,300/MW), a substantial saving for grid scale projects.[13]

The proportion spent on spares and inventory also plays out perfectly with increased project sizes. This advantage is available for both wind and solar projects. For a wind project, for instance, the number of spare nacelle parts, spare wings, or inverters is now a small percentage of overall project cost, resulting in substantial savings.

Feasibility Analysis of Plain Vanilla Solar Project

Solar photovoltaic (PV) technology has dominated renewable energy capacity additions in India recently. While during the start of the sector's journey, wind energy ruled the market, solar PV's phenomenal cost deflation over the last decade, coupled with the country's vast solar energy potential, quickly brought it to the forefront of India's energy transition efforts. Consequently, India has some of the lowest tariffs for solar projects worldwide.

[13] IEEFA Analysis; industry insights.

The following sections elaborate on the assumptions and financial feasibility analysis of a modelled plain vanilla solar project.

Figure 6: Solar Project Related Assumptions

Parameter	Value
Project PPA Tenor (years)	25
Construction Period (months)	12
AC Capacity	50
Loading Factor	1.5
DC Capacity	75
Year 1 P90 PLF (%)	18.7%

Source: IEEFA Analysis

The above table lists the project related assumptions for a solar project of 50MW AC capacity bid out in Rajasthan. The P90, P75 and P50 levels have been derived[14] after considering several factors, including irradiation, variability levels, and solar module technology. The levels represent the probability that the plant's performance will be higher than or equal to this number 90%, 75% and 50% of the time. P-90 would hence be less than P-75, which in turn will be lower than P-50.

Figure 7: Solar Total Project Cost (75MW AC)

Cost Items	Rs (Cr/ MWp)	Total Cost (Rs Cr)	Total Cost (US$ Mn)	% of Total
Land Costs	0.05	3.8	0.5	1%
Evacuation Costs	0.3	18.8	2.4	7%
Modules	2.3	173.7	22.6	64%
EPC Price	0.8	60.0	7.8	22%
Hard Cost	**3.4**	**256.2**	**33.3**	**94%**
Soft Cost	**0.2**	**15.8**	**2.1**	**6%**
Total Cost	**3.6**	**272.0**	**35.3**	**100%**

Source: IEEFA Analysis

[14] Industry insights.

Figure 8: Simplifying the Rule of Thumb Around BCD on Solar Projects

Modules contribute ~60% of gross project cost for a typical project. India has levied basic customs duty (BCD) on the import of solar modules, whereby ~44% additional duty/tax is charged along with an additional 12% GST. Changes in tax laws are mostly considered a pass-through cost for executed power purchase agreements (PPAs).

A rough calculation shows that for a project bid at a tariff of Rs2.00 per unit, 44% duty (including cess) on 60% cost heads would roughly lead to a ~17.4% or Rs0.35 per unit increase in base tariff (also adjusting for previous duty).

SECI's auction of 1,785MW solar in Rajasthan got one of the lowest tariffs in recent auctions at Rs2.17/kWh.[15] This was before the imposition of BCD, and adjusting for it, the landed tariff comes to ~Rs2.8/kWh. We have considered a Rs3.00/kWh tariff in the base case.

For projects bid out after the BCD/GST announcement, the base scenarios have changed. BCD on cell import is ~25% viz a viz 44% for module import. Cells constitute ~50% of the total module cost. Hence, if the developer can assemble the modules at the same price as imported modules, the effective landed tax impact of BCD comes to ~12.5% - i.e., 50% of 25%.

Module Versus Cell Import Comparison	Cell (US$ cents)	Module (US$ cents)
Non-Cell/Assembly Cost (per Wp)	12.0	0.0
Cell Cost (per Wp)	12.0	21.0
BCD (%) (inc cess @ 10% of BCD)	27.5%	44%
GST (%)	12%	12%
Landed Cost (per Wp)	**30.6**	**33.9**

The above table gives an illustrative example of the import of solar cells versus modules. For cells, the total cost, including the price of imported cells, assembly and associated BCD and taxes, is almost 10% lower than importing modules directly. Currently, domestic facilities for the assembly of cells to modules are limited. A competitive back-end integration to materials in the domestic market is a critical lookout for the sector in the years to come. And with industry stalwarts like ReNew Power, Reliance Industries, Azure Power and Adani Group preparing to manufacture solar modules and cells, further efficiencies are bound to come in the sector soon.

Source: IEEFA Analysis

For the base case, the total landed cost is Rs36mn/ MW (US$ 0.47mn/MW). Most large solar projects use leased land. Therefore, land accounts for 1.5%-2% of total project costs (TPC). Considering cell imports and assembly in India (through tie up with key players), we assume developers will buy solar cells at US$0.12/Wp (before duty and taxes) and US$0.31/Wp (after BCD & GST), including non-cell assembly

[15] Mercom. SECI's 1,785 MW Solar Auction Gets Lowest Tariff of ₹2.17/kWh. December 2021.

cost at US$0.12/Wp. At a total landed cost of Rs23mn/MW (US$ 0.30mn/MW), 64% of TPC (refer to figure 9 below), solar cells are the biggest project cost item. While the raw module price may appear aggressive considering prevailing prices, industry belief is that these are aberrations owing to the Ukraine war and COVID-19 related supply chain disruptions, especially in China. Therefore, it would be fair to assume that long-term average prices should revert to the sub-US$0.12 level (before taxes) for cells and ~US$0.20-US$0.22 for assembled modules.

Figure 9: Operating Assumptions

Item	Rs Crores (If applicable)	US$ Thousand (If applicable)
Tariff (per unit)	Rs 3.0	3.9 cents
O&M Cost – 3rd Party & Internal (per MW)	0.04	4.6
Advance received revenue (in months)	3 months	3 months

Source: IEEFA Analysis

Operating expenses for solar assets are very low as the majority of the costs are the frontloaded initial capital expenditure. Operating and maintenance (O&M) costs typically entail module cleaning, monitoring and security costs. The typical year's EBITDA margin for such projects is 85-90%.

Figure 10: Financing Assumptions

Item	Value
Debt (%)	80%
Equity (%)	20%
Interest Rate Post COD Term Loan (%)	8.5%
Debt Tenor (years)	20
DSRA (quarters)	2

Source: IEEFA Analysis

Interest costs are one of the most significant cost heads for a solar project. Even at a cost of ~7-8%, it eats into ~45% of the total topline. However, it has also been the most prominent value earner for solar projects as lending costs have trended downwards over the last couple of years. A cost of 8.5% is often a comfortable base case number adjusting for suppliers' credits – a lower cost of debt results in a double benefit for a project. Lower rates result in lower pricing, making the project much more stable and capable of handling more debt.

Another base case assumption is the equity investment in the form of Compulsorily Convertible Debentures/ Non-Convertible Debentures (CCD/ NCD) by the sponsor (considered at 75% of total equity contribution and carrying a 12% coupon rate). The coupons of such CCDs/NCDs are useful to provide a tax shield to a project.

Project Returns

Under these base assumptions, the project gives a project internal rate of return (IRR) of 7.7% and an equity IRR of 9.6%. As initially discussed, the competitive scenario for solar projects has intensified as the sector has gradually de-risked on the construction, technology, revenue, receivables and, above all, offtake risks (for central offtakers). As a result, the returns form a steady threshold for any investor in the sector.

Figure 11: Base Case Return Metrics

Return Metrics	Value
Project IRR	7.7%
Equity IRR	9.6%

Source: IEEFA Analysis

Why, then, are the bids oversubscribed at these tariffs? And that too by the most prominent local and global developers and investors. The following scenario building exercise aims to answer this question.

Solar Project Scenario Building

We have run six scenarios on the current model incrementally. Each scenario is superimposed on the previous one and provides a kicker to the equity IRR. The reason for this is fairly simple – many developers are already implementing most of the financing improvements (or financial engineering), and the scenarios take our base model to a more current or contemporary state.

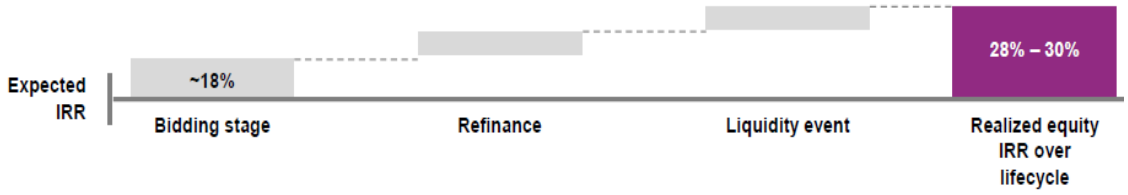
1. **Imported cells at 10% lower cost (@ US$0.108):** The record low solar bid of Rs1.99/kWh discovered in India, in December 202016 came close on the heels of record low module prices of ~US$0.19/Wp. The trend line for solar module pricing has been relatively linear historically, steadily declining from the US$0.40 mark, even reaching US$0.16-US$0.17 for a fair amount of time. The solar cell price could be ~US$0.10 itself in the steady state – adjusting for the current aberrations.

2. **Refinance of debt at 7.5%:** Last year India issued its first AAA rated renewable energy green bonds on a non-recourse basis.[17] The issue was unprecedented because of the rating and the pricing at 6.49%. Other similar issues have happened in the 6.6%-6.9% range.[18] As the sector evolves further, the demand for such papers will increase. The equity IRR takes a further upward flight, adjusting for this refinance cost.

[16] Mercom. Gujarat's 500 MW Auction Sets A New Record Low Solar Tariff of ₹1.99/kWh. December 2020.
[17] Business Standard. Vector Green's subsidiaries to raise Rs 1,237 crore in green bonds. June 2021.
[18] Moneycontrol. Avaada Energy's Rs 1,440 crore green bond issue oversubscribed. March 2022.

3. **Foreign bonds with no amortisation for five years:** The international bond market has been more proactive in the renewable energy sector than the domestic one. While the cost of debt was initially higher as a sum of coupons, hedge and fee, they were "non-amortising" for 3-5 years. For a non-amortising bond, the promoter does not repay the principal debt initially, and the cash after interest servicing is available for further equity infusion. From a project balance sheet point of view, this is simply preponement of equity and provides the most significant bump up to equity returns. Most players have followed up a refinance of projects with foreign bond issuance, and hence, they avail of both these upsides sequentially.

Figure 12: Capital Management Cycle of Adani Green Energy Limited



Source: Adani Green Energy Limited Equity Presentation May 2020

4. **Accounting for engineering procurement and construction (EPC) margins and management fee:** Most of India's large renewable energy companies currently have EPC divisions. Therefore, even when competitively considered, EPC margins of 10% (on non-module costs) are a fair assumption in renewable energy projects. Logically speaking, loading this margin of EPC on the project means that the actual equity invested in the project is lower by this amount. For a non-module cost of Rs 1bn (US$13mn), this would mean lower equity by Rs 100mn (US$1.3mn), or ~20% of base case equity. The IRR would, hence, bump up further.

5. **Purchase of assets by InvITs/investors with a lower cost of capital (equity):** Just as developers replace high-cost debt with low-cost debt once projects become operational and de-risked, it is easy to assume that the cost of equity for operating projects would be lower than that for under construction projects. India has been witnessing this churn for a long time now with more and more consolidation in the sector. With the success of InvITs, much larger pools of such lower cost equity are accessible to the developers.

6. **Revival of carbon market:** Carbon credit, a legally tradable certificate that permits the right to emit one tonne of carbon or carbon dioxide equivalent. Carbon credits trading can help companies worldwide meet their goals to reduce greenhouse gas emissions and achieve their net-zero commitments. Several renewable energy companies from India, such as Azure Power, Acme Solar, ReNew Power, and Adani Green Energy, have started considering the revenues they earn from selling carbon credits as an important source of

income. The carbon price considered in our model is US$1/tonne, though prices in India have ranged from US$1-10/tonne in the recent past.[19] Currently, about 98% of the carbon credits generated in India go to developed economies,[20] but government efforts are on the way to create a domestic marketplace too. Amongst all the value enhancers, carbon credits are one of the only enhancements that derive additional revenue for the projects – and hence, lead to improvement not just in equity IRR but make the project more viable by also improving the project IRRs.

Figure 13: Solar Project Scenarios

Parameter Changed	Project IRR (%)	Equity IRR (%)
Cell Price @ US$0.11/Wp (Module cost US$0.30 including non-cell cost and taxes)	8.1%	10.8%
Loan refinance @ 7.5% rate	8.2%	12.6%
Refinance through Bonds @7.5% with no repayment for first 5 years	8.2%	16.7%
Self EPC Margins @10% of non-module cost/ Optimising BoP Cost	8.2%	20.6%
Valuation Benefit through selling to an InvIT that derives tax benefits	8.2%	25.4%
Revenue from sale of carbon credits	8.6%	28.2%

Source: IEEFA Analysis

Considering all the above scenarios pan out perfectly, the current solar projects are viable and attractive and could see much lower tariffs.

It is important to note that we have assumed the returns considering the import of cells and not modules. While this is desirable, there is a clear shortage of module assembly plants in India. Solar power developers will be running a race against time and supply to tie up with reputed module assembly players for the outstanding bids. By virtue of scale and bargaining power, the GW scale players are likely to take the lion's share of these assembly units' capacities, leading to a higher landed cost for the players/projects who will import modules from China.

Other Upside Triggers for Solar Project Returns

Globally, there has been a gradual shift towards the higher yielding bifacial modules, which produce power from both sides of the module, increasing total energy generation. While its uptake has been slow in India, these panels are becoming

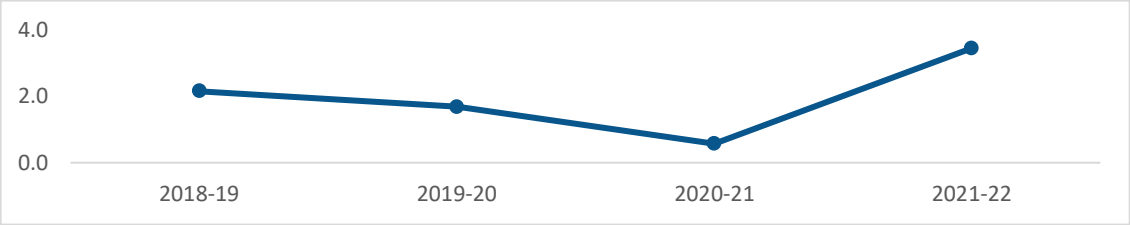
[19] Saur Energy. EKI Energy Services Races To Make The Most Of Its Headstart In Carbon Credits. December 2021.
[20] BNEF. Indian IPO Darling Sees National Carbon Market in Three Years. January 2021.

increasingly popular. Bifacial modules with a single axis tracker could lead to almost 4-5% improvement in overall utilisation factors and be a key value driver soon.[21]

Another emerging trend is the automation of O&M through the implementation of robotic arms for larger projects, leading to a significant lowering of already small operating costs. Additionally, this would lead to better cleaning, lower major maintenance capex, longer project life and higher power generation.

Competition breeds creativity and innovation. The Government of India does realise this, and it has implemented BCD under two slabs – a higher 40% for module import and a much lower 25% for cell import.

Figure 14: Value of Solar Cells (Assembled or Unassembled) Imported in India (US$bn)



Source: India Lok Sabha

Lastly, as India moves from being a developing economy to a developed one, the thresholds for debt and equity returns will lower further. It is quite likely that the Indian entrepreneur is waiting to unlock value from that progress in times to come.

Figure 15: A Word of Caution on Key Global/Macro Risks

Global supply chains have been in tatters lately due to the disruption caused by the pandemic and, more recently, the Russia-Ukraine war. China continues to be the single largest supplier of materials for solar (modules) and wind (steel), and the Chinese economy, even with limited public information, is under deep stress. Both WTG producers and solar module manufacturers have been hiking prices as materials, freight, labour needs coming out of the pandemic, and geopolitical risk weigh down critical raw material prices. Developers do not budget for simple delays in the supply chains that the Indian regulator often absorbs to ensure that the industry survives and thrives. However, the developers should be cautious about pricing volatility and project implementation timelines and de-risk themselves from the material price volatility as much as possible. It will ensure that the growth in the sector is sustainable and not marred by one single large uncontrollable event like the pandemic.

Secondly, rising inflation across the globe has kept central banks on their toes. Inflation has a two-fold impact on the projects at hand. It increases the cost of materials that can directly impact the project returns and make the thin margin projects unviable. Further, the sharp,

[21] IEEFA. Solar tariffs projected to increase by one-fifth over the next year. May 2022.

seemingly uncontrollable inflation is making the central banks tighten monetary policy, leading to a steep increase in interest rates. Lower interest rates play the most significant role in making projects more attractive today. Conversely, rising rates will have the most severe impact on the short-to-medium-term sustenance of the projects. It will be necessary for developers to hedge themselves from this risk in the current scenarios.

Feasibility Analysis of Solar-Wind Hybrid Project

The biggest challenge with a solar or wind project is its intermittency. Solar power is generated during the day while wind (in addition to seasonality) is more during the evening and night hours. India's electricity load profile indicates that peak load is generally during morning and evening. However, the evening peaks are higher than the morning peaks. Moreover, all India peak load is typically in September/October.[22] With increasing project sizes, renewable projects can cause grid stability issues, with a surplus during the day and a shortage at night. To achieve the global goal of reducing (and eventually eliminating) the use of fossil fuels, bundling these projects will make them more reliable round the clock. India can achieve this by using pumped hydro storage (PHS), battery storage, or the more nascent option of storing generated renewable energy as green hydrogen.

Given the above, SECI and other central offtakers have started sponsoring bids for hybrid and storage projects over the last two years. A wind and solar project combination results in a more streamlined power supply and is more grid friendly. Hybrid projects set a minimum threshold of a mix of two technologies to align with grid stability and steady power throughout the day. The lower threshold was 25% for earlier bids, which has increased to 33%.

A hybrid solar-wind project is practically just a sum of parts of independent solar and wind projects.

The below section will establish the project capital expenditure and operating assumptions for a wind project of 100MW capacity.

Assumptions for a Plain Vanilla Wind Project

Figure 16: Wind Project Related Assumptions (100MW)

Parameter	Value
Project PPA Tenor (years)	25
Construction Period (months)	18
Wind Capacity (MW)	100
Year 1 P90 PLF (%)-Wind	34%

Source: IEEFA Analysis

[22] CERC. Report on Optimal Generation Capacity Mix for 2029-30. January 2020.

Typically, a wind project commissioning period (owing to multiple land parcels and greater evacuation complexity) is ~18 months vs 12 months for a solar project. The biggest positive in current times is that with greater engineering efficiencies and height of turbines, the PLFs of 34-43% are achievable at P-90 assumptions for good wind sites, up from ~18-20% last decade. WTGs unsurprisingly constitute the highest cost component for a wind project. There has been a remarkable amount of engineering and innovation for wind turbines like in solar. Today, the designed capacity of new turbines is 2.5MW - 3.5MW. Larger turbines are suitable for deployment even in medium or slightly lower wind zones, and with high wind zone sites getting over, higher capacity turbines are the way to go. The PLF considered in this model is on the lower side at 34% at P90 levels.

Figure 17: Wind Total Project Cost (100MW)

Cost Items	Rs (Cr/ MW)	Total Cost (Rs Cr)	Total Cost (US$ Mn)	% of Total
Total development costs	**0.3**	**29.9**	**3.9**	**4.1%**
EPC Price	5.2	520	67.5	72.0%
BoP Costs	1.4	140	18.2	19.4%
Total construction cost	**6.6**	**664.4**	**86.3**	**92.0%**
Total financing costs	**0.3**	**27.7**	**3.6**	**3.8%**
Total Cost	**7.2**	**722.0**	**93.8**	**100%**

Source: IEEFA Analysis

The cost of a wind project per MW today is in the range of Rs70mn/MW (US$0.9mn) to Rs75mn/MW (US$1mn). Today's higher costs are justified much more due to much more engineering and much bigger machines, movement costs, land and other evacuation matters.

Figure 18: Operating Assumptions

Item	Rs Crores (If applicable)	US$ Thousands (If applicable)
Tariff (per unit)	Rs 3.1	4.1 cents
O&M Cost – Wind (per MW)	0.07	9.6
O&M Cost – Wind BoP & Spares (per MW)	0.05	6.5
Advance received revenue (in months)	3 Months	3 Months

Source: IEEFA Analysis

The operating costs for a wind project consist of normal O&M and spares/other O&M (combined 80-90% of total operating costs). Owing to fewer machines and improved designs, the aggregate costs have decreased substantially. O&M costs are largely a function of the number of turbines rather than capacity, meaning doubling turbine capacity can slash O&M prices. As per BNEF, there has been a 76% decrease in onshore wind O&M prices in real terms since 2009.[23]

[23] BNEF. 2H 2021 Wind Operations and Maintenance Price Index. December 2021.

Figure 19: Full-Service Initial Contract Prices for Onshore Wind Turbines Over 1MW by Signing Year

Source: BNEF

In terms of cost/unit of power generated, this is even more competitive than past. The O&M cost triggers from year 4 or year 5 onwards, as the WTG manufacturers package their machines with 3-4 years of free O&M. Costs still leave healthy operating expenditure margins for the WTG manufacturers, anywhere between 30-60%. This is evident from the market valuation that the WTG manufacturers derive from their maintenance units. Many large (GW scale) players focus on building their own large O&M and spares setup in-house, to save on the O&M costs even further.

Figure 20: Financing Assumptions

Item	Value
Debt (%)	80%
Equity (%)	20%
Interest Rate Post COD Term Loan (%)	8.5%
Debt Tenor (years)	20
DSRA (quarters)	2

Source: IEEFA Analysis

Financing costs for wind projects, just like solar, have become more competitive and are hence, one of the biggest proponents of improvement in the project economies. Wind projects, by design, have marginally higher risks than solar because the resource risk (sun vs wind) is different. Further, construction of a wind site is more challenging with an increase in the number of sites, movement of cranes, dependence on inclement weather and land/R&R issues. Naturally, with all other parameters remaining the same, a lender would consider a higher rate (25 to 50 BPs) and higher DSCR cushion (1.25 vs 1.2 to 1.15) for wind compared to solar.

Total Project Cost for Hybrid Project

The total project cost for the project is the sum of costs for the solar and wind projects. The cost per MW is aligned at ~Rs108mn/MW (US$1.4mn/MW). A project with more capacity in wind (2/3rd in our case) will have a higher cost per MW than one with a reverse combination of solar. Commercially though, as both the projects have IRRs within the same range, economies of scale play out based on a player's competence – whether it is higher in wind or solar - or resource availability with the bidder (in wind vs solar) and evacuation lines.

The current bids permit a player to have separate locations (state wise) for the wind and solar projects. For instance, the solar project can be in Rajasthan or Gujarat, while the wind is in Gujarat, Karnataka, Tamil Nadu, Maharashtra or other high wind zones.

If a developer can find a site suitable for hybrid projects, there can be some economies of scale for the evacuation setup and other ancillary setups, leading to greater cost competitiveness and savings. However, such opportunities, currently, are few and far between.

A hybrid project is, in effect, a portfolio of two projects. With the diversification of technology, geography and resource, a hybrid project provides a risk mitigated solution. It is also more aligned with the government's energy goals, has more grid balances, and will be in a favourable position with the regulators and offtakers. The interest cost can be more competitive. The only limitation is that a large hybrid project would entail a higher overall cost and would leave only a handful of players that can underwrite the entire exposure.

Project Returns – Hybrid Project

Figure 21: Base Case Return Metrics

Return Metrics	
Project IRR	7.4%
Equity IRR	8.7%

Source: IEEFA Analysis

The returns for a hybrid project, like a wind and solar project, are a weighted average of the individual projects. While some economies of scale in staff, admin and management costs can play out, the same is not considered in the base case as it is dependent on the location of plants etc. and a tiny part of the overall cost.

Hybrid Project Scenario building

In the previous section, we ran six scenarios to establish that several avenues are available for project developers to improve their equity return profiles over the project's life. The following section will build on the previous scenarios to consider the changes to the returns in a wind-solar hybrid model.

Figure 22: Hybrid Project Scenarios

Parameter Changed	Wind-Solar Hybrid	
	Project IRR (%)	Equity IRR (%)
Cell Price @ US$ 0.11/Wp (Module cost US$0.30 including non-cell cost and taxes)	7.5%	8.9%
Loan refinance @ 7.5% rate	7.6%	10.5%
Refinance through Bonds @7.5% with no repayment for first 5 years	7.5%	13.0%
Self EPC Margins @10% of non-module cost including Wind EPC Margin @ 7%	7.5%	19.0%
Valuation Benefit through selling to an InvIT that derives tax benefits	7.5%	23.1%
Revenue from sale of carbon credits	7.9%	26.0%

Source: IEEFA Analysis

Considering all the above scenarios pan out perfectly, the current hybrid projects are viable and attractive. They could even see a tariff of Rs2.8/kWh (including duty and taxes). The table below provides the equity IRRs for a range of tariffs.

Figure 23: Hybrid Equity IRR Range

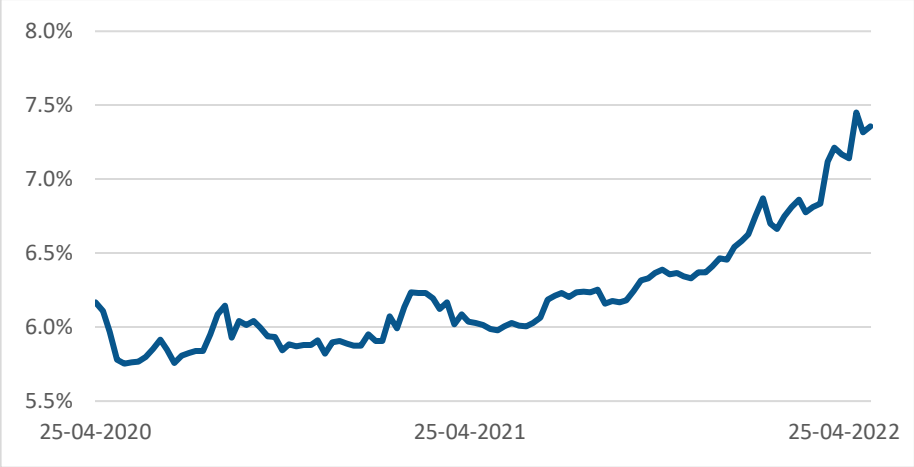
Tariff (Rs per unit)	Equity IRR (%)
3.13	26.0%
3.00	21.2%
2.80	12.3%

Source: IEEFA Analysis

As attractive as the equity IRRs look for a hybrid project (or renewable projects in general), it is essential to note that the sensitivity towards the tariffs is exceptionally high. Simply speaking, the margins of error are minuscule. As the financing structures become more complex and risky, a small error or delay can substantially wipe out the project returns. Looking at the volatility in India's 10-year benchmark government security (G-Sec) rates can provide a glimpse into the risk of financing and refinancing for renewable energy projects.

Several interest rate hikes by the central bank are on the cards, the rising cost of imports is denting India’s balance of payment position and potentially affecting country risk premiums, and the relative attractiveness of developed country assets is increasing. It would be wise for promoters to tread with caution on the leverage side, which is like the sword of Damocles in project financing.

Figure 24: Government of India 10 Year G-Sec Yield



Source: Bloomberg

Other Upside Triggers for Hybrid Project Returns

A wind site utilises ~10 acres of land per site, including the approach roads and site spaces. A large part of the land is often vacant and unutilised, especially as the geographic conditions are difficult for cultivation. Over time, we expect developers to place solar cells on vacant land. As the evacuation system is already available, this can lead to design and generation efficiencies.

On a larger scale, the co-location of the two projects can lead to excellent efficiencies and grid stability.

As the bids for hybrid projects mature over time, we expect projects to utilise the learning of these combinations and storage to better prepare for RTC (round the clock) bids.

On a larger scale, the co-location of the two projects can lead to excellent efficiencies and grid stability.

Once RTC projects become commonplace, we would be able to visualise generators almost as electricity distribution companies (discoms), providing a bouquet of grid stabilised solutions to the end users. Investment by the largest renewable players in this line of business looks to be a well thought through and forward-looking strategy.

The war in Ukraine has exposed the developed world's dependence on fossil fuels. Large fossil fuel owners can exert pressure on the largest economies and this has led to an increased focus on the renewable energy sector, with the valuation of even the existing plants going up substantially. Climate change by itself is the most critical issue that the world faces today, and movement towards a greener earth is happening on a war footing, faster than ever before. Owing to these two global factors, there is a likelihood of more investments in the sector in the medium term.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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