Council on Energy,
Environment and Water

October 2016 | New Delhi, India

CEEW Policy Brief

# Anatomy of a Solar Tariff

## Understanding the decline in solar bids globally

Kanika Chawla and Manu Aggarwal

ceew.in/publications

Thapar House
124, Janpath
New Delhi 110001
India

Tel: +91 11 40733300

info@ceew.in

# Anatomy of a Solar Tariff

## Understanding the decline in solar bids globally

KANIKA CHAWLA AND MANU AGGARWAL

CEEW Policy Brief

October 2016

ceew.in

A policy brief on 'Anatomy of a Solar Tariff: Understanding the decline in solar bids globally'.



Peer Reviewers: Bhaskar Deol (Mynergy/NRDC), Deepak Gupta (Shakti Sustainable Energy Foundation), Shahid Hasan (KAPSARC), Aditya Ramji (CEEW)

The Council on Energy, Environment and Water (http://ceew.in/) is one of India's (and South Asia's) leading think-tanks with a vast scope of research and publications. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It does so by promoting dialogue and common understanding on energy, environment, and water issues in India and globally through high quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public. Visit us at http://ceew.in/ and follow us on Twitter @CEEWIndia.

Council on Energy, Environment and Water
Thapar House, 124, Janpath, New Delhi 110001, India

# About CEEW

The Council on Energy, Environment and Water (http://ceew.in/) is one of South Asia's leading not-for-profit policy research institutions. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high quality research, develops partnerships with public and private institutions, and engages with wider public.

In 2016, CEEW was ranked the best in South Asia in two categories three years running (Global Go To Think Tank Index); among the top 100 out of 6846 think-tanks in nine categories. This included CEEW being featured on a prestigious list of 'Best Managed Think Tanks' and 'Best Independent Think Tanks'. In 2016, CEEW was also ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings. In 2013 and 2014, CEEW was rated as India's top climate change think-tank as per the ICCG standardised rankings.

In six years of operations, CEEW has engaged in more than 130 research projects, published well over 70 peer-reviewed books, policy reports and papers, advised governments around the world over 260 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on more than 50 occasions, helped state governments with water and irrigation reforms, and organised more than 140 seminars and conferences.

CEEW's major projects on energy policy include India's largest energy access survey (ACCESS); the first independent assessment of India's solar mission; the Clean Energy Access Network (CLEAN) of hundreds of decentralised clean energy firms; India's green industrial policy; the $125 million India-U.S. Joint Clean Energy R&D Centers; developing the strategy for and supporting activities related to the International Solar Alliance; modelling long-term energy scenarios; energy subsidies reform; decentralised energy in India; energy storage technologies; India's 2030 renewable energy roadmap; solar roadmap for Indian Railways; clean energy subsidies (for the Rio+20 Summit); and renewable energy jobs, finance and skills.

CEEW's major projects on climate, environment and resource security include advising and contributing to climate negotiations (COP-21) in Paris; assessing global climate risks; assessing India's adaptation gap; low-carbon rural development; environmental clearances; modelling HFC emissions; business case for phasing down HFCs; assessing India's critical mineral resources; geoengineering governance; climate finance; nuclear power and low-carbon pathways; electric rail transport; monitoring air quality; business case for energy efficiency and emissions reductions; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; resource nexus, and strategic industries and technologies for India's National Security Advisory Board; Maharashtra-Guangdong partnership on sustainability; and building Sustainable Cities.

CEEW's major projects on water governance and security include the 584-page National Water Resources Framework Study for India's 12th Five Year Plan; irrigation reform for Bihar; Swachh Bharat; supporting India's National Water Mission; collective action for water security; mapping India's traditional water bodies; modelling water-energy nexus; circular economy of water; and multi-stakeholder initiatives for urban water management.

# About the Authors

## KANIKA CHAWLA

Kanika Chawla is a Senior Programme Lead at the Council on Energy, Environment and Water (CEEW), India. She leads CEEW's work on renewable energy policy and finance. Prior to her association with CEEW she has worked at the Renewable Energy Policy Network for the 21st Century (REN21) Secretariat in Paris. She has worked extensively on distributed renewable energy in developing countries, urban energy policy, renewable energy jobs and skills, and investment in sustainable energy. Kanika specializes in international cooperation and renewable energy finance.

She has researched policy issues in developing countries around the world with a specific focus on renewable energy, energy access, and climate change. She has previously also worked with GIZ on sustainability reporting standards for industry. Kanika holds an M.Sc in Economics and Development Economics from the University of Nottingham and an undergraduate honours degree in Economics from Miranda House, University of Delhi. She is fluent in English and Hindi and speaks basic French.

## MANU AGGARWAL

Manu Aggarwal is a Research Analyst at the Council on Energy, Environment and Water (CEEW), India. His research interests lie on the intersection of development policy, finance and institutions. He has a keen interest in primacy of global coordination and cooperation in bringing country level changes. He has varied experience of more than four years in business consulting, energy derivatives markets and international development.

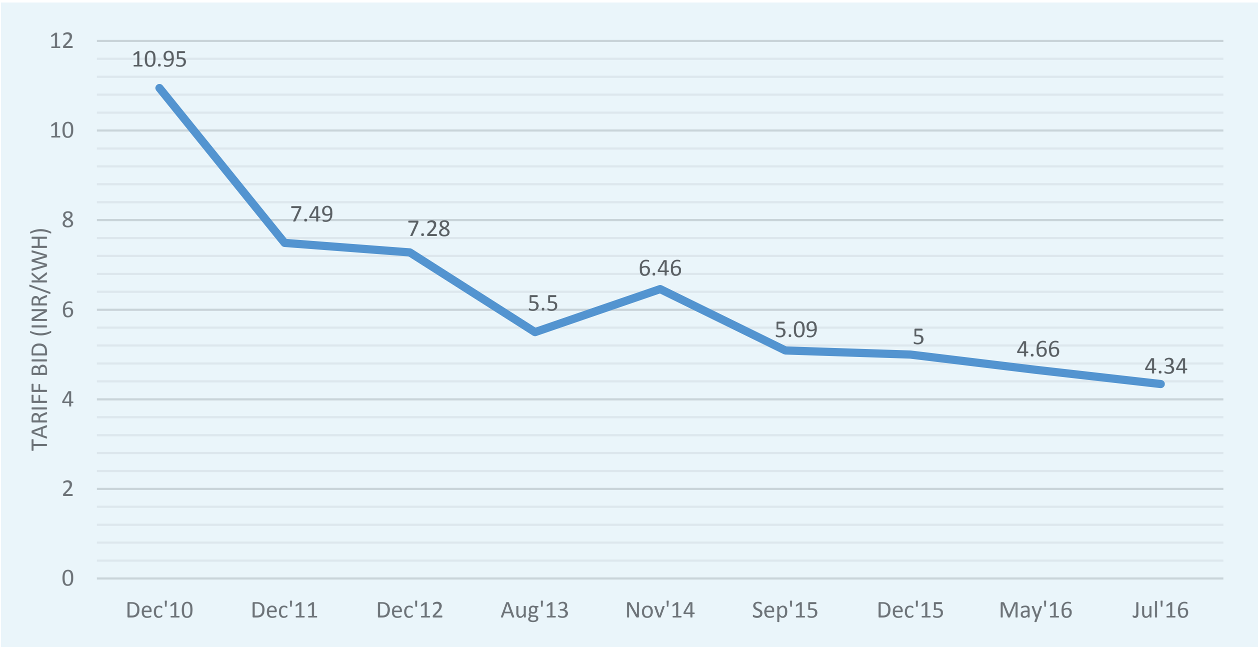
Prior to CEEW, he has worked with Mu-Sigma in advising clients on designing their marketing campaigns briefly followed by trading in international oil & gas markets at Futures First in Bangalore. He has also worked with Seva Mandir, a grass-roots development organisation in Udaipur, where he coordinated the efforts of the Natural resources management programme, especially in maintaining the commons dealing with government and community level tribal groups. He looked into the gaps in implementation of MGNREGA Act and Forests Rights Act on the grassroots level at Seva Mandir.

His academic training is in Mechanical Engineering with a B.E. from Thapar University, Patiala. He is waiting for his CFA charter from CFA institute, USA and has cleared the Level III exam.

# 1 Euphoria and skepticism around solar tariffs

In October 2014 the government first announced the revised target of scaling up installed solar capacity to 100 GW by 2022. The target was met with much skepticism by traditionalists and renewable energy enthusiasts alike. Pressing concerns around the feasibility of this mammoth target included grid infrastructure, health of utilities, the availability of finance, etc. but the most pressing concern was around the economic case for solar power. Despite (weighted average) prices having declined from INR 12.16/kWh when the National Solar Mission (NSM Batch 1) started in December 2010 to INR 6.72/kWh in November 2014,[1] shortly after the new targets were announced, solar power was seen as being a long way off from cost competitiveness. Continued decline in projected cost of inputs, combined with favourable national and international policies, the high learning curve of renewable energy technologies and record low bids by developers in the last eighteen months has led to several of the skeptics buying in to the idea of an energy future that sees a significant share of renewable energy in the electricity mix. Figure 1 below shows the declining trend in solar bids in India, comparing the lowest solar bids from the beginning of the National Solar Mission, till now.

**Figure 1: Declining Solar Bids in India**




Source: Authors' analysis

Moving from feed-in-tariffs (FiTs) to the competitive auction-tendering paradigm has proved to be the real game changer in many parts of the world, with more and more countries employing reverse auctions to encourage competition and drive down solar tariffs.[2] New developments in utility scale storage along with the right policy support have the potential to challenge the age-old hypothesis of base load's reliance on fossil fuels,[3] increasing the feasibility and probability of seeing a 100% renewable energy power regime in the future.

1 http://mnre.gov.in/file-manager/UserFiles/GW-Solar-Plan.pdf
2 http://reneweconomy.com.au/2016/germany-confirms-end-to-renewable-energy-feed-in-tariffs-97024
3 http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-new-economics-of-energy-storage

However, the optimism around the potential of solar power is not unanimous, with concerns being raised around the sustainability of the aggressively low solar bids, especially as bids went as low as USD 3 cent (INR 1.99)/kWh[4] this year in Dubai and Chile[5] [6]. Solar is already at grid parity with fossil fuels in many parts of the world and the continuing positive market developments are silencing critics who look at solar as a new bubble with unsustainable business models, low margins, hidden costs in the form of cheap debt and government subsidies, uneven solar irradiance, variability in energy supply from solar, etc.[7] Some solar developers, a few of which are traditional energy companies diversifying into solar, are prioritising market share over profit maximisation in the short term, recognising the huge market opportunity that solar power presents.[8]

## 2 Various forms of solar

Solar energy is either harnessed in the form of solar PV or solar thermal technologies. Solar PV constitutes a majority of the solar capacity installed worldwide. Within solar PV, deployments can take either the form of offgrid applications (solar pumps, solar home systems, solar mini-grids, captive rooftop systems, etc.), rooftop solar (grid interactive) or utility scale solar projects. In India, uptake of rooftop solar is small. However, in recent times, rooftop solar has been on the rise with decreasing system costs and government incentives such as capital subsidies, generation-based incentives, and policy developments such as net-metering, etc. In India, industry pays an average power tariff of INR 6.3/kWh. Commercial consumers pay even higher tariffs, INR 7.7/kWh on average and as high as INR 11/kWh in Maharashtra. In contrast, rooftop (captive) solar supplies power at INR 5-8/kWh, without any subsidy, depending upon the size of the system, site conditions, and the cost of finance[9]. As a result, commercial and industrial customers are the leading adopters of rooftop solar in India.

Utility scale projects cater to distribution companies (DISCOMs) and in some cases standalone large buyers such as city transportation services, industries[10] mainly due to the option of open access. Open access allows large users of power (typically 1MW or above) to buy cheaper power from the open market and not necessarily from the DISCOMs. This provision was first introduced in the Electricity Act, 2003. There have been a few constraints in commissioning these projects such as the cost and availability of land, high cost of capital, regulation for inter-state transmission infrastructure and charges, etc.

While the cost of capital majorly depends on factors beyond government intervention, they can certainly contribute by developing structures, which minimise risks associated with financing these projects and addressing local factors like land and evacuation infrastructure. Introduction of measures such as solar parks and the green energy corridor among others,[11] with the help of state governments, have in fact addressed these local factors in part. Solar parks have land and other evacuation infrastructure already available at annual charges, allowing developers to 'plug and play' with their solar systems. Due to these features, these projects attract a broader set of developers and result in lower bids.

4 Exchange rate is taken to be INR/USD – 66.55

5 http://www.apricum-group.com/dubai-shatters-records-cost-solar-earths-largest-solar-power-plant/

6 http://www.bloomberg.com/news/articles/2016-08-19/solar-sells-in-chile-for-cheapest-ever-at-half-the-price-of-coal?utm_content=business&utm_campaign=socialflow-organic&utm_source=twitter&utm_medium=social&cmpid%3D=socialflow-twitter-business

7 http://www.bloomberg.com/news/articles/2016-06-16/solar-s-latest-subsidy-is-squeezing-down-costs-and-companies

8 http://ieefa.org/dubai-solar-project-bid-comes-cheaper-coal/

9 https://www.kpmg.com/IN/en/IssuesAndInsights/ArticlesPublications/Documents/ENRich2015.pdf

10 http://economictimes.indiatimes.com/industry/transportation/railways/delhi-metro-likely-to-get-green-power-from-solar-plant-in-mp/articleshow/52037078.cms

11 http://www.energynext.in/gec-to-smoothen-grid-connectivity-of-re-projects-piyush-goyal/

A solar park project of 500 MW last year in the southern state of Andhra Pradesh received a bid as low as INR 4.63/kWh.[12] Even standalone utility projects are not far behind. ReNew Power won a standalone project of 100 MW in the state of Telangana this year at a bid price of INR 4.66/ kWh.[13] But, for the electricity from solar to be at grid parity with coal and other sources, it would further require various costs such as cost of capital, cost of land, etc. to come down. Measures and policy interventions continue to be needed to address issues such as increased intermittency (due to the increased proportion of renewables in the total energy mix), timely payment to developers, efficient transmission infrastructure, etc.

# 3 Comparison of levelised cost of electricity (LCOE) for utility-scale solar systems

Solar tariffs worldwide are on the decline, especially in areas with high solar irradiance. As discussed above, and later in this brief, cost of capital, price and availability of land etc. play a huge role in deciding the final LCOE. Tariffs are the amount that utilities are charging consumers and not their procurement price from the developers whereas bids are the prices agreed upon by the utility and the power producer as per a power purchase agreement (PPA). Table 1 below shows the average utility-scale LCOEs prevailing in different parts of the world.[14]

Tariff to the consumer = LCOE + profit margin (developer) + margin by DISCOM
= Bid price + margin by DISCOM

While the average LCOEs (see table 1) are a starting point to find the lowest per unit cost solar power in the world, detailing the various costs further helps to explain the prevailing trends of solar bids across the globe. This analysis deconstructs and compares the lowest global solar bid and the lowest Indian solar bid, to understand the varying constituent costs that result in the difference in the bids made in these two cases.

Table 1: Average utility scale levelised costs of electricity (LCOE) across the globe

| LCOE (USD/kWh) | | |
|---|---|---|
| Country | Min | Max |
| USA | 0.07 | 0.12 |
| China | 0.08 | 0.14 |
| Germany | 0.11 | 0.17 |
| Japan | 0.10 | 0.14 |
| India | 0.08 | 0.11 |

Source: http://pv.energytrend.com/research/Installed_Cost_of_Utility_Scale_PV_System_in_the_US_Down_17percent_YoY_in_3Q15.html

# 4 Anatomy of utility-scale solar bids

A utility scale solar bid by a developer is a complex product of the price of sub-components that go into the setting up of a solar plant, as well as solar irradiance, policies and regulation, maturity of the market, transmission infrastructure, and other possible strategic objectives such as being the early mover in the market and so forth. The following section details the most important factors that determine the LCOE, and in turn the economic feasibility of a solar plant.

12 http://pib.nic.in/newsite/PrintRelease.aspx?relid=130221
13 http://www.bridgetoindia.com/blog/another-day-another-auction-indian-developers-on-a-winning-spree/
14 http://pv.energytrend.com/research/Installed_Cost_of_Utility_Scale_PV_System_in_the_US_Down_17percent_YoY_in_3Q15.html

## 4.1 Cost variables

Modules Solar PV modules come in different specifications. Crystalline silicon PV modules have been the market leader so far but thin film has been gaining market share lately, especially in the hot and humid regions.[15] The cost of modules makes up a substantial portion of total costs of a utility scale solar project. It is more than 60% of the total project cost in India but this is expected to come down as their prices fall further.[16] These costs are determined in the international market, given that India does not have a significant domestic module manufacturing capacity.

- **Balance of System (BOS)**
  BOS includes civil works, mounting structures, power-conditioning unit and preliminary and pre-operative expenses. It remains the same for standalone as well as for solar park projects, barring small gains from economies of scale of larger projects.

- **Land**
  Land costs are incurred for the area required for installing modules and other affiliated infrastructure. It is around 5%[17] of the total cost of a solar PV project in India but it can rise in the future given the potential increase in the land requirement for other developmental needs as India transitions to higher incomes and higher population density per area. In fact, India has the highest population density among the top 10 countries by landmass.[18]

- **Transmission & evacuation infrastructure**
  Transmission costs include the cost of infrastructure required to transmit electricity from a point near the site of generation to the grid. In India, as in most parts of the world, the transmission network is usually built by the government directly or through a Public Private Partnership (PPP). Evacuation is the infrastructure required to evacuate power from the generation site to the nearby point, from where it will be further taken to the grid through the transmission network. The evacuation infrastructure, in most cases, is built by the developer except in the case of solar parks. In solar parks, the entire required infrastructure is taken care of by the governments in exchange for an annual user fee.

- **Financing**
  Considering the huge upfront capital expenditure in renewable power projects, financing is one of the major factors that affects the levelised cost of electricity (LCOE).[19] Most of the capital for solar projects in India is raised as project finance and is debt-heavy. Debt to equity ratio of these projects stands at around 70:30.[20] Cost of equity (ROE) and debt for utility scale projects are in the range of 13%-16%[21] and 10%-14%[22] respectively, significantly higher than the cost of debt in most parts of the world. Cost of debt ranges from 5% to 7% in the United States.[23]

- **Operations & Maintenance (O&M)**
  O&M includes the recurring expenses incurred throughout the life of a project. Developers can successfully win bids in this tight market if they are able to increase operations efficiency and cut

15 http://www.bloomberg.com/news/articles/2016-04-14/first-solar-making-panels-more-cheaply-than-china-s-top-supplier
16 http://www.cercind.gov.in/2016/orders/SO17.pdf
17 Ibid.
18 http://geohive.com/earth/pop_density1.aspx, CEEW Analysis
19 http://www.firstsolar.com/en/Products/PV-Power-Plant
20 http://blogs.worldbank.org/ppps/innovative-financing-case-india-infrastructure-finance-company
21 http://www.bridgetoindia.com/blog/how-to-make-money-in-the-indian-solar-market/
22 http://climatepolicyinitiative.org/wp-content/uploads/2012/12/Meeting-Indias-Renewable-Targets-The-Financing-Challenge.pdf
23 Ibid.

their O&M costs by deploying innovative cost-cutting, higher efficiency methods and mangement processes such as moving to 'Asset performance management' from the conventional O&M practices, an optimised cleaning frequency and procedure etc.[24 25]

# 5 Comparing the lowest global and Indian bids

Earlier this year, the lowest global solar bid was recorded in May 2016. A consortium of Abu Dhabi's Masdar and Spanish developer Fotowatio Renewable Ventures (FRV) bid US 2.99 cent/kWh (INR 1.99) in Dubai. Saudi Arabia's Abdul Latif Jameel Energy and Environmental Services acquired FRV in 2015. The project being tendered has a total capacity of 800 MW, which is to be installed in three phases (200+300+300 MW) in the Mohammed bin Rashid Al Maktoum Solar Park.[26] The evacuation and transmission infrastructure for this project has been made available by the domestic authorities. It is important to note that Dubai, being a smaller territory[27] with high population density[28] compared to India, requires relatively less transmission infrastructure.

Just as the world thought that solar tariffs could not go down further, Solarpack Technologies successfully bid at US 2.91 cent/kWh (INR 1.94) for a 120 MW project, located in a solar park in Chile in August 2016.[29] Further, in September 2016, a consortium led by Jinko Solar and Marubeni bid at US 2.42 cent/kWh for a 350 MW solar park in Abu Dhabi[30].

Also in May 2016, the Indian state of Telangana tendered 350 MW with capacity fragmented into 35 projects of 10 MW each and a bidder could apply for a maximum of 10 projects. ReNew Power won 100 MW (10x10 MW) at INR 4.66. The onus of acquiring land would be on the developer as the project is not part of a solar park. It is offered under the state specific bundling scheme (NSM Phase II, Batch II).

As explained in earlier sections, system costs and the cost of capital account for a major portion of the total costs incurred. Considering how rapidly system costs for solar technology are falling and how volatile and fast-moving financial markets are, it becomes imperative that two bids with similar timelines for bidding

**Chile leading the solar revolution with the lowest solar bid in the world**

Solarpack technologies, a Spanish multinational focused on solar PV energy, successfully recorded the lowest solar bid for a 120 MW project at US 2.91 cent/kWh in Chile. Several factors could be responsible for such a low bid price. The foremost is its commissioning timeline of 2021. Systems costs for solar technology are falling rapidly due to the global supply glut in the solar modules industry and are already beating the projected estimates. It is expected to fall from current US 40 cent/watt levels to US 25 cent/watt in 2019.

Solarpack will also be using horizontal single axis tracker to further capture the solar irradiance. It is expected to produce 280 GWh of annual energy from its 120 MW capacity. This translates to a capacity utilisation factor of 26.64%, significantly higher than the Indian average of 19%. Chile's sovereign rating of AA (very similar to Dubai's rating), is also much higher than Indian rating of BBB. This further results in comparatively cheaper access to international debt markets.

24 http://saudi-sia.com/wp-content/uploads/2014/10/12.-Tamer-Shahin-KAUST.pdf
25 http://prod.sandia.gov/techlib/access-control.cgi/2016/160649r.pdf
26 https://www.dewa.gov.ae/en/about-dewa/news-and-media/press-and-news/latest-news/2016/06/dewa-announces-selected-bidder
27 http://geohive.com/earth/pop_density1.aspx
28 Ibid.
29 http://www.solarpack.es/ing/desarrollo_noticia.aspx?guid=381&origen=listado
30 http://www.bloomberg.com/news/articles/2016-09-19/cheapest-solar-on-record-said-to-be-offered-for-abu-dhabi

**Abu Dhabi shattered all records with a solar bid at US 2.42 cent/kWh**

A consortium of Chinese solar module manufacturer Jinko Solar and Japanese Marubeni Corporation bid for 350 MW project at US 2.42 cent/kWh in September 2016. This has been the lowest solar bid seen everywhere and it has just come five weeks after Chile's record lowest solar bid of US 2.91 cent/kWh. The project is expected to be operational by the first quarter of 2019.

While the bids have been submitted, the same have not been finalised as the Abu Dhabi utility is still evaluating the economic feasibility of these bids. It can also decide to increase the size of the plant to 1.1 GW and asked the bidders to bid for the increased size as well. The same consortium is rumoured to bid at USD cent 2.3/kWh for the increased size.

and commissioning are compared. Choosing closely spaced bidding dates ensures that the risk-return equation does not change considerably. It further insulates our analysis from any external shocks. Both Telangana and Dubai bids happened in May 2016 whereas the Chile bid happened in late August 2016.

Also, a commissioning date very far in the future has its own risks in the form of increased uncertainty about technology, sovereign credit profile, etc. Since Chile's bid was made in August 2016 and the project will be operational only by 2021,[31] the price bid in Dubai, whose first tranche of 200 MW will be operational by April 2018, has been used as the case to compare against India's Telangana bid by ReNew Power (operational by the end of 2017). [32]

## 6 Deconstructing the bids

In order to understand the tariff composition, a breakdown of the LCOE is estimated for the bid by ReNew Power in Telangana in May 2016, using discounted cash flow analysis. Throughout this analysis, the 'Indian bid' refers to the INR 4.66/kWh ReNew Power Bid, which is being used as the reference case. Other than the costs mentioned in Section 4, solar irradiance, government incentives such as accelerated depreciation, tax-benefits, FITs etc. (if any), also play an important role in determining the final LCOE.

Table 2 below highlights the data and assumptions used for this analysis, for both the Telangana and Dubai solar bids. Costs affecting LCOE of grid-connected projects are taken as stated in Section 4.1 and the LCOE is calculated based on the methodology discussed above. Other government incentives (if any) such as accelerated depreciation, tax benefits, FITs etc. are also taken into consideration.

31 http://www.solarpack.es/ing/desarrollo_noticia.aspx?guid=381&origen=listado

32 http://www.bridgetoindia.com/blog/another-day-another-auction-indian-developers-on-a-winning-spree/

33 http://climatepolicyinitiative.org/wp-content/uploads/2012/12/Meeting-Indias-Renewable-Targets-The-Financing-Challenge.pdf

34 http://www.reuters.com/article/acwa-power-loans-idUSL5N0W304420150301

| Table 2: Data and assumptions for estimating the LCOE from solar projects | | |
|---|---|---|
| All costs are in INR lakh/MW | Telangana | Dubai |
| Electricity Generation (in kWh) | 2 million units per year | 2.12 million units per year |
| CUF | 22.83% | 24.24% |
| Panel Costs | 328.21 | 328.21 |
| Balance of System Costs | 132.63 | 132.63 |
| Land Cost | 25 | 0 |
| Evacuation Infrastructure Cost | 44 | 0 |
| Operations and Maintenance Costs | 1.5% of initial capital expenditure with 5% increase per year | 1.5% of initial capital expenditure with 5% increase per year |
| Terms of Debt (interest rate and tenure) | 14% (12 years)[28] | 4% (27 years)[29] |
| Required Return on Equity | 16%[30] | 10% |
| Taxes | 34.61% (30% IT + 12% surcharge + 3% Education Cess) | 0 |
| Debt Equity Ratio | 70: 30 | 87: 13 |
| Discount rate | 11.21% | 4.78% |

Source: CERC, Authors' analysis

Table 3 below shows the component-wise breakup of the expected LCOE for the solar power plants in Telangana and Dubai, under consideration. Our construction of the Dubai bid comes out to be INR 2.80. In reality, the project was bid for INR 1.99 (US 2.99 cent), assuming an exchange rate of INR 66.55/ USD.

| Table 3: Component wise break up of LCOE for two bids (INR/ kWh) | | |
|---|---|---|
| Cost | Telangana | Dubai |
| Operations and Maintenance | 0.59 | 0.55 |
| Modules | 0.80 | 0.56 |
| Balance of Systems | 0.32 | 0.22 |
| Evacuation | 0.11 | 0 |
| Return on Equity | 1.51 | 0.89 |
| Debt Servicing | 1.80 | 0.57 |
| Financing (ROE+ Debt Servicing) | 3.31 | 1.46 |
| Accelerated Benefit | -0.54 | 0 |
| Total | 4.58 | 2.80 |
| Tariff Bid (actual) | 4.66 | 1.99 |
| Profit Margin | 0.08 | |

Source : CEEW Analysis

The debt amortisation schedule is taken as 12 years for Telangana, as per Central Electricity Regulator Commission norms. The same is taken as 25 years for Dubai since long-term debt is rumoured to be available for Dubai's project from the likes of Mubadala and Abu Dhabi Investment Authority (see Section 6.1).

Data for the cost of panels used in the installation in Dubai was not publicly available so Indian panel costs have been used as proxies. However, it is important to note that the Telangana deployment is going to use Fixed-tilt (FT) system whereas Single-axis tracker (SAT) systems are going to be installed in Dubai. SAT systems are typically more expensive than FT systems. Tracking systems cost around US 8 to 10 cent/Watt more compared to FT systems.[36] They also incur more O&M costs compared to FT systems. However, for comparison, the same panel prices have been used for the two bids.

35 http://mnre.gov.in/file-manager/Compendium/O%20Order/Karnataka%202.pdf
36 http://www.solarpowerworldonline.com/2016/05/advantages-disadvantages-solar-tracker-system/

## 6.1 Plugging the gap - Estimate v/s Actual tariff

As indicated in Table 3, our estimates are very close to the actual bid made in Telangana. However, as noted above, our estimates are higher than the actual bid in Dubai, even after taking into account the preferential costs of land and finance available for the Dubai deployment. In order to identify the points of divergence between the estimated tariff and the actual bid, the influence of various factors affecting the costs were examined. For ease of analysis, we consider one variable at a time. In reality, a combination of factors is likely to be responsible for the discrepancy between the estimated and actual bids.

The Return on Equity (ROE) for the project is kept at a conservative level of 10%. This is due to intense competition, historically proven track of PV power plants to be low-risk investments[37], bankability of the project and the low off-taker risk.[38] Other strategic reasons (mentioned later in this section) and government-owned equity owners are other reasons for such an assumption. Even after taking a conservative assumption for ROE, it needs to further come down to 0.63% to bridge the gap between actual and estimated tariff. This is only possible if the government decides to accept a much lower required ROE, which may be the case since the equity investments comes from government owned outfits.[39] It may be noted that the ROE for Mubadala Development Company (owner of Masdar) for the fiscal year 2015-16 comes out to be only 0.66%.[40]

Alternatively, the cost of modules must decline to INR 195.12 lakhs/MW or US 28 cent/W from the current price of US 48 cent/W at which they are available for the estimates to match the submitted tariff. Since the entire project of 1GW will be installed over the next five years, the following scenarios could justify such lower prices:

- Lower future prices for modules may have been adopted (most probable reason), or
- Module manufacturers (possibly First Solar) may have been given equity in the project, or
- The module manufacturer has strategically quoted lower module costs in order to be considered for future contracts.

A third factor - O&M cost needs to come down drastically to 0.22% of capital cost instead of 1.5%. This can happen on the back of innovative ways of decreasing O&M costs (similar to the one mentioned in section 4.1).

A combination of these markdowns could have resulted in the final bid of USD 2.99 cent/kWh.

## 6.2 Areas of divergence between Indian and Dubai bid

As identified in figure 2 below, the major areas of divergence between Dubai and India bid are cost of capital (both debt servicing & ROE), cost of modules, and the cost of the evacuation infrastructure.

The cost of debt is determined by many factors, such as credit quality of borrower, sovereign rating, currency risk, an investment mandate of lender. For example, some pension funds cannot invest in debt papers below a certain credit quality or in certain sectors. Most of the sovereign wealth funds also

37 http://www.apricum-group.com/dubais-dewa-procures-worlds-cheapest-solar-energy-ever-riyadh-start-photocopiers/

38 http://www.solargcc.com/dewas-rock-bottom-solar-bids-the-real-story/

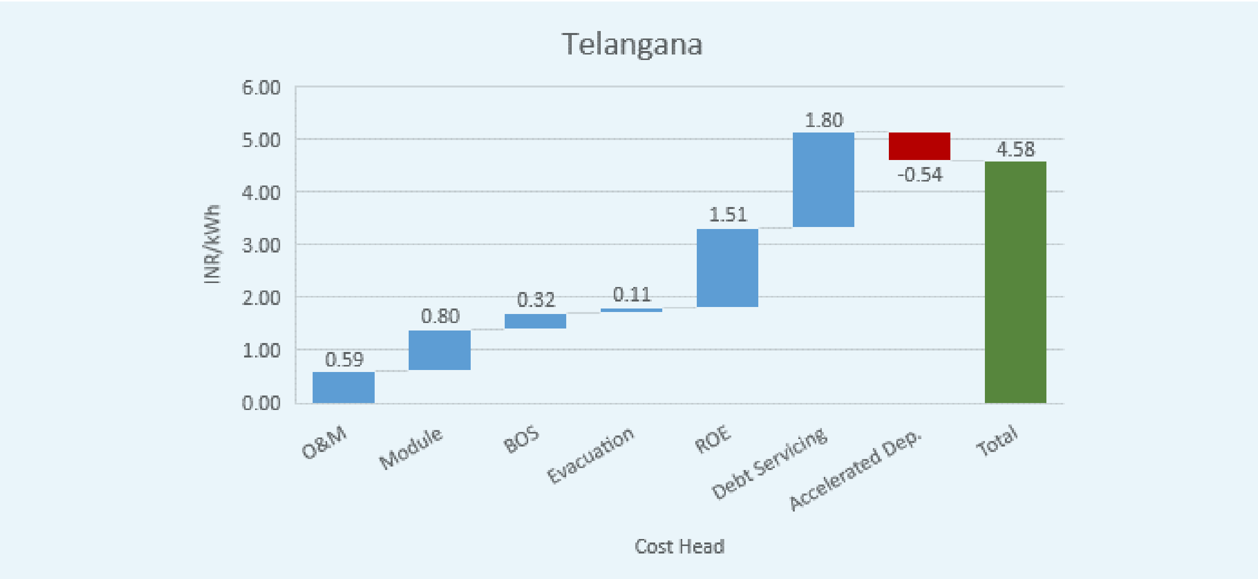
39 http://www.apricum-group.com/dubai-shatters-records-cost-solar-earths-largest-solar-power-plant

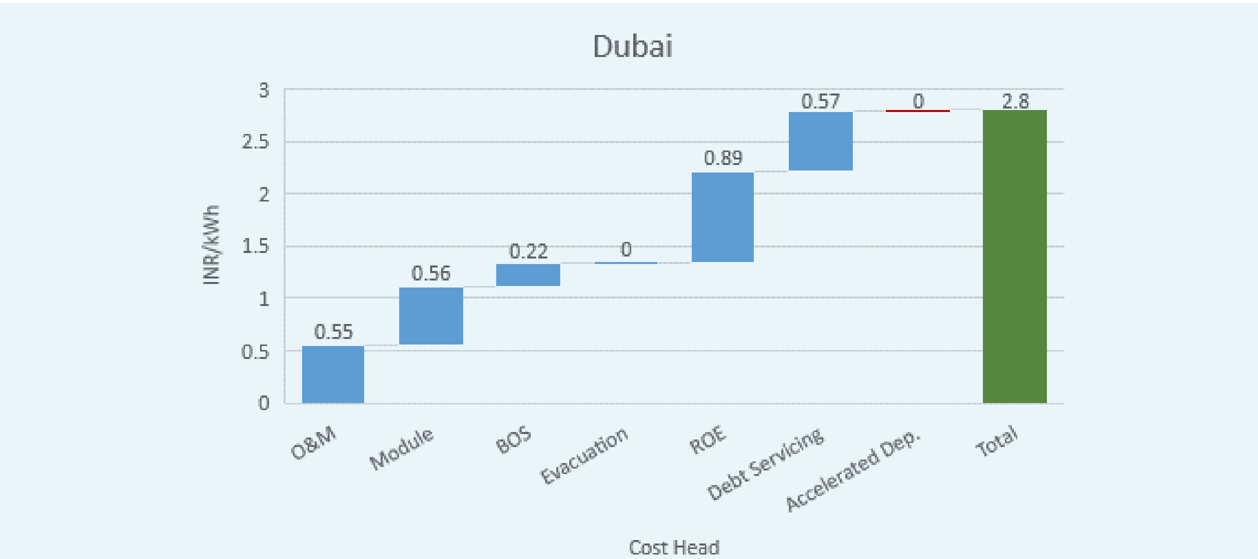
40 http://mubadala.com/annual-review-2015/en/images/performance/MDC-Consolidated-Financial-Statements-FY-2015.pdf, CEEW analysis

have a domestic mandate, which provide capital for developmental and social purposes at low cost for invetsments within domestic economy. Since Masdar (40% equity owner) is a government entity and owned by Mubadala Development Company, which in turn is a wholly owned investment vehicle of the government of Abu Dhabi,[41] it can access debt at preferential rates, which significantly lowers the cost of the project. Regional banks financing the Abu Dhabi project are also rumored to provide debt at rates as low as 5%.[42] As mentioned in section 6.1 above, the other equity owner, DEWA (60%), is also a government owned entity.

Renewable energy projects in India are mostly developed privately and do not have access to this kind of low-cost capital. The Indian government plays the role of a facilitator in the auctioning process and provides capital subsidies, in some cases, but no loan subsidies. Most of the renewable energy generation projects are financed at market rates in India, which are more constrained both on the quantum of debt available, as well as the rates at which debt is accessed.

**Figure 2: Cost of finance contributed the most to the lower tariff bid in Dubai tenders**




Source : CEEW Analysis

Note: These are CEEW calculations of the weekly breakdown of the bids. The final bids were of a different value.

41 http://www.masdar.ae/

42 http://www.apricum-group.com/dubais-dewa-procures-worlds-cheapest-solar-energy-ever-riyadh-start-photocopiers/

Currency risk, a factor that limits the flow of preferential foreign investment into India, is negligible in the UAE, as its currency, the Dirham, is pegged to the US Dollar. India does not have this advantage, as its currency is unpegged and is determined by market forces. The Reserve Bank of India only intervenes in case of excessive volatility.

The Dubai government is providing for evacuation infrastructure at no cost. Hence, evacuation charges are non-existent in case of Dubai, whereas it contributes INR 0.11/kWh to LCOE in India. Depreciation is based on 'uniform depreciation approach' using the straight-line method for Dubai. The depreciation rate is 3.6% for 25 years in Dubai whereas for Telangana, depreciation is based on 'differential depreciation approach' using straight-line method as prescribed by the renewable energy tariff regulation.[43] It is 5.83% for the first 12 years and 1.54% for the latter 13 years. The salvage lives of equipment are considered to be 10%. The greater depreciation of modules and BOS in the earlier stage of plant life in the case of India results in the higher contribution of modules of INR 0.80/kWh to LCOE for India versus INR 0.56/kWh for Dubai. The discount factor used to account for the time value of money is much lower in Dubai than India owning to its lower weighted cost of capital. This is also one of the reasons behind the difference in contribution of the cost of modules to LCOEs.

## 7 Future roadmap and lessons for India

The future of solar in India looks sunny. The lofty target of 100 GW of solar capacity by 2022 requires the installed solar capacity to double every eighteen months between now and 2022 with the current solar installed capacity standing at 8.6 GW.[44] The optimism around India's solar future is rooted in the pace at which new capacity is being commissioned. The government intends to tender 21 GW of additional capacity in the next few months, to stay on course on its targets.[45]

For future capacity, the price curve of solar tariffs will be well supplemented with a further expected decline in module and balance of system costs. Costs of panels are expected to decline from US 48 cent/W to US 28 cent/W i.e., from the current INR 328.21 lakh/ MW to INR 195.11 lakh/ MW by 2025.[46, 47] This would translate into the LCOE declining to INR 3.45/kWh, if everything else remains unchanged.

It is crucial for the government to examine and mitigate certain local risks around land availability, evacuation and access to capital in order to drive down solar tariffs further. Competitive solar tariffs, while resulting in increased deployment and confidence in the sector, are also an encouraging signal to investors about the feasibility of solar projects, resulting in increased investment into the sector.

Debt is used to finance more than 70% of each renewable energy project in India. Cost of debt is in the range of 3%-6% in the developed world, as compared to the 10%-15% rates in India. Large pools of debt could be directed to projects in India, at comparatively lower rates if investors were insured against risks that plague their investments, such as forex risks, offtaker risks, etc. The quantum of debt flowing in India could substantially improve if the credit rating of India improves, especially as it graduates from a USD 2 trillion economy to the USD 5 trillion club in the future.[48] This could help to unlock those sources

43 http://cercind.gov.in/2016/orders/SORE.pdf

44 http://mnre.gov.in/mission-and-vision-2/achievements/

45 http://economictimes.indiatimes.com/industry/energy/power/india-surpasses-solar-energy-target-for-2015-16-more-than-one-and-a-half-times/articleshow/51886824.cms

46 CEEW analysis

47 https://www.kpmg.com/IN/en/IssuesAndInsights/ArticlesPublications/Documents/ENRich2015.pdf

48 http://indianexpress.com/article/business/economy/indian-economy-to-more-than-double-to-5-tn-in-few-years-jaitley-2830856/

of finance, which are currently prohibited from investing in India. The government is exploring innovative ideas for setting up currency hedging facilities and, if these were designed and implemented well, they would help to reduce the cost of debt and equity.

Government policy is aimed at attracting private players to execute most of renewable energy projects in India. But it cannot accept the lower ROE that government sponsored organisations in Dubai can afford. It should also be noted that the tax benefit offered in the form of accelerated depreciation to developers is also likely to expire in 2017. However, the government would need to play an important role in reducing the cost of capital by mitigating risks and directing public money into innovative financing mechanisms pertaining to hedging costs and reduction in cost of capital discussed above. As the world economy is expected to grow at lower rates in the future, there is a chance that investors recalibrate their returns on investment, and in turn, target lower returns.[49] This would further bring down the cost of financing.

The expected decline in solar tariffs in the range of INR 3.5/kWh to INR 3.7/kWh in the next ten years or earlier[50] can be accelerated further by supportive and innovative policies such as land availability at fair prices, innovative use of wastelands to deploy renewables, currency-hedging facility etc. Externalities like technological breakthroughs, better technology and transfer of funds from developed nations to developing countries could further result in a downward revision of the longer-term price curve for solar energy in India.

49 http://www.mckinsey.com/~/media/McKinsey/Industries/Private%20Equity%20and%20Principal%20Investors/Our%20Insights/Why%20investors%20may%20need%20to%20lower%20their%20sights/MGI-Diminishing-returns-Full-report-May-2016.ashx.

50 https://www.kpmg.com/IN/en/IssuesAndInsights/ArticlesPublications/Documents/ENRich2015.pdf

Council on Energy, Environment and Water,
Thapar House, 124, Janpath, New Delhi 110001, India

Tel: +91 407 333 00 | Fax: +91 407 333 99

OUR WEB RESOURCES

- ceew.in/publications
- ceew.in/blog
- ceew.in/news
- ceew.in/events
- ceew.in/videos
- ceew.in/images
- ceew.in/annualreport

OUR SOCIAL MEDIA RESOURCES