

BROOKINGS INDIA  
KAMALNAYAN BAJAJ CONFERENCE ROOM

Discussion | Scaling of RE in India

What's real, what's missing?

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PROCEEDINGS

*Rahul Tongia:* This mind space in India is dominated by targets. 175 gigawatts by 2022 is known to pretty much all of us. As you know, we're closer in the order of a third of that right now and five years are left. Instead of targets, one of the things that we've asked about is "what are the frameworks to making it happen". So, when we say is there enough money? Well, there's always enough money if it makes sense, globally, capitally speaking. So, are the frameworks right is really one of the tough questions.

One of the findings, and these are parts of studies that will be coming out shortly from Brookings [India] and Brookings DC jointly, is systems-level thinking about renewables. Because much of renewables today has been focused on the L1 which is the levelised cost of energy cheap as possible.

I mean, I'm sure people have been watching with surprise that the price falls, Bhadla being a record, then it crept up a little bit but people were not as expecting wind to also find

such a dramatic decrease so suddenly when it moved from a feed-in tariff towards the bidding norms.

So, some commentators have asked this question: is this a race to the bottom? So, there's the viability side that we may talk about, there's the side that you are dependent on imports, specifically Chinese imports, and in the last few months those panel prices have firmed up a little bit. So, whether they firmed up isn't the issue, it's more, is this trend that we're expecting and basing entire models on going to continue over 3, 5, 7, 10 years?

Jury's out, the same question could, in fact, be asked about one more enabling technology which is batteries, because we've been doing some analysis and what it points to is in the near mid future, which means the next 10 plus years, we don't foresee peak coal. There's people who are saying, "peak coal is upon us, it's just a matter of time", if you do the math, depending on assumptions -- so, the first caveat that any scholar will make is 'well, it depends on this' and then you hedge yourself against all these problems -- but if we just do a back of the envelope and say India has two targets; one well-

known 175, now 2030, it's not clear what an articulated RE target is, 350 is one number that Arvind Subramanian, for example, used in his talk and a number of people have used but there's more fuzziness in the second half, so that's one of the things. Now, first observation you will see is if you're growing so quickly to 175 in a shorter time span, then in 8 years do you only double? So, what does that mean? Is it that you may not meet the 175, it'll come later, but meet the 350 or does it mean that you're can hit saturation effects? It's easier to put in this smaller-medium-large amount but the enormous amount that people are talking about, to the point where you no longer need coal, that's sort of one of your backstop, that may actually get tougher.

And so, a very back-of-the-envelope way to look at it is twofold; one is not look at capacity but energy, because that's one of the problems in a lot of planning. Because the plant load factor of renewables as you know is about 20, a little higher for wind, 21, 22 over in aggregate, while a thermal plant could or should be, forget 60 per cent but ideally 70-plus per cent

load factor, so adding 300 more of renewables is equivalent to adding a 100 of coal on an energy output basis.

So, in the next 13 years, using 2030 as a benchmark, India's expected electricity demand is going to be more than an addition of 50 per cent of where it is, or 30 percent. So, that just means even if you meet the government targets, it's not enough. The second challenge is the time of day because, as we know solar is available in the middle of the day, so to meet it at the off-peak periods, if you're truly displacing coal, you're reliant on a battery and those economics are also out.

So, there's a modelling that'll be coming out very shortly on why and how we may or may not, more likely, hit peak coal in the coming decade.

So, REs had some hiccups in the last few months, forget prices, bids, even globally RE had seen this. And another sort of question that I'll throw out there and then look forward to your opening remarks is obviously on finance, is that the bottleneck, is that the enabler, is that the tail-wagging the dog? Because there's a lot of money chasing it based on targets but the bottom-up ability to absorb that RE, that feedback loop,

that hasn't necessarily closed. This is why we're seeing the RE excitement shifting along India. It started with the southern states, Western and they've sort of said "thank you very much, I'm full, no more PPAs for you". So, then you have other states in India which have been the leaders but will they also reach a plateau somewhat quickly, is a million-billion-Rupee sort of question.

And then the last sort of point that I have in my opening sort of thoughts and then the [response] is on the split between different technologies grid and rooftop. So, if I could ask David to just sort of take a higher level of view before we dig into India and just talk about what's happening with renewables worldwide with that perspective; what's real, with prices. Because you look at the US, they have very cheap interest rates, there's an investment tax credit and yet we're expecting renewables in India to be cheaper than the United States, how does that work?

*David Victor:* Yeah. The United States market may be about to see a series of very big changes. We're undergoing a process of tax reform right now that might in various ways implicate the US

market. The capacity of the United States to adopt dumb policies is infinite and we're about to adopt a dumb policy around tariffs on imported solar and that's gonna make it more expensive in the United States, so I hope India does not follow.

*Rahul:* I think India said that it will not...

*David:* You will benefit, because demand in the United States will be lower. But I'd like to take a kind of step back and talk about where this is headed overall. I can't speak about the targets in India, that would be not appropriate.

Governments like to set targets, what really matters is what you can implement and I think this is where the Indian experience is really instructive to the rest of the world.

I guess three or four main points: the first is that in the early days of an industry developing, focusing on L1 makes sense because you generate electricity from renewables, you dump it on the grid, somebody else manages the integration problem and the market develops and so that I can completely understand.

We're not in the early days anymore, we're now at the stage where significant penetration of renewables has happened



and we need to start developing instruments and policy instruments that reflect the variability of the power output and get the market signals right.

We are struggling with the same question in the United States and I think, essentially, every market that has large amounts of renewables is still struggling with that, there is no plan, there's no playbook for how to do that.

People now know what the problems are but we don't really know what the policy solutions are and so, to the extent that the experience in India can help focus on experimentation with different policy solutions and then India helps kind of tell the world what it's learned while the world also is learning, that would be enormously valuable.

I will say one thing about the cost reductions. Many technologies through learning effects have big cost reductions but those don't go on forever. The famous example in history is of gas turbines, a 20-30 percent reduction in cost for every doubling of capacity but then that slowed down, and I think we're starting to see that in solar, we're plausibly starting to see that in wind; it doesn't mean the innovation is over but it

means that we're starting to see some plateaus and so we have to be very careful about just extending those curves out into the future.

I want to talk a little bit about scale, what we've learned in the rest of the world about scale. There's a lot of academic research out there to try and address the question of what's the maximum amount of renewable energy you can have on the grid and, of course, the answer is "it depends" and you'd expect academics to say "it depends", in part, because that's a perpetual employment programme for us as academics but "it depends" because it depends on the characteristics of the supplies and the grid and things like that.

*Rahul*: What else do you have than your grid, yes.

*David*: Exactly. And it's been interesting because grid operators have responded, so people are now running big coal plants and even nuclear plants mid-merit in a way that they never thought they could do before, it's not very good for the plant but this has been one of the kinds of responses.

The academic work suggests that up to about 60% or 80% of renewable penetration in ideal circumstances, you could imagine integrating renewables. I don't really believe that. I think that the real numbers are smaller because in real grids, where you have real reliability concerns and not everything is optimally designed, the effects of errors and forecasting and so on are magnified.

Let me give you an example, the Southern California grid is now one-third renewables roughly, dominated by solar for various reasons, in addition to the fact that California is a very sunny place, we have a lot of solar power. With one-third renewables, we have seen this last spring the largest curtailment of solar output on record. And so already with one-third of actual power output on average as renewables, we're not able to integrate fairly effectively. So that gives you kind of some sense of these kinds of issues.

I wanted to say a couple things to close in my opening remarks here, which one is about integration. I think grid operators around the world are now struggling with and finding lots of ways to integrate renewables. We as techies, as

engineers, people with any kind of engineering bent tend to focus on the technical side of that, so we're very focused on batteries and on battery storage, we forget that globally there's much more storage in hydro and pump-to-hydro than in batteries and so batteries are exciting to everybody but actually most of the action is in pump storage. And we also forget that a major way of integrating renewables is demand response. And so, to the extent that it's possible to introduce tariffs that generate demand response and we understand how demand response works, in some sense, demand response and storage are substitutes for each other and they can be complements but they're often substituted and so your views about the viability of demand response has a very big impact on your views about the future of storage.

What we do see is the duck curves are happening with a vengeance – this is the famous curve in solar dominated systems in the late afternoon as the sun goes down and power output from solar drops but demand for electricity goes up, you see this big spike, that's the back of the duck – the duck curves that have been projected for Southern California for the year 2020, we now

already see some days last year and the kind of steepness of the back of the duck is beyond what anybody could have imagined. And so, I think the reality is that the integration issues are gonna be much harder.

And the last thing I'll say is we have to remember what is it we care about. I think when you read the press in this area, people seem to care about renewables because they like renewables, and I think it's important to care about something, but if what we care about is emissions, that's not the same thing as renewables. And I'm really worried about that because if you integrate a lot of renewables into a grid where the marginal source of energy is a mid-merit low-efficiency high-emission power plant like a coal plant, then emissions actually go up and that, in fact, has been exactly the German experience.

The German emissions are going up for a variety of reasons including the phase-out of nuclear power, which is not complete, but Germany is one of the most successful countries in introducing renewables and frankly has not been very successful in reducing emissions and I think that's something we have to keep in mind as we go forward.

*Rahul:* Thank you David. So, bring remarks but probably reality, I think, and this point I want to come back to is what's the rest of your grid look like and we also have people in the audience who may comment. Do we have time of day pricing, for example, that would really enable demand response and storage and many other technologies and solution, so does frameworks issue include time of day for a procurement perspective. When people say time of day, everyone thinks consumers paying time of day, that's the other side of the coin; the first side is we need contracts for buying power for the utilities Discoms who buy to recognize that not all power is the same, where, when, what ramp, what predictability, they're different, so that's that problem with the L1 for saying what's a good electricity. So, now just turning over to people who deal with L1 and the lot, Gagan?

*Gagan Sidhu:* Thanks Rahul, thank you David for that perspective. I think when I sort of look at tariffs, I step back and look at it as something sort of impacting renewable energy generation and RE generation itself is one of the three pillars along with

storage and transmission, which is gonna be changing energy as we know it in our lifetime.

But getting back to the tariffs today, you know there's a lot of talk about tariffs hitting rock bottom in India but the reality is that tariffs are actually not the lowest in India as compared to other places in the world. I mean, we are at 2 Rupees 44, which is about \$3.75, in the U.S. it's a few bits below that. Mexico is 3.5, you've had Dubai hit at 2.99, again, cost to calculate is a separate issue but absolute tariff levels are even lower. I mean, Abu Dhabi has hit 2.4, Chile has hit 2.15 and Saudi has hit 1.98. So there's no way that I believe that we're actually the lowest in the world, far from it.

I also think there's certain sort of contractual reasons for the tariffs to be where they are today. First of all, you know, when you look at the power purchase agreements in India, you have a structure where you are signing a power purchase agreements either with a central organisation who is not the final off taker or you have a PPA which is signed directly with the state DisCom. What you have is a mirror power sale agreement

where the central offtaker agrees or contracts to sell to the end-user which is the DisCom.

Now, when you look at these PPAs and the PSAs, they are more in the nature, as I was telling Rahul the other day, of pay-for-what-you-take rather than take-for-pay. So, there is no sort of financial obligation or no consequence on the DisCom for not off-taking certain amount of power or any power and there's various shields that they sort of hide under and they can hide under, I'm not saying they do it but that is a tangible risk.

So, the reason why tariffs have gone low, and I'll talk about returns afterwards, is to ensure that this product that you're generating moves out the door. So, this product is low enough, attractive enough for the DisComs, for them to buy it and, you know, that is the overarching reason, it's not a competition to secure capacity as such, it's a competition to secure capacity at a tariff where you are almost quasi-writing an insurance policy on the guarantee of your product moving out the door. Now that is one aspect.

The second aspect is this product that you're selling, what do you compete with? You're competing, at least during the



day time for solar, with other sources that these DisComs off-take from and a number for that cost is represented by the average pooled purchase cost that these discounts pay for pooled energy. So, that blended cost is somewhere in the range of 3.5 Rupees. So you know it's no surprise that tariffs for renewables, for solar, would fall below that number and it's no surprise that they would fall much lower than that number.

Now, I don't want to get into a debate on the merits of a particular tariff, that's not the idea here but, clearly, there's a logic for it to be below 3.5 and there's a logic for it to be really low in the first place -- that's from a purely pushing-the-product-out-from-the-door perspective.

And again, you know, it's no surprise that the MTBC Chairman himself has said 3.0-3.2 he sees as a tangible realistic tariff for solar. So, talk about four cents, I mean he's been on the record to say that.

So, that sort of takes care of the pushing-the-product-the-door, the other side of the coin is returns. Now, when you look at returns, is it correct to benchmark the returns you should expect from solar against thermal? Definitely not, I mean

certainly not because the risks, both in the execution phase as well as the O&M phase are far different. So, if you say that a 16 percent IRR is what you're seeking for thermal, then you have to sort of believe that your target returns from solar should be much lower. I'm not gonna get into how much lower but that's one aspect of it.

Now, the second aspect of it is that a lot of people tend to believe that their cost to capital is something that should drive the expectation of how much money they should make from a solar investment or from any investment. I mean, that's the misunderstanding. The target returns you should make from any investment should represent the risks and return profile of that investment, so it doesn't make much sense to me to sort of say that "well, you know, Japan has a cost to capital of almost zero and therefore they should invest in India in solar because that's all they're gonna want to make", well, that's not really the case, right? If you invest Yen in solar in India, the first thing you do is transfer or you exchange that Yen into rupees and the moment you've transferred it to rupees, rupee chases rupee risk, that's the fundamental sort of thing to understand.

And thirdly, I mean when you're talking about what should be the required rate of return from solar, there's some empirical studies from the US that sort of clearly show that we required return for yield curve, so these are operating assets not under development assets, the required rate of return from yield curve is significantly less than it is for traditional sources of energy generation and the numbers that I've come across are in the range of about six and a half, so six and a half percent is what dollar seeks in the US for operational yield curve. If you want to get a good estimate of what the forex hedging cost would be, and Vikas will probably give us a better idea from a bank perspective, but I sort of look at what it costs NTPC to raise rupees overseas and dollars overseas. So, the NTPC dollar bond issue that yielded about 4.15 percent in London and the masala bond which is basically rupee risk, at 300 basis points above that.

So, there's investors out there looking at the same piece of paper, same underlying credit but different currencies charging or looking at a 300-basis point premium. So, you add 300 basis points to six-and-a-half, you get to about nine and a

half. How much more do you want to add for execution risk for a solar project? Maybe 100? Maybe 150? So, really the target returns for solar in India is nowhere close to 16% and it's nowhere close to the cost to capital of a guy who's bringing in dollars, it's somewhere in between and you know, if one builds it up, you'll get into a number which is not way off what the current tariffs actually represent.

*Rahul:* So, if I extrapolate that thought, we've already achieved where it can go in, now further improvements will get much tougher or am I reading too much into that?

*Gagan:* Well, certainly the pace of fall, as you get closer to the bottom, it doesn't sort of decrease as quickly. Secondly, on the flipside, is the concern that not enough capacity is being tendered out by the government. So, if you have a lot of money chasing a limited market, that will wash against the tendency to flatten out, you know, and there's tons of money chasing solar in India for sure.

*Rahul:* Thank you. Vi kas?

*Vikas Bansal*: Thanks, thanks. And I think I somewhat agree with Gagan on the tariff side but from a banker's perspective, I'd like to get out of this tariff view for a while and just to understand where exactly is the capacities and the utilization of these capacities heading. And from the bank side, we've been engaging with lot of stakeholders and we've been really lucky to engage with Rahul on and off of very interesting discussions that we already obviously have on these topics. One area where long term investors like debt bankers have a real concern is about how the utilization of these capacities will happen and how Discoms are building themselves up in terms of their financial health, in terms of their operational efficiencies to take up these additional renewable energy capacities. The Discoms have been given a lot of thought in the last three years where government have introduced a lot of programs, bases which this capacity addition that we've seen in the last three years which has happened almost more than double the capacity which has already been installed from the 2013-14 levels and in this capacity addition, we've seen multiple discussions, multiple issues being discussed at various forums about how are these Discoms going to tackle the challenges which they are offering.

Already, in 2017, we've seen a major shift in the thinking of Discoms, States, about the last three years growth and the growth that we are now foreseeing in the next three to four years, the three to four years growth before 2017 is now in question because people are questioning what were those tariffs about, when we are actually seeing a significant drop in just two three months of bidding to these levels. What will happen to those contracts which was signed, which were financed by lenders and which are now facing questions about their tariff being a bit higher from the 2017 tariffs? So, this is one big challenge where we need to convene ourselves up with other stakeholders and really find out what is the major impact of all those development that is already happening.

For the future, three to four years, at least till the time we have given ourselves a target for, how this increased generation from renewable energy will be utilized in the grid. One area where we are also advocating with the government, with the other stakeholders is how to get Discoms online to take this additional renewable energy. One bigger suggestion from our side is getting Discoms out of the trouble of the whole politics

about electricity in India and how Discoms can be made a market player rather than a political player in the hands of governments and States and central ministries. One thing by which this is largely possible is the way government has done in gas and they are now thinking about fertilizer is the direct benefit transfer, how they are doing that eligible consumers to be linked through digital payments mechanism and the intermediaries like the gas distributors or Discoms in power sector can they be avoided to fall into that value chain of managing those subsidies or those political ambitions which people will normally like to have in this basic value chain. So, a direct benefit transfer is one thing which we as a long-term stakeholder in the sector are actually advocating by which Discoms maybe actually spared of all this managing subsidies, and in a way, to improve themselves in terms of their financial health and be ready for this huge influx of power, huge challenge of tackling growth in electricity which Rahul just mentioned. While the estimations are there that the growth in electricity is paramount in India and it is it is going to happen but how will that be actually serviced? Are the Indian players like Discoms and private entities really ready to

actually service that huge growth in electricity that we are estimating?

And the other thing is this is the one part where Discoms are in the picture and this is actually 90 percent of the picture where the additional generation capacity would obviously be dependent upon. The other 10% part I want to talk about is about the way the markets are changing now, the markets are trying to bypass Discoms and find their own consumers; the generators, the developers, the independent distributed generators like rooftop players or rooftop owners, how they are going to bypass Discoms and find their own market. The one big market that's visible is electricity vehicle, EVs that we call them and how we can club renewable energy targets without EV targets and make a suitable infrastructure possible with justifying business models, with good amount of participation from private and public both entities and club these targets of both the areas, both the sector's and work towards it rather than just focusing on challenges which needs to be tackled at the Discoms levels or the state government's level, how can this be integrated and we can just move quickly towards that. The



other big area in in that 10 percent category, is the open access customers. The open access customers, of course, they are high-level high-value paying customers of Discoms but their demands are growing and Discoms are not able to service them, there needs to be a space for them to actually source their power themselves. And in renewable energy developers at least, we are seeing lot of bigger players entering into this domain and finding their own customers wherever possible. The only challenge lies is how do we standardize their contracts in the open access category, different open access customers are demanding different types of clauses, contracts and this would actually not help in taking this particular sector with the growth targets that we want to have. So, this is one area where as bankers we would love to engage in standardizing the way people want to operate and make them more bankable, make them more economic, make them more justifying in terms of their economic sense. Thank you.

*Gagan:* Few things that Vikas mentioned right now, earlier on he mentioned the irony that it's the high tariff BPA's that seem to be risky, so you know, that sort of reaffirms my point but it's

the value of a piece of paper that says the buyer's gonna pay X rupees per unit is only worth its weight or more if the buyer's willing to buy it. And in a world where there's no obligation or there are carve outs, there are ways to escape that liability or that commitment, there will be a race to the bottom and that race to the bottom has negative connotations but one needs to sort of weigh it against what should be the actual rate of return one should expect. Now, it's great if one can expect a higher rate and you're operating in a market where a higher rate of return on your rupee is possible but in an open market with lots of players, very little barrier to entry, you will get to that normalized level.

Second thing that Vikas mentioned is the non-utility scale bit of the business. I mean, solar you can either build to sell to the Discom or you can build to sort of use it for yourself. When you look at Rooftop today in India, it is about 1 gig out of 12 or 13 gig of total solar, so that's less than 10%. The world average is something like 40% today. Australia, 90% of their solar is rooftop and that's really because of a unique condition where Australian retail energy prices are about double

triple what they are in the UK and US. But as I was telling Rahul earlier, that if you want to look at where we are today and where we need to be by 2022 to achieve our targets and I'm not fussed if we don't or not, as long as we get close, but if one needs to sort of get close to that, wind has to grow by 2x, utility scale solar has to grow by 5x but rooftop has to grow by 40x. So, you know when we talk about achieving the targets, rooftop to a certain extent is the key; we can't achieve them unless rooftop picks up.

*David:* Yeah. Let me just kind of just briefly comment on this. I wouldn't necessarily look to the rest of the world as revealing what the optimal balance is between Central Station and rooftop because, first of all, you've got these oddities in the tariff structure which persists so long as there's not too much erosion of the customer base and now in places where we're seeing that erosion, we're seeing the utilities fight back. And also, we have to remember that the politics of renewables are very very attractive and so there are a lot of places that have tariffs and support for renewables where when you take a step back, it doesn't actually make a lot of sense in terms of what's the most

cost-effective strategy but politically, it's very popular and local generation is even more popular. And so, I think when you think about this from an engineering point of view, I can't speak about the Indian in this situation, particularly when you look at this from an engineering point of view, it's actually still Central Station renewables that make the most sense at scale and so I just would have urge that we not overreact to the fact that the rest of the world in some senses may be over deployed rooftop and use that as a benchmark for India to try to do the same thing.

*Gagan:* So, I think my disk was that we're certainly at the bottom of where our peers are. Now, I'm not advocating a 90 percent or 40 percent but I think there's certainly some room,

*Rahul:* We're behind

*Gagan:* Yeah, we're behind on rooftop.

*Rahul:* So, I think the point about distortions and tariffs driving it is key because in India, you've got the C&I - the Commercial and Industrial, the so-called paying customers will be the first ones that go to rooftop as it scales or big scale

residential, which drives me crazy because you have, in some states, 30 percent capital subsidy for residential rooftop, so you're subsidizing the rich which is what you're doing which doesn't make sense.

*David:* Well, we should watch C&I customers on many fronts, not only because they have the scale of demand and professional operations to be able to do their own self generation but what we've seen in the California market is they are also the early adopters of on-site battery systems, now that's because of the tariff structure of what I'm going to call demand charges and capacity charges. But when you think about the fundamental economics of the power grid, they point you in the direction of demand charges or capacity charges, so that's actually a kind of revealing fundamental behaviour and it's the C&I customers that have been the earliest adopters of these on-site battery systems. So, it doesn't allow them to become independent of the grid but it does create a huge risk to the traditional utility that's making a lot of money usually pass through but a lot of money around charging demand charges that then are now in play because of these battery systems, in my view, it's actually a

more interesting development now than the spread of renewable power because it's been so quick and so phenomenal.

*Rahul*: So, I think that alludes to the next sort of general point. You talked about renewables and a lot of other transitions in this space coming at the edges, you want to bypass the Discom is one sort of phrase, you want to sell not necessarily to one but directly hook your RE to the central transmission unit, the CTU, well, that only scales up to a point. So, one of the fundamental questions that starts academic but then becomes very real very quickly is at what point does that break because you're not just chipping away at the edges, your fundamental core could get hollow at some point if your paying customers go to one way, I mean at the rooftop example, the extreme end is called uberization, for lack of better term, Uber is not the most popular company to use for that example but it's disruption from the edge and in some cases, enabled by digital and we can fight it but it's already there. So, you mentioned that open access some 10% that number was in play but if you step back and look at the numbers, in Maharashtra according to one Praia study, even a couple of years ago, 50

percent plus of the units sold were actually sold higher than solar and so if you look at HT consumers - the high-tension, the big consumers - they're a small number of players and yet they're 40 to 60% in many states of units that are eligible to exit the traditional system, in fact, de facto can. Its other issues, like you said, carve-outs, there's all these other mechanisms that are resistant. Is it just that we're fighting a battle where the dams are leaking and we're just putting our fingers in or is it going to be a slow and controlled transition or at some point, do you think things will snap?

*Gagan:* If I can just sort of point to a few things that have sort of driven the renewable energy boom or whatever word you want to use, we already talked about the tariff. Now, you know, for every developer or seller, there's a buyer at the end of it, so if tariffs hadn't fallen, there would be no buyers for it, so if we park that aside. There's also been certain measures that the government is taking; solar parks, central offtake, infrastructure investment trusts, which actually have an impact beyond just solar. So, these are clear measures that have sort of benefited solar and renewables. Going forward in terms of

what I see the bottlenecks are, in terms of what might hold back renewables, the funding definitely is a bottleneck. I mean, today we have about 6 lakh crores which is about \$90 billion of exposure by the Indian banking system to power. In order to get to the targets, and again as I mentioned, I'm not really home to the targets...

*Rahul:* So, is that RE or total power?

*Gagan:* Total, 90 billion dollars, billion with a 'b' exposure to the power sector by domestic Indian banks. So, if you are talking about increasing from 50 to 175, you're looking at a number which is almost equal to that, a bit short. There is just not enough Headroom in the Indian banking system to absorb that much additional exposure both from an absolute perspective as well as concentration risk. So, clearly, the money to get to 175 or whatever that number is gonna be, has to come from overseas, there's no way out of it. And the way that capital is gonna come is, in my view, the primary development risk is always going to be financed by Indian banks because the bond market does not like development risk or execution risk and typically, the model that I see evolving is Indian banks finance primary execution



development risk and the bond market, whether it's a local bond market solution or overseas bond market, does the take out and that money is then recycled in the Indian banking system and this carries on and on and on. So, that clearly is the way forward and I think the infit structure which allows companies to upstream cash without paying a dividend distribution tax is a great way to sort of work around it.

*David:* Can you comment just for a moment on whether you think the international bond market will be able to absorb the currency risk?

*Gagan:* The quantum of currency risk that's an interesting point but in terms of how bond markets... well, you know, \$90 billion of rupee risk if that's what you're talking about, yeah. So, it's not gonna be just the overseas bond market, the Indian bond market also has to take its share as well as what I would call 'private debt funds', so the bond market was a loose term for pools of money that are not channelled through the banking system but direct to the investor. But having said that, I think the offset here is compared to other infrastructure. I honestly

believe that renewables, if done right, offers a far far lower risk perspective than other infra.

*David:* Can I make two comments on this?

*Gagan:* Sure.

*David:* First, what assign that the revolution has happened that we expect conventional power projects to require a higher return than renewable projects, that this is a sign that really the world has changed and so that's some sense that's pretty extraordinary because I think most people not so long ago would have modelled this in the opposite way, so that's pretty incredible. To me, look I think this question of how much rupee risk can be absorbed as it scales up is a very very important question and people should be doing some work on it and maybe some of that should be done in an open setting where we could help at Brookings India. To me, the issue for these renewable projects that's really important over the long term is the credibility of whatever the counterparty arrangement is. So, somebody asked will the system break? I can imagine Discos breaking and so on but the role of the wires remains fundamental

and so presumably, if there aren't big errors made along the way, some mechanism will continue to be there and assembled to keep the wires in place and to value that because the value of the grid is incredibly high, even for all these distributed systems and so on, the value of the grid interconnection is, you know, for a whole range of reasons that people understand, the value of the grid is where the real pivotal value is. If there's one thing I would watch very closely, is what happens as more renewables are not dispatched. So, the question: who pays for that which has not, we've seen in lots of different markets, that not really contemplated very well in the classic PPA but as the share goes up, especially if you have grid congestion and so on, you're gonna have renewables output that's not being paid for and so if there isn't a way to either socialize that risk or somehow credibly cover that risk, then you could see the expectations around risk, not so much execution risk because operational risk in these projects go up a lot, and that could be you know hundreds of bases points.

*Rahul*: I mean, in California there is a mechanism, and we've been talking to them to try understand how to adapt it for

India, where they have to spell out curtailment whether it's technical or economic and break it down by the operator side, local or grid scale, where was the congestion and what. Because as of now, we don't have the data on what's even happening at the lower levels of the Indian grid, forget the curtailment level and there's a lot of disputes; now is it just a commercial dispute between both ends or their policy frameworks to manage that.

*David:* But it would be important to look at multiple markets - Hawaii is another example, the European markets - it seems to me that when we as analysts start looking at this, we have a tendency to focus on the knobs and how do we turn this knob and how do we turn that knob and so on, I'm glad somebody's paying attention to the knobs but what really matters is the credibility ultimately of whoever's guaranteeing the payment structure. And so, I would I would focus more on the credibility and less on the knobs.

*Vikas:* Exactly and I think this is where I wanted to bring this point about Discoms, how they're going to tackle their challenges and while central government can do as much by

bringing in schemes like [Hudey] which has been there for more than two years now, there seems to be not the clarity on how operational efficiencies have been built in there to take care of the future or avoiding the future losses as we can see. So, the breakage point, as you Rahul mentioned, is going to be how the transition of this business shift from Discoms to the open access or you say the bypassing of Discoms happens and if it is slow, if it is thoughtful, I think there will not be any breakage point because there will be business models around it where Discoms can manage themselves up and as well as cater to this big stream of consumers who want good quality of electricity available either through Discoms or through open access and still managed to a bigger chunk of retail consumers which are there in the state, of course, as you mentioned. The rest of the 50 percent in Maharashtra, can they service them at a profitable level and just think about how they can improve on their efficiencies in managing them?

*Rahul*: One of the mechanisms that's been used to handle open access, forget before the renewables, has just been to talk of cross-subsidy surcharges, wheeling charges and all of these. On

the other hand, current policies talk of waivers of all of that for renewables, so the question is: how long can that work? I want to come back to this more broader transition that you mentioned, surprising changes whether it's through maturity or just this time is different with renewables worldwide, like the risk levels can actually be lower. But traditionally, people have said that let's have energy markets for electricity once you're mature, so capacity versus energy markets is one sort of a designed debate and there's pros and cons. But if we just think of energy markets for a second, two things sort of strike you; one is renewables have a zero-marginal cost, so if that's your signalling, then you're gonna be driving prices down very often very much.

And second, how do you actually incentivize the growth, which is what India still actually needs. So, if we use a framework that says renewables can price cheaper than coal, the numbers you quoted were compared to the average power procurement cost but if I look at the marginal power procurement cost and now your question of what's your next incremental, David, which is coal in India's mid merit. I mean, coal is your

mid merit in India because we don't have gas sufficient, the US uses gas for merit load following. Variable cost of coal is not 3.5 rupees, on all India basis it's closer to two rupees plus or minus, varies by location because railways is your big differentiator. So, compared to a pit head where you maybe 11.2 rupees variable cost, renewables seem to be a world away. So, if I'm a Discom and I have to have this coal plant because there's no battery at least in the near term, so I have to have the coal plant because other than the bell curve of solar's output, I know I need something else. Now, I have to pay them, in the middle of the day, my PLF just falls and not just PLF but my efficiency of my plant can even fall because of the increased RE, then my decision-making, do I want more RE, looks very different if I'm trying to decide who to dispatch versus who to set a contract up with to buy another power plant, that's a problem that I don't think has been solved. I mean, US is in a very different place because it's got sufficient capacity relatively speaking, while India's in a growth rate to some extent.

*David:* There are a lot of moving parts there, Rahul, so we talked about some parts of it. First of all, the United States is a diverse country and so in the Southwest and the Northeast, it's gas at the margin, in the Upper Midwest, there are many nuclear plants at the margins, in the Southeast, it's coal at the margin, which is one of the reasons why there's some various research showing that electric vehicles in the Southeast under some conditions actually raise emissions not lower emissions because you're powering them at the margin with coal. And so, what's really at the margin has an impact and it's just a reminder that if our goal is emissions not just greenhouse gas emissions but emissions of all kinds of pollutants and so on, if our goal is emissions, the more work we do in this area, the more important it is for us to focus on policy instruments that target the emissions. I think the lesson in most of the world around these liquid markets for power has been exactly what you alluded to, which is we need separate markets for power and for capacity. It's possible to run a pure power market and if you have a lot of backbone to allow the pure power market to get the right signals, this is done in Texas for example, but there's a lot of Cowboys in Texas and a lot of things happen in Texas that



can't happen in the rest of the world where they have a pure power market and every once in a while, power prices rise up into the stratosphere and more than every once in a while, they go negative and so there are now people trading in the pure power market and generating outcomes that are actually pretty reliable with lots of wind and lots of coal and now merchant storage, that's very hard to make work in most of the world's. I think for most of the world, I can't speak about the Indian situation, the lesson has been we need to think about capacity and the ancillary services as separate distinct markets from the kind of pure short time pull power. You were about to say something, Gagan

*Gagan:* Yeah, I think two points you made, David, on emissions and let's say diverse market. If you look at the split or the pie chart of the emissions in India, you know, the source of emissions, about 38 percent of it comes from electricity, seven percent of it comes from vehicles, so almost half of what you see outside is coming from electricity and vehicles. Now, imagine a world where you had 100 percent renewables, you know, when storage came around etc. etc., became cheap and by the way,

I'm a big believer that storage costs are gonna surprise us in terms of how fast they come down because storage always needed, and it's the other point you were making, always needed renewable capacity to make sense in a certain way, otherwise, you are just shifting emissions from the tailpipe to the chimney, right, on a macro level it just didn't make sense. So, storage follows, I think, renewable energy; the more renewable energy capacity that you have on the ground generating, the more storage will be attractive and that's just going to create a virtuous cycle of storage costs coming down faster than we expect. So, that's clearly from an emissions point of view, from a storage point of view, there's a lot of merit in looking at renewable energy.

The second point you were making was the diversity of the US market and Vikas also talked about the Discoms. In India, we have 25 odd States, give or take, and we have...

*Rahul*: 29 actually

*Gagan*: 29 or something like that, I stopped counting, and we have more than 40 Discoms, that's a lot of Discoms for any investor to sort of get their head around, let alone a foreign

investor. The second point is the creditworthiness of these state Discoms is also a kind of a bridge too far I'd call it, because the central government does come out with something called an 'integrated rating booklet' for state Discoms but if you read the fine print, and those numbers look very fancy - A plus B plus C C triple C, whatever have you - they look very appealing and seductive but it's not credit risk because credit risk is the assessment of probability of repaying your financial obligations via an assessment of probability of default, that is what credit risk is. These alphabets that have been assigned are actually called gradings and these are gradings of the financial and operational health of these Discoms. So, once it's gone a long way in helping us understand what lies beneath these Discoms, it's not yet good enough for an investor who's sitting overseas to say "well, you know, 100 million bucks for XYZ Discoms" or PPA which has XYZ Discoms underlining. So, that diversity is a bit of a hindrance here in India where I don't really see a deep market for pure Discoms PPA's from overseas, so clearly the bond market we're talking about earlier, those dollars are gonna primarily flow into PPAs which at least have

an NTPC or the MBBN or a Seki in between to give that added layer of comfort, you know.

*Vikas:* So, this grading you mentioned is actually based on a two to three years old financial result?

*Rahul:* So, I mean, again if I want to put words in your mouth or take it too far maybe, is on average the system can't handle that because you've got 78 or whatever a number of Discoms in play, but is it that obviously NTPC's investment grade and certain other players are investment grade, so it's on the back of their balance sheets that really, we're seeing this action. But then, at what point does that run out till you start actually hitting the next layer, is sort of one of the big questions to meeting these targets.

*Gagan:* Yeah, you know, as I talked about earlier, when you talk about a PPA and the kind of revenue stream that underlines that PPA, it's got two elements; one is does the PPA ensure that my product goes out the door? The second element is once that product goes out the door, will I get paid? The PPAs today do not ensure the first part, yes, there are sort of consequences

for not continuously up taking the power but that consequence is an event of default. I mean, what good is an event of default for me as a developer? It doesn't really help me. So, it's the price for the tariff that works to the benefit of ensuring that product goes out the door but the security or surety of my payment is actually governed by a tripartite agreement between the central government and various state governments which dictates, and I haven't seen that tripartite agreement I'll be honest, I don't think too many people have, but the belief is that it works very well in penalizing states who refuse to pay for power that they have sort of taken in that central grants of an equal amount, I think, are withheld. So, that system of guaranteeing that payments for power once taken comes in the door, is an important leg in sort of why certain investors view the NTPC and [NSEC PPAs] to be more valuable than the Discoms PPAs. And I've thought about this, I don't think it's an additional risk that's put on to NTPC balance sheet because at the end of the day, it's not NTPC that's forking out the money, it's the central government which is withholding the grants. So, there's no really incentive for a state government to not pay for power when it knows that if it doesn't pay for a hundred

bucks, a hundred bucks is gonna be withheld, you know, there's no basis.

*Rahul*: Remains to be seen. I mean, politically, with elections and all these. So, I want to change a little of the format because we have a lot of hands I've seen, a lot of comments and questions but we also have some people I would like to reach out to to say a few words and then we'll come back to the panel for both final thoughts as well as the point about suggestions; what's missing, it's very easy to say what's wrong but now let's look at what's right or what we can do, so we'll want to close with that.

Thank you very much.

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