

WORLD SUSTAINABLE DEVELOPMENT SUMMIT 2021

**REDEFINING OUR
COMMON FUTURE:
SAFE AND SECURE
ENVIRONMENT FOR ALL**

February 10-12, 2021
New Delhi, India



Executive Summary
Second Virtual Sustainable Action Dialogue

World Sustainable Development Summit 2021

21 July 2020

Energy Transition Webinar

The World Sustainable Development Summit (WSDS) is the annual flagship event of The Energy and Resources Institute (TERI). Instituted in 2001, the Summit series has marked 20 years in its journey of making 'sustainable development' a globally shared goal.

Given the current global health crisis and its close inter-linkages with climate impact, the WSDS 2021 will be held under the umbrella theme of 'Redefining Our Common Future: Safe and Secure Environment for All'. Discussions at the platform will focus on the current crisis and the roadmap that nations need to adopt enroute a greener recovery. Through a series of virtual dialogues between now and February 2021. The first virtual dialogue was held on the eve of the World Environment Day - June 4, 2020. The occasion also marked the launch of a very special initiative underlining the role of youth, 'Youth Unite for a Safe and Secure Environment for All'.

The second in the Virtual Dialogues Series was hosted on the theme of 'energy transition' with a focus on the Indian power sector in collaboration with the Energy Transitions Commission (ETC) India on July 21, 2020.

*The occasion also marked the release of reports on 'Renewable Power Pathways: Modelling the Integration of Wind and Solar in India by 2030' & 'Bending the Curve: 2025 Forecasts for Electricity Demand by Sector and State in the Light of the COVID Epidemic' in the presence of chief guest - **Mr R K Singh**, Hon'ble Minister of State (IC), Power and New & Renewable Energy & Minister of State, Skill Development and Entrepreneurship, Government of India; **Mr Sanjiv Nandan Sahai**, Secretary, Ministry of Power, Government of India **Lord Adair Turner**, Chair, Energy Transitions Commission.*

*The keynote statements were followed by a panel discussion featuring - **Ms Neerja Mathur**, Former Chairperson, CEA and the former member of the Electricity Regulatory Commission; **Mr Sumant Sinha**, Chairman & Managing Director, RenewPower; **Mr David Turk**, Acting Deputy Executive Director, International Energy Agency; **Mr Mohit Bhargava**, Executive Director, NTPC. The Institute was represented by Director General – **Dr Ajay Mathur** and Senior Director, Communication Outreach and Advocacy Division - **Dr Annapurna Vancheswaran**.*

Dr Annapurna Vancheswaran opened the session proceedings with a presentation on the Summit series. Thank you and good afternoon. This webinar is the second pre-event that is being hosted in the run-up to WSDS 2021. The Summit series has marked 20 years in its journey and over the past 20 years, the Summit has brought together several luminaries to speak on this platform. As we all know that this is the annual flagship event of the Institute and we are pleased to host this discussion on energy transition at this platform. Many of you do of course know that the Summit platform was initiated for focussing on regional challenges of the developing world; the platform promotes exchange of knowledge, encourage initiatives which are collaborative and collective and weave partnerships across sectors. We have, as I mentioned, had a plethora of luminaries, heads of states and governments, on a platform that was initiated by a non-government organization. Given the current global health crisis, we have picked a theme this year which is reflective of the current circumstances - 'Redefining Our Common Future: Safe and Secure Environment for All'. It encompasses all the issues that we need to look at and discuss from now till February 2021. WSDS which usually is hosted in the month of February every year, will sport similar content at WSDS 2021 too but may employ a hybrid format a combination of virtual and on-site engagements. There will of course be plenaries, and business exclusive sessions as well as an e-expo; instead of an on-ground expo. There shall also be on-line thematic tracks. Major focus will be laid on the role of women and a wide series of discussion will be hosted addressing the theme, 'Women on The Rise: Redefining Our Common Future' these discussions will help underline the role women are and can play in rebuilding our economy. Youth shall continue to be an important segment of the Summit proceedings representing the most dynamic and vibrant segment of our population. We wish to take their valued thoughts, ideas and innovations and encourage them and incorporate those in an on-going policy dialogue. These virtual dialogues are building blocks for the Summit's deliberations and play a crucial role in helping us engage with multiple stakeholders. There is a slew of themes that we have short-listed as we move towards February 2021. WSDS 2021 is positioned at a very crucial point. Businesses, countries, and civil societies that will come together at WSDS 2021 will help us collate an action programme through their deliberations. Discussion points from the above interactions will be collated as a Charter of Actions which will serve as a reference document for a variety of stakeholders. Thus, in a nutshell - deliberations of WSDS 2021, which will be held

in February, will contribute to discussions of COP26 and will then be followed-up again at WSDS 2022. The approach and reach of the Summit platform will help bring closer national and international networks driving home the point that action now is imperative. Hence, we have in these pandemic times brought together a series of actions that can take us post-pandemic which is from February 2021 to February 2022. So, thank you very much and we do look forward to all of you joining us in these deliberations as we move ahead. Thank you.

Dr Ajay Mathur focussed on the kind of structural changes seen in the electricity sector thus far and the changes that are expected in the coming 5-10 years. The capacity to supply electricity in the country today; is way more than the economic demand. Quite different from what it was - every home today is electrified. Even in rural areas homes are connected to electricity. Energy efficiency now accounts for something like 5% of savings. So much so that the 5% savings and the 5% growth in the last year we saw almost no increase in the electricity demand.

The important issue is that under the current leadership we will be able to mainstream it into economic activities of the country. It has also been witnessed that between 2015 and 2020, the number of variable renewables - solar and wind have gone up from less than 5% in 2015 to more than 10% in 2020. With focus on implementation, we have changed the very nature and very structure of the dynamics. Looking into the future, examining the Kusum scheme; by linking the renewables, energy efficiency with water conservation; with economic growth we have the makings of a programme that can completely change not only the electricity sector but the whole scenario of rural growth. As far as the carbon intensity target is concerned, we have committed to reduce it by 33 to 35% in 2030 and are now clocking already somewhere near 25%. The commitment, that 40% of electricity capacity in 2030 would be based on non-fossil fuels we are already at 38.5%. We are well on our way to achieving this target before the year 2030. We also seen it the past few weeks that the round the clock renewable electricity, renewable plus storage would cost less than new coal electricity in 2 to 3 years.

All of this provides us with a structure that will be very different in the future than it was in the past. Both in implementation and policy, this sector has seen a change which has not been witnessed since the time of independence. Looking ahead, we would like to focus on four

key messages. The first message is that we have seen a huge drop in the electricity demand in the past few months because of the pandemic and lockdown. We expect that no matter how the recovery occurs this will shape a growth which is slower than what we had anticipated prior to the lockdown. We may look at a demand which would possibly be anywhere between 5 to 16% less in 2025 than it was earlier. Why this huge gap, one may ask? This is because it depends on which kind of recovery occurs. If we can have the kind of recovery that the Prime Minister has proposed through the economic recovery plans there may be a 5% reduction.

If the recovery takes much longer, then the demand for electricity would be 16% less in 2025 than it is now. The short point being that we will see a reduction in the demand in the years to come. The second message is that with these two new bids that were found through the Solar Energy Corporation of India tenders, we are looking at prices of round-the-clock electricity which would be competitive with new coal power in the years to come. And they will be competitive at least for about 50% of the storage capacity, which essentially means that we can go to much larger levels than we had earlier anticipated. Now in doing so, we looked at both capacity costs in coal and variable costs in coal. We also looked at prices of solar on the one side and prices of battery on the other side. What we have seen is that unless we go for very high levels of variable renewables, the current capacity would be able to manage the amount of variable renewables that we are talking about including enhanced 450 gigawatt of capacity that was talked about earlier. Thirdly, while this huge capacity will be created, we will also have the capability of managing it till 2030 at no extra system cost. This is important because we are looking at two kinds of costs, we are looking at fixed costs and variable costs. If you put in more storage the fixed cost increases but the variable costs decrease. But as far as the system cost is concerned, the two of them together, that does not change over the time that we are talking about. Hence, a policy decision about where is that we invest, that we do both capacity and variable is a key issue that comes out in front of us. The point that I would like to make is that it is possible to meet our full demand with a very high degree, it will be 30-40% with no problem and at no additional cost. The last point being that this would obviously imply that we must invest in flexibilities. What we must look at is one kind of flexibility that is battery storage. Of course, there can be other kinds of flexibilities ~ what we also looked at is how much battery capacity could we put in, when it is charged when it is discharged. But the point to be underlined was that

with this kind of storage capacity we should be able to meet our goals. The battery capacity cannot be built overnight. And therefore, we need a range of flexibility options. First of all we are looking at coal power stations which are cycling up and down and second we are looking at energy efficiency, essentially providing signals to consumers that we should reduce their energy demand, and with air-conditioning, there is a huge potential. If we increase the load, increase the temperature set point from 24 degrees to 26 degrees there is a net 10% reduction in energy demand. And if we can provide a financial benefit to people who switch within a given period, that could be used as another means to meeting the demand. The third is of course, storage capacity or as we investigate the years ahead. This will clearly imply that we need a policy structure which will help us secure this goal. Very clearly, we are lucky that we have a system in which there are capacity costs and there are variable costs. This should continue, there should be a capacity market that indulges building-up of battery banks that allow around the clock supply. Lord Turner chairs the Energy Transitions Commission which is a global group of CEOs of power companies, power users, energy users not just electricity working across the world but also how countries and companies can move towards low and ultimately zero carbon options.

Lord Adair Turner

The Covid19 crisis world over has forced us to connect virtually. However, as distressing the current conditions are it is imperative that we do not take our eyes off the big picture – the big threat of climate change which we have now been dealing with for decades. And if anything, over the last few months, there has been accumulating evidence of just how huge a challenge this is. Last summer, India experienced an intense heat wave; while it has been a better summer this year, but flooding continues to be a menace in several parts of the country. Elsewhere in the world too, we have seen some truly dramatic developments. Northern Siberia across whole north of Russia has experienced a summer 6 to 7 degrees higher temperature than normal which was preceded by a winter in northern Russia also many degrees above normal. We are witnessing record levels of ice melting in the Arctic, massive floods in China which can only be explained by climate change. So, all around we are fast approaching the tipping points which can both prove dangerous and disastrous. Dangerous for a country like India, where further increase in summer heat will act as

a massive deterrent to both human health and welfare. Further melting of the Himalayan glaciers may pose serious risks to water supply.

The Energy Transition Commission (ETC) is a group of about forty companies and institutions and it is growing month by month; adding to its fold ~ organisations committed to the idea that the world must limit global warming to a maximum of 1.5 degrees above pre-industrial level. To ensure that we reach this goal the whole world will have to get to zero-carbon by mid-century. We would say the developed world has to get there sooner by 2050 or even 2045 and the developing countries will need to be there by 2060 as well. If we are serious about dealing with this problem of climate change.

The good news, is that broadly we know, speaking how, to do that technologically. We know what the technologies are; they are available and the most crucial aspect; it is becoming affordable every passing day. The only way to build a zero-carbon economy in India, in world, in America, in China ~ anywhere, is massive electrification of the economy. Electrifying surface transport, electrifying as many aspects of industry as possible and making sure that all electricity comes from zero-carbon sources. But the great news, is that the cost of zero-carbon electricity has collapsed; solar is down about 85% in ten years, on-shore wind about 60-70%, off-shore wind which is very important in the UK is also now down about 60 or 70% in cost in comparison to the last ten years.

This has created a fundamentally new environment where the cheapest way to produce kilowatt hour of electricity is renewables. That is a cheaper way to produce kilowatt hours of electricity than coal. The key challenge however remains, what to do when the wind does not blow, and the sun does not shine? It is how you deal with renewables integrating them with the system? How is flexibility included? The most crucial task that the ETC has undertaken this year at the global level and in China and through Teri here in India is focused on the issue of systems integration of the balanced process. We know this is technologically possible and it is quite interesting to compare the different scenarios being presented for the future power system in Europe. To see what is agreed and where the areas of disagreement are? Those areas of disagreement sometime reflect different starting points of different companies.

I was with a major fossil fuel company, an oil and gas company last week and they have set out scenarios of a decarbonized European electricity system in which

they believe fossil fuels might continue even in 2050 to account for 20% of total demand with that being entirely matched by carbon capture in storage. I have been talking to a renewable energy company in Europe who believe that the fossil fuel CCS element could be as low as 3%. But the point I want to make is those in absolute agreement, the renewables can go to 65 or 70 or 80%. The range of debate in Europe now amount who much fossil fuels we technically need to balance the system is between the people you think it as low as 3% and the people representing the fossil fuel industry who think this is much 20%. So, it is technically possible to develop systems, primarily focused on variable renewables particularly if you have some nuclear and hydro as well. But across the crucial issue is how fast can you build such variable renewable dominated systems and on what cost. And to answer that question, you must do detailed analysis. And that is what the Teri report which is being produced today are on renewable power pathways set out. This is incredibly detailed and a professional piece of work which goes to the level of each individual co-power plant in India and works out how flexible they could be and what the cost of production which works out where specially in India would catch the wind and solar and what are the consequences for transmission lines and it clearly shows that it would be possible for India to take zero carbon sources to as high as 47 or 48% of its electricity demand by 2030. With variable renewables in that as high as 32% while if necessary, doubling electricity demands from current levels to support the growth of the economy. And it clearly shows, the total cost of such an increasingly variable renewable system will be the same if India went ahead with a more fossil-fuel-based basis for growing. And indeed in the next ten years, we will find the report which Teri is putting up today; will be little bit cautious because quite rightly the team have been deliberately cautious, they made sure that they do not over stretch the assumptions. But if you look at the latest auction for solar plus battery, whether solar plus battery deal providing power 80% of the time for 2.9 rupees per kilowatt hour/ 3.8 cents per kilowatt hour. That really tells us, we will be able to go even faster and that an even cheaper route, towards the most viable renewable system. But at the global level, as we try to understand the implication of this report from a global point of view. We are taking from it a simple message. Now, at a time with renewables, where the fundamental principle across the world we believe should be that all growth in electricity demand should be met by zero-carbon sources. That will still leave the existing coal plants in place for many years with a certain coal demand. And then we

will have to work out in 2030s and 40s how do we get out of that existing coal capacity. But if we can move globally to a principle that all the growth from now on should be zero carbon that will make a huge contribution dealing with this massive problem of climate change which is still there and which if anything is accelerating, getting worst month by month and year by year.

Minister R K Singh, in his remarks, highlighted that India has the highest rate of growth of renewables in the world today and this has been the trend for the past two years. Rate of growth of renewable energy in India has been the highest in the world. The solar energy capacity has increased sixteen times since 2014. Independent surveys have categorised India as the most attractive destination for renewables. Almost every major fund in the world is invested in India. Renewable energy capacity has been expanding at a huge pace. The energy sector is transforming at an impressive rate. When our Government started ~ we were power deficit. We converted this country into a power surplus country, and today we export power to our neighbours. We are exporting power to Nepal, Bangladesh, Myanmar, and we have united the country, the whole country into one grid. Its perhaps the largest single grid in the world operating at one frequency. In about eighteen months, access was extended to every home. About 19,000 villages were electrified which had not experienced electricity. 26.7 million homes reached in eighteen months. This was the largest expansion of access in the world in such a short time.

The Indian Prime Minister and government are firm on their stand to reduce the burden on the environment. We staunchly believe that our environment needs fixing; that we need to leave behind a world which is healthier for our children and great grandchildren. By 2022, we will add 175 gigawatts to our renewable energy capacity, we have added about 88 gigawatts and 45 gigawatts is under installation and we have made another about 31000 megawatts. These figures only highlight solar and wind. If hydro is included another 45000 megawatts of hydro which is already started and 12000 megawatts of hydro which is under installation. So, if you take the capacity which had been installed and which is under installation it comes to 190,000 megawatts, 190 gigawatts already, whereas we had promised, that you know we will add 175 gigawatts by 2022. On the side lines of COP21, we had committed that by 2030, 40% of our capacity will come from renewables. Currently, 38.5% of our capacity

is sourced from renewables. As per estimates by 2030, 450 gigawatts of renewables minus hydro would have been added. Including hydro another 60,000 megawatts can be added so may be 510 gigawatts will be from renewables. Teri's assessment that by 2030, about 40% of our capacity will be from renewables is incorrect. By 2030, at least 55% of our capacity will be from renewables. If not 60%. In fact, I would say that by 2030, 60% of our capacity will be from renewables and that is on a conservative scale.

For us environment is a matter of religion. We are not only adding capacity. We are also looking ahead, and you know this has had challenges, adding capacity has challenges but have been meeting those challenges. The challenges have been we had have to flexibilize so flexibilization of our thermal capacity is going on, that programme is going on and we propose to flexibilize it to 55% in the first stage something which is being recommended by Teri. But we propose to bring it down to 50%. And gradually the flexibilization will be across the entire capacity. All our growth requirements are being met by renewables.

The growth in capacity is owing to renewables and growth in demand is mostly being met by renewables. The balancing is available already. We have 45,000 megawatts of hydro and we have about 4000 megawatts of pump hydro. As a strategy, for every bid we are now adding renewables and our bids are henceforth going to be more and more hybrid plus storage. So, the experimenting and innovating is ongoing. We have a growing capacity of floating solar, which is way more efficient. We had a bid for renewables for meeting the peak-hour demand, which is in the evening and early morning. And that bid was also very competitive post which we finalized about 1200 megawatts and then there was a bid for 400 megawatts which was again competitive; and we will be coming out with more and more bids with storage added. So, the effort is to contribute towards bringing down the price of storage. It is bound to depreciate owing to the huge market and storage will be added to every bid so that the prices of storage also decrease. Our next move is to invite people to come and manufacture batteries in India. Post which tariff barriers will be set-up so that batteries manufactured in India can be used. That is will also be extended to solar sales and modules.

Otherwise we found that because of our huge capacity expansion which is underway some of our neighbouring countries were dumping solar cells at prices which did not even meet the cost of manufacturing. So, we levied

safeguard and custom duties to prevent that dumping. In a similar experience with the steel industry, safeguard duty had to be levied to prevent dumping from our neighbour in the north. Similarly, we have been facing dumping from our neighbour of north in so far as solar cells and models are concerned from China. So, we had to deploy safeguard duties in place.

Thus, this huge expansion in capacity will continue, and we will insist on most of the things being made here. In wind, 80-90% of all the components have been manufactured and we are exporting from here. We are also exporting some solar cells and models, with capacity enhancement underway; about 7-8000 megawatts of capacity expansion is currently on-going. A very innovative approach has led to structures balancing and our balancing system and our grid is working. We have two programmes for constructing green energy corridors. While one is almost complete. Another programme is under construction and we are having another green energy corridor which is under construction. The World Bank, KfW - need to be acknowledged for their support here. We are adding lots of capacitors; this huge injection we have been able to manage and balance very well. All our grid despatchers are now experts at balancing, we have not had any disruption. In fact, there was a challenge when the Prime Minister announced that on a date, we will switch off our lights and light candles as a mark of respect for the frontline corona warriors. We had a dip of almost about 40,000 megawatts just for nine minutes. 40,000 megawatts went off and came back. I think it was slightly more than 40000 megawatts, but we managed it. So, our flexilization system is working well. Challenges exist in other fields as well. We have a vision. Our country has a vision of electrifying the economy.

Electrical mobility is a mission. We have started on this and intend to proceed ahead with this, electrical cooking is another mission on which we have undertaken. So, we want to electrify our economy and of course we are going to sort of green our electricity. Incidentally, the green cover in India has also increased. Environment is a huge priority for India and should be a priority for the world. Just us setting our house in order will not solve the problem; all the countries must join in and constructively contribute. An example in this direction is the International Solar Alliance. I am pleased to share this has been a success and we have about 87 countries who have signed-up to become members and we have so far hosted three general body sessions in which ministers from these countries participated. We have a vision of one sun, one world, one grid, then you do not even need

storage because when the sun sets in Vietnam, it shines in India. And when the sun sets in India, it is shining in Oman and may be in Morocco. So, if there is a single grid, then the problems of storage are taken away, they are reduced. A study has been instituted for this supported by the World Bank. We thank them for that. We believe that this is feasible, and we are going to put it in place.

The energy transition is not only adding of renewables, which we are doing at a fast pace. It is also about energy efficiency. For example, we changed about 11 million streetlights in just about 18 months. 11 million streetlights we changed to LED. About 360 million LED blubs we changed by our PSU and if the private sector is included; another 700 million can be added more. So that is about thousand million pieces already gone out. We have a programme for increasing energy-efficiency in industry. The first cycle of that resulted in savings of about 8 million tonnes of oil-equivalent and the second cycle has resulted in savings of about almost 9 – 10 million tonnes of oil-equivalent. We are already on the third, fourth, fifth cycles whereby we make all our major industries energy efficient. And that is reducing CO2 emissions. All these efforts have added up to almost 120 million tonnes of CO2 emissions being avoided because of these energy efficiency measures. Our energy efficiency measures are also perhaps one of the leading energy efficiency measures in the world. We believe as we are transforming the energy sector. It is deeply satisfying and the challenge also exciting. We are happy to engage with the challenge. And we believe that we are making a difference. A difference for the better. A difference that is essential for the world. I am certain that other governments in the world would also be doing the same.

Addressing the challenges faced by Covid, in the months of January, February and March there was no decline in consumption. Decline came in April. The decline was about 24.9% if you take it in terms of megawatts. In April 2020 compared to April 2019 the decline was 24.9%. In May, the decline was 9.1% further when compared to May 2019. So, the peak decline was in April. In May, it was 3.1% compared to May 2019. In June, it was 10% compared to June 2019 and July it was only about 2.7% and in fact today also the decline, compared to the same date last year it will be in only that region, about 3%. The thing is despite the lockdown and even after the unlocking ~ many of the workers have gone back home. And it took them time to return and for the industrial activities to start. We have rebounded and this trend will continue. Owing to the huge expansion of access; do not

foresee any long-term impacts in the power sector. The pace of growth may slow down may be for a year, but growth will be there. We will be back. We are almost back. On many days, for example on the 18th the gap between the 18th of July 2020 and the 18th of July 2019 was only about 5000 megawatts in demand of 160. So, 5000 out of 165000 is how much ~ 40%. That is where we are. The government has been very conscious to kick- start the economy. Now once the public spending also starts which has started in some areas the growth will pick up again. We are also engaged in another form of transition. Now, this form of transition is democratisation of generation. But with experience when we started on our programme of expanding access. There at that point of time, the grid had not reached many corners ~ Leh, Ladakh, Arunachal. Solar was available so we lighted homes using solar. We found that the solar apart from low cost also afforded us this flexibility because of distributed generation. In a drive which we have launched, we are starting to convert most of the consumers we have everywhere, not only in the rural areas but also in the urban areas to prosumers. So, we are coming out with 'charter of rights' of prosumers. Every consumer will also become producer. Rooftop, or if he is a farmer with solar panel on his fields and if you add it then solar panel covering in his entire field and his earnings from renewable energy will probably rival if not exceed their earning from wheat and rice crops which he grows. We found even if the farmer just leases out his land, his barren land, suppose his land is barren, and if leases it out per acre, his income can go up to almost 60-70000 rupees per year, which will be more than what he will earn if he were to grow rice in his field.

Similarly, we are going to digitalize agriculture. And we have started this programme of KUSUM under which we are going to solarize every single piece of irrigation equipment which the farmer owns. That is all the pumps being solarized. That is another movement which is happening. So, the farmer becomes a producer, the surplus energy when he is not using for his fields, he sells to the grid and the grid will buy it. This is one of the rights which we are providing in the rights of prosumers. So, we are looking transition across several fields. It is only a question of ideas. We welcome ideas. If Teri has any ideas, we welcome it and we like experimenting with ideas, we love adventure. So please come up with ideas and we will try it out.

Responding to the minister's remarks, Lord Turner stated, it is very important that new ideas flow not just from around the world to India also from India to the world. I just want to

stress that what is happening in India on solar and wind and in particular some of these round the clock contracts is I think in many ways ahead of the world and certainly our work through Teri on the power system within the ETC is cutting edge. To clarify, I think the Minister was suggesting I might have been a bit conservative with my 47 to 48%, but just to be clear that is generation and the percentage of capacity would be much higher still. So, I think we are talking very much the same story. But one of the reasons, why I am very keen to continue to build our activity in ETC India is that India has a lot of things to teach the rest of the world both on the development of renewable power and on the energy efficiency programmes as well as the other way round.

Mr Sanjiv Nandan Sahai expounded on the data available about energy consumption ~ on 20th July; and how a non-fossil fuel generation, it shared the total generation was 31.3% in energy terms. So, they are not doing too badly. I am talking of non-fossil fuel generation. I had a chance of interacting with Teri and others and I was sharing this last at the renewables committee at which Teri gave some very important inputs. I am really looking forward to the findings that Teri has made today in form of these two reports, I am really looking forward to these reports.

A key issue is about how to move forward with renewable energy generation and its integration ~ aspects related to cost, policy parameters and requirements. I am sure, I saw in the slide about the YPSA Indian model, I am sure you must have interacted with CEA who also have a model and would have both you I think to tune it to a point that would be more robust. The Honourable Minister had mentioned, and I think Dr Mathur too, of flexibilization of the coal fleet on 55% and below and then extend it to the state generating food plants. There really needs to be a policy of incentivising this to the state plants to at least 55% if not below.

Today, there is a belief that they cannot go 70%. For integration of RE energy, RE into the grid and an important development that has happened is the inauguration of the real-time-market; started June this year and it is becoming very popular. Lot of the variability short term, variability and requirement of short term flexibility can be met from the market and the market will be able to indicate the true price of the short term flexible power which then could give signal to different kinds of storages to invest. A lot has been said about cost and there are two points to raise here. One, the co-relation between GDP growth and power growth. I do not know

how strong the correlation is; and if I look at data of 1920, the electricity demand in the country increased by less than 1% of about 0.5 - 0.6% only. GDP growth was substantially more about 5%. The correlation between GDP growth and the power demand needs to be examined in context of the effect of weather.

Last year, owing to the extensive monsoons and in states like Gujarat for example in September the agricultural demand was negative 6 - 7% compared to the previous year. Overall, in the country the agriculture demand during the monsoon season was minus 21 - 22%. So, the weather makes a big difference along with obviously demand made by industry and commerce. And as Dr Mathur mentioned, energy efficiency has its own impact. So, there is some degree of decoupling with GDP growth, is not a one to one correlation. If GDP grows it will not necessarily pull-up energy as is illustrated by an example cited of the last year. It could be an outlier but that possibility exists. On the cost side, I wish to talk not today but sometime later; on the policy of free transmission waiver regarding RE power. In my mind, and I have requested NTPC to get that study done and to get the report. What happens with free transmission waiver is stacking up of transmission cost. Then it incentivizes the RE generator; specially a solar generator to go to the deepest areas where installation may be high and land cheap irrespective of the cost of transmission because that was socialized. This brings the key question of integration of RE to the grid as who pays the cost of variation? Who pays the cost of incentivized transmission? Because with free transmission what is happening, today is, that even the non-fossil fuels such as hydro, gas and gas because of low gas prices ~ production has increased by 30% in the last fortnight or so. They end up paying the cost that somebody else should have borne because both are required for balancing. So, this is a policy question which if it is possible, I would be happy if Teri could examine it. I am really pleased the way this whole exercise has been carried out by Teri and I hope to have more detailed interaction with Dr Mathur and his team in the near future so that I learn from you and as the Minister said we are always open to ideas. We are also working very hard on making the gearhead market and the capacity market. Something interesting will happen in the next four months, a big policy step which will make the market far more liquid than we see it today. We have also interestingly, may not have gone noticed, but three to four years down the line an office memorandum that we issued about a week ago allowing financial instruments to tread on the power sector. So, now you have auctions, sector derivatives which can tread, this is going

to provide a great edging mechanism and will make the very hard bound PPS somewhat more flexible.

Teri looks forward to working with the power ministry, which has changed the outlook ~ into one which is looking at institutionalisation; developing looking at the policy instruments and looking at the kinds of both technical requirements as well as the financial requirements where the grid is concerned.

Ms Neerja Mathur stated that the Indian power sector has certainly come a long way from huge power shortages which were rampant in each state and access to electricity which was also very limited. Through concerted efforts on the part of center and the state a huge capacity addition took place in the decade from 2005 to 2015. Because of these efforts, sufficient generation capacity is available now to meet the demand of the country and the reported peak; and energy shortages have been reduced to a miniscule level of about 0.5%. However, this has resulted in underutilization of the existing coal-based capacity which has also led to stranded assets in the power sector. About 79% during 2007 / 8 and about 61% in 1819 and they have reduced to a low of about 48% in May 2020 which is due to the Covid effect. Traditionally, the electricity generation mix in the country is dominated by thermal and hydro power. However, environmental issues, power station and climate change concern along with cost of renewable energy sources have given a push to the solar and wind-based power generation technology. With an increased focus of the government on renewable power, and greening of the power sector, India's target to install about 170 gigawatts by the year 2020. However, the intermittency associated with RE technology is certainly a limitation and this needs to be addressed and taken care of. One option, which can help in large-scale integration of renewable energy can be adoption of grid scale energy storage technologies which can complement in RE generation sources. Storage hydro plants and pump storage plants can also facilitate integration of high variable RE power into the power system. Therefore, the successful operation of a large quantum of variable RE capacity can only be possible if renewable energy is integrated into the grid in a very smooth and effective manner. Teri's report which has been launched today has drawn up very cost effective and feasible plan for India's power system to achieve high levels of wind and solar electricity generation by the year 2030. These studies provide a very a solid base for the policy makers and planners to pave the way for de-

development of a reliable and efficient power sector while minimizing the mission. However, it is pertinent to mention since the generation is de-licensed there is very little control one has over setting-up of particular type of generation plant and therefore these plants at best provide a guided framework for setting-up of generation capacity in the country. However, if these plants are extremely important because they give an insight to the policy framework should be conducive for incentivizing the implementation of the plant. Therefore, the emphasis here on policies which need to be suitable so that these plans can be implemented. Also, it is important that these plans need to be revised, modified at a regular interval in accordance with the actual materialisation of various types of generation capacity. Because we know that these plans are based on certain assumptions of plants coming up or demand projections, so from time to time it is important to capture the realistic happenings on the ground and then modify these plans accordingly. This may also entail enroute changes modifications and policy to provide any midterm cost correction if so required. It is to be noted, that, several generation planning studies have been carried out on an all India level to estimate the capacity required to meet the projected target with emphasis on reducing emission. However, the level of success of this plan materialising is largely dependent on the state utility level initiative and measures which need to be taken. As we are aware the distribution sector is still a very weak domain of the power sector and it is riddled with immediate problems. It is therefore imperative that the distribution utility also carry out power planning studies which will help them in procurement of power in the most cost-effective manner while also fulfilling their renewable purchase obligation. This exercise would involve a robust system of state level demand projection short-term in a chronological manner as well as long-term. Once this is done the least cost option of power procurement needs to be evolved. So that in short term power procurement from its own generation or purchase from the market can be done corresponding to the projected demand on an hourly basis. Since the generation basket now has a prominent component of renewable power which is non-dispatchable in nature; the utility experience the additional challenge of forecasting the renewable generation from these plants on an hourly basis. Earlier they had the task of projecting the demand but now along with projecting the hourly demand, they also must project what the renewable generation would be like. This certainly requires expertise which has already been developed by several states while some states are yet to gear up their forecasting techniques. Demand

response is also an effective tool to flatten the load curve. Another challenge is to have adequate balancing capacity with fast ramping up and ramping down capabilities for complementing the infirm renewable power. Grid level storage technology is a feasible solution for this purpose. However, the cost of round the clock renewable power needs to be brought down to competitive levels. This certainly is heartening to note that recent developments point towards availability of reasonably priced round the clock renewable power and it should be available in about two years' time. It is often said that the power planning is not only a science, but it is also an art. Therefore, the thrust of acquiring power planning techniques like capacity building and proper training is very important. It is important that each distribution utility should have a dedicated unit comprising of adequate manpower trained in respect of various aspects of power planning and procurement. This includes the area of demand forecasting, techniques of forecasting solar and wind generation and economic principles to enable cost optimisation of the power purchased. Power purchase is a major cost of the average revenue requirement by any utility; its optimisation would certainly have a very favourable impact on the tariff of the distribution utility. Teri is suitably poised to handhold the state utility in training the manpower in areas of economic despatch and hourly operation planning with a view to minimize the overall cost incurred. Another challenge, before us today is non-compliance of the RPO targets in some states which is severely hampering the country's plan for development of renewable power plants. Till the time that the round the clock renewable power is more expensive than the coal based plants some states will not see any reason to purchase renewable power but will procure cheaper power even at the cost of fulfilling their RPO targets. This has an adverse effect on the existing renewable capacity and in sense discouraging signals to the market, thereby, hampering setting up of new solar and new wind-based capacity. This then negates the efforts and the plans to set up renewable capacity in the country.

The need to build-up capacity utilities and through the distribution utilities forum that we support; might be a good way to reach out to utilities about the kinds of needs that they have.

Mr Sumant Sinha shared that the absorption of renewable energy up to 2030, is frankly one of the most critical questions. The target is very ambitious as we all

know. From a pure generation standpoint, of course we can discuss whether it is doable or not and I certainly have some views about that. But certainly for that target to be achieved; what is critical is the absorption of that power into the grid because if that doesn't happen and there is any sort of curtailment that becomes one of the biggest disincentives for investments to happen in the sector.

Technology in our sectors is evolving rapidly. We have recently seen some of those results. Till literary three to four years ago, the conversation was about how much more expensive renewable energy was than the conventional power sector. Today, that is no longer a topic of conversation. Now the question is in pure generation terms, both wind and solar and particularly more solar which is at significantly now a lower cost. So, what are the additionalities that we can build in terms of other characteristics on to renewable energy that this reduction in pricing now allows us to do. This is really where storage and all these kinds of issues then begin to become viable. This is not something that we could have anticipated literary three years ago. But that reality has now come to pass. In the process, therefore, opening an opportunity to see how we can manage the big disadvantage of the renewables which is the intermittency factor. So, coming back to the issue of technology which will continue to evolve in the future as well. Therefore, the choices that we make today and this is one of the big public policy conundrums; in a sense, is that the choices that we make in public policy today will ultimately stay with us for the next 20-25 years. This is a capital intensive industry and therefore whatever projects we put up right now have to be amortized for a very long period of time and if we end up making wrong choices today, we will have to live with those wrong investments for a considerable period. Therefore, it is imperative the government makes the right policy choices. Given the evolution of technology makes it a lot harder. The government has done some very interesting things and the Minister displayed the right attitude when he said that this is an adventure and therefore, we must experiment. Only caution to be exercised, experiment as wisely as possible and experiment in small measure, do not experiment in situations where you are going to give away 10 -12 thousand megawatts of capacity on a single bid, because then that may lock you into very high tariffs for a very large quantity which may not make sense literary three-six months later. The second, is the decision that the government makes on transmission charges and how that will work out this is also going to be very critical to the role-out of the renewables in the country. Very

simply, if ISTS charges are loaded on to the renewable energy capacities then those renewable energy capacities will come up in very different parts of India. It would not make sense for a state buying from let's say a project that is being put up in Rajasthan; if in fact, they are going to charge a rupee or rupee 50, for that project being put up in Rajasthan rather than put it up in their own state and pay the 70/80 paise or whatever amount more that would be required; if they use intra-state transmission capacity. So as we think about addition of another 3 or 70000 megawatts of renewable energy capacity, the question on transmission will have a very big impact on where these actual capacities of renewable energy will come up in India and therefore the development issues are also obviously linked to that as are the job creation issues.

The third aspect, of course, is the issue of how we broaden the value chain in renewable. Today, we have been looking at the IPP part of it mostly, and if you look at the total value addition in IPP part it is about a third of the total cost of renewable energy project. Two-third goes into the equipment and in the case of solar is mostly solar module, wind turbines, but there are a whole host of other things that go into it but those are the two biggest components of the cost. Wind turbines, fortunately, have a domestic manufacturing chain so that is positive. But solar which is where two-third of our renewable energy capacity is going to come from if not three quarters, there of course we have been importing most of that and so therefore, if we can you know indigenize this value chain, that certainly would be very useful because there would be an investment of almost 200 billion dollars in next ten years just on solar modules and solar equipment. And so, we must make sure that part of value chain does get indigenized. The government certainly is moving in that direction very strongly. Ten years from now, we could actually have an industry where we have companies that are among the largest companies in the world in renewable energy, simply because a market is going to be among the largest in the world.

Secondly, we will have a manufacturing and a back-end value chain that is going to be very robust which can then be a really large exporter of products from India as well, and expertise as well, and so I think you know as we look forward at 2030, there could be a development of a very large industry which will actually dwarf number of others certainly in the infrastructure space in India. Looking at the total number of investments required in the sector, we have to add another 3 and 70000 megawatts to hit the government's target of 4 and 50000 3 and 60000 and that

coincidentally is equal to the entire installed capacity of our power sector today, from all sources. So, we are in some ways trying to replicate in ten years the capacity that we have as a nation set-up from the dawn of our history. In all parts of the power sector so far. So, it is a humungous task, it cannot be underestimated. It is such a large task especially looking at issues of land acquisition and physical execution of projects; we might fall short just purely because of the physical constraints on executing of large mode of capacity. The other thing that might be a limitation is capital. We need almost half a trillion dollars of capital to come into the sector. Today, we are investing may about 10 billion dollars every year we will soon be having to invest may be 40-50 billion dollars every year. And it is not clear to me from where that capital is going to come from because domestic sector, liquidity constraint, foreign lenders are very limited and so in some ways the international community has put their money where the mouth is and if they feel that India is in fact ground zero for energy transition and for climate change issues then we may need to have lot more capital coming into the Indian renewable energy sector. There are a lot of obviously positives that are going to drive the growth of renewables and therefore ensuring that their absorption into the grid is seamless, very critical but there are also a number of other challenges which will also have to be addressed as we go forward. The issue of discoms, is one of the most critical issues that will also have to be dealt with but nevertheless grid integration is going to be one of the biggest challenges and in that regard the work done at Teri and ETC, act as strong guidelines for all of us and for the government hopefully as well. This will make the integration much more seamless going forward.

Mr David Turk, stated, IEA and India have shared a very strong partnership for many years now. Looking forward to this further improving and increasing even further over the next critical few years.

First, Covid-19 impacts on energy globally. Just to lend a sense on how big and unprecedented the impact is, there is a 6% reduction in global energy demand. That amounts to a huge reduction in global energy demand over the 2020 period and an even larger impact with 20% reduction on investment. These are significant, unprecedented shocks in the system. All fuels have been impacted. Coal use has significantly gone down in 2020, oil is of course because of transport restrictions. Gas is down. In fact, the only fuel that is going up modestly or

we will hope to have gone up in 2020 is renewables. In fact, renewables have been the most resilient of the fuels across the world so far in the Covid crisis. We do an assessment every year looking at forty-six different sectors and technologies across the energy landscape. And when I say energy, I mean transport, industry, and buildings in fact anything that uses energy. Of those forty-six, different sectors and technologies, only six of those are on track. Only six of those are doing what they need to do on an annual basis; to get us collectively to significant air pollution reductions achieve our climate objectives and achieve universal electricity access. Of those six, there are some very important ones for today's conversations. Solar PV because of the cost reductions, because of Indian leadership, because of efforts in various other countries around the world and real credit to India as was mentioned by the Minister with the Solar Alliance in particular.

Solar PV is one of those six of the forty-six, which is doing its share to get us on track.

Another one is electric vehicles. Electric vehicles had a binary year in 2019, 2.19 million new electric vehicles on the streets. But even in 2020, electric vehicles are outpacing their internal combustion rivals in the period so far in 2020. So, some significant progress at least in a few areas. But overall, we have a lot of challenges globally for achieving the kind of clean energy transition at the pace and the scale we need to achieve our shared objectives. But there are also plenty of opportunities currently. This is no doubt a time of significant challenges, health challenges, job challenges, economic challenges around the world. But there also lies some opportunity here as well. Let me explain, what I mean by that. As the governments dig their way out of their recession, as the governments look to promote jobs, build livelihoods, re-build livelihoods as well. There will be also once in a generation opportunity to also accelerate clean energy systems of the future. So, building towards the future of clean energy as a policy is building back to the energy systems that we had previously. We would be doing a lot of work in this direction at IEA, we have put together something called the IEA Sustainable Recovery Plan. Outlining a few headline numbers to give you a sense of what is possible along these lines. First, it does come at a cost. It does come at cost that will increase investment; public investment much of the private investment as well. One trillion in a year over the next three years. It is a significant amount of money, but it is also only 0.7% of global GDP. So if you think of these numbers globally, if you think of the kinds of volumes of funding being spent

around the world to bring economies back on track, it's a relatively modest amount of funding which you give for significant GDP growth. In fact, these investments in energy allow you to get a 1.1% boost in GDP growth each year over the next three years. And now 1.1% of the global number developing economies receive a larger GDP growth than the advanced economies around the world. Energy systems so far and over the course of 2020; as per rough estimates will lose 6 million job globally. Throughout the energy space ~ oil jobs, electricity jobs and a variety of different sectors. The plan at this cost would provide 9 million additional new jobs each year. So, there are huge job opportunities in the energy space. Now if you look at the different measures, their efficiency would be no surprise. 40% of the measures that we explore that we highlight in the sustainable recovery plan are efficiency measures. Buildings efficiency, transport efficiency also resource efficiency improvements in industrial complex. Efficiency measures are the jobs machine.

So, 40% of the measures are on efficiency, another 33% of the measures are on electricity. Electricity generation, the renewables opportunities; a significant part of that investment was recommending in grids. In fact, we would recommend is as part of the sustainable recovery plan as a 40% additional amount of investment in grids from countries, from private sector each year going forward to really have grids provide the ability to balance. To include the efficiency opportunities in renewables and importance of grids on that front. Let me just add on the urgency of now and dovetailing with what Chairman Sinha said, as we look back at previous economic recessions, all of them are different; different causes of recessions, different features of the recessions but what we see is quite common. Take the 2009 timeframe, we had a great recession is indicative. There actually was reduction in global emissions in 2009 relatively modest six times more modest than the reduction would have seen in global emissions in this recession caused by Covid but a reduction, nonetheless. But what we saw was governments around the world not taking advantage of these opportunities as they spend their economic stimulus dollars as they spend their economic recovery plans. In fact, only 16% of the global investment on energy after the previous recession 2009 went to clean energy technology. The rest 84% went to other kind of energy investment, other kind of energy infrastructure, only 16% for clean energy technologies. It was no surprise that the emissions came roaring back. So, we had a temporary drop in emissions during the recession as the global economy contracted a bit, but the emissions came roar-

ing back in 2010-2011, steepest increase overall absolute increases we have ever seen. So, the question before all the policymakers is can, we learn from history? Can we do something different in 2020? Can we take advantage of this opportunity during this period that we are all experiencing as governments, as private industries spend get economies going to get jobs back up and running. Can we structurally adjust, can we build towards those cleaner energy systems of the future that we have been talking about today?

We put together a plan, we are very eager to work with partners including Teri and the Indian government, do whatever we can to ensure that we do take advantage of this window of opportunity. We have it before us for 2019 to beat the definitive global peak in emissions ever. Because of the reductions we have seen during this recession. But we can have those emissions come rolling back. That will be a wasted opportunity in a world that is running out of opportunities on that front certainly from the climate side of things.

Mr Mohit Bhargava speaking of NTPC, said it use to be the National Thermal Power Corporation and yes, we did change that fifteen years ago. It is a sign, that the times are changing because our forte now is not only restricted to thermal, but all sort of energy sources and renewable. As the hon'ble Minister mentioned that the grid operator, POSOCO and PowerGrid did an excellent job in April this year when lights had to be switched off for 9 minutes at 9 p.m. We could see that we handled the flexibility very well then. But of course, what we are talking about now is going to be much bigger in terms of size and the changes and flexibility requirement systems. A couple of quick points, I think it is mentioned in the Report that the integration for this level can happen at no extra cost but as it was mentioned that some of the key things are still not considered. So, one of the things, I think Secretary Power mentioned in his report was the transmission charges which are free as of now. But for obvious reasons will not remain free forever. So, one of the things which comes into play as far as the consumer is concerned is what is the delivered cost of power. So, the cost of integration when we look at it is not only the cost at the generator end but also the cost at which ultimately the buyer gets the power. So whether it is the cost of transmission charges or the cost of balancing, it is actually the cost of developing flexibility, as the Secretary mentioned very eloquently that currently only companies like the NTPC have the capability of going

down to technical levels required. On the other hand, most of the states, other IPPs as well are refraining or not going below 70%. So, it is important that if we are looking at flexibility the entire fleet can do a thing which is required of the grid. And this means every generating company, every generating unit should be able to come down to a much more reasonable. This will require investments. So, when we look at trying to control the curtailment, we have a couple of quick suggestions. One is if we are looking at dispatchability, why not link it to environmental compliance? Because it is well established, that the whole country has environment compliance requirements. Many of the generating stations for reasons known to them are still not starting work to attain environment compliance. This is not only with respect to carbon dioxide but also for SOX, SNOX so on and so forth. So, it is important that at some point irrespective of the fossil fuel being used for generation, it should be compliant with the latest norms as defined by the Government of India. So, we need to build that in, which will automatically give us some more flexibility in terms of what exactly is the capacity available. The other is also to take a step forward in terms of retiring inefficient capacity. Today, lot of our plants which have very high heat-rate out of 3000 to even 3500 and they are operating. Primarily because they are the cheapest. So, we probably need to take a call why not we take a decision to retire beyond a certain number. I mean, I could suggest 2500 or 2600 kind of heat-rate, but that call can be taken by the government. CEA did a good report a couple of years ago and had come up with a good number indicating units which could be retired. That will in fact give us another important leeway in terms of how much variability we need on the coal side. The other point is looking at capacity. We are talking about one central gigawatts now. The larger number is 450 gigawatts by 2030. So why not look at avoiding all these electrons going into the grid? And start using these electrons to make molecules and use that to power the energy system? One such system is hydrogen. IEA came out with an excellent report on the future of hydrogen. Thus, hydrogen needs to be looked at more specifically and green hydrogen. In a very-very strong manner. All these electrons do not have to be pumped into the grid because that will create unnecessary variability and risk into the grid. Green molecules can be created and used with hydrogen which is very versatile. It can be used for mobility, but it is also fit for hard-to-abate sectors like steel and even aviation. A lot of work is underway for using hydrogen as a storage. So, hydrogen can be used for re-electrification, it can be used in some other form, hydrogen can be transported

much easily in terms of ammonia, green-methane and so on and so forth. Hydrogen needs to be looked at very closely so that it can be built as an important element in the flexibility management system; the IEA report needs a special mention in this regard. Because we do not want to create a system where out of 800 gigawatt of installed capacity, 450 gigawatt of renewable energy, variable renewable energy keeps getting pumped into the grid.

Ultimately, we need security, reliability, and stability of the grids to supply affordable and reliable power. And in India, as the Hon'ble minister stated, that the entire country is connected, all the households and even Dr Ajay Mathur mentioned; in the villages people are enquiring about the Kusum scheme. So, electricity is going to be a way of life. Electricity is available for transport; electricity is going to be available for cooking. So, we need to ensure that lot of this is coming from the renewable sources.

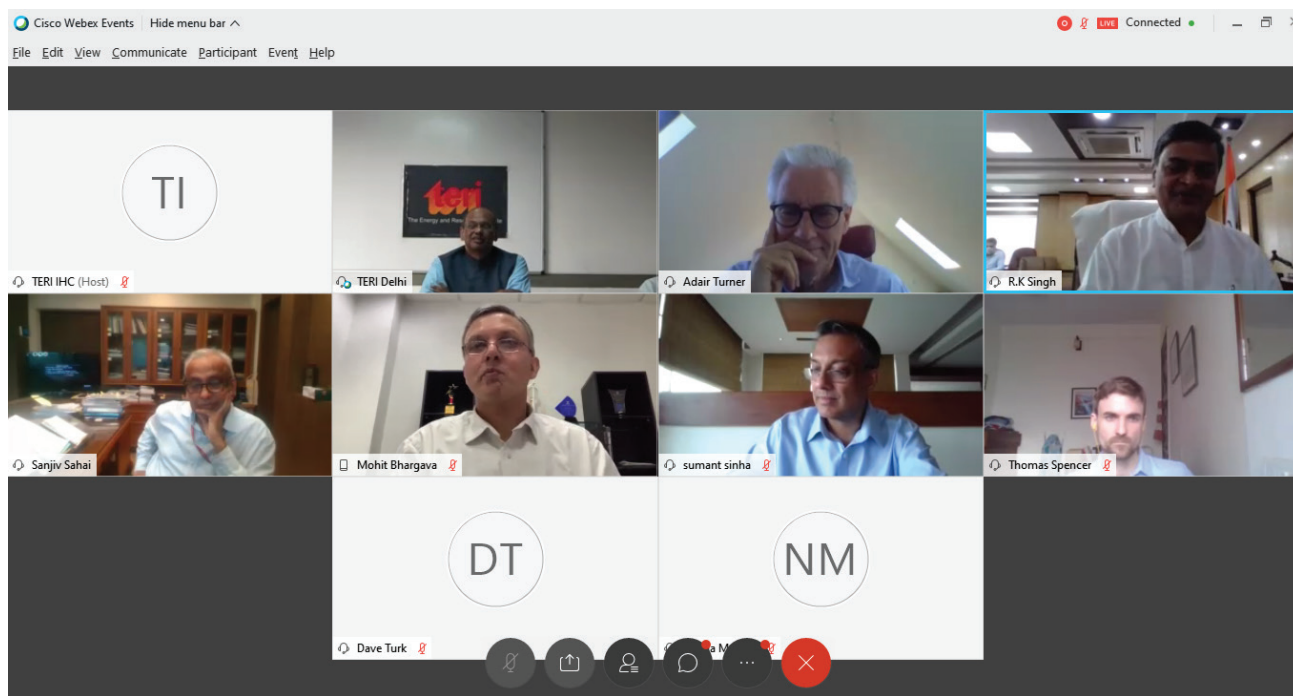
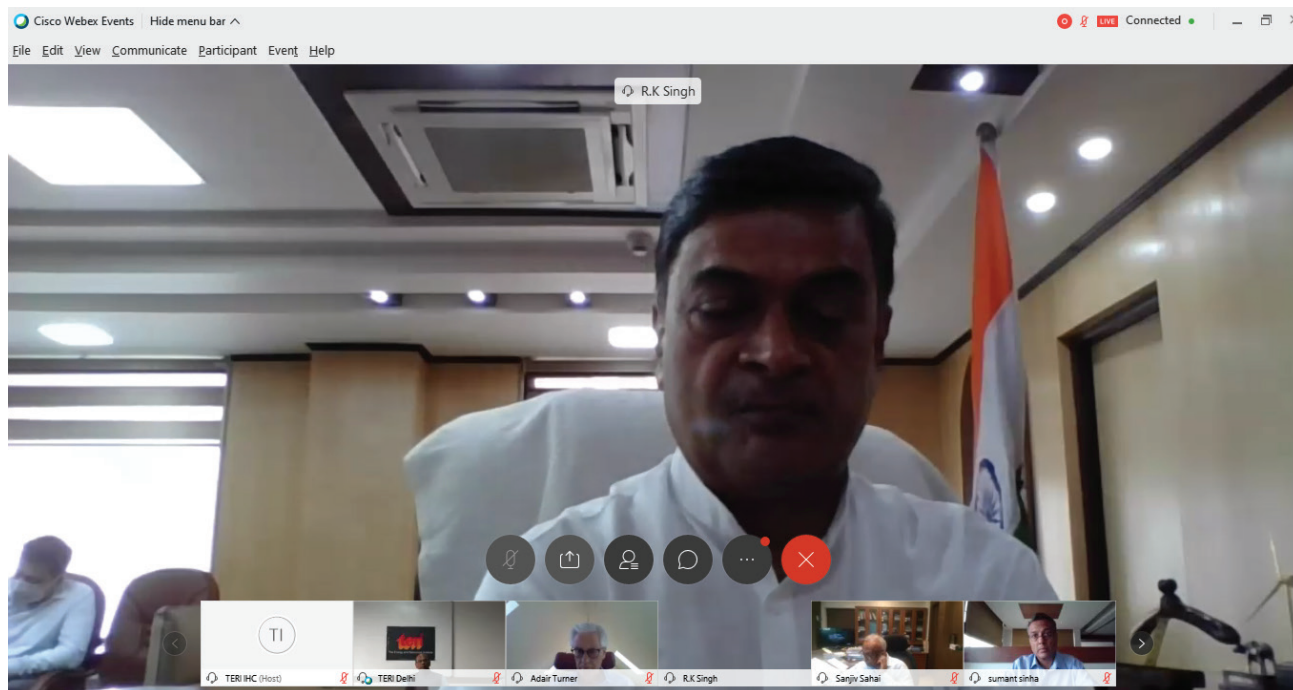
One more suggestion we have was that lot of this VRE is today linked to PPS. And I am using PPS in a generic form because the entire auction mechanism and actually hats off to Mr Sumant Sinha and his team, they have been doing wonderful work on winning lot of these auctions, but all of this is based on the premise of winning a PPE. Secretary Power mentioned earlier that they are going to do something very important in terms of market in the next 3 to 4 months. Why not have renewable energy coming to the market? And for that we have been suggesting that we do not actually need to create a separate market. All we need to do is ensure that renewable energy is brought to the market, and it gets despatched at whatever is the market clearing price. We will have enabled more and more renewable coming into the grid. While moving away from a system of having PPA, thus the need of having PPA. Because ultimately PPA is while from our side, as a generator it is a license to produce power. But on the behalf of the discom, it is in many cases looked upon as a liability because they already have so much. So, they feel if they have more flexibility in procurement. If it comes into the market that will make it that much easier. So, it could be an option that we not only ensure that VRE comes. VRE comes, sans the PPS so that it is much easier. To move away from PPS, come to the market make RE coming on much more easily.

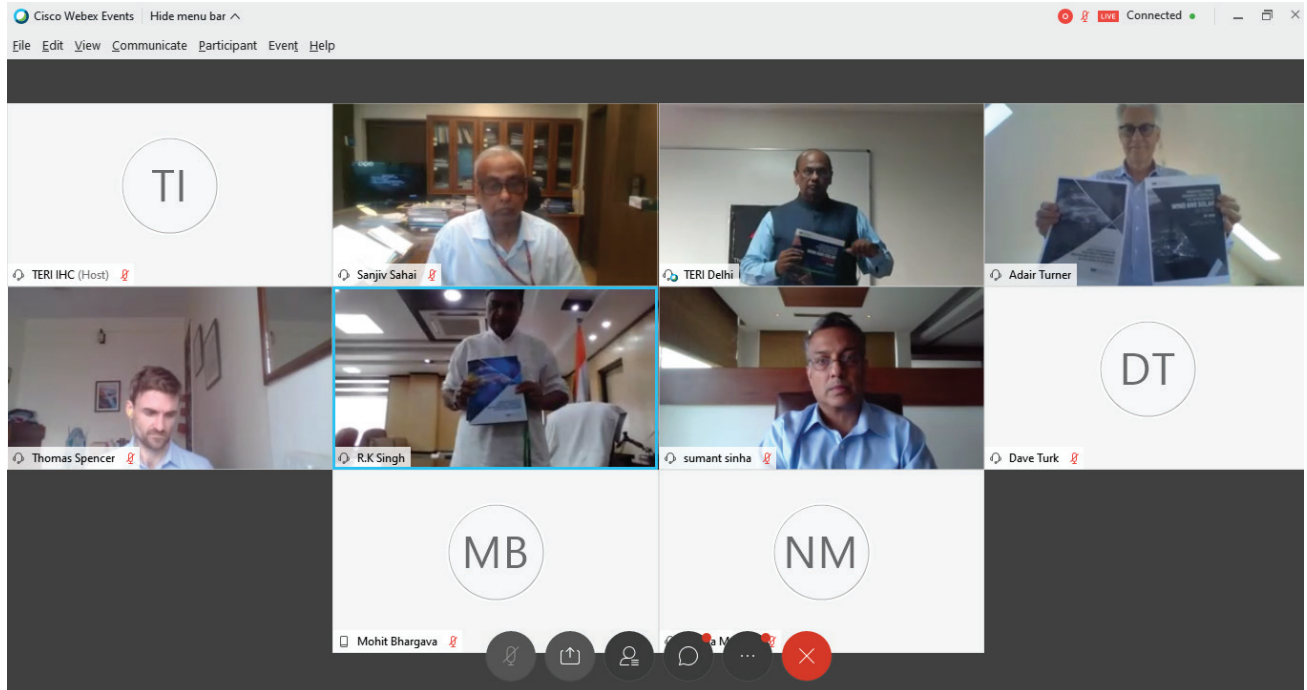
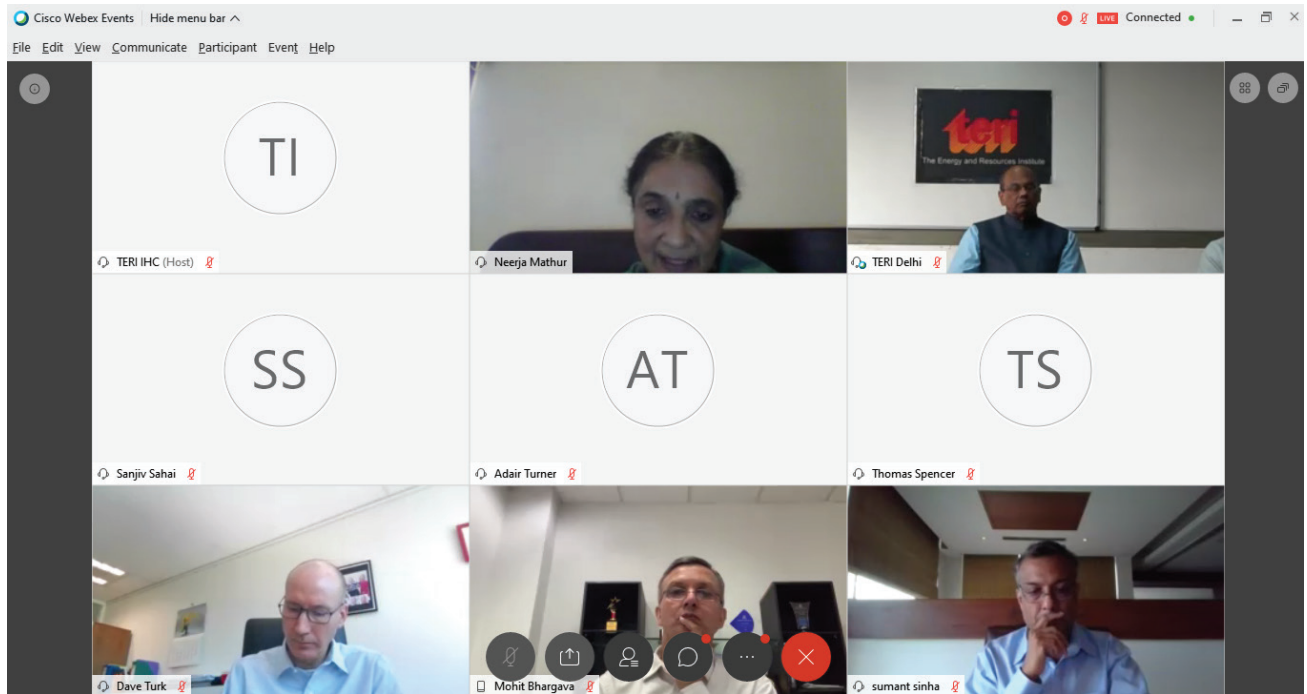
Thanks to all the presenters, the panellists, the Minister, the Secretary. We want to make sure that these pieces of work which continue to excite us, which continue to provide us with the raw material to be able to structure them into new ideas. We are looking at policy instruments that

would add today's problems. We are also as policy analysts looking at the problems that may arise tomorrow and therefore what are the kinds of problems. We hope that the availability of these reports and the availability of the data in the public domains would spark a lot of interest and a lot of work that can help us move in this direction. We will continue to focus on work of the ETC, looking at 2050 roadmap towards a no carbon electric-

ity system leading to 2060 to a zero-carbon system. We are looking at externality assessments, we are looking at water neutral electricity production, we are looking at the issue of just transitions. With a view to provide the kinds of discussions, kinds of inputs that are needed to move these ideas forward and to put in the kinds of policy instruments that can help address and provide the right signals.

Glimpses from the Pre- event





Quotes



“Renewable energy is now the cheapest source of electricity in India. However, the 'Renewable Power Pathways' report from TERI shows how India can balance the variability of renewable energy. This will allow India to achieve penetrations of wind and solar in its power mix of greater than 30% by 2030. To integrate such large shares of variable renewables, a portfolio approach to power system flexibility is required. Enhancing the flexibility of the power system is now the most important bottleneck to achieving India's renewable energy ambitions. This report shows the way forward.”

Dr Ajay Mathur,

Director General on the occasion of the second pre- event of WSDS 2021 on 'energy transition'



#Act 4Earth



“The only way to achieve a zero carbon global economy is through massive green electrification. The challenge is how to deal with the intermittency of renewable supply . TERI's s detailed and highly professional report on Renewable Power Pathways, which forms part of the Energy Transitions Commission's work , shows that this challenge can undoubtedly be solved by deploying multiple levers to increase power system flexibility.This is a crucial finding for India and for the world”

Lord Adair Turner,

Chair, Energy Transitions Commission on the occasion of the second pre- event of WSDS 2021



#Act 4Earth



“The global transition towards clean energy is critical to improve air quality and solve the world’s shared climate challenge. The global recovery plans will shape long-term energy infrastructure and determine whether the world can meet its sustainability and climate goals. We need to take advantage of these recovery plans to be on the path to sustainable recovery. IEA looks forward to continuing to enhance its partnership with TERI to support the clean energy transition in India and around the world.”

Mr David Turk,

Acting Deputy Executive Director and Head of the Strategic Initiatives Office, IEA on the occasion of the second WSDS pre- event on energy transition



#Act 4Earth

Presentation made by Mr Thomas Spencer, Fellow, Earth Science and Climate Change Division, TERI

Studying the Integration of Variable Renewables in the Indian Power System: The PyPSA-India Model



Technical Detail

- Full representation of generator technical constraints, like ramp rate, technical minimum, start up costs.
- More than 900 generating units represented



Temporal Detail

- Hourly simulation for all 8760 hours, capturing daily and seasonal variability of demand and supply.
- 15 minute resolution of some parts of the year to capture ramping constraints



Spatial Detail

- Each state represented individually, with unique demand and supply profiles.
- Full representation of the interstate transmission system.
- Spatially explicit siting of renewables



- ✓ Optimise system operation to minimize cost
- ✓ Ensure respect of technical constraints
- ✓ Derive insights into system operation for high RE integration

Scenario Framework



Generation capacities

- Baseline capacity scenarios (26% VRE in total generation)
- High renewable energy scenarios (32% VRE in total generation)



Power system flexibility

- Degree of thermal flexibility
- Introduction of battery energy storage

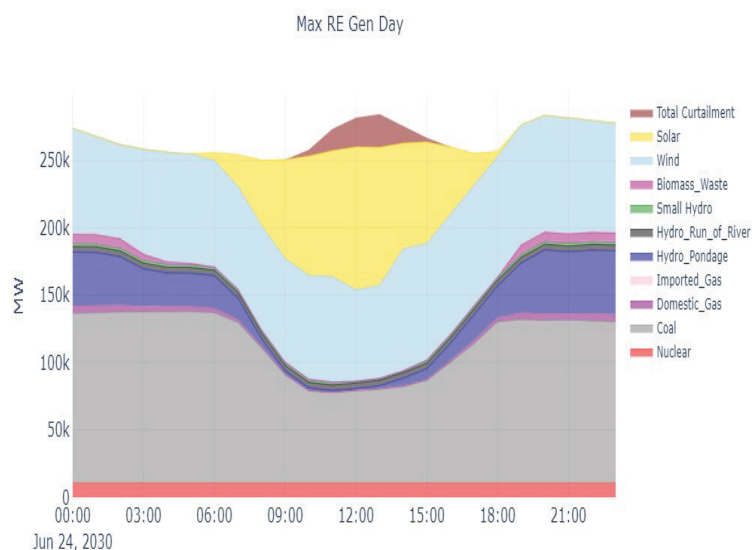


Transmission system and power transfer flexibility

- Development of the transmission system
- Optimization of scheduling and dispatch across states

- ✓ Seven unique scenario combinations
- ✓ Four sensitivities around key aspects of RE integration
- ✓ More than 100 hours of model simulation
- ✓ Entire results dataset available for public download
- ✓ Dedicated website for results visualization and exploration

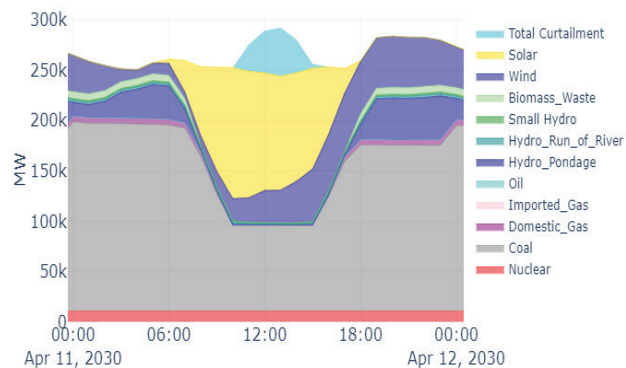
Key Message 1: The Conventional Coal and Hydro Fleet Has a Crucial Role to Play



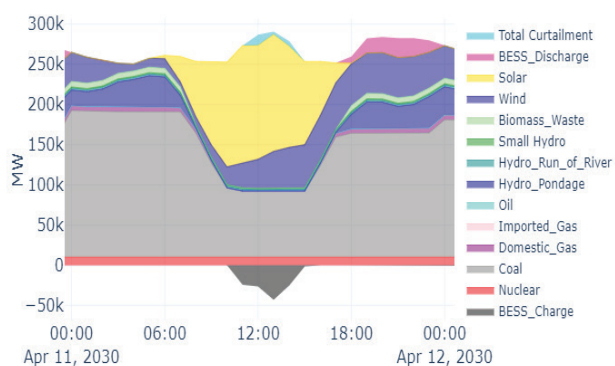
- ✓ The aggregate annual PLF of the coal fleet is 58-65%.
- ✓ But coal shifts from providing baseload to providing substantial flexibility by varying its output across the day and across the seasons.
- ✓ Achievement of the 55% technical minimum is crucial for the entire fleet by 2030, and some plants may be required to achieve a lower technical minimum.
- ✓ Technically challenging 'two-shifting' may be required from some coal units, unless other sources of flexibility are developed.
- ✓ Hydro provides an essential fast-ramping resource for peaking, and must be reserved for this purpose.

Key Message 2: Battery Storage and Pumped Hydro Storage Can Provide Multiple Benefits and Need to be Developed At Scale by 2030

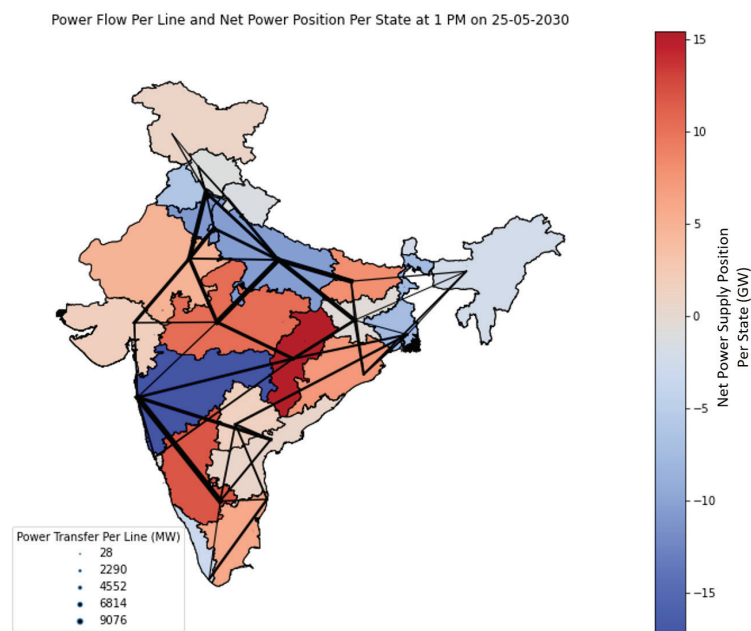
Maximum Curtailment in High Renewable Energy Scenario



Battery Storage in High Renewable Energy Scenario

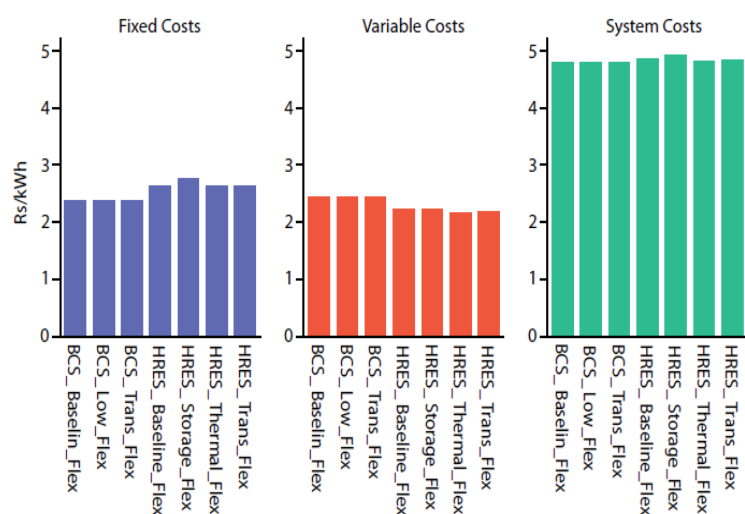


Key Message 3: The Power Grid Provides a Crucial Tool for Facilitating Higher Shares of RE Than States Could Achieve On Their Own



- India's large and integrated grid provides a crucial tool for integrating large shares of RE.
- Interstate power flows are substantial and vary in direction and magnitude depending on the time of day and the season of the year.
- Managing these power flows requires not just more infrastructure, but also regulatory and market reforms to promote cross-border scheduling and dispatch of power.
- Power system planning at state level needs to incorporate a regional perspective, so that resource planning takes into account the regional perspective.

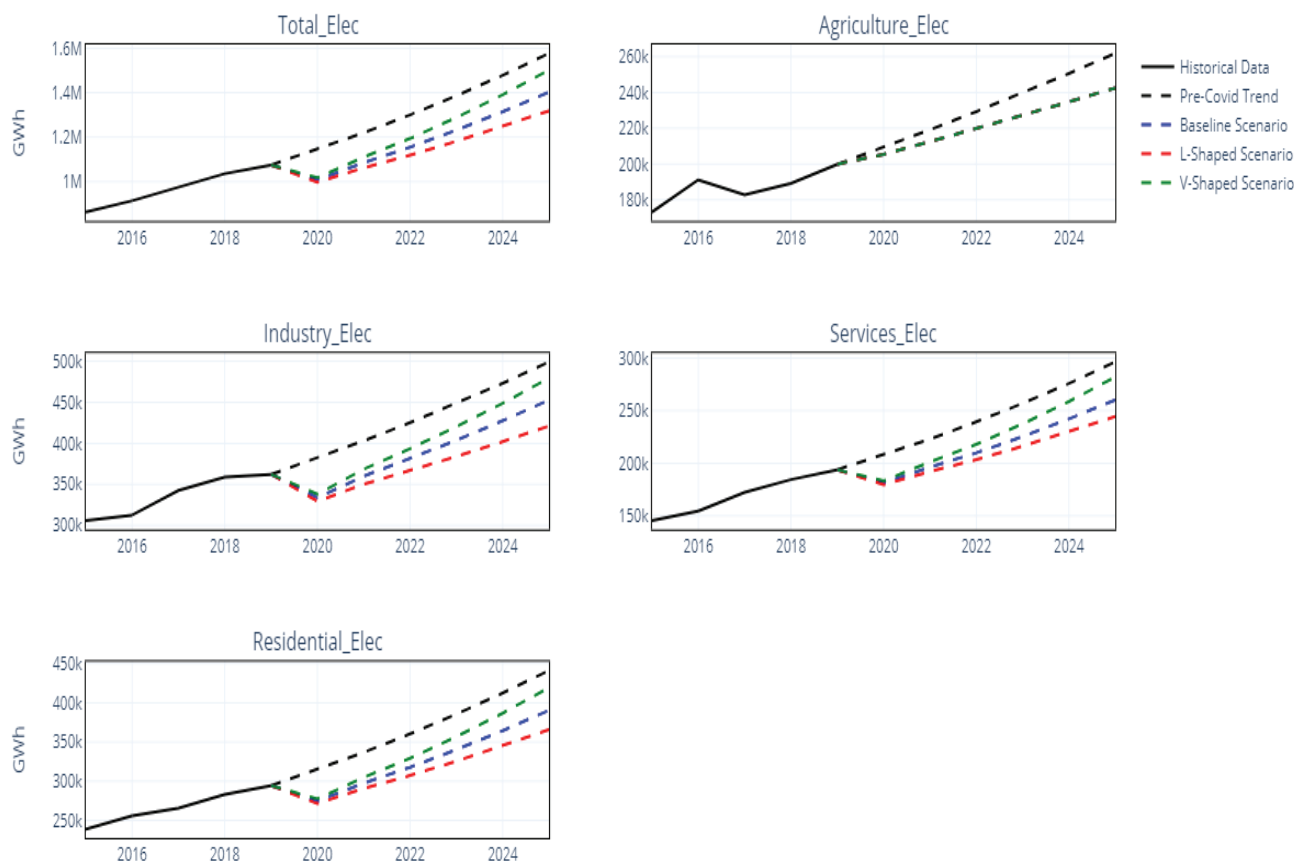
Key Message 4: India Can Integrate Large Shares of Variable Renewables by 2030 At No Extra System Cost



- The model provides a detailed assessment of total system costs:
- Fuel costs and start up costs.
- Investment and fixed O&M costs in generating assets.
- Total fixed costs are highest in the HRES scenarios, because these have the highest capacities and additional costs in the form of battery storage.
- However, total variable costs are lower in the HRES scenarios, because there is lower dispatch of high marginal cost power.
- Total system costs are essentially the same between the BCS and HRES scenarios, because of this substitution between fixed and variable costs.

Key Message 5: The COVID-19 Epidemic Is Likely to Have a Durable Impact on the Growth of Power Demand

Electricity Demand Scenarios for All India



- India's GDP is expected to contract by 5-9% in FY 2020-21, according to projections from international agencies and domestic actors (SBI, ICRA, etc)
- Although the GDP growth rate can be expected to rebound in FY2022-21, it will not achieve the level of the pre-COVID trend.
- As a consequence, we can expect electricity demand to be lower than pre-COVID forecasts for the next several years to at least 2025.
- This decline is in the order of 6-17% depending on the post-COVID recovery scenario.
- This implies that investment, asset retirement, tariff determination, and power system policy will take place in a 'new normal' of a lower rate of demand growth.
- This opens up both opportunities and challenges for the energy transition:
 - The case for new coal investment is weaker.
 - The financial health of DISCOMS may be structural, if the decline in commercial and industry demand persists.



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