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Panel Discussion

India Energy Outlook 2021:
A Special Focus on Coal, Natural Gas and The Transition

Centre for Social and Economic Progress (CSEP)

New Delhi

Monday, July 5th, 2021

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Watch the event video here: https://www.youtube.com/watch?v=DjQrrGWGwIo

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PROCEEDINGS

Rahul Tongia: Welcome everyone. Good afternoon. And, on behalf of The Center for Social and Economic Progress, CSEP, it is my distinct pleasure to welcome our distinguished panelists, to have a very important discussion on one segment of the energy transition in India, which focuses on certain fossil fuels, gas and coal. And we are building this webinar discussion upon the India energy outlook recently released by the IEA for which we have one of the lead authors from the IEA joining us, Peter Zeniewski.

We also have with us Mr. Seethapathy Chander, who's a longtime energy expert. He was one of the early persons at NPTC, served on their board. He was the ADB energy lead, and still serves on many boards. And he's a long hand in both the technology side, but also the business side and finance sides of all energy, but especially the large energies.

And we also have Swati Dsouza who is an expert in many aspects of the energy transition. Maybe I should be bold to say all aspects of the energy transition. And we hope to have a very deep and sort of forward-looking discussion without being speculative.

There will be time for hopefully a lot of questions and answers from folks. I would encourage everyone to please type in their questions. We will then be combining them as appropriate and sharing them and trying to go through these.

And I want to first request all my panelists to just share some opening remarks on this question. Before we do that, I just want to set the context a little bit. As you know, there is a decarbonization transition that is worldwide in different countries at different places. Now, in addition to decarbonization, we have transitions of other types ongoing as well in the country. We have digitalization, we have transformation of market systems. There's a lot of change going on. People seem to remember or focus on decarbonization and the rise of renewables only. But from an India perspective, we have the old workhorse which has been coal. We have a potential new entrant, natural gas. We have of course, an already entrant renewable energy, which in the electricity sector, especially has made very large inroads. From a percentage share, renewables are still only about 10% and rising of the electricity mix on a generation basis. But if we look at the investments, if we look at where the growth is, it is virtually entirely renewable energy.

And then of course there are ambitions towards hydrogen for which used to be called the fuel of the future. That is no longer necessarily the case. It is now upon us. And hydrogen's role is very important when we think beyond the power sector. In the power sector, renewables have a clear pathway for certain industrial and chemical processes. Electricity is not sufficient. So, if you look at a developing country like India, where there's a need for steel and cement, one of the questions becomes what does that look like? And in fact, that was one of the highlights of the IEA report. I'm sure Peter will share a few remarks on that aspect.

We at CSEP have done very deep dives on a number of these issues. Last year, we had released a book on the future of coal in India, "Smooth Transition of Bumpy Road Ahead." The book has been well received. And we really found out that in addition to the sheer availability or typical supply demand pricing sort of lenses for coal, there is an important political economy aspect of coal in the country. Many people think about just jobs, sort of fossil fuel jobs has been a concern worldwide. In India, the embeddedness of coal is much deeper for certain coal bearing regions, there's a financial aspect, but there's also deep linkages to the Indian railways.

We have recently finished a book which is dealing with the future of natural gas in India. It's called "The Next Stop", edited by our chairman, Vikram Singh Mehta. And it is available online. It has not been formally launched yet due to some delays, logistical as people can imagine. And this book on gas is very interesting because, unlike the work on coal, which was both prospective or forward-looking but also historical, with gas, there's a deep understanding of the rapid potential transition. As we know, the Government of India had announced a plan to make gas about 15% of the energy mix, from the at the time of announcement about six and a half percent share that natural gas had.

And so, for natural gas, many countries view it as a bridge fuel, that it's the cleanest of some of the fossil fuels, and therefore we use that until we go for purely green sources, whether it's a renewable energy or green hydrogen.

And the question for India is, is that feasible? Is that practical? Is that appropriate on both economics ground, but even on a carbonization ground? Because natural gas is not fossil free, it is much cleaner than coal from a fossil perspective and non-fossil pollution perspective. But reaching such a high share if one were to achieve this by 2030, would imply an enormously aggressive growth rate of natural gas. One of the issues that India has, unlike, for example, the UK or the United States is, where is the natural gas, the inexpensive natural gas?

So, from an Indian perspective, a lot of the marginal or incremental natural gas has been imported LNG. And so, it's been not as cost competitive. You also have of course, issues of infrastructure, taxation, and other things that I'm sure we will discuss amongst our panel.

So, we have four sort of fuels in the mix, so to speak. I am not discounting hydro or nuclear by any stretch. But these four, especially coal and gas and their interplay with the others are some of our focus today. And the issue, isn't just, how fast can you grow anyone, but also how much do you blend and synergize with existing ones? Because it's not as if one can scale overnight. So, this issue of time constant is very, very critical for large infrastructure. (A) how long it takes to build it? (B) how long these are expected to last versus how long are we allowing them to last?

And so, with these sorts of brief thoughts, I now would like to welcome Peter to set the stage. IEA has launched this report several months ago, and they've already done several discussion sessions on some of the high-level findings. We hope to dig a little deeper into this sector in particular. Peter, over to you please.

Peter Zeniewski: Thank you very much Rahul, and thanks for the invitation to the session. So, I'm very pleased to be here today to share some of these key findings with you. And that was a great scene setter, Rahul. So, I hope that I'll be able to sort of go into a little bit of depth on some of the points that you raised. So, can everyone see my screen and hear me, okay? I hope so?

Yes? So, I'm just going to use two scenarios to illustrate the key differences in coal and gas demand over the next sort of 20 years. So, you might know that in the IEA, in the world energy outlook team, we have our stated policy scenario, which reflects more or less today's targets in so far as they're backed by detailed implementation and support policies. And we also have our SDS or Sustainable Development Scenario, which works backwards to reach the goals of the Paris Agreement and meets a lot of UN SDGs along the way. So, energy access goals are met, the negative health impacts from air pollution are avoided and so on.

And so, we have projections out to 2040, but there's a high degree of relevance here to the longer-term focus on net zero. So, in the SDS, India reaches net zero emissions by the mid-2060s, but its emissions overall peak much sooner, so, before 2030 in this scenario. And clearly there's a lot of

uncertainty there, but we try and explore these through our use of scenarios, which aren't forecasts, they just tell sort of coherent, internally consistent story lines about where the energy sector could evolve.

So, with that in mind, let's maybe just first consider the fuels in the context of India's overall energy mix. So, as Rahul pointed out, all this investment is going into modern renewables, and so that really underpins growth in India over the next two decades. And a lot of that is for the power sector, and it really is underpinned by this massive expansion of urbanization and industrialization that happens in India over the next two decades.

So, just as an illustration, the urban population swells to well over an additional 300 million people. That's like adding 13 Mumbais over the next two decades; floor space doubles and so on. So, there's a huge increase in steel and cement demand. But really what you see here is that modern renewables have growth in the power sector covered. The vast majority of new investments are made in that sector.

So, you can see as well that, of course oil plays a big role, and that's driven by 300 million additional vehicles sort of purchased over the next 20 years. And we hear a lot about electrification, especially for two to three wheelers, but this is less, less prominent a penetration in passenger cars or trucks. So, we still see a huge amount of demand grow for internal combustion engines, and the results is a 4 million barrel per day rise in oil demand. And that makes India the largest growth market for oil worldwide in this scenario.

Now, if we consider coal, there's quite an interesting shift going on here. Because, over the last three decades or so, almost three quarters of the growth in coal demand went to power generation. But this time it's dramatically different. Growth slows in power and gets concentrated much more into industry. And that's iron and steel and cement and other industries that fall back on coal.

If we look at natural gas, the picture is broadly the same as is the split of industries. So, gas has start to play an increasingly important role for India's future in the stated policy scenario. And there's big targets and ambitions as Rahul said, that make gas an increasingly important fuel, not just in industry, but in city gas distribution. So, that's smaller scale industrial demand is met by gas and there's also a considerable growth in gas demand for transportation.

Now, there's other fields of course, nuclear as was mentioned, and we also see in the state of policy scenario, a drop in traditional biomass. So that's a fuel used for cooking that gets displaced by LPG, by natural gas as well and by electricity. But still, by 2040, there's still around 500 million people in India that still rely on this traditional source of energy for cooking and other sort of household uses.

Now, this is the picture in steps as we call it. What happens in SDS? The Sustainable Development Scenario, that's where India achieves universal access to clean cooking by 2030, it reduces air pollution and peaks its emissions. And you can see already, there's quite a different picture here for coal. There's a huge reallocation of capital towards modern renewables. So, they become even more prominent in the investment landscape.

And you see that natural gas doesn't change very much. And we'll get into the reasons why in a few minutes. But what's important here is that all these targets are met. So, the 450-gigawatt target is actually exceeded by 40%. There's a huge amount of additional solar and wind coming on to the system. And that starts to really put pressure on coal and gas, well, coal, especially in this scenario.

Now, all this sounds great for gas, in SDS, there's still quite a significant growth. But before we get there, we need to think about the affordability argument. And that along with a domestic supply base

that hasn't been able to keep pace with demand growth. These are the two biggest problems facing gas in India today. There's a lot of other things going on that we can unpack in the discussion, but I just wanted to focus here on price. Because the important factors determining the price of gas in India are not just the sort of market fundamentals, if there are any, it's more about the mix of imported versus domestic supply. Domestic supply, being a regulated commodity. Government administered allocation policies have traditionally reserved domestic gas for specific customer categories.

So, you see here that what we've done is we've kind of, dis-aggregated the price of gas paid by all the different segments of users in India just to see what they pay. So, this is very much a bottom-up assessment sector by sector, technology by technology, and also state by state, because there's a patchwork of different tariffs and taxes applied to gas across India.

And so, what you see is these red bands and the brown band are the competing fuels that are used in these sectors. Now, it's not always an easy one to one switch here, but you can already see that a lot of the gas that gets used today is actually potentially less affordable than alternative uses. And that's particularly the case in the power sector, which has very much struggled. Gas plants are now stranded, a lot of them they're distressed assets, so it's making it very difficult for gas to make inroads into the power sector. But elsewhere, there could be some upside as you see there, the transport component. There's a lot of taxes applied to petrol and diesel. So, there is a scope for growth in gas in the transport industry.

So, let's look more closely at the impact of gas on emissions in both STEPS and SDS. So, as we know, gas is often seen as this transition fuel and a bridge to low carbon future. And so, there's a lot going on in this chart, because we decomposed all the fuels and technologies to understand the drivers of growth in demand, and then considered what the impact on emissions are. So, in the STEP scenario, gas grows by 150 BCM over the next two decades. So that's solid growth. And a lot of that is pure market growth, meaning gas connects to new factories, buildings and so on. But there's also emissions reductions going on here because the role of gas also means existing customers switch away from coal, they switch away from oil and they ended up using gas instead. And this avoids emission. So, we can see that as a credit to gas to help avoid emissions from switching. But still, the overall net change here, which is that orange dot for steps is higher than it is today. So, we see an additional, a hundred million tons of CO_2 as a result of the growth in gas demand.

Now, what about the SDS? The SDS actually has higher natural gas demand. And what you see there is actually the net effect of lowering emissions. Why is that? Because we see that switching is a much more prominent role of the growth in gas. You see that gas steps into much greater extent to lower coal use and oil as well, oil product use for raising heat in industry. And so, you see higher efficiency, gas plants coming online, you see an investment in CCOs and hydrogen production and much greater rollout of low carbon variants like biomethane and bioCNG. So, that leads to a net effect of lowering CO_2 emissions.

So, it really depends what gas is being used for to understand how it might actually contribute to emissions reductions, in addition, of course, to the improvements in air quality from that large scale rollout of gas.

So, let's sort of look at the flip side to this and understand how changes in coal demand come about in our scenarios. So, if we think about our starting point, the coal inputs to the Indian power sector are the fifth largest single category of energy sector CO_2 emissions globally. So, there are sorts of poor air quality and mandates to improve this, have a patchy record of implementation.

So, three quarters of India's existing coal power plants are subcritical units, low efficiency units and the production targets for India are very much very bullish, very ambitious. But that's becoming more and more difficult to reconcile with the other targets going on. The 450-gigawatt target, the evolving energy priorities in India, particularly in terms of local air pollution and emissions as a whole.

And so, what we see in the Sustainable Development Scenario is that you see a huge decrease in coal demand relative to what we might see in STEPS. And the drivers for that are really reducing emissions from existing power plants. So, you see those wedges there that are split into reductions in subcritical, supercritical, and ultra-supercritical units, play a huge role in getting India down to a trajectory consistent with the Paris agreement targets.

So, of course that's a difficult challenge, assuming today's level of utilization, we have 50 years left on a lot of these coal plants and they would emit 25 gigatons of CO2, and that's equivalent to about half of India's cumulative emissions in the SDS. So, avoiding that locked in stock of emissions is very challenging, both financially and logistically. And obviously relies on a range of policy tools to address.

So, I'll stop there just to give you that brief context overall and hand it back to Rahul. And hopefully we can chat about these dynamics a bit further in the Q&A.

Rahul Tongia: Thank you, Peter. And we definitely need to understand because, well, one, of course, its large numbers, large volumes, so even small shifts add up and make a very big difference. Before I turn over to Swati, I just want to make one quick observation that's relevant. You mentioned, for example, there's so many people relying on biomass both today and in the STEPS. I think it's important both for coal and biomass to understand capacity versus utilization. Because in the biomass case, many of them now have access to cleaner modern cooking fuels. But the problem is that the utilization rate of these has not been as expected. So, for example, LPG cylinder refills has not been sufficient. So, there still use of biomass.

Similarly, with coal power plants, you're showing the energy side in your slides. So, capacity of coal is one of the questions that we can really get into because coal is still useful as a “firm source of power” and renewables are by far the cheapest new build, only when they are considered as VRE, Variable Renewable Energy. That's true for India. It's probably true for the rest of the world. Maybe you can share some insights, you or Seethapathy have some insights. But we're not quite there yet on battery prices, so to speak. And so, even if we do, we still don't dynamite the existing coal plants. I mean, there are countries which into mothballs / dynamite their coal fleet. For India, with a growing demand. I think the first point is can we at least reduce or plateau or peak some of these before trying to get them to zero? Because I think this push to zero is somewhat confusing if not distracting from steps to really get there.

Swati, you have been managing, co-editing this large study that CSEP has finished on natural gas in India. And you've also been thinking a lot on transition issues, beyond just finance, but all aspects. So, maybe I could request you in your opening remarks to give some thoughts on some of these topics.

Swati Dsouza: Thank you, Rahul. Good evening to everyone. So, I don't have a presentation. I'm just going to raise a couple of points based on Peter's presentation and IEA outlook, as well as the gas book that CSEP has come out with in the recent past. So, one, I thought what was particularly interesting in the India Energy Outlook was the bottom-up tracking of gas in different sectors. Because, one of the main arguments that natural gas in India has had over the last decade or more is the traditional chicken and egg situation. **[Inaudible 00:24:30]** we put up infrastructure? This has been sort of the area where everyone has been conversing around. With the recent reforms, with the idea of 15% target, the supply side issues have started coming down.

But then again, the key question comes. Where is the demand? What we've seen, to my mind, how India differs from other countries is the fact that we don't have large anchor consumers or even going forward. The idea of gas having a large anchor consumer is something that we will need to rethink our strategy. Why? Because in almost every country, gas is essentially used in power generation and heating. In India, we don't have heating. In power generation, it's a losing game given the LNG prices and given the fact that we have regulated tariffs on the demand side.

So, then what is the next sector that we can think about? Fertilizers. But then again, fertilizer demand will grow to an extent, but it will not grow beyond that extent. So, what we did in the book was (A) we tried to identify what sectors demand can come up from. And (B) what are the steps that we need to take from a policy perspective to get to this? Some of the sectors that we identified were essentially city gas distribution, transport and industries. Even in industries, we focused our study more on the MSME side rather than the big industries. So, if you look at steel expansion, there's a lot of conversation about natural gas in steel processes. But if we think about a strategy and expansion, if you're looking at another 150 million tons, about 50 to 80 will come from waste to heat processes. Another 40 to 50 will come from blast furnace itself. And the change that will happen will happen on the DRI side of the steel sector. So, then we thought, okay, we haven't done this...

Rahul Tongia: This is by what timeframe? Sorry.

Swati Dsouza: This is by 2030. There's a national steel policy by 2030. And then if you break it down into the industry, as well as the kind of technology, this is the broad approximate split that you end up getting.

So, then we thought, "We have a large informal market and MSMEs contribute a significant chunk of revenues to India. So, how do we think about transitioning in that sector?" From a policy perspective, what we realized was, supply is a problem. Yes. But information, there's a lot of knowledge gap that is there in the MSME sector that needs to be filled in. Margins are wafer thin, so, how do you deal with that? Can we think of bringing gas under the GST?

Now to do that, we decided to go approach it from the taxation perspective. And we realized oil and gas actually doesn't contribute a significant chunk to the states checkered the way it's currently structured. So, what we decided was we compared it to different fuels and we realized that if we bring gas under the 5% bracket, it will actually help competing with a lot of the fuels in the MSME sector, particularly when we are looking at NAFTA and fuel oil.

And it is something that actually can be done, because unlike petrol and diesel, which contribute close about 35-40% to state revenues, natural gas has about 2% to 3% share in the entire state revenue. And there's a good idea that this will increase once the gas prices actually come down.

The other sector was transport and CGD. Now, the thing with CGD is there's a government push to increase the gas penetration in the country using the city gas distribution network. To that end, there is some movement. For example, we've seen since FY14 to a FY20, the share of gas consumption in CGD has gone up to 30% from about 11%. From an energy perspective, given that we have gas in the non-energy sectors, it has gone up again from 19% to 30%.

So, there is considerable demand coming up in the city gas distribution sector. Price is again something that is helping this. I mean, if any of us have a PNG connection, we know how much cheaper it is to an LPG connection, particularly given the volatility in oil prices. What actually is a bit worrying is the fact that, expanding your PNG network may not help in the financial solvability of the companies, because

without having transport demand that underpins the PNG network. Many of these countries may not be financially solvent going forward. So, we need that transport demand.

Okay, so then when we think about transport demand, there's CNG, and there is also LNG for long distance freight. Now, LNG long distance freight is something that we've been speaking about in the last two to three years. We've seen examples of it and there is conversation about setting the infrastructure, at least between the Delhi-Mumbai industrial corridor. Because, again, the Western side of it has great pipeline. But to actually end up achieving that, there's going to be some amount of conflict between the companies that have already been allotted the land and the rights under the bidding situation and the companies that are actually going to be setting up the LNG pipeline.

There's also the question of the fact that most of your CNG demand right now comes from buses in almost every major city in India. And a lot of these buses are been shifted to electric, again, to compliment with the industry electric policies.

So, there is some question on how much transport demands actually going to come. And the question is not how much demand but whether this demand and the prices that the revenues that the companies will get out of this demand will be enough to fund their expansion project on the infrastructure side? That is basically the key question that is one of the things that's being raised by the book. So, I think on the gas side, these are some of my brief comments.

Rahul, I think, will take up the entire transitions issue probably in the discussion because, is that okay?

Rahul Tongia: Yes, of course. Thank you. And sorry to interrupt you. There was just a clarification needed on the timeline. Because, if someone says "I'm going to double it." Sure...

Swati Dsouza: No. This is a National Steel Policy of 2017. And it's about you're doubling almost your capacity. And that's enshrined, again, in the document.

Raul Tongia: Absolutely. Because time frames matter for much of this. If I could now request Seethapathy to just share his opening remarks. You've seen of course, energy use plans, long-term plans across many countries around the world. You have a unique, both India insights as well as global. If you could just share your opening remarks,

Seethapathy Chander: Thank you, Rahul. Good evening everybody. And I'm grateful to the organizers for giving me this opportunity. Coming in last, of course, much of the content has already been shared and commented upon. I'll just be brief and comment about what I think has been covered very few really or not covered.

Broadly, the discussion centers around renewable versus hydrocarbon, but as Peter pointed out, Swati has pointed out, there's also intersect between hydrocarbons, there is a contest or a competition in the application. So, we discussed coal versus gas, primarily in the power sector, maybe a bit in the fertilizer and cement and steel as well. Oil versus gas primarily again in the transportation and chemical sector. But we have not discussed coal versus coal. That is something we need to focus upon in the Indian context. And I take the example of both Japan and China as being examples, one, which has done it in a very steady manner. That's Japan. And one which did it in a very, let's say quick manner, but very effective manner. And that's China.

So, let me explain myself. See, we talk about substituting something with another in theory. That's fine. The issue then becomes one of transition. How do we manage and keep the finances and the marketplace running while this transition takes place? But in the case of coal, what we forget is, as Peter pointed out, much of our generation stock is pretty old. And it's essentially kept running for

employment considerations, or I would say wrong notions of employment considerations. So, there is nothing stopping us from acting like what Japan has done through the market, market mechanism of retiring plants well before anybody else. If you see the life cycle of Japanese plant retirement, it's much before any other country. Or China, which when it went on to a coal adding spree in the early 2000s, they stopped licensing subcritical and inefficient plants, and actually remove them by fiat

So, everybody talks about the 200,000 or 250,000 megawatts that China added in the 2000's, but they forget about talking about the 60,000, 70,000. 100,000 megawatts pulled out of the system, which were inefficient. So, if you crack the energy intensity of electricity generation using coal plants in China, you'll find that there is a sudden increase in the efficiency in this period. Unfortunately, India has not done that. Our planning mindset was essentially how do I extend existing plants to get more out of the capital investment I've already made? And this was very important because all of our electricity boards were cash strap. And cash strap for what? Again, it was a policy issue. They were by design, cash strap.

So, I leave it there. So, even today, we have a lot to save. We can save a lot of carbon emissions if we allow the so called now stranded assets which have come into the market recently to be allowed to go into the market and sort off by Fiat, takeout the inefficient plants, which today have an efficiency of around something like 27% to 30%. There's a huge stock we have. Just 27 to 30, which is operating still, I mean, off and on in the system, not very reliably, but it's there. So, that's one major issue I had.

The second thing is when we say, let's say, substitution of fuels, we have to also look at the energy efficiency of the process. Substituting today's energy efficiency is not good enough. When you substitute, you must also think "I'm adding new capital expansion. I'm adding new plants, so, I must get something which is going to be at the forefront of technology for that particular application over the next 10, 20 years." Otherwise, you will end up with, again, the problem of standard assets in that industry, not the power sector, but in that industry, which we are investing in. This is something people forget.

The third is, I think we've come to the political economy. Why did India rely on coal or why did China rely on coal? It's because this was a domestic fuel. They didn't have to pay hard currency or foreign exchange for it. It was cheaper to a large extent as compared with other fuels at that point in time using technologies of that time. And the cost was essentially built up with the government's own taxes. The government gains a lot on taxes, and Swati, you mentioned this briefly. Going forward, if you're going to completely remove coal from our mix, and just going into the extreme. We are not going to do that very soon. But suppose let's say, two years from now, India's coal consumption goes down to zero, certain states are going to be extremely badly hit. And they are actually the poorer states in India. So, I don't think from this point of view, also, it's going to be an easy transition. Something that, I mean, we tend not to speak off. Let's put it that way.

There are some other technical issues in the operations, and I just want to bring one or two. I'm not going to go into detail. Yes, gas-fired combined cycle power plants, they are highly efficient. 64-65% operate a big technology, compare to coal at say 44-45% at best. But they are extremely intolerant to variability. The moment you take them off from what they call the mean continuous rating, the efficiency of CC gas plant drops much faster than the efficiency of a coal plant deviating from its NCR rating. So, we have to look at that when we are talking about marrying them with renewables. Again, we have to look at what is it that we are getting out of that gas plant as compared with what is it that we are shifting? So, that's another thing that we must look.

Nuclear, again, an option. Do you want to look at it? Not look at it? Various countries have looked at it differently. I would say it makes results. I wouldn't support entirely, let's say for example, Germany is

opt-out of nuclear, for good reason because they produce perhaps the best plants. So, you lost some of the best suppliers in the process. But that's part of the game. So, back to India, given that it is a fuel importer, both for oil and natural gas, but it should be some kind of general understanding that if we are reducing coal usage, we should look at the nuclear option once more. I'm not saying build extensively or anything like that, but it's something that we are not discussing on the table as if it's something not to be discussed.

Finally, if you are to increase the renewable energy component and generate green ammonia and green hydrogen, there is a necessity to invest in newer technologies.

Unfortunately, again, like EVs where we missed the bus by not investing heavily in the technology development, they are doing the same thing with green hydrogen. We have been speaking about green hydrogen and green ammonia for the last, I think four or five years, but I haven't seen any plant or investment of any significance. Even where we think that it can make some sense. So, I think if we decide yes, green hydrogen is the way forward, it's the fuel of the future, we would like to see some kind of intensive discussion leading to investment in R&D pilot plants, the whole ecosystem. Otherwise, by the time we build an ecosystem, it's going to be, I think you will have to build up your poll stocks again. Once you build up your poll stocks, your specifics for 15, 20 years, anyway, as a minimum, because you're not going to wash away that capital expenditure.

So, in summary, I would say, yes, we should decrease, our carbon emissions. The way forward has been indicated. There are several plans which work towards it, and I am fully for it. Don't mistake me. But there is a need to consider how we transit out of coal because access is an important issue, such as sustainability is an important issue. I mean, financial and supply side constraints. So, there are issues, there are real ones. Let's think of how we get going forward. So, I would stop here and then really come back during these questions. Thank you.

Raul Tongia: Thank you very much. You've flagged the point that I'll have to push, not push back on, but try and ask you to elaborate on. But I just wanted to share how I thought we could have this discussion is there are a few up questions from your remarks, but also some pre-prepared questions that we had shared earlier. We will try and cover those in about half an hour, leaving us around 15 minutes for audience question and answer. So, folks joining us online, please do type out some of your queries.

Now, you flagged a very interesting point on coal versus coal. This is not discussed nearly enough because everyone sort of looks to the ultimate end state. And that really brings me to the heart of this question. The pathways. Everyone agrees that the end state looks like zero carbon, but does that end state take us from where we are or is there a side highway maybe that we have to get onto before we can actually get to the truly zero?

So, opening sort of question to everyone in place. Very few of these are directed to anyone in particular. Is there an appetite in there politically or financially to really do what China did, which is sort of say, we'll give one more round of ultra-efficient coal power plants cleaner, more flexible capable, or is it just that in India, there is a temporary so-called surplus of coal capacity? The plant factors have fallen dramatically? Your flip that you didn't mention is while we have some power plants that are inefficient, we also have underutilized more efficient power plants, especially the newer ones disproportionately owned by the private sector. There's a contracting issue there.

So, in a scenario where you've got a so-called surplus, I mean, let's not debate how much, how long it would last, et cetera, but there is a surplus in the capacity side of coal. This includes of course, keeping your older ones alive to get to that surplus point. So, in such a scenario, what would be the ability

appetite or sanity in saying, let us not just have graceful retirements but aggressive retirements. But if you go aggressive, then you would need to also perhaps add more coal or do you foresee that you won't ever need to add coal except maybe of course, the under construction around 42 gigawatts or plus, or minus that is already under construction? So, talks towards this. I mean, this is a key trillion rupees question.

Swati Dsouza: Peter, do you want to take this?

Peter Zeniewski: Well, I can just kick us off, but by just saying that, certainly for coal it's a complex issue by any stretch of the imagination to consider the sort of inter competition between the more efficient and the less efficient units. I mean, the way that we approach this when we model India, so we have an hourly power sector model, it gives us information about the run times of various units. And clearly there is an emission saving and just an overall sort of efficiency saving in using those higher efficiency units as often as you can.

I think the problem is of course, the market design issue that you have these power purchase agreements that - it's been 10, 15 years since a wholesale market was notionally created, but the amount of volumes traded on that market are still relatively small. There's not a lot of great deal of interconnections between states, things are still led with different stakeholder interests in mind. And so, sort of cleaning up that entire sort of sector might allow for greater efficiencies to come through, not just on which coal plants run and when, but just the overall sort of dispatching of plant assets across the country. So, I think that's a worthy goal to pursue. And at the IEA, we look at that in quite some detail, especially as sort of renewable integration challenges come to the fore.

And then on the coal side specifically, we looked at this from the point of view of whether plants can be retrofitted, repurposed or retired early, and clearly the most economic pain is incurred when you retire a plant early before its economic lifetime. But in fact, in our scenario, only a relatively small part of the overall coal fleet could be subjected to that. The rest of them could in fact, repurpose or retrofit, depending on sort of plant-by-plant conditions. So, that's something that needs to be done holistically with the value chain approach to each plant. But certainly, something that could be explored as a way of sort of easing the pain on that end. But I'll stop there and let others chime in,

Rahul Tongia: But just politically, globally, how would the world react if India says "We're going to use coal for finite period and reinvest in the sector." Now, that's where one would have to look at a marginal baseman curves equivalent, or some technique to say this is worth it or not. But economics is one part, but funding and political economy and political acceptance is another. Would that even fly or would the argument counter be given well, let's push renewables on one side and natural gas would be the other option above and beyond this point?

Peter Zeniewski: Sorry. I don't know Rahul if that's for everyone, but just one interesting part of this discussion is, is that natural gas, there's no guarantee that gas will be heavily supported by the international financial community either over the next several sort of years. We've already seen early signs that there's more scrutiny of their environmental performance and so on. So, it's a challenge, not just for coal, but also for gas to raise the finance that you need.

And so, we just released a report on financing, clean energy transitions across the sort of emerging market and developing economies. But found that, for natural gas, 90% of debt financing has come from countries outside of developing markets for big gas projects, for LNG and re-gasification projects and so on. And that's not a guaranteed flow of finance in the future by any stretch. So, that's something that I think investors also need to be aware of there's no guarantee that capital will be forthcoming for gas either.

Rahul Tongia: Swati, can you share a little more about sort of gas in your plan? I think, one of the other things that would be interesting and important for India to consider is outside the power sector. In the power sector, there is a much clearer pathway. And your own report of course, Peter emphasizes that as one of the key findings is a lot of the emissions growth is going to be outside the power sector because growth of fossil investment has slowed down dramatically in the power sector.

Swati, are we there yet in the sense-? Peter, your slide on the prices versus demand by each of those five sectors was I think very, very telling. At one extreme, if it's worthwhile people would go to gas, but clearly that's not the case entirely. So, Swati, is it an issue of just policy support or is it just the fundamentals, the economics, or what else is happening or can happen or could happen?

Swati Dsouza: So, I'll just make a point in continuation to what Peter was saying and also to tie in with what you're asking me right now. It's true that financing for coal and gas is going to be very, very difficult going forward. But India has recently signed, I think there are 10 oil and gas companies, multinational oil and gas companies that have actually signed the MoU and are entering the Indian market in the last two or three years. So, clearly these companies see India as a growth market. One way to look at it would be to say that, okay, because they anticipate that demand going forward in the global north is going to start diminishing or declining, and which is why they're expanding their market in Asia and not just in India, but also in Pakistan and several other countries in the Asian region.

But there is also considerable pressure from investors. The recent Dutch judgment where Shell was given a judgment by the Dutch high court is an interesting perspective. So, while these companies may have money, it's going to be about whether their own investors and shareholders allow them to invest that money in the gas supply chain. Typically, it takes about at least 25 to 30 years is a gestation period, particularly given the heavy capital-intensive nature of the infrastructure in the sector for you to start recouping your returns. And also given the fact that certain demand sectors in India are still regulated. So, the prices essentially mean that your ideal 25-year discounted period is actually 35 or 40 years, when you take into account, the actual returns you'll get from something like that.

But the flip side of this coin is India is going to require, Rahul, some amount of fossil fuels. I mean, you look at 2,500 terawatt hours by 2030, you think about 3,500 to 4,500 terawatt hours by 2050. Even if you account for battery storage and for hydrogen, there is still going to be some amount of demand that has to be fulfilled either by gas or by coal. And given the fact that we actually can mine coal domestically, and even gas domestically, to an extent. It's going to be interesting to see whether we go down. Personally, to my mind, I think given the fact that we've not mentioned gas in any of our policies, barring transport, barring PNG, compressed natural gas, compressed bio gas, now the recent announcement. So, in sectorial approach, given transport, given residential cooking, and to some extent, which in industries, there is no stated policy that we are looking at gas consumption anywhere else.

So, given that, I think the other option is we will come back to coal. If not, in a big way, the way we expanded between 2009 and 2014. it will be in some small capacities going forward. That's my personal take on this.

In terms of sector and in terms of prices, this was something that I had alluded to earlier. So, something that came out of the book was, it takes about 1.5 trillion rupees to set up a CGD network capacity of 1.5 mm-cmd. How you're going to recuperate this because your PNG prices are barely a factor. It takes about 33,000 to set up one PNG connection. And the return you get on that is probably 300 or 600 rupees. I mean, these are approximate ranges. These are not exact figures. These are approximate ranges. So, take that.

So, given this rather large approximate ranges, then where is your money going to come from? Transport, yes, is one potential sector. But the only reason transport is that, is because your oil and gas is still not under GST. That is, petrol and diesel is still not under GST. The day we decide to actually homogenize petrol and diesel under GST, natural gas loses that advantage against petrol and diesel. Let us also assume that for the next five years, we are not going to put petrol and diesel under GST, we are going to keep them as it is. But five years is not the kind of gestation period we need to recoup our investments on gas. We need at least 25 years. So, what this essentially tells you is that for the next 25 years, more or less petrol and diesel is not coming under GST, if gas investment by companies needs to get its returns. That is the sort of the problem with leveraging yourself just on one sector.

The other side is industry. You know, one of the challenges that we found when we were speaking to MSME sector and players, so your oil and marketing companies have two or three different arms. So, your NAFTA liquid, LSE, all of that is one arm, petrol and diesel is your other arm. And there is a third arm, which is also doing natural gas business. So, these things sort of compete with each other. And if your gas distributor decides to sell you gas at a certain price, it doesn't take too long for your ONC to undercut them on the NAFTA or the fuel oil side, because the maximum amount of revenues that they earn is from petrol and diesel.

So, until we don't control the revenues on the petrol and diesel side, it's going to be very difficult, again for natural gas to start competing with other fuels in the MSME side. Like without giving numbers, I'm just trying to explain the complex political economy of substituting natural gas with other liquid fuels. Because what we realize is it's not substituting coal in the power sector, that is something that actually in your paper itself in the gas book that spoke about this. We're looking at low volumes, high prices in case we decide to go ahead and implement time of day prices. But without that, it's very, very difficult in the power sector. So, therefore, your competition is only liquid fuels, which is what the IEA study also ends up showing.

But then, as a very intense and complex political economy when we're looking at the substitution. It's not just an infrastructure game. It's not just the traditional old "Will I get supply?" But it's also a little bit about changing mindsets and behaviors and actually implementing your regulation. So, the dirty air quality act that has come into place by the NGP in the NCR region. How much of that is actually followed it? There is still diesel oil being used in the NCR region where the monitoring is the highest given the entire noise that comes about during your smoke season as I call it. So, I'm just going to stop over you with these.

Rahul Tongia: Thank you, Swati. You've raised a lot of flags. I mean, obviously enforcement and following through on policies is a key one. And I think you've teed up the ball very nicely for a future discussion we'll be having on the gas book when it is formally launched. So, there's much more on gas that can be discussed.

But stepping back, I mean, in some ways, gas fixes. If we talk of transitions, they are two types of usage of growth. One is a substitution side of it, which is in some ways, much harder. But you've also got an organic growth that may or may not happen. So, I'm going to start with an open question maybe to Seethapathy and Peter global lens as well from their experiences. Is it just the economics in the sense that if something is cheaper than coal, we would have switched to it? So, renewables have grown, not just because India wants to be green, but it's also because it makes sense. Today, the prices for solar, India has the lowest CapEx costs of solar projects in the world. Higher interest rates actually are the reason it's per kilowatt hour prices are not absolutely the lowest, but they're still very aggressively, low.

So, as we get better finance, and this is where that finance threat comes in, is there a premium that will not just remain, but grow to certain alternatives to the equilibrium? And the current equilibrium to me includes RE in the electricity sector.

So, you mentioned about the hydrogen, where are we towards that pathway, which is a longer-term pathway? So, the question becomes (A), how much do we see the premium? So, in the power sector to get rid, rid of coal means I need cheap batteries or cheap storage of some kind. That's not necessarily there yet. So, how long do we see that away? And the flip question from that is should India just wait in the sense, continue what we're doing in the state of the art, with the current trajectory, and then ride the global wave? Because, if you look at batteries, it's a global wave that's going to determine the prices, not inherently India's policies.

Seethapathy Chander: Okay. Can I take the...?

Rahul Tongia: Please do.

Seethapathy Chander: Two quick comments on the past question of coal versus coal. First, if you look at the capacity that can be decommission, 27% efficiency plants that can be decommissioned without affecting our energy, it's quite easy. About 50,000 megawatts hardly contributes anything to our energy. It's just, what do you call plate listed capacity. If I may say so. Much of it doesn't run. If it runs in fits and starts. This is largely there as an employment thing that people don't want to do...

Rahul Tongia: Chander, one question. If you're saying at one end that they're not used much, like their contribution is modest, but then their emissions and pollution are also going to be modest?

Seethapathy Chander: Yes. Correct. But then we are having a nameplate rating counted in our calculations. See, so that's a problem. And they have fix and starts, which makes the bigger plants difficult to operate in this regime. When I have a plant that operates say two days or three days a week, and then shuts down again, I'm just giving an extreme example.

A more efficient plant cannot have a flat run. So, that makes it very difficult, both for the efficient plant and of course for the regulators. Because one is financially cheaper than the other. By financially cheaper, because it's 30 years old. Its capital costs have been completely written down. So, when it runs, it runs at 1.63 rupees per kilowatt hour, when it runs. The fact that it hardly runs doesn't matter. I mean, that's part of a political equation. Okay. That's number one

Number two. Why did we go into this cheap and cheap regime? It's because of our entire fixers, we felt somehow that tariffs would be unaffordable increases. Okay. That's another reason, but it's now coming to haunt us again.

If you look at captive generation units, let's say for the aluminum plants, the steel plants, railways, they are all subcritical because they have these small sides. You can't have a backup plan more than say 100 megawatts, 150 megawatts, 60 megawatts that varies. Okay, 250 is the best that we have as a captive.

Now, we are giving flat load because these are 24 hours, three shifts, flat industries. Because they wanted to avoid the financial charge of subsidies on the general supply. So, what we have done is we have given an inverted load demand to some of our less efficient units as compared to the most efficient units, which are now having to back down to accommodate these units because it's a financial problem.

So, we have a market issue to solve yet also, which is fundamentally focused on tariffs. Basically, if we don't want a tariff change, nothing is going to help. Okay. I can almost say for as a given. So, if someone wants to change the tariff regime, yes, we can do many things. So, just two quick points on coal-

Now comes CNG as a fuel for other means like transportation. They have been investing quite heavily now, or we have plans to invest quite heavily on the electric part of the business. Again, we could have invested a little earlier, but we chose not to. They said, when technology is better developed, we will apply it. That's it.

Now, when we say we come back to the old argument again, as to why was coal preferred over oil and natural gas. Because it's a domestic fuel. It's an indigenous fuel. No foreign exchange output. But, instead of having foreign exchange outgo on your commodity purchases, if you have foreign exchange outgo on your capital purchases, it makes the same thing.

Today, if you look at our solar panels, we are dependent on China for about 85% to 90% of our panels. They come from China. So, what happens? Your substituted and import source like oil or natural gas with a capital outgo on your panels. The same thing is going to happen on batteries. The same thing will happen on hydrogen. If we don't believe that at least we can contribute. And I don't think it's impossible for India to at least contribute towards development of this. We may not make any breakthrough technology innovations or what have you, but at least we should have some degree of indigenous capability that we avoid this.

So, I think we are heading towards a situation where if we rapidly expand our RE production, want to rapidly expand our battery storage issues and rapidly expand our hydrogen at some future point in time, we are going to end up with a huge foreign exchange capital problem rather than an import of fuels. And I can almost foresee that the decision-makers would be veering towards the easy way out of purchasing cheaper hydrocarbon fuels rather than going for very expensive high technology investments.

Coming back to why was our solar program so successful as an RE, was because it's distributed. You did not require a lump sum, large capital at any one go, like a big power plant or a big gas turbine unit. You didn't need 500, 600 million at once. It was a series of small, small investments, 40 million, 50 million like that, even for the utility scale plants. It's only now after 10 years that we are really touching the biggest things. And in the first period, you have to remember the government actually under wrote subsidies. We started off with substituting rupees per kilowatt hour, when coal fire generation was at three rupees per kilowatt hour. But, because the government said, "Yes, I will pay." But as capacity expends, as many countries are found out, which includes Germany, include Spain, includes many other countries, you can't keep subsidizing forever. There is a limit to it. Your finances will not take it. So, I think that's another scheme that we have to carefully consider.

The only way out is, give some reasonable assurance that they will be a domestic contribution towards these technologies, then the application time comes in the big picture. Thank you very much.

Rahul Tongia: So, I'll leave it as a rhetorical question. Is there a premium, and how much and for how long? But Peter for you, maybe I could make it non-rhetorical?

Peter Zeniewski: No. I think it's an excellent point, and harks back to the affordability issue, for gas and why coal has done so well. As you said, it's an indigenous relatively cheap, non-dollar denominated. So. all those factors come into play.

And if we think back to 2010, 2012, when you had Krishna Godavari, and the big expectations for gas was that there would be this domestic supply to fall back on and to grow the market. And that just didn't materialize at scale. And you saw the response on the demand side, demand just plateaued, fell back and has fallen behind ever since. So, these fundamentals are really underpinning where the future is taking us.

And at the IEA we often say, of course, if there's a policy push for gas for its air quality benefits, for its ability to balance renewables, to play those kinds of roles, if that's recognized and remunerated, then you have a different story ahead. But the trouble is of course, what do you do when you're facing these large-scale investments, needed? And to what extent do you subsidize, if you're confident in the large-scale deployment of solar, if you think that there could just be this coal plus renewables sort of role in the future that could, that could muscle out gas!

So, these are the kinds of sensitivities that we've explored to see what level of premium gas could be before you start to think that it's maybe not a viable route to meet the goals that you set for yourself.

So, in our scenarios, it comes out pretty clearly that gas can play a role in the SDS. Now, if we extend, extend the time horizon, and if we think about net zero that could come about sooner, then the role for gas, your horizon shortens quite considerably and the investments you make today, there's a bigger question mark, over whether, or which ones are viable. And then you need to start thinking about, is the infrastructure I'm building, is that hydrogen ready? Is it amenable to bioenergy to using feedstocks to develop biomethane and so on and so forth?

So, there's all those new considerations that come into play. I see Rahul, you've got your hand up. So, I'll stop there and let you follow up.

Rahul Tongia: Well, this is the key question because financial lifespan to physical lifespan are often decoupled or very, very different. So, from affordability, as well as just general financial prudence, you want to extend the life or use as much as you can. So, gas infrastructure in the west, it wasn't built for 25 years. It was built for much, much longer. I mean, typically how long would you ideally want infrastructure to be built for?

Peter Zeniewski: Yes. So, if we look back to the example of when they discovered the growing gas fields in the Netherlands. They thought to themselves, "How do we build a market around that?" And they're the ones that sort of pioneered this early approach with oil indexation, because they were trying to get rid of oil products in their residential sector. But what they had in front them was, as Swati said before, that the anchor customers that they could sort of latch on to all that infrastructure development onto, and that was a captive customer base, was an entirely different market model back then. If you have a liberalized market model now, and you're trying to push gas into the mix without necessarily having that monopoly role that you can play, it could be seen as a lot more difficult to amortize those long-lived assets in any amount of time.

And I think that's what's interesting to me when I was looking at these CGD developers, their utilities, it's a whole range of companies involved in the sector. How are they structuring it so that they can see that payback period to come through before the whole sort of existential threat of potentially removing gas from the system becomes a factor.

And currently, there's reasonable comfort that gas can play a role, that its life extends to 2050 and possibly beyond. But if that whole timetable changes, then the whole economic calculation might change. And I don't have an answer for when that could happen. So, I'll push it to, to the others to let us all know.

Rahul Tongia: I think last question before we open up for some of the audience. Swati, you had flagged this, especially, which is the demand side of it. It's not just a supply issue. If you build it, they will come. Now, let's put our hat on as if we're - I mean, Seethapathy, you had talked about, for example, the captives. So, these are really where you find hard data or mindset on demand. So, what should an industry do? If I'm setting up a new plant, if everyone just says, “Oh, this technology is just around the

corner." So, green hydrogen is being touted. I mean, are they demean? Are they waiting? Are they paying a premium? Or is gas sort of the accepted alternative? And so, I think some of the issue is uncertainty, not just regulatory or policy uncertainty, but just markets and economics, uncertainty in lifespans. And I mean, this is a problem that the renewable sector has faced. When solar was 15 rupees, then it became 13, 11 and kept falling, so the competition of renewables is not just with coal, but with future renewables. Because if I'm a state and I've got contracts that are five, seven rupees, a kilowatt hour, and yet there are people saying, "Hey, it should only be two, two and a half or less." Then, that itself is a concern.

Any thoughts towards this sort of an issue? Please? You are muted.

Swati Dsouza: No. I think Mr. Chander wants to make a point. Sir, do you wanted to go first?

Seethapathy Chander: Okay. I just wanted to say that the commoditization of electricity has had some benefits. It's also given us some problems, which nobody has sort of put back and try to resolve.

I give you an example, not from India let me go to Europe because the forefront of this kind of study. If I was in Austria today, and Austria is a great place for hydropower plants. If I wanted to build a hydro power plant in Austria today to let's say supply additional load demand that there is there, okay, it might be cheap, but I would never be able to get finance for it. The reason is people will be looking at it as if we can earn a return in three years or five years, not in 40 years, which it can last. That's because the trading has made everything so commoditized. That's the same thing with this kind of mentality to say, "I have a PPA at five rupees. The current prices two rupees or two and a half rupees. Why should I honor that PPA?"

The reason is people have been sort of taught to think that today's price is the same as the price that was given when the risks was different and the market was different. That's a competition of yesteryear. You'll have to honor it. Otherwise, there's no market. Finally, you will end up by breaking the whole market if this kind of thought process goes on.

The second is, at some point, our markets do not capture the externals. The external benefits. And one of them is environment benefits. Okay. What it does is capture only the economic benefits, even if it was not distorted by taxes. And today it is, they started heavily by taxes and cross subsidies. So, we have to look at what is it that we want as a society? And if we want something longer term as a society, the society should factor in and make that investment. It might mean slightly higher prices. It might mean the government taxing differentially, which is it's doing anyway. So, we have to look at it as a composite goal of a society, otherwise there's no way they can do it. If you look at it as a commodity and look at today's trade prices, now actually they've extended it to day ahead, and hour head trading now, which makes it extremely difficult to manage any longer-term investments. So, it will then veer around to smaller and smaller scale investments of a big volume because then the risk goes down. But it doesn't mean that you're most suitable sort of supply capacity. So, I'll stop here. Thanks.

Rahul Tongia: Swati, you were going to...

Swati Dsouza: I think from an industry perspective, Rahul, it's not just about the technology, but I think it's a combination of policy and financing. To be quite honest, take the example of the automobile sector and think about it from their perspective. So, there is equal amount of push on electric vehicles. There is equal amount of push on BS6, the efficiency on fuels. There is equal amount of push to go towards CNG. Where do you end up investing that money? I mean, there's only a set forth of money. So, what is the opportunity cost that you have as an industry?

So, which is why I think it's not just about all like, which technology's better, but more about what will be the cost of capital for that particular technology? And what is going to be the policy support that I'm going to get for that technology? LNG in transport in freight is not something that's a pipe dream or is it still under experimentation the way hydrogen is, it's actually happening in markets like China and in Europe.

What stops that in India? I mean, we don't have a policy push that essentially gives companies the confidence going forward saying that, "Okay, we are going to support you in this particular timeline. So, why don't you start putting in money in this area?" It's the same thing with CNG versus EV, right? Where do you put your money in the assembly line at the end of the day?

I mean, can we think about actually, if we really want to increase the potential for gas in the country? Can we think about having some sort of debt financing schemes at least in industries where you know you want to take away the dirty fuel, you know, NAFTA, you know fuel oil is bad for you. So, can we then look at this particular sector and do a targeted focused exercise on how do you deal with this particular sector? You know that your biggest competitor over here is coal and you know it's fossil fuels. So, can we then have a combination of having the dirty fuels policy for example, which is only for the NCR region to have it across the country? So, that sort of pushes your state pollution control boards to start implementing pollution norms. That's one aspect of it. Coupled with that, then can we have something on the infrastructure? See, to my mind, I don't think the problem with infrastructure is that oil and gas companies have the money to invest in infrastructure, it's just that without an anchor consumer in demand, they don't know where it's at.

So, I'll just quickly wrap it because I'm seeing the timing. I think it's a combination of both policy, as well as financing mechanism that will actually help push demand or technology for gas at least in the fuel sectors.

Rahul Tongia: Thank you very much. We have a lot of questions. Some you've been gracious enough to type answers. I'll combine a few of them and just ask this point about carbon taxes. So, there are implicit carbon taxes in India like the poll says, and there are high taxes on liquid fuels drives the state finances. So, is that the way forward and by when or what does that look like? Or is it these focused supports? How do we see this playing out?

And the other flip side is, for prices to be meaningful, it would have to be quite high. Because a couple of dollars at times doesn't really change your crossovers or your equilibrium necessarily. I mean, it takes you up that curve that you've drawn Peter, but it's not going to take you all the way, Peter?

Peter Zeniewski: Sure. No one ever wants to answer about carbon prices at the IEA, because, it's a thorny subject at the best of times. And certainly, there is a sort of an elegance to it amongst economists to sort of say carbon pricing will sort out everything else because you'll get - if implemented and designed properly, you have a level playing field where different players can sort of choose to invest in the technologies that become the best ones and the most cost-effective ones.

But I just don't think that it's the pan Asia that a lot of observers think it is. Simply because you need all of this to be backed by very well-designed other policies related to. If you want to roll out solar or wind, you have to understand the variability aspects to it, the flexibility aspects, a lot of system planning is required to go into it, so, you know, you can't just sort of unleash a carbon price and hope that the market will start sort of valuing other aspects to these externalities involved beyond that. So, I mean, certainly it's part of a toolkit and in our scenarios, there's an implicit carbon price that grows quite substantially, especially in net zero. And what that does do is it reveals some of these sorts of

preferences for different technologies, depending on their cost curve and their marginal abatement performance and so on.

And it's essentially what needs to happen if we need to see change on the scale that we need to reach, those climate goals. So, it's certainly sort of part of that. But again, it's just part of a suite of other tools.

And certainly, in the case of India, it needs to be considered along those broader aspects, Rahul, that you've identified at the very start, that we're not just talking about energy or emissions or even air quality. We're talking about jobs and economic redistribution and so on, that all plays a part in planning and designing this responsibly and in a way that ensures a just transition. So, those are the sort of official lines to take on that currently.

Rahul Tongia: One day, we'll get an unofficial line as to it. But, to what extent might India look different than some of the other countries in the sense, some places are going to be, and should be perhaps more forward looking on the premium for CCS, Carbon Capture and Sequestration, or CCUS, utilization and sequestration. And one counter question just becomes, why should India be at the forefront of that? Because it is a premium for sure.

And similarly, there's a talk of, even that year report talks about growth of biofuels, bioethanol or bio-based, because you need certain fossil equivalent fuels for processes. And so, feedstock, just as one extreme example, it's very hard to get away from that.

And so, the counter to that also is land. Because for India land is a severe challenge. So, any thoughts on how India may, or should be different? Is it just that India has less burden because of its emissions historically being low, so, the deadlines that India should have to just be a little bit lower by which time the technologies would improve? Or is there something more fundamentally different about how India should look at this? Seethapathy or Peter or Swati, anyone?

Seethapathy Chander: Let Peter start, and then I would.

Peter Zeniewski: Yes. Oh, sorry. Yes, of course. I mean, briefly, your point about bioenergy is interesting because there's this huge amount of organic waste that could be put to productive use in India, and that's been long recognized. You know? There's a long legacy of using bio gas and bio energy in India. But we still see a huge scale up and growth possibilities.

And some of these challenges are the same as the challenges to get gas off the ground. They're infrastructural. They're, policy-related. They're about getting access to land and responsibly developing bioenergy supply chains and using sustainable feedstocks. Right? So, not just using energy crops that might compete with food production and so on.

And the co-benefits, I mean, it's wild. There's so much a benefit that you could get, reduced air quality, additional digest state, rural and economic development in the areas where you might see a decline in coal demanded, sustainable transitions, you could easily see a scale up in bioenergy.

So, there's those types of things that just need to be adequately sort of recognized and remunerated to get it off the ground. And I think that's what is a sort of key things is to see where your different resources can add value to the transition, not just that it imposes a burden on it. But I'll let Seethapathy correct me.

Seethapathy Chander: No, no, I think that's a good answer. See, there are two issues that we need to look at. One is, has somebody said correctly, the availability of land near cities given that much of the refuse is generated by the cities. Where the land is the scarcest are the most expensive. So that's one constraint.

And if you want to transport it to some off center, that's a transportation cost that you incur, which is probably more expensive than the fuel itself or the raw material itself. Something like Ash transportation power plant. So, that's fine.

The second is we have to be careful that any kind of technology or applications for generation which releases methane into the air is probably as damaging as recovering the waste. Simply because methane has a pollution intensity, which just 22 times that of carbon dioxide.

So, given these two constraints, I think it will never become mainstream, but it's a useful ad on, it's a useful supporter of all the anti-pollution sort of activities that we can think of. Yes, in small quantities, small packets like renewables, I think a lot of people will come forward to attempt it. But my suggestion would be better done in the smaller cities, or it will be probably more widespread in the smaller towns where it's rural interface, you'll get more and more combustible material also to supplement the bio waste fuel stock and therefore generate a higher percentage of methane than you can probably get in the cities. I'll stop there. Thank you.

Rahul Tongia: So, we've exhausted our time and let's set ourselves up for many discussions that need to be had. But for closing remarks or if you wish to add. I mean, we already know the easy answer, just fix the market distortions and everything will get better, but that's sort of a motherhood, apple pie, sort of a statement. It's easier said than done. It's a process. It's a journey that India is undertaking and it'll take some time. So, we know that for example, we need to not just remove distortions, but also introduce time based signaling so that we value the premium that cleaner or more flexible fuels have, et cetera. There are so many things that are reasonably well known, how we achieve them is a much different question.

What else should India really be thinking about or worry about, or take as the flip side as an opportunity? What is not discussed? Any sort of last thoughts if you have either a magic wand or a spare billion dollars in your pocket, or $10 billion.

Swati Dsouza: I think we need to start thinking about transition. Peter mentioned this, you mentioned this, Seethapathy has mentioned this multiple times. There is a very large number of people in this country who are dependent on fossil fuels. And it's there even in some of the questions that have come up on, both from an economic point of view, from a financial point of view, from a social and a cultural point of view.

Coal mining in India has been happening for 200 years. Assam from about 1800's or early 1900's. So, at the end of the day, the problem is not just large governments, but it's an individual also. It's about changing that mindset. It's about trying to say, "Okay, Hey, gas is good or renewables is better. Yes. It's going to eat into your margins". How do you stop that from eating into their margins is something that governments have to answer. But the, the idea that, "Oh, can I think about transitioning?", is something that an individual will have to think about. And that is where I think it's as much a people's problem, as much as it is a larger problem. Those are my last thoughts.

Rahul Tongia: I mean, we would need a whole separate discussion on the transition issues.

Swati Dsouza: Absolutely. I just thought that it's something that we've not touched upon the fact that this is not just a capital problem, or a finance problem, but it's the people struggle at the end of the day. Like, what do you do about these billions? And we are 1.3 billion. What do we do about so many people who are employed in the sector who depend on the sector?

Rahul Tongia: I mean, so Germany had the funds to buy them out. Essentially the answer for their transition and the workers has been throw money at the problem. And it's not clear that such money

is available. Would the international community step up, Peter? Would they? I mean, that South Africa's plan anyways.

Peter Zeniewski: Yes. No, indeed. And I think that's one of the risks that we identify in our financing report is of course the cost of capital is higher, it's more difficult to sponsor bankable energy projects in developing markets. So, you have all those structural issues that you need to sort out. And then of course you have this huge ESG sort of movement, which could potentially crowd out investment. As we talked about earlier, more efficient coal, or potentially a company that has a different starting point for its ESG targets than these more sort of other companies elsewhere.

So, I think that, we need to reflect on in the run-up to 2026. How do we sort of sort out these issues? Because I think that's one of the central parts of getting this whole transition globally on the right track is by pushing more money into emerging markets where the cost of emissions - we calculated this at $5 per ton on average, across the, across the spectrum, which is nothing compared to having to build these advanced hydrogen networks in Germany. We can easily funnel that money into better uses in the emerging world and have all those co-benefits in there as well. So, that's one of our mandates is to push for that.

Seethapathy Chander: I would like to mention two things. One is that India is not one gray mass. There are very situational things that can happen. For example, in the cities, if you choose to enforce laws in the cities that are different from, let's say non-cities, because that's where the concentration of pollution and usage of fossil fuels for certain things like transportation is, I don't think people will mind. Because, there's very little impact of the production part of the oil or coal industry in the cities. They look at their own pollution problems, their own medical problems as a consequence of pollution. And I think you'll get support, as has been seen in the cases in Delhi, Bangalore, Mumbai and so on. So, that's a substantial amount of population. I mean, you don't want to think of the 1.2 billion. You can definitely think of the 100 million, 200 million that are covered by these large metropolitans. So, that's number one.

Number two, I think more important than big investments or big-ticket investments is to see that there is a path way forward by looking at technologies that can be looked at as being feasible or applicable or not applicable. And let's see the seeds of such thought. My main worry about this hydrogen business is not that people are not talking about it, or people don't know anything about it. Frankly, it's not rocket science right now. The fact is no Indian large energy company has invested. I'm not saying coming forward to investment because everybody is making announcements now. The question is, has anybody even put in say 50 million into it in a pilot project? Answer is no. That worries me, because we are now getting back to where we were in EVs, about four or five years ago. We made the same noises, but at the end of the day, nobody invested in real research and development on developing anything in the EV sector**.**

We had a problem with imports. I mean, imports mean people bet against imports in general. I mean saying, "Oh, domestic is important and so on." Then we changed our laws to make it more globally applicable. And now we are getting investments in the EV space. So, there is also a time, but we have lost three, four years of precious time where we could have influenced the industry rather than be a follower. I think that's something that we have to look at.

Rahul Tongia: I think this is a wonderful observation that ties everything together is the pathway isn't going to be just one. It's going to be a portfolio approach to use your phrase, Peter. But also, there's a risk to just relying on the big bang, 100-billion-dollar sort of scale. Eventually you'll get there, but

whether you get there with just a couple or a lot of more distributed organic and sort of competing almost in some ways, is an important thing.

Because investments of a certain scale are much easier. Because if you say I need a $10 billion investment to actually be somewhere, perhaps that's true in some global sense, but then you're down to just a handful of entities who could be doing it in India. A couple of the government entities, entities as CIL, Reliance, I mean, there's a handful only at this stage. And so, that's a very different world. So, that is one takeaway for this larger transition.

The second point that I've also learned is we need to have many more such conversations because there's so many points that have been flagged. I'll push back slightly as my closing sort of thought is it may be very cheap on a dollars per ton, CO2 abatement cost to invest in developing countries, we absolutely must do it, but that shouldn't be counted as the benefit of the developed country because you're then writing someone else's curve. Because if you look at long tail sort of theories, then who's going to take care of the tail out of the developing country? Time is not going to be enough. So, there's a whole series of discussions and planning that need to be heard. That's a topic for another day. We will be having more discussions on natural gas as we formally launch and showcase some of the findings from our natural gas work.

But I want to thank you for joining me for this discussion and everyone who's joined us online and later on for a series of continuing questions, India has grand ambition plans towards the transition. It has done remarkably well in many niches. The question is, do we have the, not just the vision, but the steps of execution that are really needed to take us there. So, thank you very much again, to our panelists and everyone joining us.

Seethapathy Chander: Thank you.

Peter Zeniewski: Thank you very much.

Swati Dsouza: Thank you so much.