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Impact Analysis Of COVID-19 On Energy Consumption In India

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Abstract: In March 2019, India saw the commencement of a coronavirus outbreak, and to cope with it, the Indian government imposed a state-wide lockdown, affecting not only 3.68 million people but also the country's economic and industrial sectors. To mitigate its impact, the government also imposed restrictions on most socioeconomic activities. This created new hurdles for India's electricity industry while exacerbating old issues. In the condition of pandemic, the energy consumption of the entire country was radically altered; we noticed a fall of over 70 KWh of electrical demand during the lockdown period, an 11 % reduction compared to 2019. This loss in supply was borne by coal-generating units. India is considered a progressive nation in terms of renewable energy sector, and this sector has been one of the leading areas to promote sustainability, and the past three years have helped the renewable sector to flourish. This paper will study the impact of COVID-19 on the consumption of electrical energy. It will also focus on the impact of the regulations placed by policymakers and administration, regarding the energy use before, after, and during the coronavirus epidemic on renewable energy sector of India.

Index Terms **- Renewable energy sector, electricity consumption, COVID-19, Sustainability.**

I. INTRODUCTION

The word "corona" refers to the characteristic appearance of viruses and is derived from the Latin word "corona" which implies spike-like structure. It was originally identified as a respiratory illness with pneumonia-like symptoms that occurred in Wuhan, China in December 2019 [1]. The virus's spread could not be stopped, and as of July 2020, the pandemic was estimated to be affecting over 213 countries worldwide, with India placing fifth with its 600,000 cases of the illness [24].

Because of the virus's unprecedented global spread, several governments have implemented various recommendations to combat it, including quarantine measures, partial and total lockdown which ultimately affected other sectors of the country. According to a recent study based on "Google COVID19 Community Mobility Report" Mobility in Retail & Leisure, Grocery & Pharmacy, Parks, Train Stations, Work Visits decreased by 73.4% , 51.2 %, 46.3 %, 66 % and 56.7 % respectively during first two lockdown periods [2].

In March and April, in our country electricity consumption fell by 9.25 % and 22.76 %, respectively, but this decline decreased to 14.16 % in May [3,4]. Also, a study by Economic Times (ET) has shown rebound in energy consumption is due to the government beginning to remove restrictions on economic activity and the increasing usage of air conditioners when temperatures reached beyond 45 degrees Celsius in May [5]. India's total electricity demand is segmented into the following sectors: industrial (30%), agricultural (21%), residential (29%), commercial and traction loads (13%) and public services (7%) [6,7]. According International Energy Agency (IEA), the epidemic decreased India's energy demand by minimum 5% in 2020-21.

As the announcement forced the closure of public facilities, as well as significant industries so user-side structure of power distribution altered, affecting overall electricity consumption and load demand distribution. Outgoing projects and a shift in energy sources from non-renewable to renewable sources in many parts of the

world have had a substantial impact on power sector consumption. Nonetheless, COVID-19 has not spared this renewable industry.

In order to determine the impact that COVID-19 has on viewing the graph created using the data gathered, this study will look at the demand for power in the commercial and domestic sectors. It will also focus on the causes and reasons for the transition of electricity generation sources from fossil fuels to renewable sources, as well as each source's contribution to the country's power sector.

II. ELECTRICITY DEMAND AND SUPPLY

Kerala was the site of India's first COVID-19 case detected on January 27, 2020 [8]. The government's major move to deal with the pandemic was the Janta Curfew which was declared by the Government of India on the evening of 24th March 2020 and executed on 25th March 2020 for a period of 21 days [5]. As the number of instances increased, the authorities prolonged the lockdown. During the lockdown (limited, partial or full lockdown) various activities such as movement, economic activities, buildings and manufacturing were restricted and energy consumption was greatly reduced [11]. Falling Energy Demand and Consumption hits Energy Business Government actions were swiftly enacted in reaction to energy industry responses primarily the electricity industry (particularly in terms of demand), since India is the world's third largest electricity producer [9]. The International Monetary Fund (IMF) has dropped its Gross Domestic Product (GDP) growth estimate for India to 1.9% from 5.8% on 16 April 2020 [10]. Considering the electricity consumption trend in India by consumer category, as shown in Fig.1 [17]. In the fiscal year 2018-2019, the industrial sector consumed 41% of all power, followed by the domestic sector (25% and 18%) and agriculture industries, respectively [12]. Weekly energy use was expected to be reduced by 9% under modest limitations, 17% in limited lockdown, and 24% in whole lockdown [12]. Fig. 2 compares the energy usage of the Janata curfew on March 22nd (Sunday) to the previous Sunday (15th march) [18]. Energy during lockdown (MWh) and peak demand (MW) have gradually decreased, as illustrated in Fig.3 [19]. By 27th of March2020, demand has decreased by 27.71 % when compared to the 18th of March 2020 [15]. The course of events that occurred on April 5th also had a little impact on the electricity system, which reported a demand decline of 32 GW, or around 30% [13].

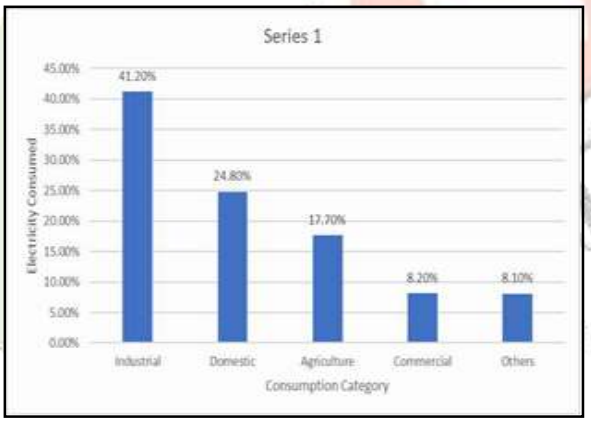

Fig 1 The electricity consumption by consumer category in 2018-19 [17]

India Railways created a 40 % gap in the country's current energy consumption (Articles: Covid Lockdown to Impact electricity demand, cash flows for discoms: ICRA, The Economic Times 2020). You can see the trend in Fig. 4 [20].

A. Services and practices influencing variations in power use in various areas: -

- Domestic: -

The various lockdown scenarios had varying effects on changes in social practices, which had a commensurate influence on power usage.

- Industrial: -

Non-essential non-food manufacturing activities have been halted in the industrial sector throughout the lockdown scenario, explain the decline of both absolute power consumption and percentage total power consumption in this industry.

- Commercial: -

Non-essential non-food manufacturing activities have been halted in the industrial sector throughout the lockdown scenario, explain the decline of both absolute power consumption and percentage total power consumption in this industry.

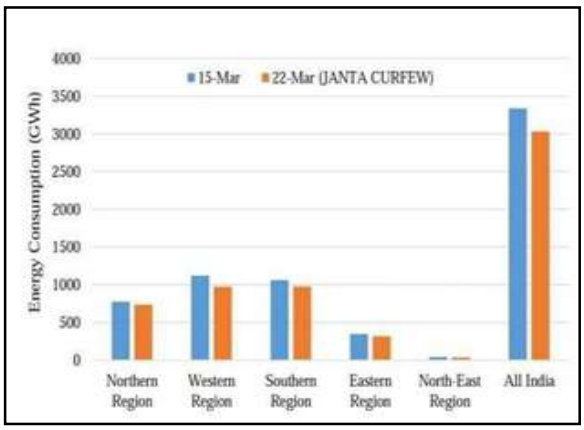

Fig. 2 Energy usage comparison during Janata Curfew Sunday (March 22nd) and the preceding Sunday (15th March) [18]

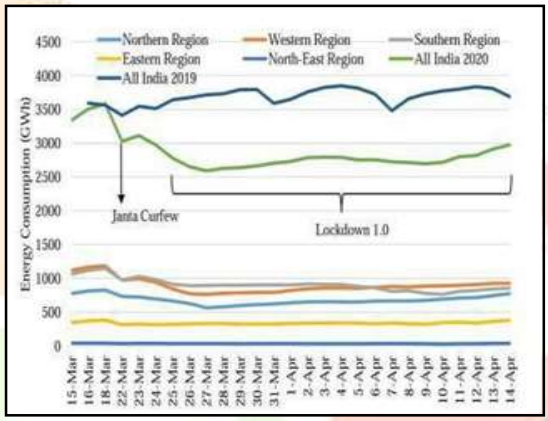

Fig. 3 The energy consumption during lockdown 1.0[19]

B. Discussion: Future impacts on energy sector of current lockdown: -

- Momentary energy transition: -

It will only endure for a short time like a year until the government removes the limitations that are causing the change in energy usage habits. If there are no inherent motives for change, energy users will eventually return to business as usual.

- Temporary energy transition: -

This sort of energy shift might span several years. This is happening as a result of targeted consent from energy consumers and other stakeholders leading to behavioral changes in energy use that have not yet been enacted into law.

- Permanent energy transition: -

The energy transformation might span decades. It is the result of deliberate behavioral modification or technological adoption backed by rules.

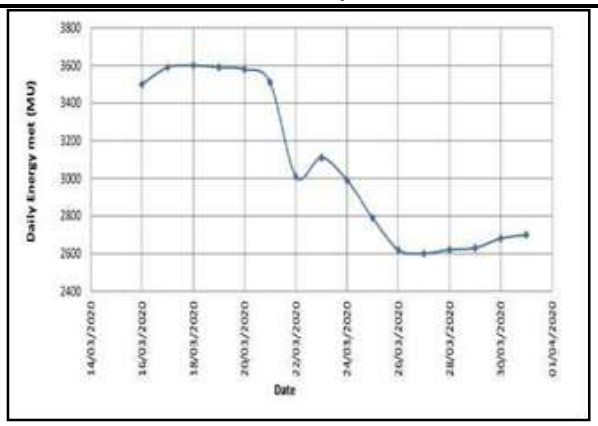

Fig. 4 Daily energy (ME) achieved before and during the lockdown period [20]

III. EFFECTS ON POWER GENERATION SECTOR

The majority of India's power business is made up of thermal power, hydropower, nuclear power, geothermal power, and renewable energy. According to statistics collected in the year 2019 and depicted in Fig. 6a and Fig. 6b [14], coal dominates with 55% of power generation in India, both in terms of renewable and non-renewable sources [14]. The total amount of thermal energy produced (including coal and natural gas) is 64 %. Nearly 21% of the total generation capacity is made up of renewable energy. Nuclear energy makes about 2% of generation, whereas hydropower makes up 13% [14].

Between March 1 and April 19, the average amount of power generated from coal fell by nearly 25% [16]. As a result, over the two eras, the share of coal in total power generation was declined from an average of 72.5 % to 65.6 % [22]. The authorities decided to switch their generation from fossil fuels to renewable sector due to such enormous decrease in the usage of that fuel on which most of the power is generated and some other possible reason indicated below: -

- The operational status of renewable energy sources (Wind, sun, and small hydro).
- In comparison to these plants, the operational costs for thermal, or more specifically fossil fuel-based, plants are comparatively quite cheap.

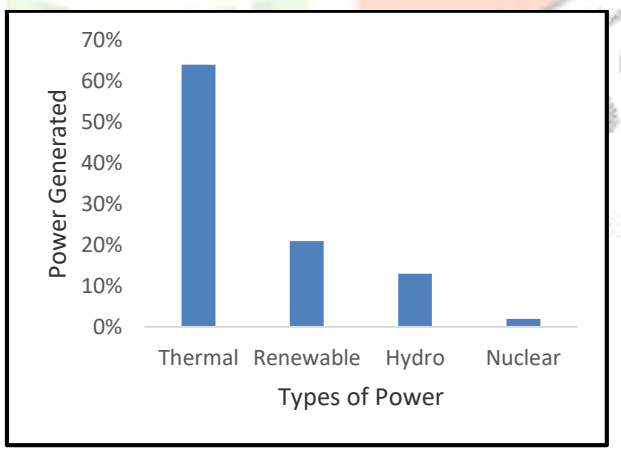

Fig 5a. Power generation capacity for all of India (as on January 2019) [14]

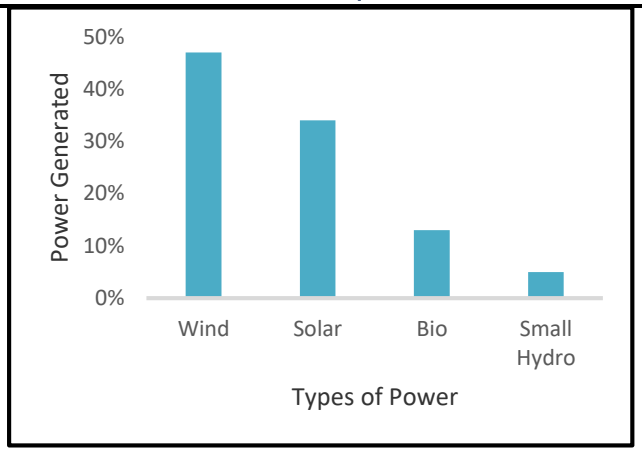

Fig 5b. Grid-based renewable energy capacity (as on January 2019) [14]

The market for renewable energy is directly impacted by this. The Kerala Renewable Energy Entrepreneurs Association (KREEPA) in India's Kerala state, the hardest-hit region of the coronavirus, has already expressed concern about the situation in the renewable energy sector [28]. Supply restrictions during the lockdown have had a similar impact on factories. In some cases, a lack of customer trust has soured relationships between companies, further eroding the renewable energy market.

IV. Financial Effect

The demand decreasing by 20–25 % of the typical peak is the most significant swing impacting the renewable energy sector [29]. This poses a serious challenge to the government's goal of generating 175 GW of renewable energy [30].

The quantity of debts owing by various Indian States in the renewable energy field from July 2019 is depicted in Fig 7 [21] below. These conditions have recently become nearly irreparably aggravated by COVID-19.

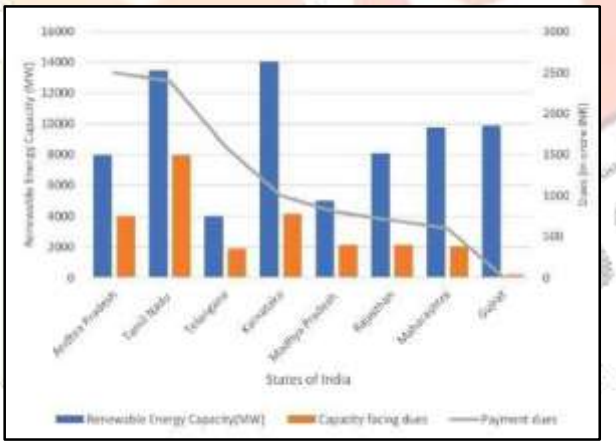

Fig 6. As of July 2019, the following states of India owe money to the renewable energy sector [21]

Our country falls under this category since China, the virus's origin and the world's largest PV module maker, left those nations in financial distress who import their raw materials for PV-based renewable facilities [23]. The state aims to use its rooftop solar installations to make up for the astronomical loss of INR 7 billion caused by the virus [28]. The emergence of this pandemic would have a major impact on the nation's wind energy sector, which ranks fourth in the world in terms of market capture and upholding that situation post COVID-19 will be difficult for the country.

Despite making significant gains in the renewable industry during the post-covid period, these are the financial decisions that the government must make.

V. CASE STUDY

In order to determine the difference between the pre and post COVID-19 durations, we have also collected data from domestic sector at small scale as well as on large scale consumption and commercial sector.

Domestic Consumption (Small Scale): -

For the observation of changes in power usage over the COVID-19 period at small scale residential sector the data collected is shown below in Table 1.

Table1. Data Collection

YEAR	MONTH	ELECTRICITY CONSUMPTION (In units)
2019	01/05/2019-31/05/2019	168
	01/06/2019-30/06/2019	137
	01/07/2019-31/07/2019	37
2020	13/07/2020-11/08/2020	422
	11/08/2020-09/09/2020	391
	08/12/2020-04/01/2021	980
2021	14/01/2021-10/02/2021	664
	10/02/2021-09/03/2021	377
	08/04/2021-11/05/2021	440
	11/05/2021-07/06/2021	390
	07/06/2021-09/07/2021	768
	09/07/2021-11/08/2021	414
	11/08/2021-11/09/2021	492
	10/102021-15/11/2021	336
	15/11/2021-11/12/2021	296
2022	10/02/2022-11/03/2022	392
	11/03/2022-11/04/2022	431
	10/05/2022-10/06/2022	732
	10/06/2022-10/07/2022	443
	07/08/2022-10/09/2022	457
	09/10/2022-09/11/2022	190

The graph obtained from the above data collection is depicted in Fig 7.

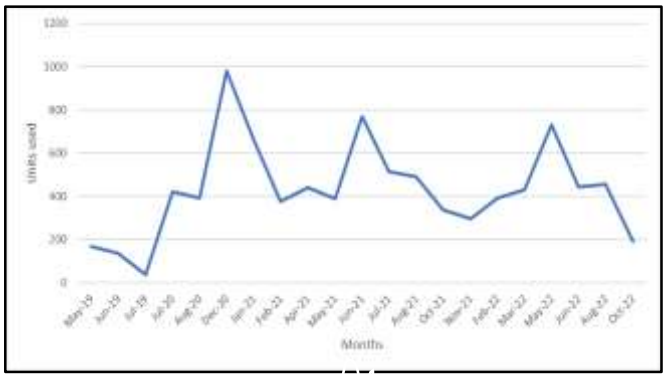

Fig 7. Graph Obtained from the Data

The National Fertilizers Limited, Vijaypur, which is a captive power plant that generates its own electricity only for its own consumption and the township surrounding the facility, contributed the data for the authors' research on large-scale usage as well.

Impact of COVID-19 on electricity consumption plant and the township are clearly visible in the aforementioned graphs, which demonstrate a decrease in consumption in the case of the factory and an increase in consumption in the township.

The large-scale information provides a clear view in the change of power consumption throughout the time period of pre post and during COVID-19 and helps us determine that the changes are big enough to be abnormal and due to external factors.

Consumption by Factory: -

The decrement in the power consumption in the case of the factory is lowered by a lot as shown in data chart and graph which is a clear indication of factory not running full time due to restrictions.

YEAR	FACTORY CONSUMPTION (in units)
2019	278491329
2020	261429631
2021	274835143
2022	265915834

Table2. Data Collection (Provided by-N.F. L)

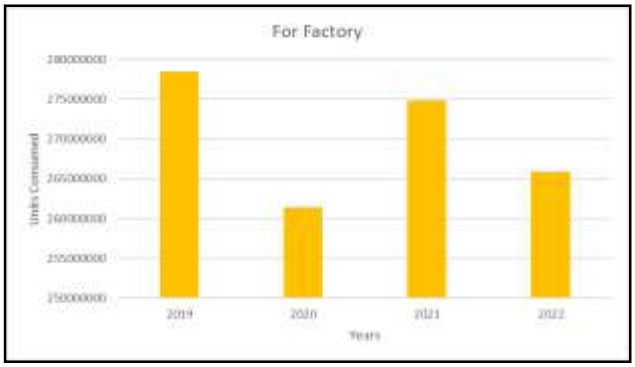

Fig 8. Graph Obtained from the Data (Provided by-N.F. L)

Consumption by Township (Large scale): -

The increase in power consumption of the township sees hikes in the COVID-19 period as shown in data chart and graph due to people being home more.

Table3. Data Collection (Provided by-N.F. L)

YEAR	TOWNSHIP CONSUMPTION (in units)
2019	3316290
2020	359623
2021	3614719
2022	3564850

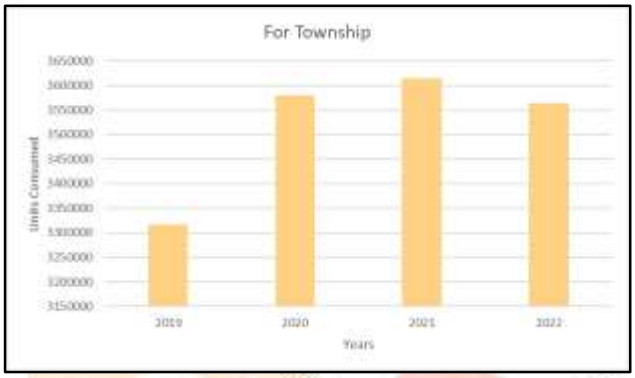

Fig 9. Graph Obtained from the Data (Provided by-N.F. L)

VI. DISCUSSION

The spread of COVID-19 has had a negative impact on India's energy sector, causing not only some severe reductions in usage of roughly 25% during the pandemic but also some issues as a result of an increase in usage after the epidemic ended because the power sector was unprepared for the increase.

The first thing to be discussed is the decrease of energy used in India during the year 2019, which was the first year of the epidemic; the decrease was around 25%. In the later year, which is 2020, there was a further decrease of power of around 10-15% due to further restrictions and Janta curfew; all of this also led to a lot of financial issues which we will discuss later [27]. Energy usage decreased even more as a result of the tightening of the lockdown parameters, which caused a stop in the production of non-essential items and a complete shutdown of commercial buildings like offices and malls. To sum up, all of this reduction was caused by severe factors that the authors have discussed in more detail.

The second point of discussion was regarding the power sector of India and how they handled the situation, there changes, the new rules, and how it will change in the future. The first noticeable change was that for the first time in two decades, coal's share of energy production dropped by 25%, and this forced the authorities to switch to renewable fuels for primarily two reasons [27], which being: -

- The renewable sector plants are cheaper in comparison to the coal plants.
- It was a chance to change the power sector of India towards the renewable energy and make it cost effective

However, COVID-19 had also made things less advantageous for renewable energy. In previous papers [25], the authors had concluded that switching to renewable sources would increase economic sustainability but our study reveals that although there was a shift to these resources, the renewable sector didn't have much success due to their fluctuating demand. In that bad scenario, the lack of trust in new things by the public, supply restrictions, and the decline of investment in this sector all contributed to the disadvantageous state of the power industry as a whole.

The third point that was made was that the financial situation of the industry had changed as a result of the epidemic. The industry lost $12 billion as a result, making it impossible for them to repay the renewable energy suppliers. This not only made the situation worse for the sector now but also damaged their ability to continue in the future.

The problem comes in the distribution of the supplies required to produce renewable energy, which India was mostly importing from China [26]. As a result of the severe limitations, many of these supplies were blocked or delivered later than expected, delaying the completion of several projects. All these issues can be

solved is the government decides to take some budget losses right now for a better future of the power sector and India.

VII. Conclusion

A case study pursued using data collected in the residential sector for the pre and post COVID-19 situation that shows while the electricity usage was similar in the pre- and post-situation, it did experience significant spikes during the COVID-19 time period that were not typically expected to occur. We can see the difference between the large-scale residential power consumption and domestic level usage through graphs in fig.7 and fig.9, and where you might not see a significant change in industrial level usage through graphs in fig.8, the authors' data collection efforts in both the industrial sector and the residential sector in both small and large scales led them to the conclusion that there is a noticeable change in the power consumption in all cases, whether it be an increase or decrease.

VIII. Acknowledgement

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