USAID
FROM THE AMERICAN PEOPLE

SARI/EI

IRADe Integrated Research and Action for Development

Impact of COVID-19 pandemic on South Asian Power Sector

May 2020

Prepared by

SARI/EI Project Secretariat

Mr. V K Agrawal, Technical Director, SARI/EI, IRADe

Mr. Rajiv Ratna Panda, Technical-Head, SARI/EI, IRADe

Dr. Jyoti Parikh, Executive Director, IRADe

Mr. Mohnish Makwana, Research Assistant, SARI/EI, IRADe

Disclaimer

This study is made possible by the support of the American people through the United States Agency for International Development (USAID). The content of this study does not necessarily reflect the views of USAID or the United States Government.

Integrated Research and Action for Development (IRADe) does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequences of their use. By making any reference to a particular geographic area, or by using the term 'country' in this document, IRADe does not intend to make any judgment on the legal or other status of any area.

The information/data as existed in the public domain and obtained/collected from the various primary and secondary sources as on 20th April 2020 has been used on an 'as-is' basis without any independent verification by IRADe. While every care has been taken to ensure the accuracy of the data/information furnished, IRADe will not be responsible in any manner whatsoever for any error or omissions, or for the results obtained from the use of this data/information and provides no assurance regarding the accuracy, timeliness, adequacy, comprehensiveness and/ or completeness of such information.

IRADe will not be liable for any losses and damages arising as a result of any inaccuracy or inadequacy or incomprehensiveness or incompleteness of such information. Any changes and updates made in the data/information after 20th April 2020 has not been incorporated as a part of this study.

All the sources and references utilized for this study have been recorded as part of footnotes and a separate section on references. The original authors retain all copyrights for such content, and any information utilized in this report from such sources are being utilized for non-commercial use.

The research paper and its findings do not necessarily reflect the views of the SARI/EI Project Secretariat. The report can be considered as a base document for further analysis and it aims to stimulate further discussion and analysis in South Asia.

IRADe-SARI-26 (2020)

INTRODUCTION

Coronavirus Disease (COVID-19) is an infectious disease caused by a newly discovered and highly contagious Coronavirus. The virus was stated to have originated sometime in the month of December 2019 in the Wuhan district of China. By 11th of March 2020, the World Health Organization (WHO) declared COVID-19 as a pandemic, after it had spread to more than 100 countries with a large number of positive cases as well as deaths. Though in South Asia the spread of COVID-19 was initially not as serious, it assumed a serious concern in South Asian Countries (SACs) by the middle of March 2020. Most of the SACs had to introduce lockdown measures, including social distancing and limiting economic activities, to counter the spread of COVID-19. The status of the lockdown timelines in SACs countries are presented briefly as follows:

- On 27th March, the Afghanistan government [1] announced lockdown in Kabul for three weeks, which was later extended by three weeks until 9th May 2020 and then further extended till 24th May, 2020[1].

- Bhutan confirmed its first COVID-19 case on 6th March, and immediately restricted entry of foreign tourists for two weeks, and sealed all international borders on 23rd March [2]. District-wise lockdown was imposed from 1st of May 2020[2] following suspected community transmission.

- In Bangladesh, the first three known cases were reported on 7th March 2020. Though initially the infections stayed low, they started increasing gradually. On 23rd March, the Government declared a ten-day nationwide holiday for the period 26th March–4th April, ordering all public and private offices to be closed, with the exception of emergency services. The lockdown measures were extended from time to time, initially [3] up to 25th April, 2020, then till 16th May, 2020[4] and further till 31st May, 2020[3].

- The first case of the COVID-19 pandemic in India was reported on 30th January 2020 and the Government took various precautionary measures, such as screening of incoming passenger at the airport. In order to arrest the spread of COVID-19 and to ensure social distancing amongst the people, lockdown in whole of the India was imposed w.e.f. 25th March 2020, initially for a period of 21 days up to 14th April 2020, and then continued further till 3rd May 2020[5]. It was later extended till May 31 with some relaxation [6].

- Nepal reported its first case of the COVID-19 pandemic on 24th January 2020. A country-wide lockdown came into effect on 24th March, 2020[7], scheduled to end on 7 May, 2020[8]. This has been further extended to June 2nd, 2020.

- The COVID-19 pandemic reached Pakistan on 26th February 2020. The country was put under a nation-wide lockdown until 9th May, 2020[9], which was initiated on 1st April and later extended twice. A partial lock down has been extended further till 31st May 2020 [9].

* On 27th January, the first confirmed case of the virus was reported in Sri Lanka[10], post which various curfews and lockdown measures w.e.f. 18th March, 2020 were put in place to limit the spread of COVID-19. The curfew in the capital district of Colombo and three other high-risk zones for COVID-19 were initially imposed till 4th May 2020 and later extended till May 11,2020.

* Maldives [11] announced a period of 14-day lockdown in Male region beginning from April 17, 2020.

Comprising over 21% of the world's population, the SAARC region is highly vulnerable to COVID-19. In an innovative approach that demonstrates solidarity amongst the regional partners to contain the pandemic, a video conference was held on March 15, 2020 by the SAARC leaders to discuss ways to combat the coronavirus through collective efforts. An important outcome of this collaboration was the creation of the SAARC Emergency Response Fund for COVID-19[12].

The lockdown imposed in the SACs to contain the COVID-19 pandemic presented a unique challenge to the power system operators due to a substantial reduction in the demand in the electricity grid for a sustained long period. Under the lockdown, in general, all the offices and industrial & commercial units, except for the establishments which come under the category of essential services were closed. This resulted in steep reduction in electricity consumption and thereby caused a large gap between demand and supply.

In South Asia (SA), the countries of BBIN region - Bangladesh, Bhutan, Nepal, and India - have a physically interconnected grid. Therefore, the reduction in demand in all these countries caused additional availability in the regional grid. In a power system based on the natural load patterns, the occurrence of certain variations in the demand during the day is a normal phenomenon. In a large grid like that of India, since these variations are spread over a wide area due to diversity of demand and other factors, such variations are addressed seamlessly. However, during the current period when the system demand was already on the lower side due to favorable weather conditions, the lockdown situation resulted in an abnormally large reduction in the electricity demand and threw unusual challenges to the grid operators

This paper describes in detail the different challenges under these conditions and how each of these was dealt in a suitable manner. It further gives an insight about the robustness of the systems and principles on which the electricity grid in South Asia in general and in India in particular, are operating. It also gives an opportunity to appraise how the standard systems and procedures can be refined further to meet such situations in future. The paper also touches upon the impacts on the Cross-Border Electricity Trade (CBET) flows due to reduction in demand in the neighboring countries within South Asia. The analysis in the paper in respect of the cross-border power flows and related impacts mainly focuses on Bangladesh, Bhutan, India, and Nepal, as these are the four countries currently operating in an interconnected mode within the region. The exact date of lockdown varies among BBIN countries and for the shake of uniformity in analysis in this research paper, 18th-24th March is considered as pre-lockdown period and 25th-31st March 2020 as post lockdown period.

II. COVID-19 IMPACTS ON THE POWER SUPPLY POSITION OF SOUTH ASIAN COUNTRIES

The South Asian countries under the BBIN Region, viz. Bangladesh, Bhutan, India, and Nepal, are connected through cross border links. The prevailing interconnections for exchanges within these countries are shown in *Figure 1.* The major cross-border interconnections are at 400KV and 220 KV level, and there are a large number of interconnections at 132 KV, 33KV, 11 KV as well. A large number of high voltage cross border interconnections are also being planned among the BBIN countries.

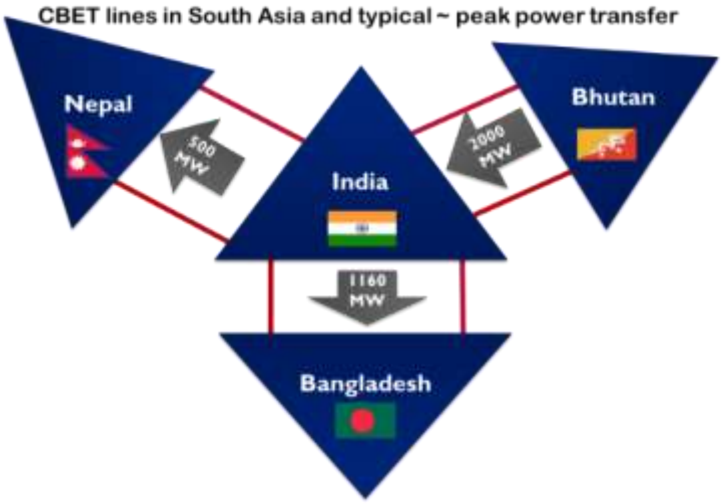

Figure 1 Cross Border Interconnections among BBIN countries

As noted above, at the time of imposition of lockdown in India due to COVID-19, lockdown/restrictions were also imposed in the neighboring countries of Bhutan, Nepal, and Bangladesh. The impact of load reduction in these countries is explained below:

Load reduction in Bangladesh due to COVID-19 restrictions: The maximum peak demand for Bangladesh is around 12,893 MW[13] (recorded on 29th May 2019, 21:00 hours), with Installed Capacity of 18,961 MW[13]. To minimize the effects of spread of COVID-19, Bangladesh declared a 10-day shutdown effective from 26th March 2020. With declaration of the shutdown, electricity generation across the country dropped due to the fall in demand, as most of the industrial units, offices, and businesses were shut down. *Figure 2*[14] shows the trends of change in daily demand and energy in Bangladesh for two weeks, with one week just prior to Covid and the other week Post Covid. The peak demand, which was around 10,790 MW as on 18th March 2020 has gone down to 9492 MW as on 26th March 2020, a decline of the order of 12.02%.

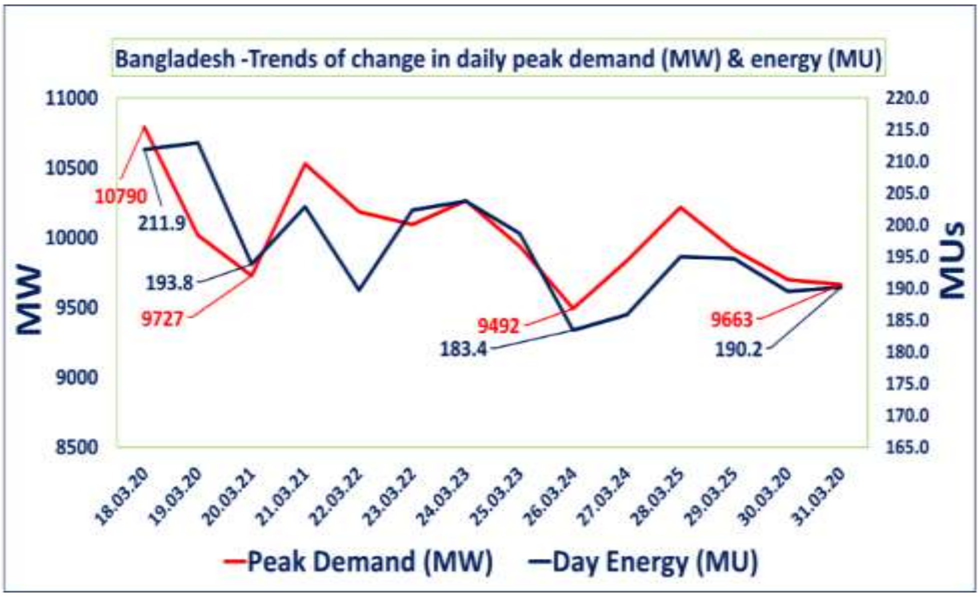

Figure 2 Bangladesh -Trends of change in daily peak demand (MW) and energy (MU) [14]

Restrictions in Bhutan: Bhutan's maximum peak demand is around 399.35 MW (recorded on 27th November 2018 at 18:18 hrs[13]) with an Installed Capacity of 2326 MW[13]***.*** The Bhutan government barred entry of all tourists into the country on 6th March 2020, after a positive Coronavirus case was found. The restrictions are continuing, including those to maintain social distance. The peak load recorded on 23rd March was 338 MW, which fell down by 28.61%. to around 277 MW by 31st March 2020, as shown in the *Figure 3* *[14]*.

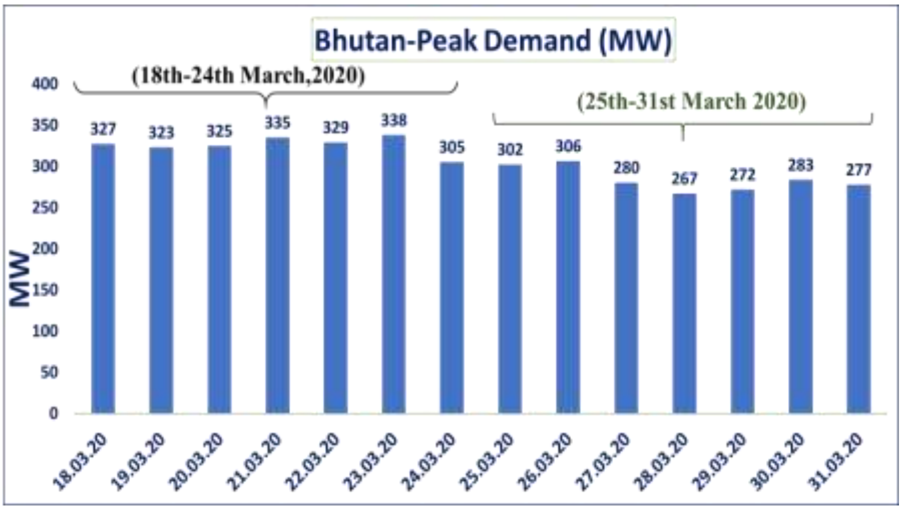

Figure 3 Bhutan Peak Load Change- trends of change in demand [14]

Large reduction in demand in the Indian grid due to lockdown: Currently, the Indian Electricity Grid has an installed capacity of 370GW *[15]* as on March 2020, with the maximum peak demand at around 176.724 GW*[16]* (as recorded on 26th April, 2019). Prior to the lockdown, the peak demand met in the Indian electricity grid on a typical day, say 18th March 2020 (just one week before lockdown) was of the order of around 164.4 GW, with the whole day energy in the range of around 3605 MU. Out of this, the contribution from Hydro was 315 MU (9%), from Wind & Solar (RE) was 251 MU (7%) and the balance (84%) was from thermal sources. However, the lockdown resulted in a substantial reduction in the demand. The *Figure 4*[17] shows the comparison of the demand met in the Indian Grid between the day of lockdown, 25th March 2020 (lowermost curve), with that of 18th March 2020 (uppermost curve), that is, precisely one week before the lockdown imposition.

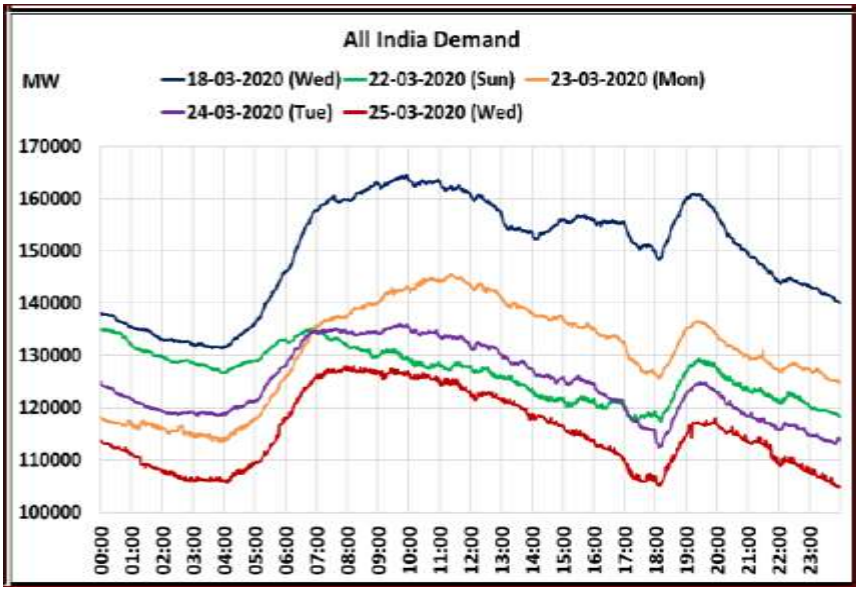

Figure 4 All India Power Demand-Comparison of the demand met [17]

The other three (3) load curves in between pertains to the days - 22nd, 23rd, and 24th March 2020, and reduced demand n be seen on all these days due to the restrictions being imposed in the country w.e.f. 22nd March 2020.

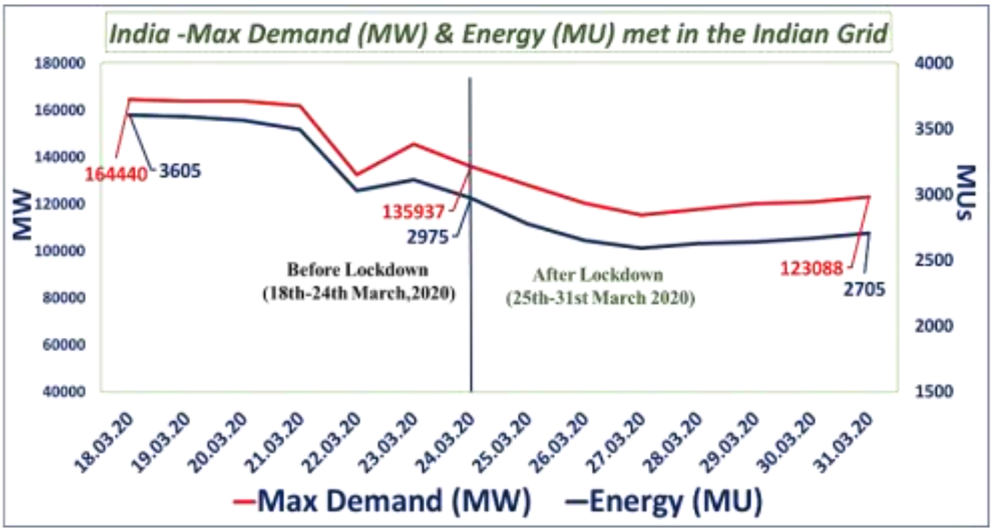

Figure 5[18] shows the comparison of the Max Demand Met and Energy Met in the Indian Grid one week before the imposition of lockdown (18th-24th March) and one week after lockdown (25th-31st March 2020.

Figure 5 India -Max Demand (MW) & Energy (MU) met in Indian Grid [18]

The representative values of variations based on the values shown in Figure 5 [18] and comparing the averages of three days of the Max Demand and Energy Met prior to COVID-19 lockdown vis-a-vis post lockdown, are shown in Figure 6[19]. As can be seen from *Figure 6[19]*, there is a decline in the peak demand by a factor of 26.10 % due to COVID–19 effects, while the decline in Daily Energy met is 25.48%. In fact, on 27th March 2020, the values of Demand Met have come down still lower, i.e. 115.2 GW in terms of Peak Demand and 2592 MU in terms of energy. However, to avoid such individual cases, where the demand may have been affected due to weather conditions too, the average values for the representative week/days have been evaluated in order to present the values in a more realistic manner.

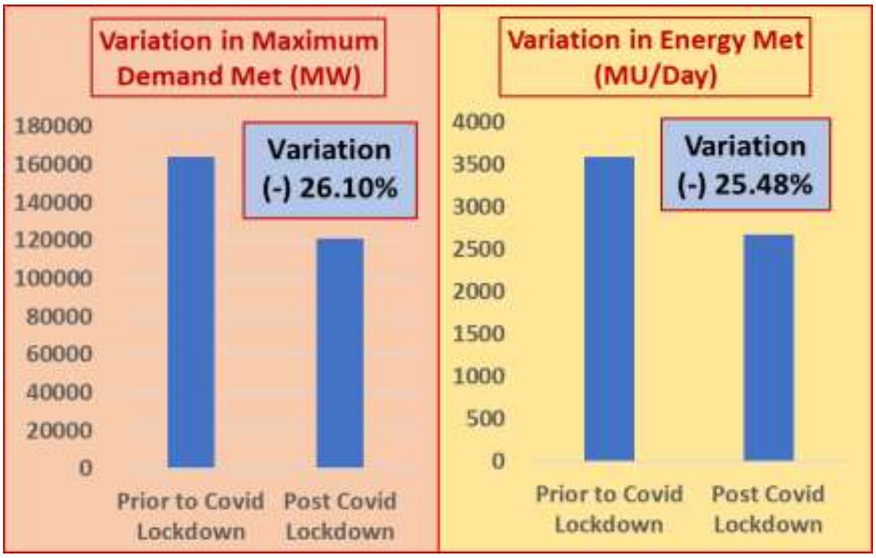

Figure 6 Variation in Demand met in Indian Grid [19]

In order to understand the change in the load pattern during this period, the all-India demand trends curves for a longer duration are shown in *Figure 7[20]*. The first week in the figure (shown in blue color) is for the period 14.04.19 to 20.04.19 i.e. almost one year before the current period. The trends of all the 7 days in the week show normal load pattern with peak demand persisting in the range 155-170 GW. The second week in the Figure 7[20] (shown in green color) is for the period 22.03.20 to 28.03.20, i.e. the week during which the lockout as on 25.03.20 started.

This clearly shows the sharp fall in the peak demand from 160 to 120 GW & below due to the effects of COVID-19. The subsequent three weeks in the Figure 7[20], i.e. from 29.03.20 to 18.04.20, show the peak demand varying in the range 120-130 GW, substantiating that the peak post-lockdown demand settled at an average reduced level of around 40 GW (25%) less than the peak demand during the normal (pre-COVID-19) period. The analysis of the variation in the daily energy figures (MU/Day) is also on similar lines, substantiating that post-COVID-19, there is an additional reduction in power consumption in the country by around 25% consistently for weeks together, which is very high, and affects the techno economic viability of the various components of the power system.

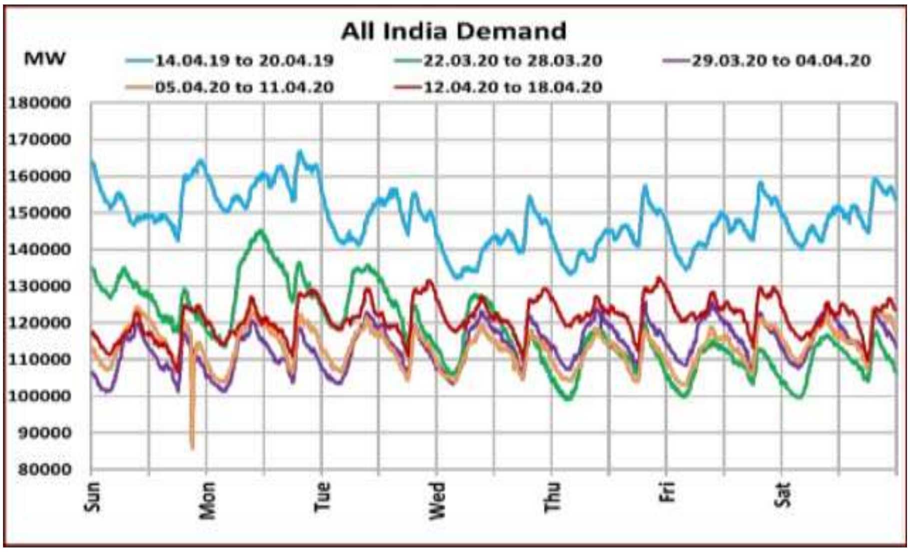

Figure 7 All India Demand trends curves for a longer duration [20]

Figure 8: Daily demand pattern in the All India Grid up to 16th April 2020 [21]

Figure 8[21] shows the daily demand pattern in the all-India grid up to 18th April 2020, indicating a slight increase in the demand reaching up to 130 GW. This is however, in view of the onset of the summer season and increase in some weather beating load. However, looking into the pre-COVID-19 level of demand, which was around 160 GW, the current level of demand is still on a very low side. This unusual situation involving substantial quantum of load crash was managed by flexing/backing down the thermal generation to high values.

This measure averted the need to back down other forms of renewable generation (mainly wind, solar and hydro) which have must-run status, and rendered saving towards carbon emission.

Load reduction in Nepal due to COVID-19 restrictions:

Nepal's maximum peak demand is around 1320 MW[13] with an Installed Capacity of 1200 MW[13]. After observing a positive case of Coronavirus, Nepal has been under lockdown since March 24, 2020, initially imposed for one week. However, after observing another positive case, the country has extended nationwide isolation until April 7, 2020. Figure 9[14] shows the trends of change in daily demand and energy in Nepal during the two weeks. The peak demand, which was around 1153 MW as on 18th March 2020 has gone down to 941 MW as on 31st March 2020, posting a 18.38 % decline.

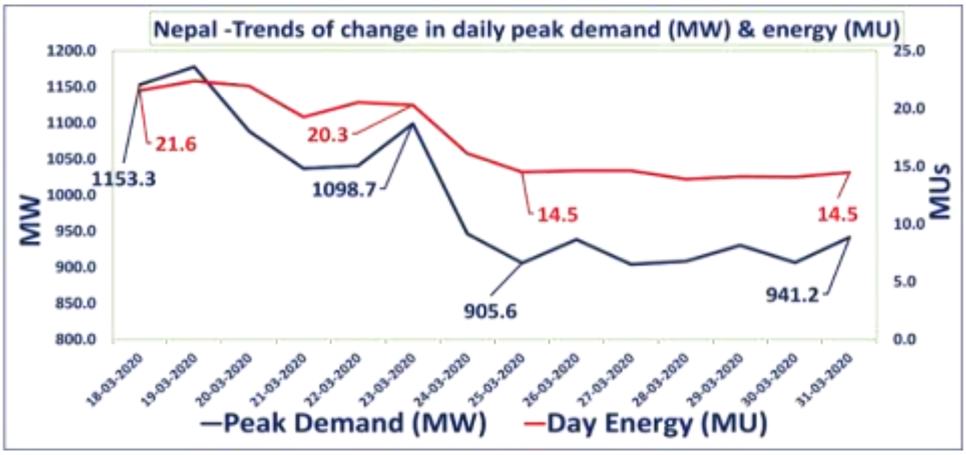

Figure 9 Nepal -Trends of change in daily peak demand (MW) & energy (MU) [14]

III. COOPERATION AMONG NEIGHBORING COUNTRIES THROUGH CROSS-BORDER FLOWS

Due to COVID-19, all BBIN countries imposed appropriate lockdown restrictions almost around the same time. Cross border interconnections exist between these countries and the Indian electricity grid, which is much bigger and wider in size. Due to the large size and capability to absorb, the variations (reduction) in the demand in the other countries, viz. Bangladesh, Bhutan and Nepal, post-COVID -19 lockdown were absorbed by the Indian electricity grid, thereby facilitating the neighbouring countries to address the variations in their respective areas with ease. The specific details of co-operation in the regional grid during this period through cross border flows are as follows:

Facilitating reduced imports by Bangladesh: *Figure 10[22]* shows the power import by Bangladesh from India during the period 18th–31st March 2020, the period one week prior and after COVID-19 lockdown. Similar to Nepal, the post-COVID lockdown period saw a reduction of load in the Bangladesh grid as well.

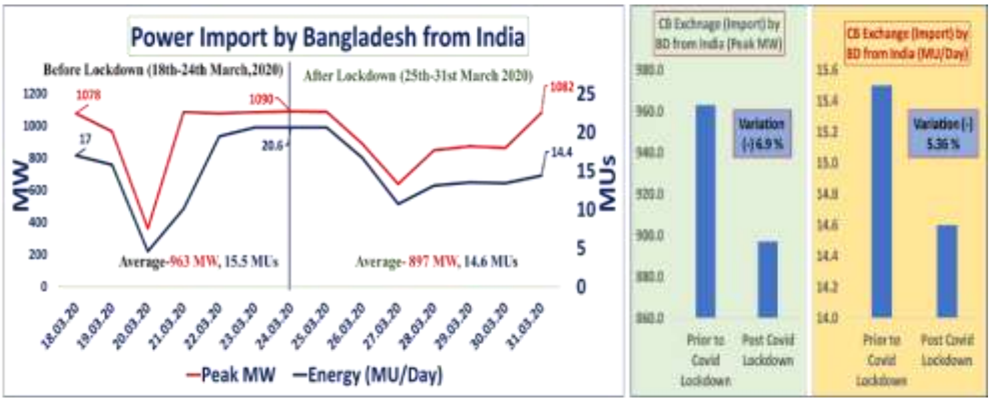

Figure 10 Power Import by Bangladesh from India and % change in variation [22]

Figure 10[22] shows that the import of 'Peak MW' by Bangladesh from India decreased from 963 MW to 897 MW (-) 6.90 %, and the quantum of power imports decreased from 15.5 MU/Day to 14.6 MU/Day (-) 5.36% in Energy terms. In the case of Bangladesh, the quantum of variation is relatively less as compared to Bhutan and Nepal systems. Further, it was in the direction to facilitate the Bangladesh grid towards addressing the surplus situation, arising as a result of the reduction in its load post the lockdown.

Facilitating surplus export from Bhutan: *Figure* 11[22] shows the power export from Bhutan to India during the period 18th-31st March 2020, which includes the period one week prior and after COVID-19 lockdown. Based on above it can be seen that post COVID-19 lockdown, the Peak MW export from Bhutan to India increased from 334 MW to 557 MW (67.14%) and Energy increased from 1.8 MU/Day to 5.9 MU/Day (235%). Enhanced export from Bhutan system to the Indian electricity grid on the cross-border links facilitated Bhutan's grid to manage its surplus conditions during the post-COVID-19 lockdown period, without any reduction in the generation and or commercial implications.

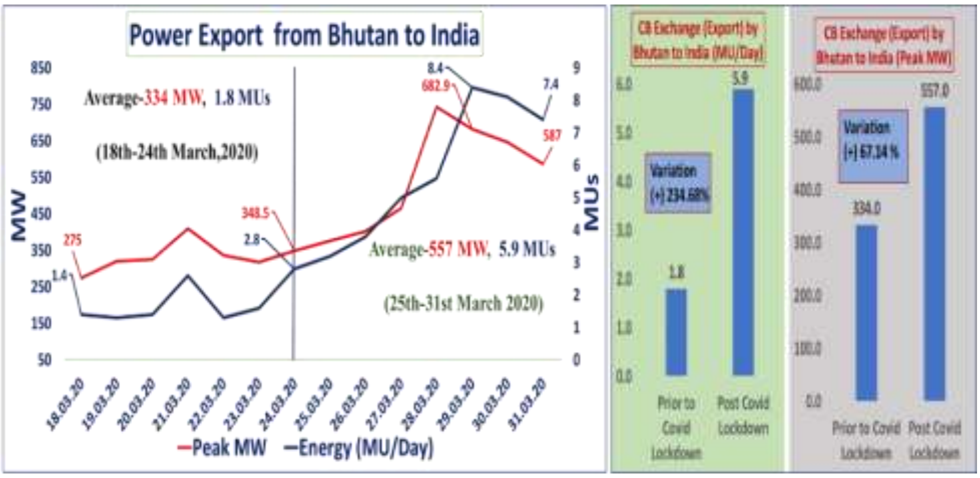

Figure 11 Power Export from Bhutan to India and % change in variation [22]

Facilitating reduced imports by Nepal: *Figure 12*[22] shows the power import by Nepal from India during the period 18th–31st March 2020, the period one week prior and after COVID-19 lockdown. It can be seen that post COVID-19 lockdown period, import of 'Peak MW' by Nepal from India decreased from 510 MW to 207 MW (a decline of 59.49 %) and Energy decreased from 9.2 MU/Day to 2.0 MU/Day (a decline of 78.32%). Nepal too, had surplus conditions during the COVID-19 lockdown period and thus there was a reduction in the quantum of import by the Nepal power system from the Indian electricity grid.

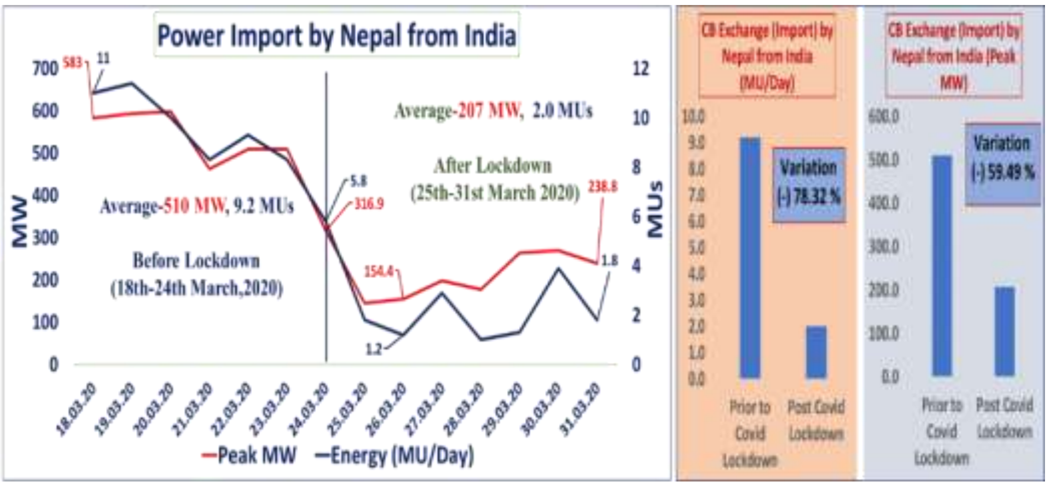

Figure 12 Power Import by Nepal from India and % change in variation [22]

All the above cases highlight the absorption of the additional power by the Indian electricity grid from the grids of the neighboring countries in South Asia, in spite of heavy load reduction in its own (Indian) grid. This is an apt example of how nations can help each other through cross border inter-connections during adverse situations and calamities. Recently, Nepal, India, Bangladesh, Bhutan officials discussed the Covid-19 impact on energy, wherein the ways and means towards extending the cooperation was deliberated further *[23]*.

IV. EFFECTS ON THE ELECTRICITY MARKET (PX) VOLUMES & PRICES

Cross Border Electricity Trade (CBET) through power exchange across all PX products has been allowed by Government of India in the new guidelines on Import/Export (Cross Border) of Electricity-2018. It opens up new opportunities for neighboring countries to take advantage of all products for making the most economical choice for CBET. The Indian Electricity Grid has a number of products in its electricity market, which includes trades during long term period (more than 7 years), medium term period (1 to 3 years) and short-term period (up to 3 months). Additionally, there is another very popular product in the market known as Day Ahead Market under Power Exchange (PX), wherein the price discovery for these trades is carried out in a transparent manner by inviting double side bidding both from buyers and sellers.

The daily price discovered under the PX market is also being used for settling the deviation mechanism amongst the different players in the market. The total volume transacted under PX

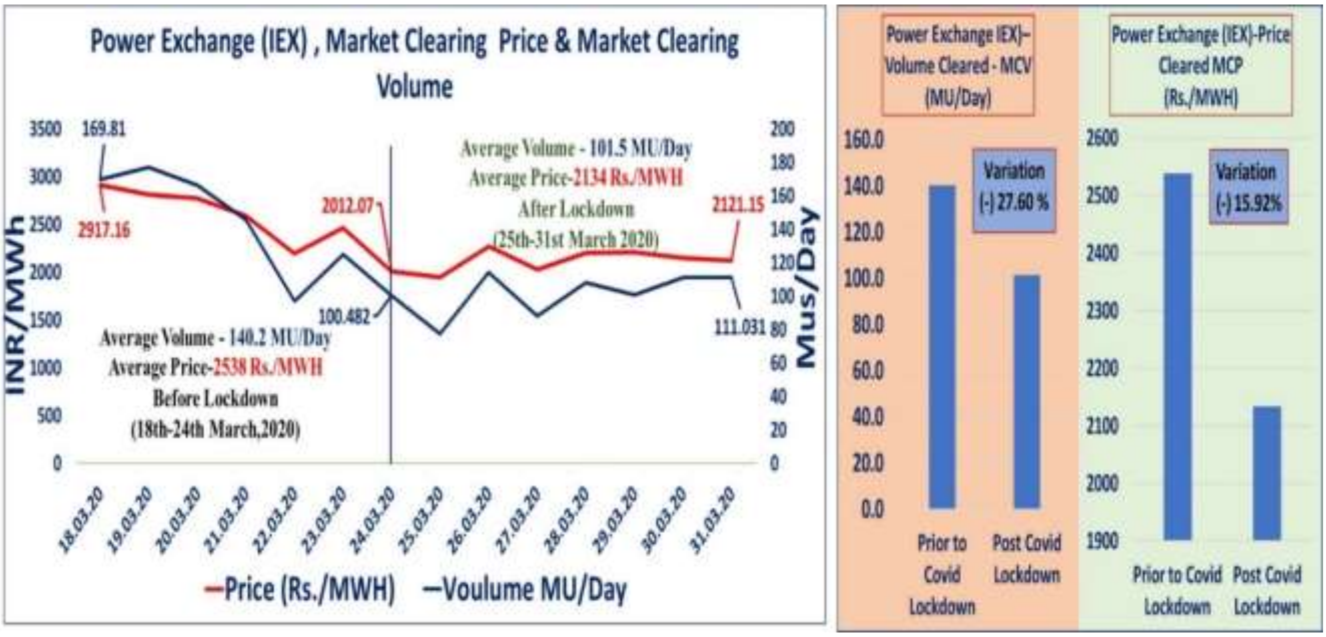

Figure 13 Power Exchange: Market Clearing Volume & Market Clearing Price (MCP) & average drop in MCV and MCP during Pre and Post COVID-19 lockdown [26]

during the year 2018-19 was in the range of around 4.16% [24] of the total electricity consumption in Indian electricity grid, and in the range of 53.52 Billion Units [25]. in terms of energy. *Figure 13*[26] shows the volume of electricity traded (Market Clearing Volume – MCV) in the PX, the discovered Market Clearing Price (MCP) during the periods, just prior to COVID-19 lockdown (18th-24th March 2020) and post COVID-19 lockdown (25th-31st March 2020). It also shows the average drop in the

MCV and MCP due to the effects of COVID-19. As shown in *Figure 13*[26], the average Market Clear Volume post the COVID-19 lockdown dropped from 140.2 MU/Day to 101.5 MU/Day, i.e. a fall of 27.6%. The average drop in the Market Clearing Price was around 16%, falling from Rs. 2538/MWH to Rs. 2134/MWH.

The drop in the market-clearing volume and prices under surplus situation is a testimony towards the sound principles on which the electricity market in India is operating. At the same time, market products of this nature also render valuable avenues and a healthy platform to meet such the contingency conditions in the grid. Once the PX-based day ahead market trades gets operationalized amongst the BBIN countries, such market products shall provide a very good opportunity to trade the power at the market driven rates, even under such critical situations.

V. CONCLUSION

Traditionally, the months of March and April are considered as low demand months due to favourable weather conditions in all the South Asian countries. However, the demand further declined during the COVID-19 lockdown due to limited economic activities in all the countries. The low demand further translated in a decline in cross-border power trade in the region (see table-1 on "Key Findings").

Key Findings
Due to the post-Covid lockdown, peak demand declined by 18.38 % in Nepal, 28.61% in Bhutan, and 12 % in Bangladesh, and ~ 26% in India
The Market Clearing Volume dropped by 27.6%, and the Market Clearing Price declined 16%.
Cross Border Import of 'Peak MW' from Bangladesh reduced by (-) 6.90 % and from Nepal by (-) 59.49 %
Cross Border Export from Bhutan increased by 67.14%.

Table 1 Key Findings of the Report

For example, the peak demand in the Indian electricity grid was around 184 GW in the year 2019-20 [27], while in the current period it was around 164 GW. Under these relatively low demand conditions, there was an additional load crash to the tune of around 40 GW during the peak period due to the lockdown. In respect of daily energy consumption, the additional loss was around 900 GWH of energy, which constitutes around 25% of the normal consumption in the electricity grid. Due to the steep decline in demand, market clearing volume in the day ahead market in the Indian power exchange also dropped by 27.6% and market clearing price declined by 16%. During the lockdown period, due to its larger size and central location, the Indian electricity grid played a pivotal role in maintaining load generation balance in the region.

The additional power due to decline in the power exports to Bangladesh and Nepal while at the same time increased exports from Bhutan was absorbed by the Indian grid. Indian grid operators took necessary measures to keep the control centers operational on round the clock basis. Table 2 lists down some of the important steps taken for continuity of the control centres operation in India.

Some of the main challenges faced by the Indian Grid included: i) continuously managing the load generation balance in real-time; ii) finding out ways and means to protect the must-run status of renewable generation by dispatching them in full; iii) absorbing the additional availability in the grid through flows on the cross border links; and iv) ensuring the continuity of the operation of the load dispatch centers and other control centers. All these were mitigated with success and key highlights in this respect are stated in the Table -3.

Steps taken for Continuity of Control Centres' Operation In India
Strict adherence to the social distancing and other norms to keep the workforce secure
Frequent Sanitization and high level of hygiene in the Control Centres
Except real time, all other off-grid functions converted to Work from Home category
Urgent & frequent calls/video conferencing with other load dispatch centers, through Forum of Load Dispatchers (FOLD)
Keeping the back-up control centre ready and operational to maintain continuity

Table 2 Steps taken for Continuity of Control Centre's Operation in India

Such contingency situations render good insight into how similar situations can be handled in the future. This may be used as an opportunity to create a detailed policy report based on the comprehensive and holistic impact assessment of such a situation. The policy paper can also address how disasters such as COVID-19, which is a unique experience related with the human health involving lockdowns and separations in large areas for longer duration, can be tackled with confidence and satisfaction. The focus of the policy report brief, which will be developed by USAID's SARI/EI program, should be on the ways to maintain the electricity grid operations and continue electricity supply with safety, reliability, and efficiency. The policy report would also develop country specific recommendations on dealing with impacts of COVID on various aspects of energy sector including new generation, transmission, system operation, and distribution.

Key Highlights
Management of Load-Generation balanced in Real Time basis in spite of significant reduction
Maintained the must-run status of renewables in India
Indian grid displayed remarkable resilience through secure operations and cooperation with neighbouring countries
Close coordination among control centres through Forum of Load Dispatchers (FOLD) in India
Load Dispatch Centres kept operational on round-the-clock basis

Table 3 Highlights of the Report

References:

1. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Afghanistan ; https://www.garda.com/crisis24/news-alerts/339176/afghanistan-authorities-extend-covid-19-lockdown-until-may-24-update-5
2. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Bhutan ; https://south-asian-monitor.com/en/bhutan/bhutan-imposes-lockdown-in-rural-district-following-suspected-community-transmission
3. https://www.channelnewsasia.com/news/asia/bangladesh-india-covid-19-lockdown-modi-coronavirus-12633418 ; https://www.aa.com.tr/en/asia-pacific/covid-19-bangladesh-extends-lockdown-until-may-30/1840126
4. https://www.aa.com.tr/en/asia-pacific/covid-19-bangladesh-to-extend-lockdown-until-may-16/1826659
5. https://pib.gov.in/PressReleseDetail.aspx?PRID=1614255
6. https://www.mha.gov.in/sites/default/files/press%20release.pdf
7. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Nepal
8. http://ddnews.gov.in/international/nepal-govt-extends-nationwide-lockdown-till-may-7-contain-covid-19
9. https://tribune.com.pk/story/2206167/1-countrywide-lockdown-stretched-till-may-9/ ; https://timesofindia.indiatimes.com/world/pakistan/pakistan-extends-partial-lockdown-to-may-31/articleshow/75657244.cms
10. https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Sri_Lanka ; https://www.newindianexpress.com/world/2020/may/01/sri-lanka-extends-covid-19-lockdown-in-risk-zones-till-may-11-2138037.html
11. https://www.garda.com/crisis24/news-alerts/333756/maldives-authorities-announce-14-day-lockdown-in-male-region-april-17-update-7
12. https://mea.gov.in/press-releases.htm?dtl/32540/Video+Conference+of+Leaders+of+SAARC+Countries
13. Based on the Country presentation made during the SARI workshop on transition to a synchronous grid-workshop presenting India & other international case studies, august 19 – 21, 2019 new Delhi, India
14. (Bangladesh -Trends of change in daily peak demand (MW) and energy (MU)) ; Bhutan Peak Load Change-trends of change in demand ; and Nepal -Trends of change in daily peak demand (MW) & energy (MU)) :- Based on Data Sourced from National System operator of Bhutan, Nepal and Bangladesh
15. Installed Capacity of India as on March,2020 http://www.cea.nic.in/reports/monthly/installedcapacity/2020/installed_capacity-03.pdf
16. https://www.livemint.com/industry/energy/india-s-power-demand-hit-a-record-high-on-friday-night-1556348316406.html
17. All India Power Demand-Comparison of the demand met: https://posoco.in/download/25-mar-2020-demand-comparison/?wpdmdl=27940
18. India -Max Demand (MW) & Energy (MU) met in Indian Grid : https://posoco.in/reports/daily-reports/daily-reports-2019-20/
19. Variation in Demand met in Indian Grid : https://posoco.in/reports/daily-reports/daily-reports-2019-20/
20. India Demand trends curves for a duration of 4 weeks : https://posoco.in/download/11-april-2020-weekly-demand-comparison/?wpdmdl=28320
21. All India Demand pattern during last one month : https://posoco.in/download/16-april-2020-weekly-demand-comparison/?wpdmdl=28399
22. Power Import by Bangladesh from India and % change in variation; Power Export from Bhutan to India and % change in variation and (Power Import by Nepal from India and % change in variation :- https://posoco.in/reports/daily-reports/daily-reports-2019-20/
23. https://english.onlinekhabar.com/nepal-india-bangladesh-bhutan-officials-discuss-covid-19-impact-on-energy.html
24. Volume of electricity traded through PX during the year 2018-19, http://www.cercind.gov.in/2019/market_monitoring/Annual%20Report%202018-19.pdf
25. Total electricity consumption in the Indian Grid during the year 2018-19, https://posoco.in/download/annual-report-2018-19/?wpdmdl=25328
26. Power Exchange: Market Clearing Volume & Market Clearing Price (MCP) & average drop in MCV and MCP during Pre and Post COVID-19 lockdown : https://www.iexindia.com/marketdata/areaprice.aspx
27. https://powermin.nic.in/en/content/power-sector-glance-all-india

This paper is developed under USAID's South Asia Regional Initiative for Energy Integration (SARI/EI), implemented by IRADe. The USAID initiated the South Asia Regional Initiative for Energy (SARI/E) program in the year 2000 to promote Energy Security in the South Asia region, working on three focus areas: Cross Border Energy Trade (CBET); Energy Market Formation; and Regional Clean Energy development. The fourth and current phase of the program, called SARI/EI, is aimed at advancing regional grid integration through cross border power trade.

About SARI/EI

The US Agency for International Development (USAID) initiated the South Asia Regional Initiative for Energy (SARI/E) program in the year 2000 to promote Energy Security in the South Asia region, working on three focus areas: Cross Border Energy Trade (CBET); Energy Market Formation; and Regional Clean Energy development. The program covers the eight countries in South Asia, viz. Afghanistan, Bangladesh, Bhutan, India, The Maldives, Nepal, Pakistan and Sri Lanka. The fourth and current phase of the program, called South Asia Regional Initiative for Energy Integration (SARI/EI), is aimed at advancing regional grid integration through cross border power trade. This phase is being implemented by Integrated Research and Action for Development (IRADe), leading South Asian Think Tank. SARI/EI program was extended to 2022 and is a key program under USAID's Asia EDGE (Enhancing Growth and Development through Energy) initiative. In its extended phase, SARI/EI will focus on moving the region from bilateral to trilateral and multilateral power trade, and establishing the South Asia Regional Energy Market (SAREM). https://sari-energy.org/

About USAID

The United States Agency for International Development (USAID) is an independent government agency that provides economics, development and humanitarian assistance around the world in support of the foreign policy goals of the United States. USAID's mission is to advance broad-based economics growth, democracy, and human progress in developing countries and emerging economies. To do so, it is partnering with governments and other actors, making innovative use of science, technology, and human capital to bring the profound results to a greatest number of people. https://www.usaid.gov/

About IRADe

IRADe is an independent non-profit, advanced research institute which aims to conduct research and policy analysis to engage stakeholders such as government, non- governmental organisations, corporations, academic and financial institutions. IRADe's focus is effective action through multi-disciplinary and multi- stakeholder research, to arrive at implementable solutions for sustainable development and policy research that accounts for the effective governance of techno-economic and socio-cultural issues. IRADe was established under the Society's Act, in 2002 at New Delhi. https://irade.org/