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Reduced renewable energy stability in India following COVID-19: Insights and key policy recommendations

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\textbf{ABSTRACT}

The COVID-19 pandemic has dramatically altered global energy consumption, particularly affecting investment in renewable energy projects. In India, strict shelter-in-place orders enforced during March 2020 have since led to a considerable change in public and private sector investments in planned renewable energy installations.

In this paper, we attempt to highlight trends in energy consumption and installed renewable energy capacity noted in India during a period concurrent with the shelter-in-place orders. We discuss recent policy measures and additions to installed renewable energy capacity, and propose key policy recommendations that may help the sector adopt a growth trajectory similar to one noted pre-pandemic.

This paper is organized into four main parts. In the first section, we draw focus to India’s renewable energy policies and pay special emphasis on recent interventions and campaigns targeted towards achieving high growth rates in the sector. We briefly discuss the need for effective public-private partnerships in order to meet these targets. In the second part, we quantitatively characterise the growth of renewables in India. We present an overview of several mechanisms and missions the government has launched in line with their policy to mitigate the environmental impact of India’s energy mix. In the third part, we analyse the decrease in electricity demand in India from 24 March to 30 June 2020, a period concurrent with shelter-at-home orders issued by the Government. We also characterise changes in installed renewable energy capacity between March to December 2016–2020 to provide causal evidence of the effect of the pandemic on the growth of renewables. In this section, we also compile and analyse data on state-wise stressed assets across renewable energy generators in the country.

Lastly, in the fourth and final portion of this paper, we highlight policy recommendations that may help the sector overcome logistical and financial bottlenecks in the short-term. We do this with the hope of outlining key measures that decision makers may employ to achieve pre-COVID sectoral growth in the long term. Our recommendations cover three different policy instruments: investment subsidies, operational subsidies, and recommendations for DISCOMs.

1. Introduction

The COVID-19 pandemic has had a severe impact on multiple industries across the world. More recently, several studies have documented changes in industry-specific drivers such as growth rate, employment, and supply chains \cite{1–3}. In this article, we discuss the impact of the pandemic on the Indian renewable energy sector. We highlight trends in renewable energy installed capacity noted prior to the pandemic and analyse the effect of COVID-19 induced foreclosures on electricity demand and installed capacity. We conclude with key policy recommendations that may help re-align the sector in order to meet short-term pledges and commitments set by individual states and the central government.

India’s renewable energy sector encapsulates the world’s fourth largest wind energy market and the sixth largest solar-PV market in terms of installed capacity \cite{4}. More recently, the renewable energy...
market in India has become a focal point for investors owing to reduced tariffs, low market volatility and an increased impetus towards sustainable, low-carbon sources for energy generation.

Prior to the outbreak of the pandemic, India was well in line to achieve its short-term renewable energy targets set by the government in 2015 (175 GW of electricity generation by 2022, which comprises of 100 GW of solar-PV generation, 60 GW of wind energy, 10 GW of small hydro power and 5 GW of bio-powered energy. For more details, refer to Appendix 1) [3]. Between 2014 and 2019, installed renewable capacity in India increased five-fold to 86 GW [6].

Due to a high reliance of the renewable energy sector on private investment and stimulus, the onset of the COVID-19 pandemic has given rise to several financial obstacles for both the government and private energy service companies and investors. Shelter-at-home orders prescribed by the government have led to reduced workforce on-site and slowed down project development activities across the country, thereby devaluing the status of ongoing projects as well as those in the design pipeline. In addition, electricity demand across the country reduced substantially, thereby leading to a decrease in revenue and lower marginal costs.

In many cases, manufacturing, transportation and distribution of materials for projects has been delayed due to shelter-at-home orders - either because manufacturing itself has been impacted, or a lack of access to transportation facilities was experienced. Small and medium enterprises that previously had an increasing involvement with the country’s green supply chain management system have also been adversely affected, damaging logistical support for the industry which has resulted in widespread unemployment within the energy sector [7].

In April 2020, India’s proposed ‘Green Window’ campaign [8] - which was based on a globally successful bank model - lost its key investors as most financial blocks began to divert cash flow towards stabilizing losses created due to a reduction in electricity demand [9-11].

The Green Window campaign’s value proposition relied heavily on three key factors. The first was expanding low carbon energy investments for the renewable energy sector. This involved raising funds from the private sector which is commensurate with funding from state governments. Following the outbreak of the pandemic, ongoing investment is now insufficient to transition to a business-as-usual scenario [12, 13]. Second, the model hoped to provide logistical and financial support to distributed energy resource segments including rooftop solar installations and off-grid energy service providers. The onset of shelter-at-home orders has delayed this process and put certain energy service companies in substantial debt-traps due to under-utilization of capacity in most areas of the country [14]. Third, the model relied heavily on existing non-banking finance companies (NBFCs) that have been significant lenders to clean energy projects in the country. In recent years, NBFCs in India have seen a increase in non-performing assets from 5.8% to 6.6% [15]. This has led to investors being susceptible to poor asset quality and an asset-liability mismatch, thereby proving to have a negative impact on the sector. NBFCs have further curtailed in-vestment in unreliable renewable energy infrastructure since the onset of the pandemic.

In this paper, we trace trends in electricity demand and new renewable energy capacity installations in India during a period concurrent with the COVID-19 pandemic. We argue that although the nature of COVID-19 is unexpected and punctuated, the central government is responsible for re-aligning the renewable energy sector in order for India to continue to meet its installed capacity and generation targets in 2022. We show that since the onset of shelter-in-place orders in March 2020, the growth of renewable energy capacity in India has been stymied due to logistical and financial bottlenecks. The sector may not be able to overcome these hurdles if not given proper direction and stimulus by the government. We intend for this paper to provide a high-level overview of the effect of the COVID-19 pandemic on the renewable energy sector in India. Although our discussion on subsidies and financial stimulus is not as granular as the situation warrants, we feel that it provides the first step towards understanding the deficit in funding for new capacity installations.

The following three sections are organized as follows. Section 2 characterizes the growth of renewables in India, while providing an overview of mechanisms and missions that the government has launched in line with its policy to mitigate the environmental impact of India’s energy mix. Section 3 outlines the effect of COVID-19 on electricity demand, in particular, renewable energy capacity installations. Lastly, Section 4, comprises of policy recommendations that may help the sector overcome logistical and financial bottlenecks in the short-term. We do this in hope of outlining key measures that decision makers may employ to achieve pre-COVID sectoral growth in the long term.

2. India’s renewable energy sector - installed Capacity and government subsidies

2.1. Installed capacity

In the last decade, the average share of renewable energy generation in India rose to 16% of total energy generated per year. Prior to the COVID-19 outbreak, with the previously projected growth rate, electricity generated from renewables would go on to account for a third of the total electricity generated in 2030 [16]. In January 2020, grid-connected electricity output from renewables reached 84 GW, with 32 GW of electricity generation from solar-PV, 37 GW from onshore wind and the remainder from small hydroelectric power [16]. The large share of wind and solar-PV in the generation mix stems from recent technological and business model innovation. Wind energy installed capacity in India has grown 14% per year from 2007 to 2016 [4]. In tandem, the biggest leaps in growth have been made by solar-PV installations (64% per year between 2013 and 2017) [4].

Since the roll-out of the aggressive 2022 target of 175 GW of renewable energy installed capacity, the Indian renewable energy sector was set to receive USD 5 billion from the public sector to establish adequate infrastructure [17]. To accelerate the development of non-performing renewable energy assets, the government introduced the Renewable Purchase Obligation (RPO) scheme. RPOs made it compulsory for distribution companies (DISCOMs) in India to buy 22% of consumed electricity from renewable sources. This would comprise of 10.5% from solar-PV and 10.5% from non-solar sources.

Decrease in solar and wind energy tariffs have made it easier for the government to expand renewable energy installations in the country [18]. The Government of India is simultaneously attempting to increase solar-PV output, which has led them to commission 42 solar parks that hold 25.5 GW of Indian solar capacity [19]. Furthermore, the National Solar Mission that was launched in 2009 aims to install 100 MW of solar-PV capacity by 2022 [20]. The funds required to meet these targets primarily stem from various bidding rounds under the National Solar Mission. These auctions were conducted in 2015 and involved two phases of bidding that took place within a time span of 6 months between February and July [18]. Since January 2015, the installed wind generation capacity has increased by 16471.3 MW as compared to the 31403.73 MW in-crease in solar generation capacity.

2.2. Government subsidies

Most of the growth in renewables across the country has been spurred by missions established by the central government, supported by an array of subsidies and funding mechanisms enabling an ecosystem

2 DISCOMs are state-led organizations responsible for the distribution of electricity to an array of customers within the state. These organizations do not generate electricity but purchase it from electricity generators and sell it to customers within the state, hence acting as an electricity distributing entity.
3. Impact of COVID-19 on India’s electric power sector

In this section, we analyse changes in India’s electricity demand from March to December 2020, a period concurrent with shelter-at-home orders issues by the government followed by a gradual reopening of the Indian economy. We employ a counterfactual framework wherein electricity demand from March 2013 through February 2020 is used to train a Gaussian process regression model that predicts India’s electricity demand from March to December 2020. This is a counterfactual scenario that models electricity demand in the absence of COVID-19. We then compare observed historical demand from March to December 2020 to the counterfactual projections to demonstrate the impact of COVID-19 on the electricity sector.

Looking at India’s long-term commitments to installed renewable energy capacity in accordance to the 2015 Paris Agreement, we note that the increment in electricity demand in India should be commensurate with new renewable energy capacity installations. This does not imply that central and state governments should resist investing in conventional energy generators, however, it helps us establish a metric wherein India fulfils its commitment to generate 40% of the country’s energy from low-carbon sources. From January through February 2020, India’s electricity demand increased by 8.7% as compared to January and February 2019, and new renewable energy capacity installations declined by 55%. During the enforcement of shelter-at-home orders from March through July 2020, electricity demand declined by 284 GW (15.9% decline) relative to 2019, while installed renewable energy capacity also declined by 1.7 GW (9.21% decline). Lastly, from July through December 2020, electricity demand increased by 713 GW (11% increase) relative to 2019, while installed renewable energy capacity declined by 0.3 GW (5.8% decline). The onset of the pandemic slowed down growth across demand and new capacity installations during the shelter-at-home period. That said, following the gradual re-opening of the Indian economy post July 2020, electricity demand recovered (which is evidenced by observed historical monthly values lying within the confidence interval bounds in Fig. 4). New renewable energy capacity installations are yet to achieve pre-pandemic growth rates.

In Section 4, we highlight measures that may accelerate the recovery of the Indian renewable energy sector. Ensuring new renewable energy installed capacity increments commensurate with increase in electricity demand is crucial in order to meet the central government’s 2022 and 2030 targets.

3.1. Is there a decrease in electricity demand from March to November 2020, and is it statistically significant?

Several studies report a causal link between the onset of COVID-19 induced foreclosures and decrease in electricity demand [11,13, 23–26]. In this study, we employ a simple and interpretable probabilistic model to evaluate the statistical significance of electricity demand between March and December 2020. The framework employed was adopted from that used by Luke et al. [27]. We elaborate on the data and methods employed in the modeling exercise, and discuss the implications of the results.

3.1.1. Data

Power System Operation Corporation (POSOCO) Limited, a Government of India enterprise, compiles electricity demand and source-wise electricity generation data, daily [28]. This data is available at three levels of geographical resolution: state, region, and country-level. We aggregate the total electricity generation data at the country-level for India in monthly intervals and utilize this for our analysis. POSOCO also lists monthly renewable energy capacity installation by source (solar- PV, bio-energy, wind, geothermal, nuclear and hydro) using

![Graph showing new installed renewable energy capacity in India from 2015 through 2020. The solid black line indicates cumulative subsidies for renewables in million USD. The graph has been compiled by the authors using data for cumulative subsidies obtained from Garg et al. [21] and installed capacity data obtained from CEA [22].]
which we compute the percentage change in capacity installations between March and May as well as March and November, for 2016–2020.

3.1.2. Methods

We use Gaussian process (GP) regression, a probabilistic modeling technique used in machine learning, to compute the mean trend in electricity demand from monthly POSOCO data. GP regression is a non-parametric, Bayesian approach to regression that helps characterise uncertainty. The GP regression model computes empirical confidence intervals that allow us to analyse the statistical significance of projected versus observed historical data [27]. Historical demand from March 2013 to February 2020 is used to train the GP model, which is then projected into Q2 and Q3, 2020, to forecast electricity demand in a counterfactual scenario in the absence of COVID-19. In order to better characterise the input data, the GP regression model uses a series of kernels to help fit the input dataset and compute projected data. In this setup, we use three kernels that fit different properties of the input data: the long-term smooth rising trend is implemented using the RBF kernel, with the length scale and amplitude as hyperparameters. The seasonal trend in the data is implemented with the ExpSineSquared kernel with a frequency of 1 year to represent electricity demand annually. Short-term and medium-term irregularities of the order of a few months are represented using the RationalQuadratic kernel. The model takes into account seasonal patterns in electricity demand (such as the effect of temperature and rainfall) via the ExpSineSquared kernel. The entirety of the GP regression model and its associated framework is designed using the GPy library in Python [29].

3.1.3. Results and discussion

We show in Fig. 2, deviations from the GP regression model’s predicted electricity consumption. The solid blue line indicates the mean computed by the GP, while the shaded blue region represents the 95% confidence interval. The counterfactual data is used to project monthly electricity demand in a business-as-usual scenario without COVID-19. The red points represent actual monthly electricity demand from March to December 2020, a period concurrent with shelter-at-home orders in India.

82 out of 83 historical monthly electricity demand points shown in green fall within the 95% confidence region (or 95% credible interval) represented by the shaded blue region. We observe that none of the points representing electricity demand from March through June 2020 lie in the 95% confidence interval. The average deviation from the mean for the months during which shelter-at-home orders were enforced is 17.5%.

Although this statistical evidence may not be sufficient for us to draw a causal relationship between historical monthly electricity demand and decreases in demand during the shelter-at-home period, it does help us draw a preliminary conclusion about the correlation between the two. Our claim of a causal relationship between electricity demand and the onset of COVID-19 shelter-at-home orders may be further validated by analysing year-over-year monthly electricity demand from January to June from 2016 to 2020, shown in Fig. 3.

Looking at Fig. 3, we see that the monthly electricity demand for January and February 2020 is higher than the historical electricity demand for these two months between 2016 and 2019. Following the enforcement of strict lockdown measures in India around mid-March 2020, the electricity demand drops by 7% in March 2020 and 23% in April 2020 compared to total electricity demand in February 2020. On April 14, 2020, the Government extended the nationwide lockdown until May 03, 2020, with conditional relaxations following April 20, 2020, in regions where the outbreak of cases associated with COVID-19 was minimal or contained. We hypothesize that these relaxations, with the subsequent announcement of Unlock 1.0 may be responsible for the gradual increase in electricity demand in the months of May and June 2020. That said, the observed electricity demand in these two months is still 17.65% and 11.32% below the mean predicted by the GP regression model in Fig. 2 in a counterfactual scenario for May and June 2020, respectively.

Table 1 summarises the statistical significance of the actual electricity demand from monthly POSOCO data from March to December 2020. In regions where the outbreak of cases associated with COVID-19 was concurrent with shelter-at-home orders, we hypothesize that relaxations, with the subsequent announcement of Unlock 1.0 may be responsible for the gradual increase in electricity demand in the months of May and June 2020. That said, the observed electricity demand in these two months is still 17.65% and 11.32% below the mean predicted by the GP regression model in Fig. 2 in a counterfactual scenario for May and June 2020, respectively.

Table 2

| Month       | Deviation from Mean (%) |
|-------------|-------------------------|
| March 2020  | 17.28%                  |
| April 2020  | 21.03%                  |
| May 2020    | 23.85%                  |

3.2. Delay in the installation of new capacity

The renewable energy sector in India relies heavily on imports from other Asian countries such as China and Taiwan [31]. The solar power industry, with 88% of modules imported from China, is expected to undergo minimal increments in installed capacity in the coming months [32]. In a study conducted by Wood Mackenzie in April 2020, the authors forecasted a delay in commissioning of 400 MW of renewable capacity installation in 2020, an 11% reduction compared to renewable energy capacity installations in 2019 [33]. In a recent announcement by the Department for Promotion of Industry and Internal Trade (DPIIT) in March 2020, the organization stated that its proposed launch of 50 solar parks with a cumulative funding of USD 1.3 billion has been pushed back to an undetermined date due to logistical concerns in light of the pandemic [34].

Across the renewable energy sector in India, the outbreak of COVID-19 has considerably slowed progress, created logistical bottlenecks, delayed auctions and stymied construction of new projects. In Section 4, we present recommendations that may fast-track the stabilisation of the industry and help establish a robust framework resilient to COVID-19 induced disruptions.

3.3. COVID-19 induced foreclosures and loss of employment

3.3.1. Data

DPIIT publishes state-wise stressed assets in India across 26 sectors [35]. We filtered this dataset to include only assets of the Electricity generation (renewable) category across all states. For the purpose of this study, only asset listings where the entry was made on or after March 22, 2020 have been included. This is concurrent with the announcement of shelter-in-place orders imposed in India.

3.3.2. Stressed assets

DPIIT has pooled 55 stressed renewable energy assets since the onset of the pandemic. These assets include 21 solar energy assets, 28 transmission and distribution assets, 4 bio-power energy assets, 1 nuclear energy asset and 2 hydro power energy assets. The state-wise distribution of these assets are shown in Fig. 5.

Financial setbacks caused due to incomplete projects and stressed

\[\text{The Government of India carried out a structured re-opening of the economy in one-month phases. As of November 20, 2020, the country is in phase six of its Unlock campaign.}\]
assets have affected 2253 contractors and 248 project developers working in the energy sector [34]. Reduced revenue for firms due to lower investment trends in addition to delayed auctions in the first half of 2020 have stymied growth and threatened the stability of renewable energy contractors.

3.3.3. Loss of employment and pulling of funding

Shelter-at-home orders have put 300,000 personnel in the renewable energy sector at the risk of losing their jobs [36]. This situation arises due to a forced trend of layoffs by organizations running in loss [37]. Heavy financial diminution has led current private players and organizations who were already investing in the sector, or those who had shown serious interests in investing, to pull their funding.

Financial setbacks such as this have resulted in the auction of non-performing assets (NPA), including coal plants and coal mines, to be pushed back to a later date [38]. The auction was open to foreign direct investments (FDI), however, due to major losses suffered by private organizations both in India and around the world, the bidding was deemed to be non-conducive. These assets include 3.1 GW of thermal capacity that were initially allocated under major Indian public sector units such as the National Thermal Power Cooperation (NTPC) and Coal India Limited (CIL). From a financial standpoint, these assets would have attracted USD 330 billion in investments from global mining firms set to bid for them during the highly anticipated coal auctions towards the end of 2020 [39].

3.3.4. Effect on DISCOMs

DISCOMs and electric utilities act as branches of the electric power network in India. Historically, utilities have been a source of major debt and slow market growth due to lack of oversight and sub-par implementation of billing and collection. In addition to this heavy debt, DISCOMs in India encounter nonviable aggregate technical and commercial (ATC) losses, which usually occur due to poor transmission infrastructure, unregulated maintenance, and theft of electricity in rural and peri-urban areas [40]. Since the onset of the pandemic, DISCOMs face many additional challenges [41].

Since March 2020, DISCOMs have suffered major financial drawbacks, which have now lead to a cumulative loss of USD 3.98 billion [42]. This figure does not include their pending dues of USD 12.21 billion prior to February 2020. The Ujwal DISCOM Assurance Yojana (UDAY) 2.0 scheme (also referred to as the ‘ADITYA’ scheme) was set to include reforms for the setup of smart meters and incentives for tariff rationalization to decrease financial burdens on DISCOMs. This has since been delayed in its roll out, initially planned for 2020 [43]. Furthermore, due to depleting customer electricity demand, these DISCOMs continue to demonstrate a decreasing performance when measured in terms of units of electricity sold compared with their sales performance in previous years.

Fig. 2. Gaussian process (GP) regression applied on historic monthly energy demand of India. The green points indicate actual historical values from April 2013 to February 2020 used to fit the GP. The solid blue line indicates the mean computed by the GP, while the shaded blue region represents the 95% confidence interval. The counterfactual data is used to project monthly electricity demand in a business-as-usual scenario without COVID-19. The red points represent actual monthly electricity demand from March to December 2020, a period concurrent with shelter-at-home orders in India.

Fig. 3. India, year-over-year monthly electricity demand trends for India for January, February, March, April, May and June 2016–2020.
Fig. 4. State-wise percentage decrease in electricity demand from January to June 2020 as compared to 2019. The color-scale represents a decline in demand from 0% to 32% for states all over India, with the darker regions representing a higher decline in demand. Graph generated by the authors using data compiled from POSOCO [30].

Table 1
Percent deviation between observed values and counterfactual estimates and 95% credible interval bounds for monthly electricity generation in India for March through December 2020.

| Month       | Percent Deviation |
|-------------|-------------------|
| March 2020  | -12.68% (±7.55%)  |
| April 2020   | -27.09% (±7.36%)  |
| May 2020     | -17.79% (±7.13%)  |
| June 2020    | -11.01% (±7.29%)  |
| July 2020    | -5.09% (±7.19%)   |
| August 2020  | -7.25% (±7.07%)   |
| September 2020 | -2.95% (±7.16%)   |
| October 2020 | -5.11% (±7.08%)   |
| November 2020 | -10.71% (±7.38%) |
| December 2020 | -2.83% (±7.16%)   |
| Average deviation | -9.81%            |

Table 3
Percentage increase in installed renewable energy capacity, India, March to November 2016–2020. Data compiled from POSOCO [30].

| Year | Percentage Increase | Capacity Increase |
|------|---------------------|-------------------|
| 2016 | 24.47%              | 9029.71 MW        |
| 2017 | 25.22%              | 12116.9 MW        |
| 2018 | 21.33%              | 12660.56 MW       |
| 2019 | 17.28%              | 12286.21 MW       |
| 2020 | 9.21%               | 7629.14 MW        |

4. Key policy recommendations

4.1. Investment subsidies

4.1.1. Reducing upfront project costs

Direct capital investments have been provided as a share of overall project investment costs, or per-kWh of rated power of the installation. The Indian Renewable Energy Agency (IREDA), India’s financial institution dedicated to clean energy, also provides low-cost financing to renewable energy projects. In addition to this funding mechanism, the Ministry of New and Renewable Energy recently inaugurated the Central Public Sector Undertaking (CPSU) Scheme Phase-II for setting up 12000 MW of grid-connected PV projects with viability gap funding (VGF) support. This funding is issued in the form of grants to projects undertaken through public-private partnerships with the intent to make them commercially viable. The maximum funding cap for VGF support is fixed at 20% of the total project cost. The mechanism also allows for the government or public entity that owns the project to provide additional grants out of its own budget for financing a further 20% of the total project cost.

This provision gives impetus for public-private partnerships to invest in new renewable energy capacity installations in the country. Not only should VGF support be promoted for solar installations, but it should cover all renewable energy generation technologies, including those that have a high capital cost. Since the onset of the pandemic, government agencies such as the Solar Energy Corporation of India (SECI) have reported under-utilization of funds, and hence may allocate the unutilized budget towards new capacity installations in partnership with private organizations. Thapar et al. [18] found that VGF support for solar projects reduced the upfront cost of equity investment by the developer down to 15% (instead of 30%). Such capital subsidies applied to domestic solar modules and other renewable energy technologies, such as offshore wind, may help increase the rate of new capacity installations leading up to 2022.

4.1.2. Accelerated depreciation

Through the accelerated depreciation (AD) benefit, renewable energy projects depreciate by a specified amount in the first year, allowing investors and project developers to avail tax benefits in the short-term. The benefit was first introduced in 1994, with a depreciation rate of 100% and subsequently lowered to 80% in 2002. In 2012, the AD benefit was withdrawn, although, it was reinstated in 2014 with the depreciation rate set at 80%. Following a review by the Income Tax Department of India, the depreciation rate was lowered to 40% in 2018. Prior to this revision, the AD benefit was recognized as one of the key factors underlying an increase in renewable energy capacity installations as it offered investors a low-risk instrument to offset profits. Furthermore, as the benefit did not require direct fund disbursement from the Government, it has been seen as an effective policy instrument to supplant capacity installations in the country.

With the sharp decrease in renewable energy capacity installations during the lockdown, there are two vital alterations that will have to be made in order to attract investors and promote new projects:
Revising the depreciation rate to 80%: although the decision to revise the depreciation rate from 80% to 40% in 2018 was made to reduce the tax revenue foregone by the central government, a low depreciation rate may not be enough to promote new capacity installations in the short term. Revising the depreciation rate to 80% offers financial support with a low risk to investors. Furthermore, as organizations are increasingly concerned about cash-flows following the outbreak of the pandemic, a benefit that does not require any direct disbursal of funds from the government to the organization increases investor confidence.

Redirecting tax incentives for foreign investors: at present, the AD benefit can only be availed by investors and entities that draw a profit within the Indian subcontinent. For organizations not eligible to draw a tax benefit in India, an additional subsidy in the form of a generation based incentive (GBI), over-and-above the feed-in-tariffs provided by SERCs, can push foreign investors to invest in capacity installations. One of the drawbacks of the AD benefit was that it rewarded capacity installations and not performance or generation. With the AD benefit redirected to a GBI in the first year (with the option to carry forward to subsequent years), the central and state governments can guarantee the proliferation of functional renewable energy projects in the long term, and of course, promote domestic and foreign investors to develop new renewable energy projects in the short term.

4.1.3. Import relaxations

With the pandemic imposing stiff constraints on both domestic and international supply chains, the central government may provide interim import duty concessions for project developers importing components for new capacity installations. These interim concessions may be in place till domestic manufacturers can reorganize supply chains and reinstate their workforce. The problem of taxation on sub-components is further exacerbated since the roll-out of the Goods and Services (GST) tax in 2018. Soman et al. [44] found that the newly introduced GST made thermal power cheaper and solar-PV infrastructure 6% more expensive. Furthermore, the Government proposed an import duty of 20% on solar cells and modules to promote local manufacturing, although this has been put on hold [44].

The high price of individual components may prevent project developers from planning new capacity installations in the short term. Regular cash flows have been disrupted and developers may still need to pay installments on capital expenditure loans for ongoing projects. Keeping this in mind, import duty concessions may help achieve two targets: 1) a lower interim import duty may help developers import available components from other countries without increasing the projected capital expenditure for ongoing projects. Which then leads to 2) developers may redirect funds to complete existing projects halted due to the unavailability of domestic components.

4.2. Operational subsidies

4.2.1. Generation based incentives

Under the GBI scheme launched by MNRE in 2008, new wind power and solar-PV projects with at least 5 MW of grid-connected capacity are eligible to receive INR 0.5/kWh for ten years, which is in addition to the tariff set by state regulators and utilities. The maximum benefit that can be availed by a project is capped at INR 10 million per MW. The GBI scheme is targeted at independent power producers (IPPs). Since the announcement of the scheme in 2008, it is estimated that one-third of new wind capacity in India has been set up via IPPs.

Power purchase agreements (PPAs) in the short-term can include a direct cash incentive for every kWh of energy generated from renewables, regardless of the installed capacity. This method has been successfully employed in Germany and the U.S [45,46]. In Germany, the process involves a direct cash payment of 0.03 Euros/kWh of renewable energy generated by IPPs. Additionally, a feed-in law enforced by Germany requires distribution utilities to purchase electricity generated by renewables at a price equivalent to 90% of the final tariff paid by the
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consumer. Such a mechanism ensures a constant purchase of energy generated from renewables even if the cost per kWh is higher than that of thermal plants. In the long run, such measures may help ensure that project developers planning new capacity installations leading up to 2022 are confident about their return on investment and project financing.

4.2.2. Three-tier approach

Existing renewable energy producers should also be beneficiaries of implemented operational subsidies. To encourage individual power producers to perform better post-pandemic, they may be divided into a three-tier system. The system proposed here draws on insights followed by the California Energy Commission [47].

The first tier accommodates the least cost-effective utilities that have yearly turnovers 10% greater than the total cost of producing energy for the same period of time. The second accommodates moderately cost-effective utilities that have a yearly turnover 20% greater than the total cost, and the third accommodates highly cost-effective utilities that have yearly turnovers of 30% or more than the total cost of energy production.

Individual power producers in each tier should be provided with direct cash payments per-kWh of energy produced. The direct cash payment to individual power producers in tier three would be higher than those in tier one and tier two. This would create a substantial incentive for individual power producers to create greater profit margins which can only be driven by providing better quality of customer services [48]. The system can be put into effect from the second quarter of 2021 and could include an additional investment subsidy that incentivizes expansion or repowering of solar or wind utilities in the country. The fiscal package for this could be included through agreed PPAs that would include a must-run or deemed generation clause for the expanded section of any power plant. Cumulatively, this would promote expansion and generation via existing renewable energy generators in the nation. Although its timely implementation must be supported by the implementation of strict, transparent anti-curtailment and must-run guidelines to increase willingness to invest among national and international stakeholders.

Since every state in India does not have a well-established network of renewable energy utilities [31], a large number of utilities in a non-performing state might find it difficult to navigate into a tier with better cash incentives. Therefore, the criteria for a utility to be assigned to a particular tier could vary from state to state. A disparate tier system must also be created for utilities depending on their respective renewable energy source. This would prevent utilities working on relatively untapped sources such as wind or geothermal from not gathering substantially greater cash incentives only because the demanded positive turnover would be too high to achieve.

4.2.3. Corporate power purchase agreements

Investor confidence in newly established renewable energy projects may be instilled if state governments take the lead in forming alliances between power producers, corporate and industrial users. A corporate power purchase agreement (CPPA) covers the framework for energy exchange between a renewable energy plant and a corporate entity. Ireland’s Draft National Energy and Climate Plan (NCEP) 2021–2030 identifies CPPAs as a subsidy-free route to the market for renewable project developers.

For renewable project developers, CPPAs provide a long-term income stream with a quicker turnaround time for revenue generation as the arrangement does not involve central or state-level government actors. For corporate entities, CPPAs are a good workaround to purchasing electricity from the grid owing to long-term affordability. Further, transitioning to sustainable low-carbon sources of energy can also aid in achieving organizational renewable targets via renewable energy certificates.

4.3. Bailing out lumbering electricity DISCOMs

One of the key issues within India’s renewable energy sector has been poor monetary fitness of DISCOMs [49]. A recent study conducted by Veluchamy et al. concluded that high monetary rates could only be stabilized if the Government of India creates conducive tariff policies and infrastructure requirements for existing DISCOMs [50]. A disjointed and unstable energy ecosystem during the enforcement of shelter-at-home orders only compounded the problems faced by DISCOMs in India.

Post-pandemic, various DISCOMs will resume their billing and collection operations. The Government of India released a USD 11.94 billion package to support DISCOMs and streamline their operations [42]. In addition to using this stimulus towards covering debt, DISCOMs should invest in strategic planning and debt-recovery mechanisms that may help prevent a similar situation from re-occurring in the long-term.

Policies such as the UDAY 2.0 aim to enforce a rigorous system of energy accounting. UDAY 2.0 ensures the payment of subsidies every month while mandating the use of smart-meters to ensure timely billing and collection. DISCOMs need to improve their management structure, keep track of inaccurate bills, recruit more human capital, and provide frontline personnel with performance-based incentives. Additionally, state regulators should account for DISCOMs to spend more on metering, billing and collection via state-sponsored infrastructure investments. While this may cause further financial expenditure in the short-term, it will help DISCOMs resurface post-pandemic.

5. Conclusion

The COVID-19 pandemic has exposed the fragility of the Indian renewable energy sector. Large-scale losses, project delays and overly-ambitious plans now face unavoidable setbacks. A clear indication of the impact of the pandemic is reflected in the sharp reduction in electricity demand all over the country. The Government of India should work towards creating flexible polices that could aid the renewable energy sector to grow with minimal hindrances post-pandemic. It is now time for the country to work towards creating a stable ecosystem by following well-planned short term goals that can be worked towards, using the resources in hand.

The pandemic may have caused unforeseen logistical and financial complications, but enough backing by the Government of India through stimulus packages and policy implementations can create a renewable energy friendly market post pandemic. Shareholders seem highly interested in the Indian renewable energy market, as demonstrated by patterns in renewable energy investment in India. Key policy interventions will reduce general uncertainty in the renewable energy ecosystem. A policy re-framing initiative would also aid in creating a sizable stand against the financial implications caused due to the COVID-19 pandemic.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
Nomenclature

ACS  Average cost of supply
ARR  Average revenue released
ATC  Aggregate technical and commercial
DISCOM  Distribution company
DPIIT  Department for Promotion of Industry and In-ternal Trade
FDI  Foreign direct investment
GP  Gaussian process
GST  Goods and Service Tax
GW  Giga watt
KUSUM  Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan
kW  Kilo watt
kWh  Kilo watt hour
MW  Mega watt
NBFC  Non-banking finance company
NPA  Non performing asset
POSOCO  Power System Operation Corporation
PPA  Power Purchase Agreement
RPO  Renewable Purchase Obligation
UDAY  Ujjwali DISCOM Assurance Yojana

Appendix 1. Source-wise Installed Capacity

Fig. 1.6. Renewable energy installed capacity in India by source. The blue bars represent historical installed capacity from 2014 through 2020 whereas the red bars represent 2022 targets set by the Government of India. The installed capacity data was obtained from CEA [22].

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