USAID FROM THE AMERICAN PEOPLE

SARI/EI

20 YEARS Integrated Research and RADe Action for Development

Paper on Risk Mapping and Impact Assessment of COVID-19 on South Asian Power Sector (SAPS):

Policy Measures for Business Continuity and Risk Mitigation

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 2021 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 2021 has not been incorporated in this study.

All the sources and references utilized for this study have been recorded as footnotes. 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.

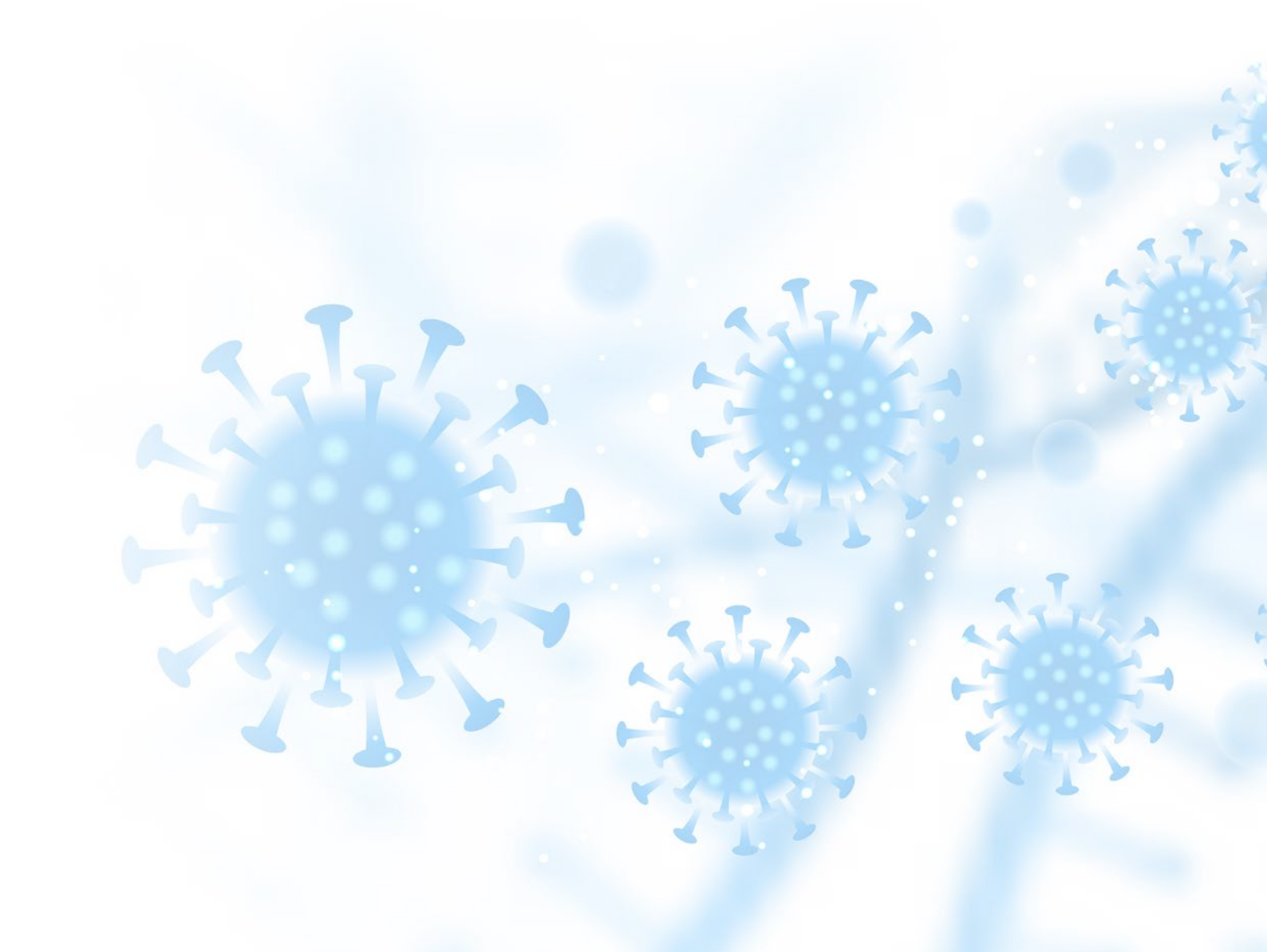
The report can be considered as a base document for further analysis and it aims to stimulate further discussion and analysis in South Asia.

IRADe-SARI-26 (2021)

Paper on Risk Mapping and Impact Assessment of COVID-19 on South Asian Power Sector (SAPS): Policy Measures for Business Continuity and Risk Mitigation

December 2021

Contents



FOREWARD

South Asia is one of the fastest growing regions in the world and energy plays a significant role in its socioeconomic development. Ensuring access and availability of energy, especially in the form of electricity, is central to sustaining the region's expanding economies and its people's rising aspirations. The United States Government is deeply committed to enhancing energy security within South Asia. Since 2000, the U.S. Agency for International Development (USAID) has been working towards this goal by promoting regional energy cooperation through its South Asia Regional Initiative for Energy (SARI/E) program.

The program's first three phases focused on building trust, raising awareness, and assessing potential transmission connections. Phase four, launched in 2012 and called the South Asia Regional Initiative for Energy Integration (SARI/EI), is furthering regional energy integration through cross-border power trade. Integrated Research and Action for Development (IRADe), a leading South Asian think tank, is our partner in implementing SARI/EI's interventions, and countries in the Bhutan-Bangladesh-India-Nepal (BBIN) region are already trading power—efforts expected only to increase in the coming years as the region transitions to tri- and multilateral power trade.

COVID-19 has impacted economies across the world in unprecedented ways, including by taking a toll on the South Asian power sector. This paper, *Risk Mapping and Impact Assessment of COVID-19 on South Asian Power Sector (SAPS): Policy Measures for Business Continuity and Risk Mitigation*, will help prepare the sector to prevent similar adverse impacts in the future.

I would like to commend the SARI/EI secretariat at IRADe for their excellent work in preparing this report. I am confident this study will serve as a valuable resource for the countries in the region for creating a framework to effectively counter similar situations like COVID-19 in the future.

Sincerely,

John Smith-Sreen

John Smith-Sreen
Director, Indo Pacific Office
USAID/India

U.S. Agency for International Development
American Embassy
Chanakyapuri
New Delhi 110 021 Tel: 91-11-24198000 Fax: 91-11-24198612
www.usaid.gov/in

20 YEARS Integrated Research and IRADe Action for Development

PREFACE

We are delighted to present the "Paper on Risk Mapping and Impact Assessment of COVID-19 on South Asian Power Sector (SAPS): Policy Measures for Business Continuity and Risk Mitigation" developed under the South Asia Regional Initiative for Energy Integration (SARI/EI) project, supported by the USAID and implemented by Integrated Research and Action for Development (IRADe).

The pandemic has impacted all sectors of our respective economies as well as the global economy. Through the paper, we wanted to firstly, analyze the impact of the pandemic on the power sector in South Asian countries, and secondly provide policy recommendations to the respective governments for mitigation of the associated risks.

The paper brings forth the various impacts caused by the pandemic - reduction of demand, impact on supply chain management, project execution, grid stability, manpower safety, utility finances and investment.

The paper describes for each country - the background of the power sector; the coverage of the lockdown in various regions or cities in the country and the impact on demand reduction. It is seen that both the electricity consumption and peak demand reduced substantially in Bhutan, India, Nepal and Sri Lanka, and—to a lesser extent—in Bangladesh and Pakistan, due to lockdowns imposed by these countries at different times.

The biggest impact has been on the finances of Power Distribution Utilities, for which various country governments provided some financial relief, to varying extents, to tide over the crisis. The paper offers recommendations on preventive measures that can be taken to see that the impact on the finances of the Distribution Utilities, in such a situation, is mitigated. Apart from the detailed impact analysis, the paper also makes policy recommendations in other areas to mitigate the effects of COVID-19.

The matter was discussed in a webinar of experience sharing by the Distribution Utilities of the countries of the South Asia region. Their inputs and thoughts have helped make this paper more robust and relevant to all the stakeholders.

I hope that this paper will serve as a rallying point for all stakeholders to understand better and respond to the various challenges that have arisen due to COVID-19 in the power sector. I am grateful to USAID for their continued and extensive support in the preparation of this paper. I sincerely thank and appreciate the team at SARI/ EI Secretariat /IRADe, for their valuable contributions and sustained efforts in ensuring that the paper is completed, despite the various pandemic restrictions and adjusting to a new way of working.

Dr. Jyoti Parikh

Jyoti Parikh

Executive Director
Integrated Research and Action for Development (IRADe)

Executive Summary

The study, prepared under the SARI/EI program, evaluates the impact of COVID-19 on the power sector in South Asian countries and provides policy recommendations to the respective governments for mitigation of the associated risks.

The study examines the extent of impact of the pandemic on the sector, particularly due to the reduction in electricity consumption and the peak demand in each country of South Asia. It examines the various impacts associated with the pandemic, that is, reduction of demand, impact on supply chain management, project execution, grid stability, manpower safety, utility finances and investment. These impacts are summarized below:

- **Impact on demand reduction** - It is seen that both the electricity consumption and peak demand reduced substantially in Bhutan, India, Nepal and Sri Lanka, and—to a lesser extent—in Bangladesh and Pakistan, due to lockdowns imposed by these countries at different times. The demand for power subsequently picked up, with the reopening of industry and commercial establishments. Bangladesh and Pakistan reduced their gas and oil based generation, whereas India reduced its coal based generation to take care of the reduced demand. Bangladesh and Nepal also reduced their imports from India. Nepal reduced its hydro generation--which forms almost 100 percent of its generation--for a while, by spilling water from time to time. Bhutan was not required to reduce its generation since it has, as per an international agreement between India and Bhutan, an assured offtaker in India.

- **Impact on fuel supply chain management** - It was seen that there was no shortage of fuel for the power stations. Rather, the power stations in Bangladesh, Pakistan and Sri Lanka were not able to offtake the committed quantity of liquefied natural gas (LNG) for their gas-fired stations. They faced the risk of paying demurrage to the port for non-lifting of the LNG cargoes and the risk of penalty for non-offtake due to the take-or-pay system. Shifting to renewable sources of energy will mitigate this fuel supply chain risk.

- **Impact on project execution** - Many projects were delayed due to imported equipment being held up at the border or non-availability of experts or labor for commissioning. There was the risk of increase in the cost of projects under construction due to the rising interest during construction (IDC).

- **Impact on manpower safety** - COVID-19 adversely affected the health of thousands of people in South Asia. Safety guidelines were issued by respective governments and power sector organizations to safeguard the personnel working in plant premises These guidelines included social distancing, wearing of face masks, frequent sanitization of offices and equipment, cleaning hands with soap/sanitizers, monitoring of temperature, reservation of hospitals for treatment of personnel/quarantining, etc.

- **Impact on distribution utility finances** – Distribution utility finances were affected as electricity consumption reduced. Further, consumption by high paying consumers (industrial and commercial consumers) reduced, whereas consumption by low paying consumers (residential consumers) increased. On the one hand, the fixed charges by the distribution utilities to generators had to be paid, irrespective of drawal of power by them. On the other hand, commensurate fixed charges could not be collected by the distribution utilities from consumers, on account of the tariff design in vogue. Revenue collection also suffered due to non-billing/ average billing and non-collection of payment, as meter readers did not go to the site and consumers who were paying physically stayed indoors. To tackle this, governments announced various financial support packages to the power utilities.

The report provides some policy recommendations as follows:

- Cross border electricity trade (CBET) between South Asian countries should be increased; daily and seasonal variations in demand and resource diversity should be considered for optimal utilization of resources.
- Force majeure in power purchase agreements (PPAs) should include pandemic situations and insurance cover specific to pandemic situation may be availed.
- Tariff design restructuring and risk sharing of the financial burden due to reduced demand should be adopted by the South Asian governments.
- Automatic meter reading and digital payment methods should be adopted to avoid manpower involvement in billing and payment.
- Safety and security of manpower at plant sites should be ensured.
- National disaster management plans must consider pandemic as one of the disasters.
- Cybersecurity should be enhanced in the power sector through a well-defined plan.
- Renewable sources of generation should be encouraged.
- Local manufacturing should be promoted, especially for equipment related to power plants.
- Cost escalation guidelines notified by regulators to estimate the time and cost overruns of power projects should be pre-defined.
- Financial risk mitigation measures need to be adopted to address the liquidity risks of power distribution companies (DISCOMs).

Section 1- Introduction

The novel Coronavirus Disease, or COVID-19, that originated from Wuhan city of Hubei province in China fast escalated into a global pandemic. It caused over 112,209,815 confirmed cases of infections and recorded 2,490,776 deaths, as on 25 February 2021, as per the World Health Organization (WHO) website[1]. COVID-19 has come to be known as one of the worst known health, social and economic crises in modern times.

There is a looming concern over the health and livelihoods of people and the overall direction of the world economy. Many countries imposed lockdowns when the WHO cautioned about the pandemic, which were later removed in phases with the decline in active cases. An assessment by the World Bank[2], in October 2020, estimated that regional economic growth in South Asia will fall by 7.7 percent in 2020. The overall impact will depend on the individual countries and their policy response to support health, livelihoods and the larger economy. The power sector, too, is not immune to the adverse effects of the pandemic. There was initially a big decline in the power consumption, with all industries, barring some essential industries, shops and commercial complexes, under shutdown. Since people were confined to their homes, the residential consumption increased. This increase, however, was outweighed by the drop in power consumption in industries and commercial establishments, resulting in a net drop in demand. There was large scale unemployment on account of the shutdown and many migrant labor went back to their home states/villages. This happened in many South Asian countries such as Nepal, Bangladesh and India. Seeing the huge negative impact on the economy, governments in all these countries decided to relax the shutdown in a phased manner. In such a scenario, revenues of distribution utilities in different countries suffered to different extents and they had to tweak their strategies with respect to manpower planning to adapt to the evolving situation.

This comprehensive study analyzes the issues related to these impacts on the power sector in South Asia. It proposes policy measures to deal with the impacts due to this pandemic and future pandemics, and to reduce the risks to various stakeholders.

The various impacts on the power sector due to the pandemic are as follows:

1. Impact on reduction in electricity demand
2. impact on electricity trade across South Asian countries
3. Impact on fuel supply (supply chain risk)
4. Impact on Project delays – delays in construction/erection of new power plants/sub-stations
5. Impact on Grid stability and operational risks
6. Impact on Manpower risk
7. Impact on Financial condition of utilities

These impacts faced by the power sector in South Asian countries are depicted in detail in Chapter 2.

1 https://covid19.who.int/

2 https://www.worldbank.org/en/news/press-release/2020/04/12/south-asia-must-act-now-to-lessen-covid-19-health-impacts

Section 2- Impact of COVID-19 on the Power Sector in South Asia

2.1 Impact on Power Demand in Various South Asian Countries

Due to the COVID-19 induced lockdowns, both the electricity consumption and peak demand reduced substantially in Bhutan, India, Nepal and Sri Lanka and, to a lesser extent, in Bangladesh and Pakistan. Bangladesh and Pakistan reduced their gas and oil based generation, whereas India reduced its coal based generation to take care of the reduced demand. Bangladesh and Nepal also reduced their imports from India. Nepal reduced its hydro generation—which forms almost 100 percent of its generation—by spilling water from time to time. Bhutan was not required to reduce its generation since it has, as per an international agreement between India and Bhutan, an assured offtaker in India.

2.1.1 Afghanistan

Background

Afghanistan generates around 640 Megawatt (MW) and imports 670 MW from its neighboring countries, Uzbekistan, Turkmenistan, Tajikistan and Iran. In terms of electrical energy, it imported 5000 million units (MUs), against its own generation of 1000 MUs in 2019. In the normal pre-COVID consumption pattern in Afghanistan, residential consumers dominate with 67 percent consumption, commercial consumers with 10 percent, industrial consumers with 13 percent, governmental consumers with 9 percent and holy places with 1 percent. The details of the power sector background of Afghanistan are given in **Annexure I**.

Impact on Reduction in Electricity Demand

On 25th March, 2020, the Afghan Government declared lockdown in Farah, Herat and Nimruz provinces. The lockdown was extended to Kabul, Kandahar, and Logar provinces on 26th March, 2020 and released in stages till 21st May, 2021. The energy consumption and demand significantly decreased throughout the country after the lockdown, especially in the more populated cities such as Kabul, Herat, Kandahar, and Balkh.

Based on the available data, energy consumption decreased in April 2020, as compared to March 2020 for all categories except residential (that pays the lowest tariff), which increased during lockdown because of people staying at home. Consumption by government category, that pays the highest tariff decreased because of limited working hours. Consumption by industrial and commercial categories decreased substantially because of mandatory shutdown of shops and factories, and other commercial activities.

Due to COVID-19, the combined industrial, commercial and government consumption declined to below 10 percent from 32 percent after lockdown, whereas the residential consumption increased from 67 percent to about 90 percent.

2.1.2 Bangladesh

Background

The total installed capacity of power in Bangladesh was 20279 MW as on 31st May 2020. This capacity comprised gas-based power plants (54.14 percent) oil-based power plants (26.81 percent), diesel-based generation (6.36 percent), coal based generation (5.65 percent), hydro (1.13 percent), and renewable (0.19 percent) while rest is imported power (6 percent). Domestic consumption dominates at 57 percent followed by industrial consumption at 28 percent and commercial consumption at 10 percent. The details of the power sector background in Bangladesh are given in **Annexure II.**

Impact on Electricity Demand

In Bangladesh, as the number of coronavirus cases started growing in March 2020, all educational institutions including schools and colleges were closed from March 16th, 2020. All types of public transport, and tourism, industrial and commercial establishments and holiday homes were closed, except for essential commodities. From March 26th, 2020, all government and private offices were also closed at various stages As the government imposed complete lockdown across the country from 26th March to 30th May 2020. The final set of restrictions on public movement were officially lifted on 1st September 2020[3]. The consumer category-wise electricity sales was impacted; residential consumption increased by 8 percent in April 2020 as compared to April 2019; industrial consumption reduced by 35 percent, commercial consumption reduced by 33 percent , irrigation consumption increased by 33 percent, while others reduced by 30 percent.

Impact of COVID-19 on Peak Demand

In Figure 1 below, L1, L2, L3, L4 and L5 represent the different lockdown phases in Bangladesh. The country implemented complete lockdown from 26th March 2020 to 4th April 2020 (Phase L1). This was extended several times to 25th April, 4th May, 16th May, and finally to 30th May 2020 when the lockdown was lifted. All restrictions were lifted by September 2020. These lockdowns affected business-as-usual in Bangladesh, and as a result electricity demand from energy intensive industries fell. The peak demand declined gradually after the imposition of L1. The average peak demand declined by 3.3 percent for the week after lockdown (i.e., 26th – 1st April 2020) vis-a-vis the week before lockdown (i.e., 19th – 25th March). The lockdown L2 resulted in an average decline of about 10 percent in peak demand, due to stricter lockdown enforcement. Power demand started reviving in L3 after 25th April, and increased further in L4 after 5th May, partly due to more air conditioning load on account of increased summer heat and partly due to lifting of lockdown measures[4] as markets, shopping malls and public transport became functional and garment industries opened[5]. The L5 period, starting 16th May, noted a decline in peak demand as the cyclone Amphan hit Bangladesh on 19th and 20th May, which reduced the electricity demand in various parts of the country. It, however, revived in a couple of days due to the arrival of the festive season of Ramzan.

Figure 1: Change in peak demand trend in Bangladesh during 15th March 2020 till 30th May'2020

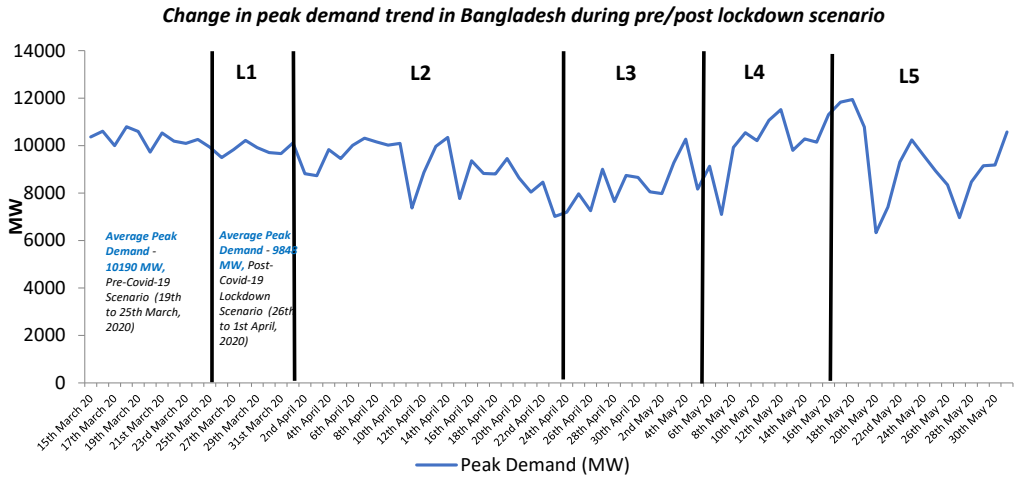


Figure 2 below shows the comparison of peak demand for the months of January to December 2020 with the peak demand for the same months in the previous year. Up to March 2020, it was business as usual, and the peak demand was higher than the same month in the previous year. In April 2020, it dropped by about 14 percent from 11303 MW to 9736 MW and started picking up in May 2020 because of certain exemptions till it exceeded the demand in August 2020 vis-à-vis the same month in the previous year.

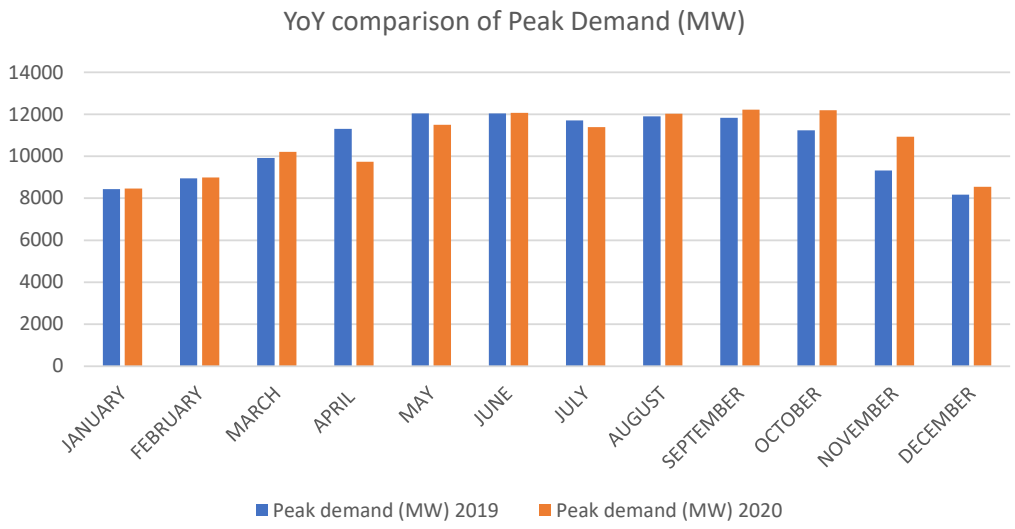
3 https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Bangladesh

4 https://www.wsws.org/en/articles/2020/05/25/soua-m25.html

5 https://www.theweek.in/news/india/2020/05/04/as-india-enters-third-phase-of-covid-19-lockdown-glimpses-from-the-rest-of-the-world.html

Fig 11- https://www.bpdb.gov.bd/

Figure 2: Year-on-year comparison of peak demand in Bangladesh (2019 vs 2020)



As per a Bangladesh Power Development Board (BPDB) report, the country's demand for electricity was expected to increase to at least 14,000 MW in the summer of 2020, due to some 3.5 million new customers in the previous year, and the increase in demand from existing customers. However, it can be seen from the above chart that the electricity demand actually fell due to the COVID-19 induced lockdowns.

The total generation, in Giga Watt hours (GWh), for the months of January to March 2020 was more than the corresponding months in 2019, whereas for April 2020, it fell 33 percent compared to the same month in the previous year, and for May 2021, it fell 42 percent, compared to the same month in the previous year. It started rising from June 2020 onwards, and from July 2020 exceeded the generation in the corresponding months of the previous year. The generation was reduced mainly in the oil-based plants, both public sector and private, and public sector gas-based plants, as well as imports from India. The contracts signed with power plants in India and independent power producers (IPPs) specify that capacity charge has to be paid by the utility, even if power is not drawn. Therefore, it was preferred to reduce the generation, mainly from public sector plants.

The reduction of generation of different sources and import from India (through the two routes, i.e., high voltage direct current (HVDC) from the western border and in radial mode, through Tripura, from the eastern border), is shown in the graphs below. Two graphs, Figures 3 and 4, have been used with different scales, since the generation from some sources like solar and diesel, as well as import from the eastern border depicted in the second graph, were comparatively much less than the other sources of generation/import from the western border (depicted in the first graph).

Figure 3: Source-wise generation trend [Gas, HVDC (import), Oil, Coal] in Bangladesh during 15th March' 20 – 28th May '20

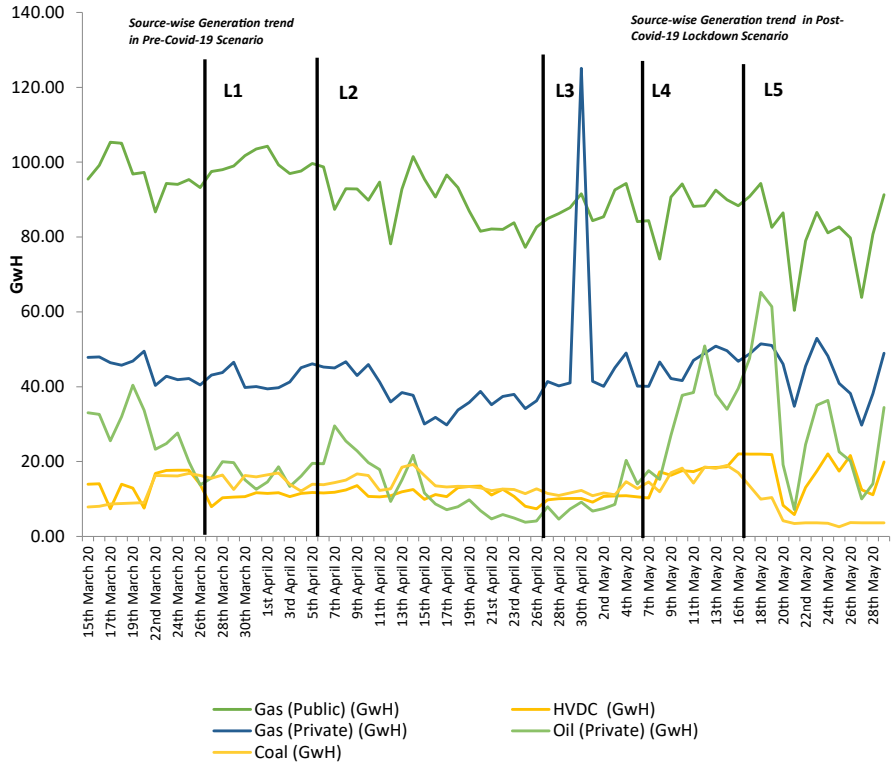
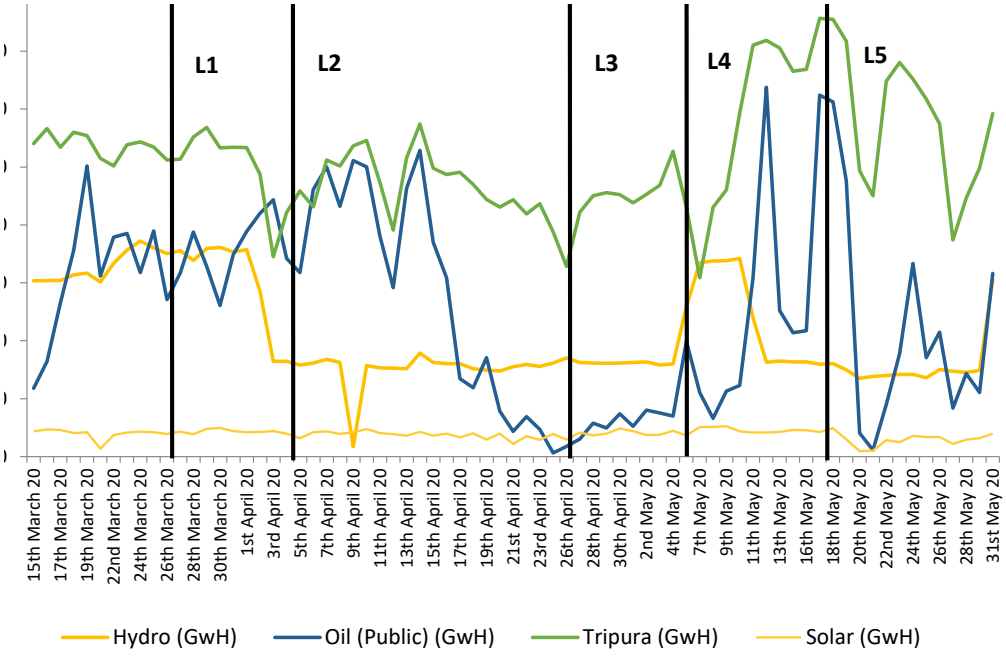
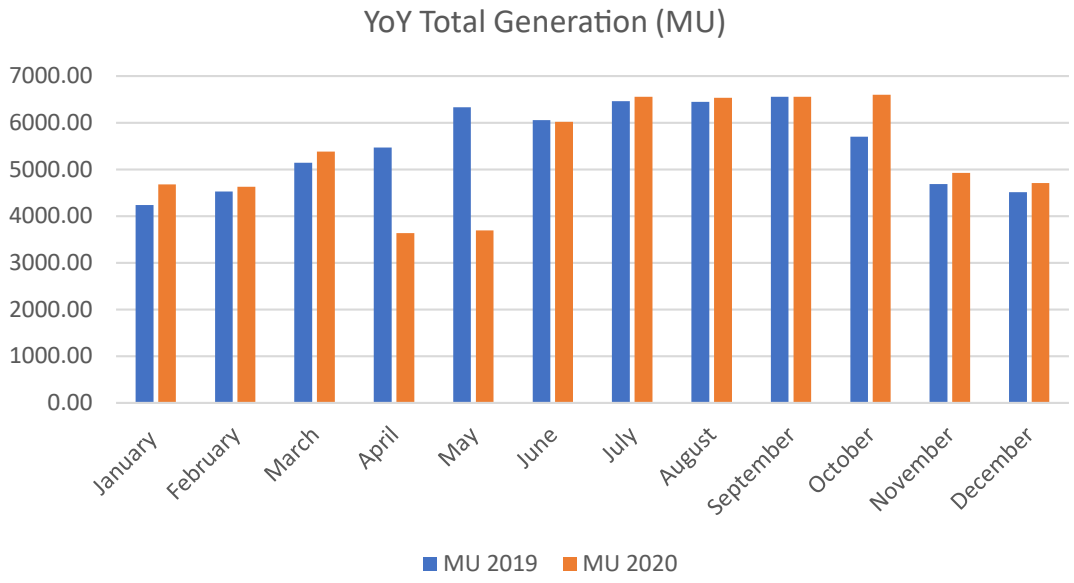


Figure 4: Source-wise generation trend (Hydro, Oil, Tripura [export], Solar) in Bangladesh during pre/post lockdown scenario



Similar to the comparison of peak demand of January to December 2020, compared to the same period last year, the total electrical energy generation for January to December 2020 was also compared with the same period last year.

Figure 5: Comparison of month-wise electricity generation for year 2019 and 2020



2.1.3 Bhutan

Background

Bhutan has an installed capacity of 2342 MW, which is almost totally hydropower, with less than 1 percent from diesel and wind energy combined. Bhutan's peak demand was 420 MW in 2020. The category wise consumption pattern in 2019 in Bhutan was – industrial (77 percent), residential (15 percent), commercial (3 percent), and others (5 percent). The details of Bhutan's power sector background are given in **Annexure III**.

Impact on Electricity Demand

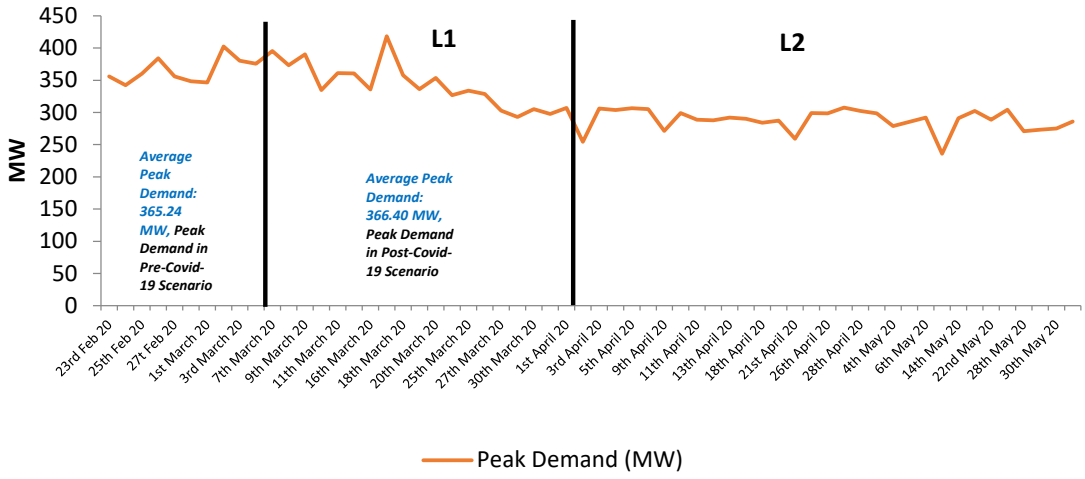
Bhutan confirmed its first Covid-19 case on 5th March 2020 and imposed two weeks of restrictions[6&7]. The Government of Bhutan was among the quickest of South Asian countries to take action by closing schools and educational institutes. On 23rd March, the Bhutanese government shut down its international borders[8] and adopted a range of strict measures. On 31st March, the government decided to extend the quarantine period for 21 days[9] to ensure the strictest preventive measures. Power generation, transmission and distribution units/services, however, were exempted from being shut down as they are classified as essential services. Lockdown was declared on 10th August 2020 and it ended on 14th September 2020.

[10]The figure below shows the daily peak demand from 23rd February to 30th May, 2020, which includes pre/post lockdown scenarios. The average peak demand decreased gradually in the lockdown period L1 in March, which further decreased in the month of April and May due to closure of industries and businesses, import restrictions on raw materials and limited manpower.[11] It can be seen that the peak demand reduced from about 400 MW before lockdown to about 300 MW, a fall of 25 percent in activities. Industries such as cement, ferro-alloys and ceramics have a share of 78 percent in total

6 https://bhutanfound.org/covid-19-coronavirus/
7 https://carnegieindia.org/2020/05/21/bhutan-coronavirus-success-story-pub-81856
8 https://bhutanfound.org/covid-19-coronavirus/
9 https://www.aninews.in/news/world/asia/combating-covid-19-bhutan-increases-quarantine-period-to-21-days20200330154711/
10 http://bpso.bpc.bt/
11 https://www.cemnet.com/News/story/168700/dungsam-cement-reports-impact-of-lockdown.html

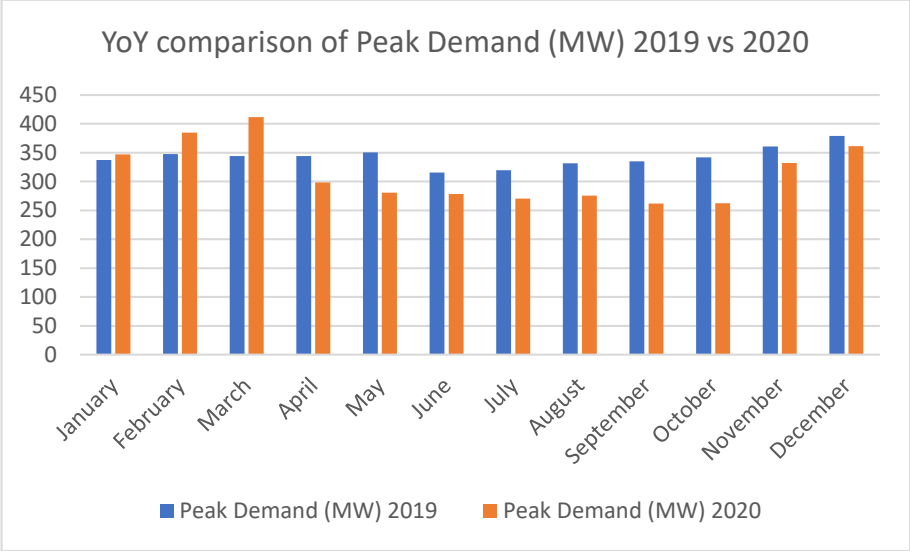
energy demand of the industrial sector.[12] Bhutan's Dungsam Cement Corporation Limited became non-functional due to domestic lockdown measures, import restrictions on raw materials and limited manpower.

[13]Figure 6: Peak demand trend in Bhutan in pre/post lockdownn scenarios



The peak demand of Bhutan from January 2020 to December 2020, compared to the corresponding months in the previous year, is depicted in Figure 17[14].

Figure 7:Year-on-year comparison of peak demand (MW) in Bhutan, 2019/2020s



The month-wise peak demand of Bhutan was higher in January, February and March 2020, than the corresponding months in 2019 due to growth in industrial activities. However, after imposition of lockdown/restrictions, the demand was lower from April to December 2020, compared to the corresponding months in 2019, due to closure of industrial and business activities.

From the data related to the figure given above, it is seen that the peak demand dropped from 344 MW in April 2019 to 299 MW in April 2020, a drop of about 13 percent. A similar trend is observed from May 2020 to October 2020, after which the demand started picking up, due to increase in industrial activities.

12 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RRA_Bhutan_2019.pdf
13 https://bea.gov.bt/
14 http://bpso.bpc.bt/

2.1.4 India

Background

India had an installed capacity of 370 GW, as on 31st May 2020, the largest share being that of coal-based power plants, followed by renewable energy sources and hydro power plants. Coal-based generation is predominant in India in terms of installed capacity (54 percent), followed by renewables (24 percent) consisting of solar, wind, biomass and small hydro (up to 25 MW) capacity, and hydro capacity (12 percent). The category-wise consumption pattern in India in 2019-20 reads: industrial (42.69 percent), domestic (24.01 percent), agricultural (17.67 percent), commercial (8.04 percent), traction (1.52 percent) and miscellaneous (6.07 percent). The details of the power sector background of India are given in ***Annexure IV***.

Impact on Electricity Demand

India imposed a complete nationwide lockdown for 21 days on 24th March 2020. The lockdown measures included suspension of public transport services (rail, road and air), shutdown of industrial activities, educational institutions, malls and other public places, while only essential services were allowed to operate. The lockdown was extended in stages till 3th May, 17th May, 31st May (classified as different lockdown phases in the figure below) and 30th June by the Government of India (GoI) to curb the growing cases of COVID-19 in the country. The construction sector was allowed to reopen after 20th April 2020. In May 2020, some exemptions to the shutdown were granted, with the reopening of government and private offices, and industries in the green and orange zones. Even in the red zones, economic activities involving essential goods and services were allowed to reopen, with certain conditions, and so the demand started picking up from May 2020 onwards. The Indian government permitted some relaxations after 17th May to revive economic activity in the country. The series of lockdown events in the country had an adverse impact on the Indian power sector in the form of lowered electricity demand and generation. The following sections depict the impact on peak demand, electrical energy met and electricity generation in pre/post lockdown scenarios.

[15] Impact on Peak Demand in India

Figure 8: Peak demand trend in India from 18th March to 31st May, 2020

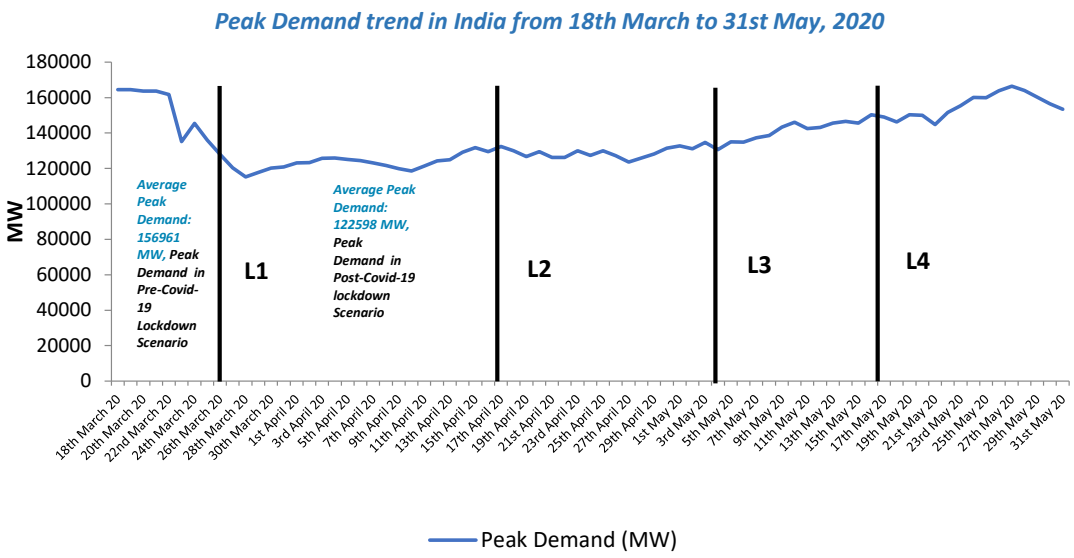


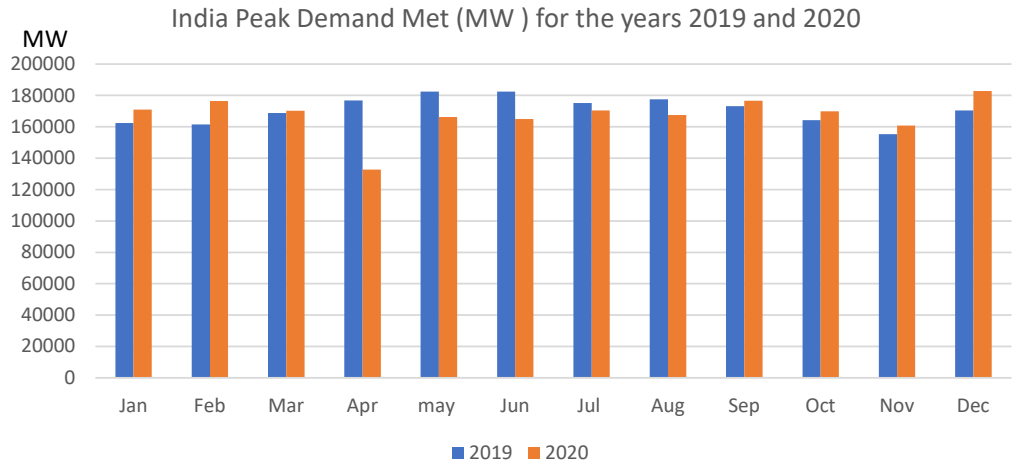
Figure 8 shows the peak demand trend from 18th March to 31st May in the pre/post lockdown scenarios. There was a 21 percent fall in average peak demand during the week immediately following the lockdown, i.e., 25th – 31st March 2020 vis-à-vis the week before lockdown, i.e., 18th – 24th March. As industrial and commercial activities came to a standstill, there was a sharp drop in power demand after 24th March 2020. The lockdown period was extended from time to time by the government, though with some relaxations, which had a corresponding effect on the peak demand, electrical energy met and generation of electricity in India. The peak demand started rising again gradually during L2

15 Fig 8 - https://posoco.in/download/22-03-20_nldc_psp/?wpdmdl=27806 /https://posoco.in/reports/daily-reports/daily-reports-2019-20/

and L3 of the lockdown phases, on account of increase in residential load due to weather beating loads like air conditioners and air coolers being used. The peak demand increased further in L4, as industrial and commercial activities in most of the Indian states were allowed by the government in a bid to kick-start the economy. For instance, approximately 51,000 units in Haryana, comprising large and small industries, brick-kiln units and e-commerce facilities were allowed to run after a long duration of lockdown.

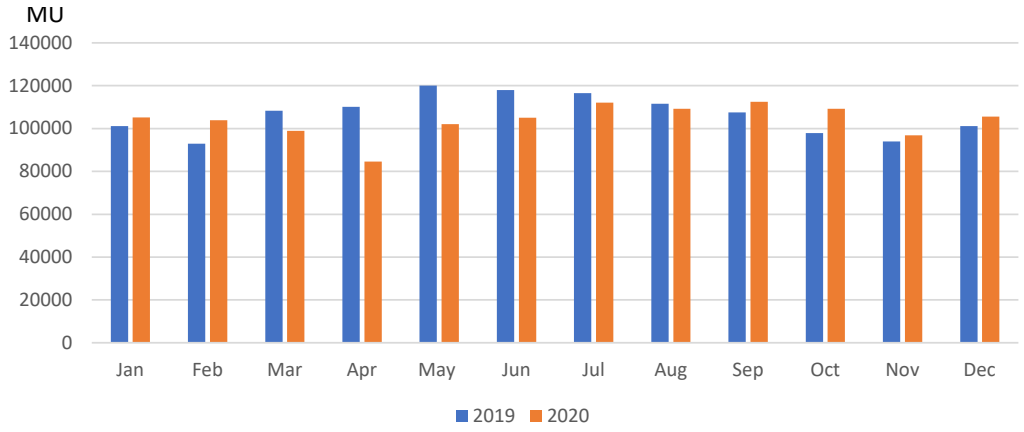
The comparison of peak demand met in India from January to December in 2019 and 2020 is shown in Figure 9.

Figure 9[16]: Comparison of peak demand met in India from January to December, Year 2019 vs. 2020



[17]It may be seen that the peak demand met from January to March 2020 is higher as compared to the corresponding months in the previous year. It was much lower in April 2020, due to almost complete lockdown, and all industries and offices remaining under shutdown. It is seen that the peak demand reduced considerably from 1,76,810 MW in April 2019 to 1,32,733 MW in April 2020, a drop of about 25 percent. It reduced from 1,82,533 MW in May 2019 to 1,66,225 MW in May 2020, a drop of about 9 percent. Peak demand started increasing in September 2020, vis-à-vis the same month in 2019, signifying a return to normalcy. In December 2020, it was higher by 7.2 percent compared to December 2019,

Figure 10[18]: India electrical energy consumption for 2019 and 2020



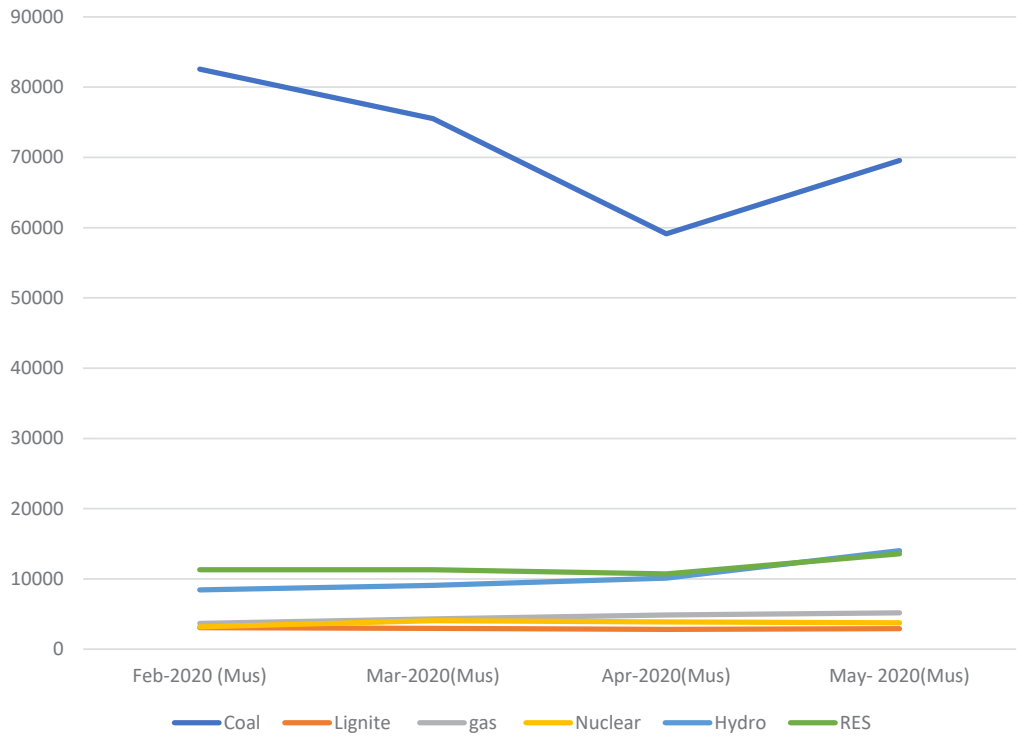
16 Figure 9. https://cea.nic.in/power-supply/?lang=en
https://cea.nic.in/wp-content/uploads/2020/03/psp_peak-12-1-12.pdf ttps://cea.nic.in/wp-content/uploads/power_supply/2021/01/psp_peak-12.pdf
17 https://cea.nic.in/wp-content/uploads/power_supply/2021/01/psp_energy-12.pdf
https://cea.nic.in/wp-content/uploads/2020/03/psp_energy-12-1-12.pdf
18 https://cea.nic.in/power-supply/?lang=en

Similarly, it may be seen from Figure 10 above that the electrical energy met in January and February 2020 is higher, compared to the corresponding months in the previous year. During March to August 2020, it is lower than the same period in the previous year, due to complete lockdown initially, followed by the gradual opening up of business activities. In April 2020, it was 84550 GWh, compared to 110112 GWh in April 2019--a drop of 23 percent; whereas in May 2020, it was 102089 GWh, compared to 120020 GWh--a drop of about 15 percent. The electrical energy consumption from September 2020 onwards increased, compared to the corresponding months in 2019, signifying return to near normal conditions.

In order to meet the reduced demand, it was mainly the coal-based generation that was backed down.

The monthly source-wise generation for the months February to May 2020 is given in Figure 11.

Figure 11[19]: Trend of source-wise generation in India (in MUs)



2.1.5 Maldives

Background

With 1,192 islands spread across roughly 90,000 square kilometers, the Maldives is one of the world's most geographically dispersed countries. This dispersion, coupled with the fact that most inhabited islands are extremely small, makes it challenging to centrally generate electricity and distribute it through a comprehensive grid network–a prerequisite to realize economies of scale. Despite these obstacles, the Maldives became the first country in South Asia to provide universal access to electricity in 2008. Since then, as mandated by government policy, all inhabited, industrial and resort islands have 24-hour electricity service.

Electricity is generated and distributed via a patchwork of independent, isolated, island-based grid systems. Each island has its own powerhouse and distribution facility, effectively operating as single, isolated island power grids. There are 186 powerhouses on inhabited islands (excluding industrial islands and islands used exclusively as resorts, or where service is provided by Island Councils), collectively generating 319 megawatts (MW) from diesel. Two state-owned utilities are responsible for delivering power supply to the majority of these islands: the State Electric Company (STELCO),

19 https://cea.nic.in/opm/auto-draft-316/?lang=en

which operates 35 powerhouses in the Greater Malé region and nearby islands, and FENAKA, which operates over 148 powerhouses in more remote islands. In addition, resort islands, which independently manage their own electricity supply, have 210 MW of installed capacity as of 2018.

The maximum consumption of electric power in Malé, the capital of Maldives, is by residential consumers (a little over 50 percent), followed by businesses (industry and commercial). The tariff is lowest for residential consumers. The electricity consumption (in kWh) of various categories of consumers, as well as the revenue (in MVR--Maldivian Rufiyaa) from them for 2019 is shown in Figure 12.[20] The tariff for businesses is substantially higher than that of the residential tariff.

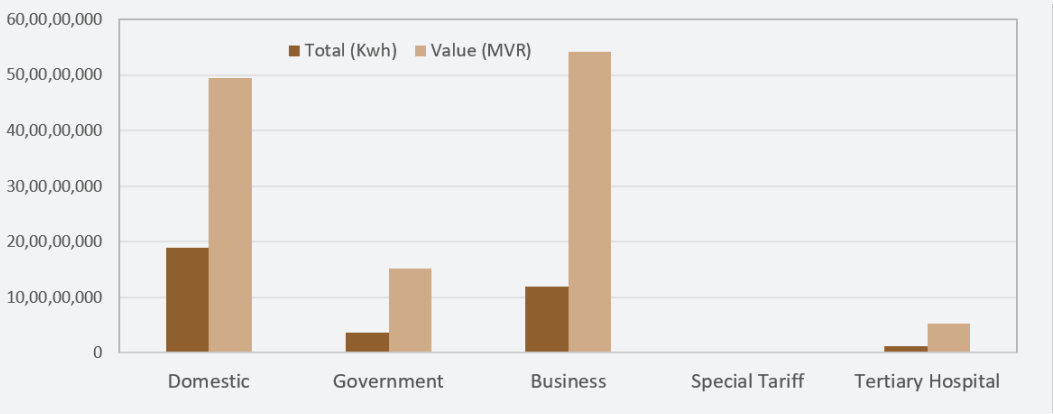


Figure 12: Categorization of electricity consumption in Male, 2019

Maldives relies on imported diesel to meet almost all its power needs. In 2019, the country imported over 700,000 metric tons of fuel, 80 percent of which consisted of diesel–mostly from the United Arab Emirates, and also China, Singapore and Malaysia. The national Strategic Action Plan (SAP) for 2019-2023 includes a specific pillar for "clean energy", including a 2023 target to increase the share of renewable energy in the national energy mix by 20 percentage points compared to 2018 levels. The Government of Maldives also committed to installing a minimum of 10 MW of solar photovoltaic (solar PV) under net metering regulations by 2023.

Lockdown in Maldives

The Maldives took prompt action to tackle COVID-19 well before the index case was confirmed on 7th March, 2020. On 12th March, the Government of Maldives declared a state of emergency, barring visitors from 10 countries, closing schools and prohibiting travel between the resort islands and local islands. Finally, on 27th March, the government took the historic decision of closing its borders to foreign tourists, shutting down two-thirds of its economy. Virtually all inter-island travel and public gatherings greater than three persons were banned nationwide and Greater Malé was under lockdown for nearly two months. These measures began to be phased out starting 28th May, but in a gradual and cautious manner over four weeks. The Maldives reopened its borders to all travelers from all countries on 15th July, 2020, except for the capital city of Malé, which was the source of the majority of the country's coronavirus cases.

Impact on Power Sector

Tourism plays a vital role in the Maldivian economy, providing 60 percent of the foreign currency earnings. There has been a 65 percent year-on-year fall in tourist arrivals from February to May 2020, vis-à-vis the same period last year. No firm figure could be obtained in the public domain on the fall in electricity consumption, but considering an elasticity of about 0.7, the electricity demand would have fallen by about 10 percent. Since tourists would be high consumers of electricity, however, the electricity demand would have fallen by much more, maybe even double of that, i.e., by 20 percent.

20 http://statisticsmaldives.gov.mv/yearbook/2020/

Measures Undertaken

The authorities of Maldives undertook special measures to reduce the suffering of the common people. A subsidy of 40 percent for electricity bills and 30 percent for water bills (issued in April and May) was declared for all Maldivian households.

2.1.6 Nepal

Background

The installed generating capacity of Nepal is predominantly hydro, about half of which is owned by the government utility, the Nepal Electricity Authority (NEA), and the other half by IPPs, which belong to the private sector. Other than that, there is a miniscule percentage of thermal (diesel) and solar power. The installed capacity was 1182 MW in 2019, consisting of NEA hydro (47.66 percent,) IPP hydro (47.33 percent,) thermal (4.52 percent), NEA small hydro (0.38 percent) and solar (0.1 percent). Nepal's consumption is dominated by domestic consumers at 45 percent and industrial consumers at 37 percent. The details of the power sector background of Nepal are given in **Annexure V**.

Impact on Peak Electricity Demand

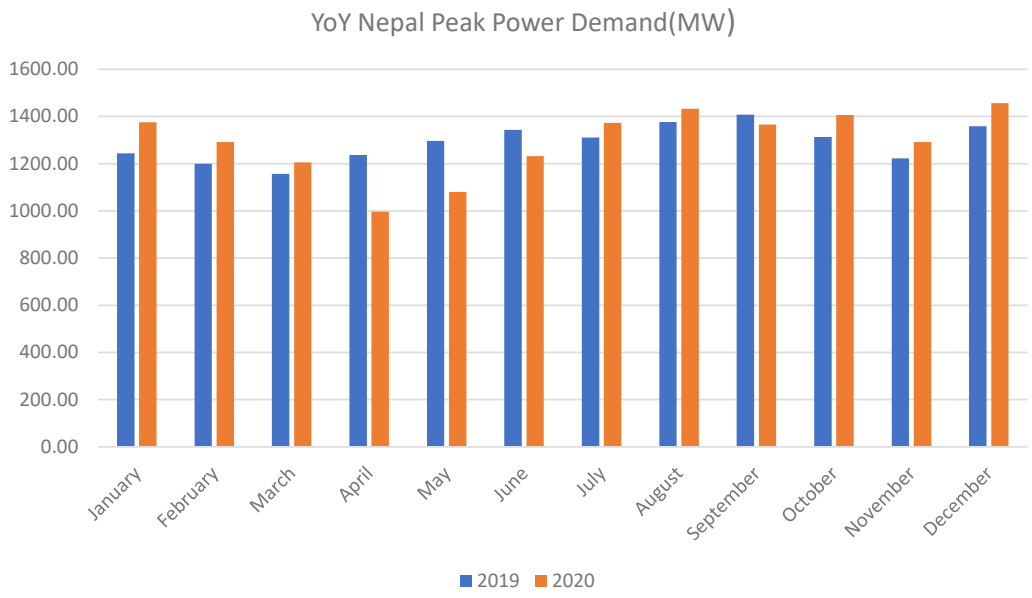
The first corona virus case in Nepal was confirmed on 23rd January, 2020, post which the virus gradually transmitted locally. After the second case was diagnosed on 23rd March, Nepal decided to close its international borders. A country-wide lockdown came into effect on 24th March. The government began easing the lockdown on 12 June, allowing shops to open. Government and private offices, and banks reopened from 15th June, with government staff working in shifts. Private vehicles were allowed to operate on an alternating odd-even license-plate-number basis, corresponding to the calendar date. The lockdown ended on 21st July, 2020.

NEA has reported a decline of about 20-25 percent in peak demand and around 30-35 percent drop in energy demand in the period after declaring lockdown. According to NEA, the peak demand for electricity, which averaged 1,200 megawatts before the lockdown, had dropped to 945 megawatts on 24th evening—a fall of 21 percent—as a result of shutdown of factories, hotels, and businesses. NEA, therefore, stopped electricity imports from India.

Comparing the year-on-year month-wise peak demand, the peak demand fell 19 percent in April 2020 vis-à-vis April 2019, and 17 percent in May 2020 vis-à-vis May 2019. After that, as the lockdown started easing, the demand started picking up. When the lockdown ended in July 2020, the demand exceeded the demand of July 2019, and was mostly higher from then on, compared to the corresponding months in 2019. The comparison is depicted below.

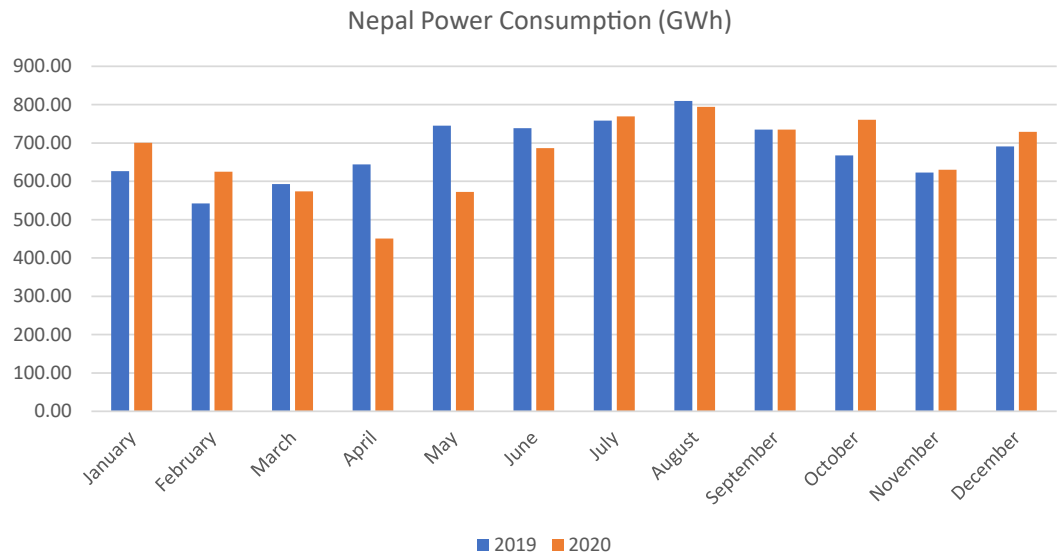
Figure 13: Year-on-year Nepal peak power demand (MW), 2019 vs. 2020

Impact on Electrical Energy Consumption



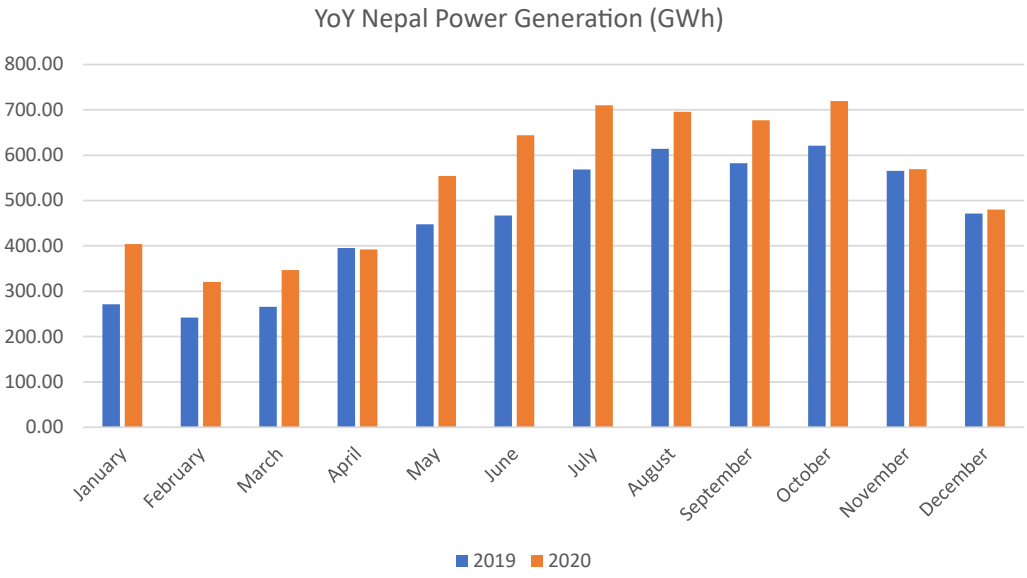
The electrical energy consumption of Nepal dropped 30 percent in April 2020 compared to the consumption of April 2019, and 23 percent in May 2020 vis-à-vis May 2019. It picked up in June 2020 and exceeded the previous year's consumption from July 2020 onwards, when the lockdown ended. The month-wise, year-on-year comparison of electricity consumption for 2019 and 2020 is shown below.

[21]Figure 14: Nepal power consumption (GWh) month-on-month, 2019 vs. 2020



Since the import from India was stopped, Nepal depended on its own generation. Nepal had to spill water during the off-peak hours, i.e., the night hours, for the power plants owned by private developers. In the worst case scenarios, in the night hours, NEA's own hydropower plants also had to spill water, even after taking all possible measures, as there was no power import through cross-border links.[22]

Figure 15: Nepal power generation (GWh) month-on-month, 2019 vs. 2020



21 https://www.nea.org.np/
22 https://www.nea.org.np/

2.1.7 Pakistan

Background

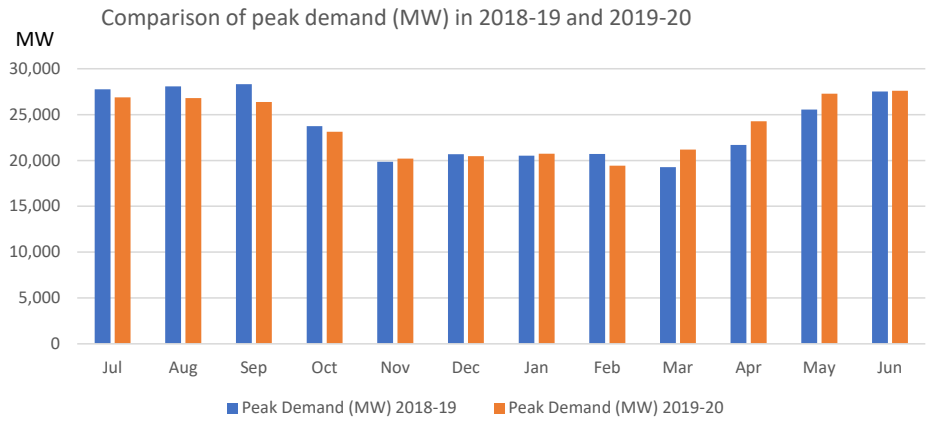
Pakistan had an installed capacity of about 38375 MW, as of July 2019, comprising mainly thermal generation (coal, oil and gas) and hydroelectric power. The thermal generation comprised mainly gas-based plants, the balance being coal and liquid fuel (mainly furnace oil) based plants. The majority of thermal generation is owned by IPPs. The source-wise break-up is as follows: thermal (65.65 percent), hydro (25.46 percent), nuclear (3.69 percent) and renewables (5.21 percent). The electricity category wise consumption pattern is dominated by the following consumers: domestic (48.79 percent), industrial (26.46 percent), agriculture (9.05 percent) and commercial (7.76 percent). The details of the power sector background of Pakistan are given in **Annexure VI**.

Impact on Electricity Demand

Lockdown was declared by the various provincial governments in March 2020. The electricity demand shrank as a result of industrial slowdown caused by COVID-19 induced lockdowns and offices, educational institutes, public transport etc. were shut down. The demand reduced by 25 percent initially. After three months of lockdown, Pakistan's electricity demand was still down by 7 percent.

The electrical energy consumption in 2020 in Pakistan was 98407 GWh as compared to 99046 GWh in 2019, a reduction of about 1 percent.

Figure 16: Comparison of peak demand (MW) in 2018-19 and 2019-20 in Pakistan



2.1.8 Sri Lanka

Background

Sri Lanka had an installed capacity of 5058 MW in 2019. The source-wise break-up was as follows: thermal (43.59 percent), hydro (27.66 percent), coal (17.79 percent) and renewables (10.96 percent). As of 2019, the thermal capacity consisted of 2205 MW oil-based capacity (1504 MW owned by the government utility, Ceylon Electricity Board (CEB), and 701 MW by IPPs). The category-wise consumption in 2017 was as follows: household (37 percent), industrial (33 percent), commercial (28 percent), streetlight (1 percent) and religious (1 percent). The details of the power sector background of Sri Lanka are given in **Annexure VII.**

Impact on Electricity Demand

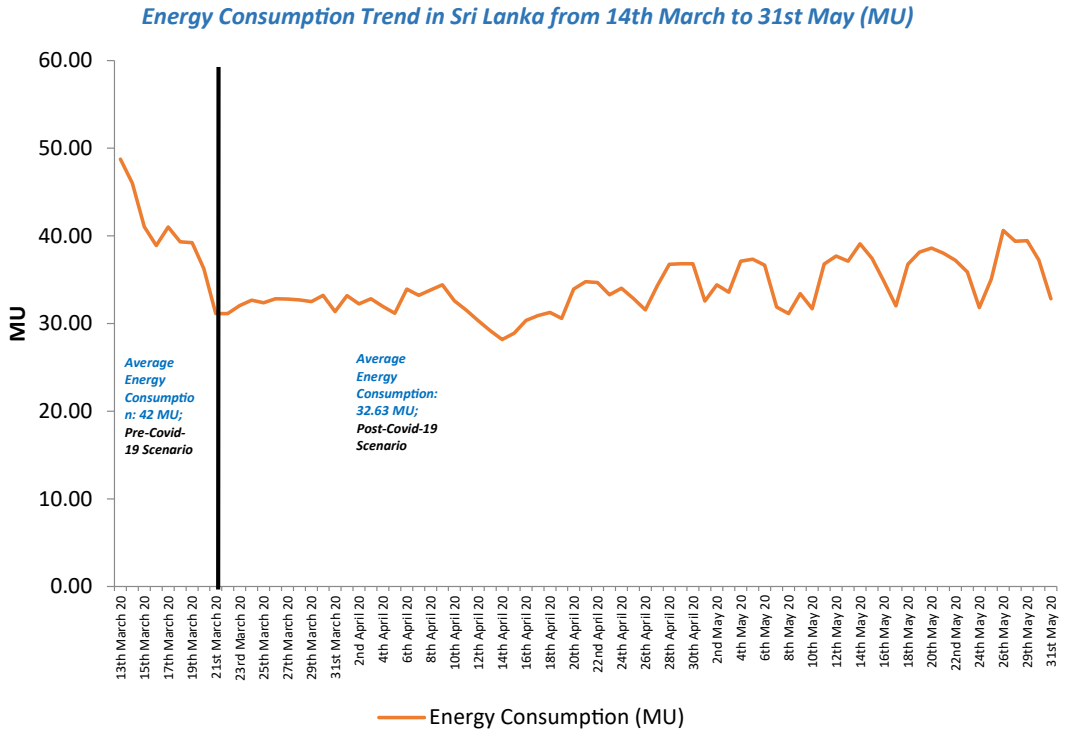
The Sri Lankan government was among the early initiators of the lockdown to curb COVID-19 in South Asia. They banned cruise ship travel on 3rd March 2020 and closed international air travel on 10th March to curb the cases of Covid-19 within the country.[23] A curfew was imposed on 20th March for four days[24] and it was later extended till 27th March, as a quarantine curfew, in most of the parts which were regarded as high risk zones. A similar kind of curfew (or partial curfew) was

23 https://www.garda.com/crisis24/news-alerts/323566/sri-lanka-government-bans-inbound-flights-for-two-weeks-as-of-march-18-update-4
24 https://www.thehindu.com/news/international/sri-lanka-imposes-nationwide-curfew-to-combat-coronavirus-pandemic/article31116503.ece & https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Sri_Lanka

imposed in risk zones of the country in April. The government allowed rubber industries and other high export items' industries to operate during the curfew.[25] In May, the government relaxed curfew in a few divisions and periodic declaration and implementation of quarantine curfew took place till 31st May.[26] From early June, the restrictions were further relaxed with public transport being allowed. On 28th June, the Sri Lankan government completely lifted the curfew after no new case of community infection was recorded for nearly two months. The second wave in Sri Lanka started in October 2020, after which the government imposed an indefinite curfew on 4th October on two western provincial towns in the suburbs of Colombo.

The figure below shows energy consumption trend during pre/post lockdown scenarios in Sri Lanka from 13th March to 31st May. The average values were calculated from 13th – 19th March and 20th – 26th March, i.e., one week before lockdown and one week after lockdown. There was a decline of 22 percent in the average energy consumption for one week after the imposition of lockdown compared to the week before lockdown. It can be seen from the graph, that the energy consumption was gradually decreasing before the lockdown date itself, on account of the signals given earlier by the government by banning cruise ship travel and later international travel.

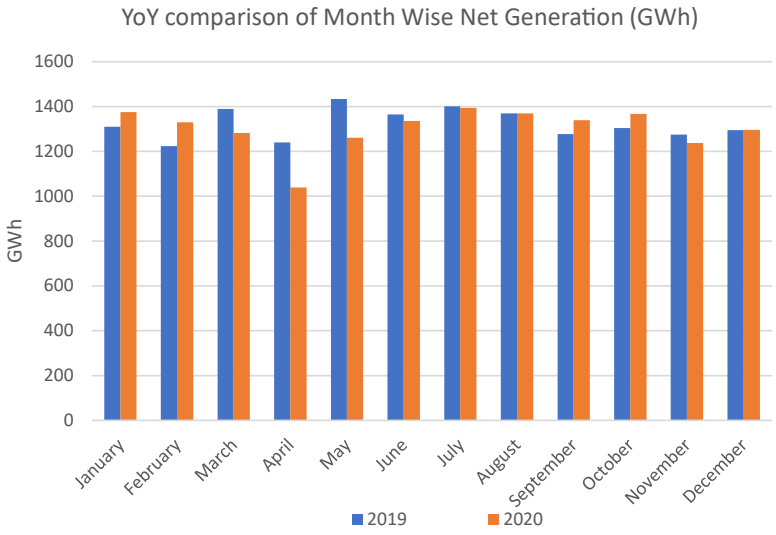
Figure 17: Energy consumption trend in Sri Lanka from 14th March - 31st May (MU)



The electrical energy requirement (net electrical energy generation) met in Sri Lanka from January 2020 to December 2020, compared to the corresponding months in the previous year, is depicted below. There was a sharp dip in the energy requirement in April and May 2020, compared to the same period in the previous year, due to the lockdown. It was lower by 16 percent in April 2020 than in April 2019 and by 12 percent in May 2020 than in May 2019. The requirement gradually started rising from June onwards, till it exceeded the previous year's requirement in September 2020. It again dipped below the previous year's requirement in November 2020 due to the onset of the second wave in November when curfew was imposed. The demand revived again to become equal to the previous year in December 2020, when curfew was lifted gradually.

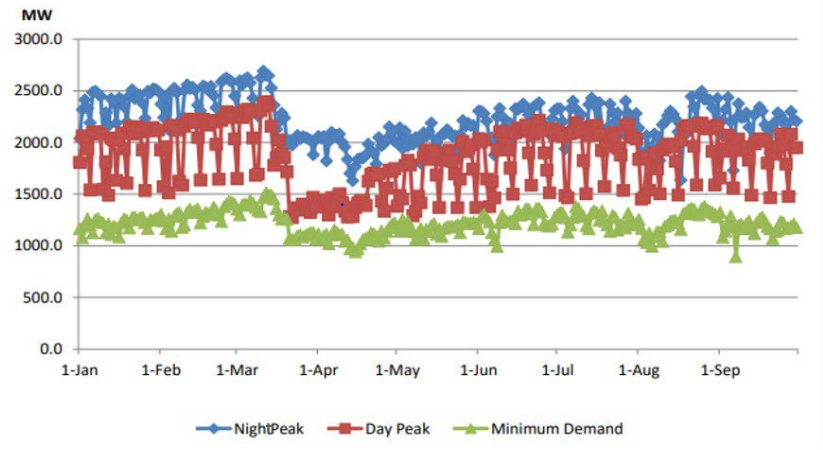
25 https://www.rubbernews.com/coronavirus/gri-rubber-companies-exempt-sri-lankan-lockdown
26 https://www.pucsl.gov.lk/

Figure 18:YoY comparison of month wise net generation (GWh)[27]



Similarly, the trend of peak demand (night demand), day demand and minimum demand from January 2020 to September 2020 is shown below:

Figure 19:Trend of peak demand (day and night demand) and minimum demand in Sri Lanka (2020)



Summary of Electricity Demand Reduction in South Asian Countries

An analysis of the impact of COVID-19 on the power demand and electricity consumption shows that the power demand reduced considerably in all countries of South Asia. In Bangladesh, it reduced marginally by 3.3 percent in the first week and later by 10 percent in the rest of April 2020. In Bhutan, the reduction was 25 percent, in India of 21 percent, in Nepal of 30 percent and in Pakistan by 25 percent. There was no reliable information on the reduction of demand in Afghanistan, Maldives and Sri Lanka. The daily electricity consumption fell 5 percent in Bangladesh, 21 percent in India, and 22 percent in Sri Lanka.

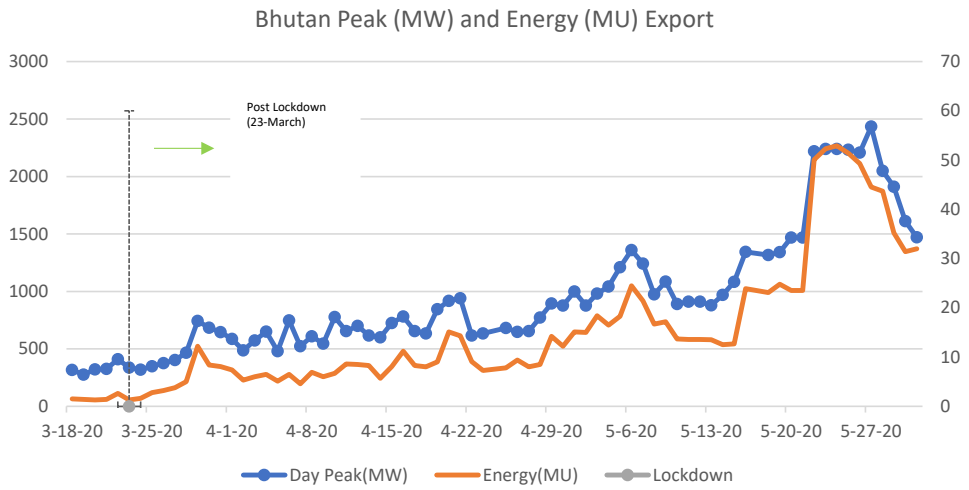
2.2. Impact on Cross Border Electricity Trade

The imposition of lockdown in most of the countries across South Asia at about the same time created changes in the CBET. Bhutan exports power to India, whereas India exports power to Bangladesh and Nepal. Though all cross-border links were maintained, cross border power flows experienced variations, depending on demand variations in the respective countries, as well as the type of power purchase contracts signed. This is shown in the graphs below:

27 https://ceb.lk/front_img/img_reports/1637771317Sales_and_Generation_Data_Book_2019.pdf/https://ceb.lk/front_img/img_reports/1637771442Sales_Generation_Data_Book_2020.pdf

2.2.1 Export of Power from Bhutan to India

Figure 20[28]: Bhutan peak (MW) and energy (MU) Export

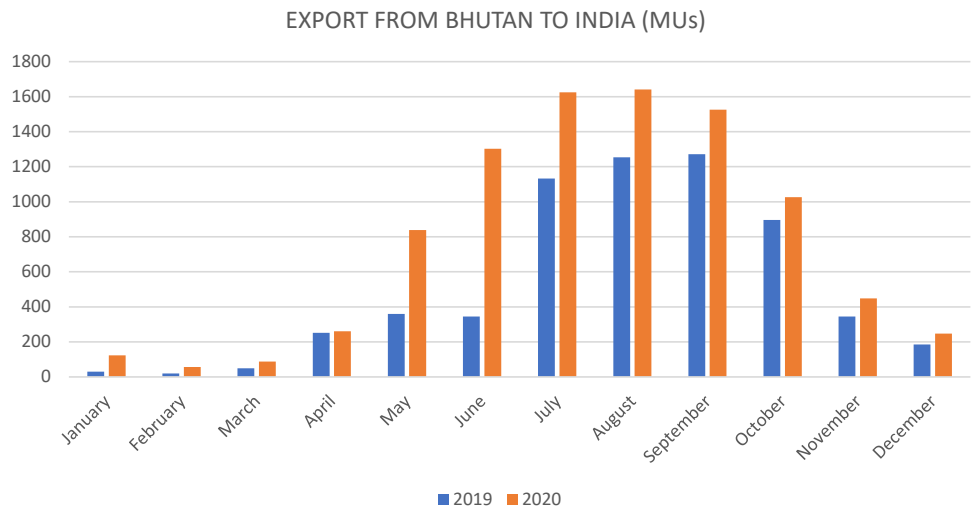


The above graph shows the export of power from Bhutan to India during the period before lockdown (18th March to 23th March 2020) and post lockdown (24th March to 31st May 2020).

The average electrical energy (MU) exported before lockdown (for the week from 18th to 23rd March 2020) was 1.6 MU whereas the average electrical energy exported post lockdown (for the week from 24th to 29th March 2020) was 3.7 MU. The peak power exported by Bhutan to India before lockdown was 410.1 MW on 22nd March 2020 and the post-lockdown peak power exported by Bhutan kept increasing till it reached 2239.8 MW on 24th May 2020. As per the international agreement for sale of power from the hydro projects in Bhutan, all power generated, after meeting the demand in Bhutan, is to be exported to India. Therefore, since the demand of Bhutan decreased, as seen above, the export to India increased. Moreover, the hydro generation of Bhutan also increased due to increased inflows because of the melting of snow.

The export of power by Bhutan to India this year versus last year is given in the figure below. We can see that as a result of COVID-19, the consumption in Bhutan has gone down substantially in May and June 2020, compared to the same period last year, as explained earlier. As a result, the export of power to India has increased. Also, as the consumption in Bhutan increased post lockdown, the difference of export to India, as compared to the previous year, has decreased.

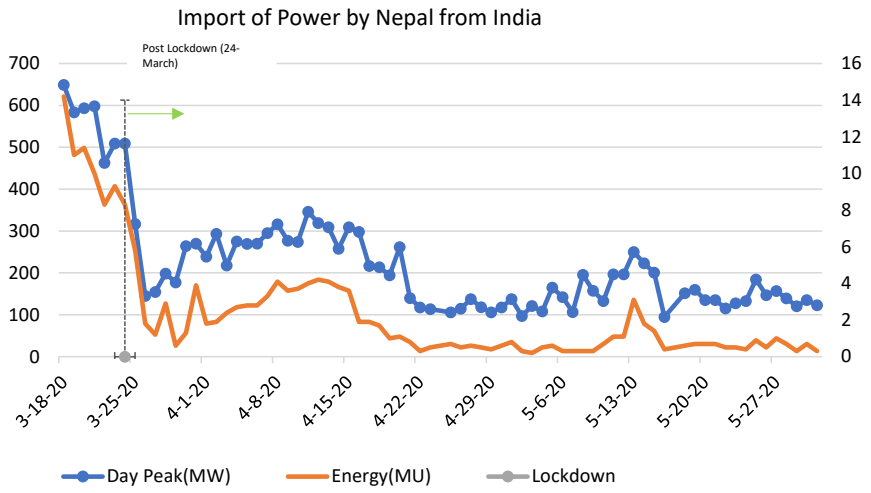
Figure 21[29]: Export from Bhutan to India (MUs)



28 https://posoco.in/reports/daily-reports/daily-reports-2020-21/
29 https://posoco.in/reports/daily-reports/daily-reports-2020-21/

2.2.2 Import of Power by Nepal

Figure 22[30]: Import of power by Nepal from India

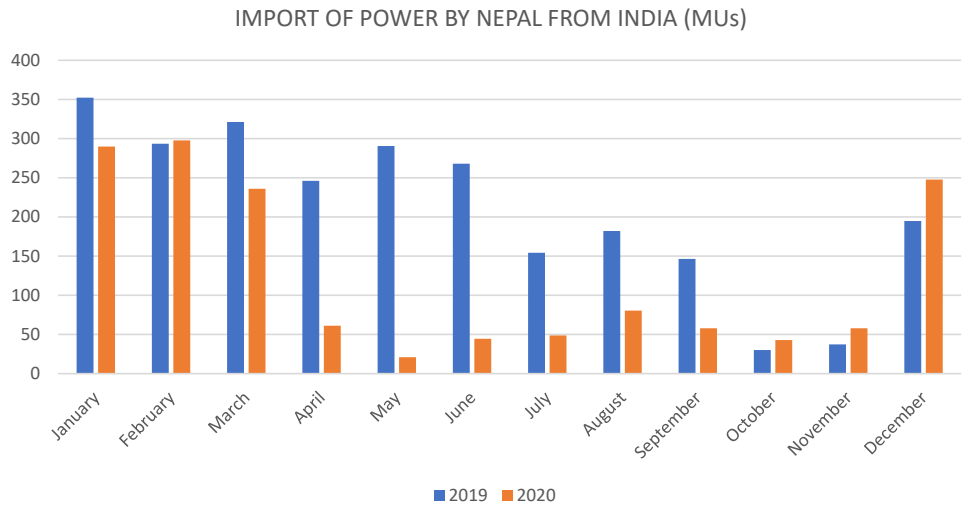


The above graphs show the trend in import of power by Nepal from India before lockdown (pre-COVID-19--18th to 24th March 2020) and the post-COVID-19 period (25th March to 31st May 2020).

The average electrical energy (MU) imported before lockdown was 10.4 MU; whereas the average electrical energy imported post lockdown was 2.6 MU, a drop of 75 percent. The maximum power (MW) which was imported by Nepal from India before the lockdown period was 648.8 MW on 18th March 2020, which reduced to 122.7 MW post lockdown on 31st May 2020. The import of power declined post lockdown in Nepal, since all the sectors were closed down, and hydro power availability increased in Nepal due to the increased river inflows.

The export of power by India to Nepal from January to December 2020, versus the same period in the previous year, is given in the figure below. In February 2020, when there was no impact of COVID-19 on the power sector, Nepal was drawing slightly more power as compared to the same month in the previous year. However, as the lockdown in Nepal progressed from March 2020 onwards, power drawn from India decreased substantially, compared to the same month last year. In April 2020, it fell by 75 percent, compared to April 2019, and by 93 percent in May 2020 compared to May 2019. It picked up gradually after that, till it exceeded the import from October onwards, in comparison to the corresponding months in the previous year.

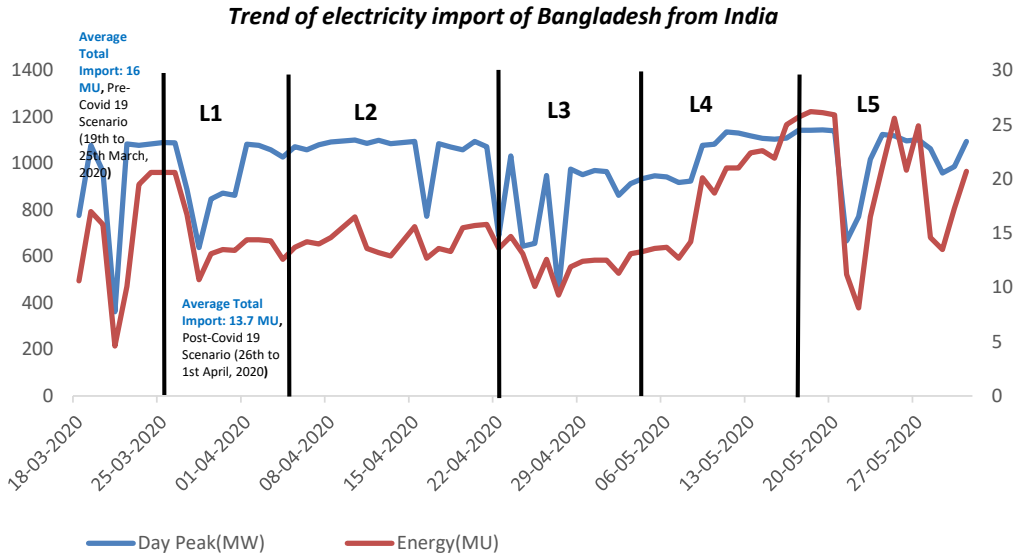
Figure 23[31]: Import of power by Nepal From India (MUs), 2019 vs. 2020



30 https://posoco.in/reports/daily-reports/daily-reports-2020-21/
31 https://posoco.in/reports/daily-reports/daily-reports-2020-21/

[32]2.2.3 Import of Power by Bangladesh

Figure 24: Trend of electricity import of Bangladesh from India, 2020

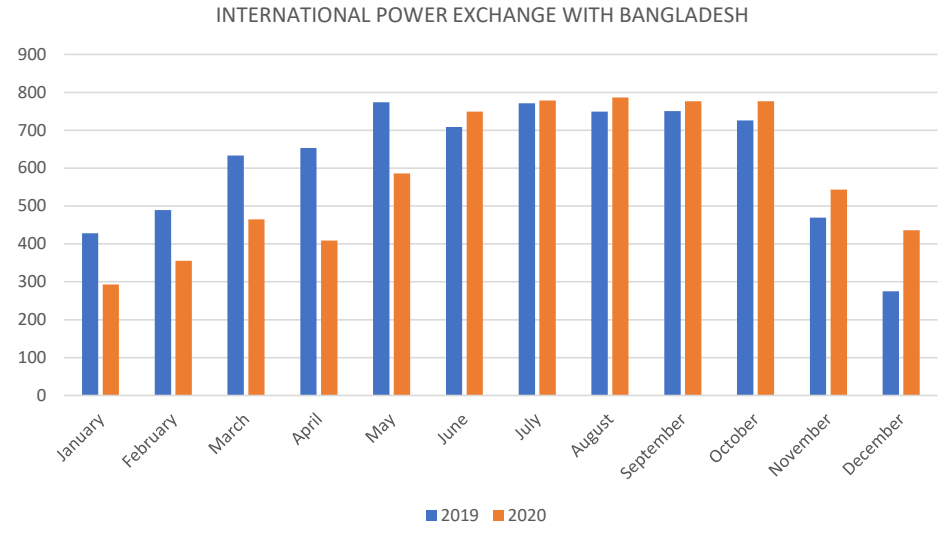


The above graph shows the import of power by Bangladesh from India before COVID 19 (19th to 25th March 2020) and post COVID-19 (26th March to 31st May 2020).

The average electrical energy (MU) imported before lockdown (for the week from 19th to 25th March 2020) was 16 MU, and the average electrical energy imported post lockdown (for the week from 26th to 1st April 2020) was 13.7 MU, a drop of 14 percent. In terms of peak power (MW) imported by Bangladesh from India, it was 1084 MW on 24th March 2020. After lockdown, the peak demand dropped to 847 MW on 29th March, a drop of 22 percent. This value increased to 1144 MW on 19th May 2020. The increase in the import of power can be attributed to the change in weather conditions, as well as the change in the lockdown phase in the country with the opening up of some sectors by the government. The effect of hurricane Amphan can clearly be seen in L5, when the import dipped substantially for a couple of days before reviving.

The export of power by India to Bangladesh in 2020 versus the same period in the previous year is given in the figure below. As the lockdown progressed from March 2020 onwards, the power drawn from India decreased initially and then started picking up again. From June 2020 onwards, it exceeded the import, compared to the corresponding months in the previous year.

[33]Figure 25: International power exchange with Bangladesh, 2019 vs. 2020



32 https://posoco.in/reports/daily-reports/daily-reports-2020-21/
33 https://posoco.in/reports/monthly-reports/

Regional Risk On CBET

Overall, the COVID-19 pandemic affected the cross-border power traded in South Asia.

On the one hand, imports by Bangladesh increased in May 2020 compared to April 2020 by 177 GWh, due to the revival of business activities and warmer weather in Bangladesh. On the other hand, imports by Nepal decreased by 40 GWh. Bhutan's exports in May 2020, however, increased 480 GWh compared to April 2020. Therefore, an additional burden of 343 GWh was passed on to India in May 2020, compared to April 2020, which India could manage because of its huge geographical size and demand. Compared to India's generation in May 2020 of 100,000 GWh, this amounts to 0.3 percent, which is miniscule and could easily be handled. As mentioned above, cooperation between the South Asian countries helped to lessen the impact of the reduced load in Bhutan, Bangladesh and Nepal.

2.3 Impact on the Supply Chain Management

These are risks associated with the supply of essential items for running of the power system such as the fuel for power stations, or spare parts for operation of the power system, i.e., power plants, transmission lines, sub-stations, distribution lines, and transformers. Fuel is required on a daily basis; for example, coal is essential for coal fired stations, as is gas for gas fired power stations and oil for oil-based stations. In contrast, spare parts are required less frequently for most of the maintenance needs. Unlike coal-based power stations that maintain coal inventory as per norms for a certain number of days in the coal yard, gas cannot be stored to a large extent. In all the South Asian countries, gas requirement for gas-based plants decreased. The following section examines the risk for each country on account of fuel supply.

As seen from the analysis shared above, power demand in every country of South Asia reduced after the implementation of lockdown. Since power had been declared an essential service by all these countries, there was no problem in the supply of fuel for power stations. On the contrary, there was an issue on offtake of the normal requirement of fuel for all types of power plants, i.e., coal, oil and gas. In India, the amount of coal dispatch to power stations had to be reduced.

Table -1: Domestic Coal Dispatch to Power Plants Pre and Post Lockdown (in MT): [34]

Company	Mar-20	Apr-20	May-20	Percent growth (Apr compared to March)	Percent growth (May compared to March)
CIL (Coal India Ltd.)	42.3	31.95	30.45	-24.47	-28.01
SCCL (Singareni Collieries Company Limited)	4.35	2.86	2.4	-34.25	-44.83

Imported coal consumption, used for blending with domestic coal in power plants designed for domestic coal, went down by 47 percent both in April and May 2020, in comparison to March 2020 (see tables 2 and 3 below).

Table-2: Imported coal receipts from March 2020 to May 2020

Sr. No	Imported coal receipt March 2020 (in 000 tonnes)	Imported coal receipt April 2020 (000 tonnes)	Imported coal receipt May 2020 (000 tonnes)	Percentage growth in April 2020 vs. Mar 2020	Percentage growth in May 2020 vs. March 2020
1	1657.4	875.7	874	-47.16	-47.27[35]

During COVID-19, generation in the Indian gas-based plants from domestic gas increased, whereas there was reduced consumption of imported gas, the latter being more expensive.

34 http://cea.nic.in/reports/monthly/coal/2020/coal_import-04.pdf
35 http://cea.nic.in/reports/monthly/coal/2020/coal_import-04.pdf

Table-3: Domestic and imported gas in pre and post COVID-19 scenarios (March /April 2020)[36]

Category	Domestic gas					Imported gas				
Month/ Year	Mar-20	Apr-20	May-20	Growth (percent) April compared to Mar	Growth (percent) May compared to Mar.	Mar-20	Apr-20	May-20	Growth Mar/ Apr	(Percent Growth) Mar/May
Consumption (MMSCD)	18.57	22.85	22.34	23.05	20.30	12.59	10.39	12.02	-17.47	-4.53

Domestic gas consumption increased because more domestic gas was available for use in the power sector, as some of the industries using gas, viz. steel, cement, cooking gas used by hotels, etc., were shut down. Gas-based generation increased 13 percent from 4302 GWh in March 2020 to 4858 GWh in April 2020, because of the cheaper cost, even when compared to some of the coal-based generation.

Bangladesh and Pakistan are heavily dependent on gas for electricity generation, whereas Sri Lanka is heavily dependent on oil. Ships carrying imported fuel, i.e., oil and LNG to Bangladesh, Pakistan and Sri Lanka were stranded at ports. The non-offtake from ships resulted in the possibility of attracting demurrages/heavy financial penalties. The countries, therefore, faced the risk of penalty for non-offtake due to the take-or-pay system. Some of these countries have appealed for treating this abnormality as force majeure.

The problem of penalties due to non-offtake of fuel for power stations, or any problem on account of the fuel supply chain, can be reduced, if countries of South Asia could go for more renewable sources of energy or for hydro based generation, which do not depend on fuel to meet their electricity generation requirements.

2.4 Impact on Project Execution

COVID-19 resulted in project delays due to delay in delivery of equipment or its installation, as well as shortage of commissioning personnel. This potentially raised the cost of the project. Therefore, this is considered as one of the risks due to COVID-19 on the power sector in South Asia. Country-wise details are given below.

2.4.1 Bangladesh

(a) A number of under-construction power generation, transmission and distribution projects would suffer the most, as most of the contractors of these projects are either Chinese, or their equipment comes from China--a country heavily impacted by the outbreak.

(b) Two power plants supposed to be commissioned by 2021–the 1,320 MW Rampal Power Plant and the 2,400 MW Rooppur nuclear power plant, would get further delayed as these projects are being implemented respectively by Indian and Russian counterparts, and hence delayed due to travel and transport restrictions because of COVID-19.

(c) The construction of a combined cycle plant of 950 MW under the Ghorashal power project is at the final stage, but its pace has slowed down due to the absence of the key Chinese experts who had gone for the Chinese New Year celebration and could not come back because of the travel ban due to COVID 19.

(d) The under-construction Adani Power 1,600-megawatt (MW) thermal power project at Godda in Jharkhand has been delayed due to the coronavirus-induced lockdown. It was scheduled to be ready by the end of 2022 .[37] The entire power generated from this plant is earmarked for Bangladesh.

36 http://cea.nic.in/reports/monthly/coal/2020/gas_fuel_consumption-03.pdf

37 https://www.business-standard.com/article/companies/1-600-mw-jharkhand-project-delayed-amid-covid-19-lockdown-adani-power-120060101759_1.html

(e) As many as 25 transmission projects got delayed. These include the construction of the Rahanpur to Monakasha Border 400kV transmission line in Chapainawabganj to import power from India (Jharkhand) to Bangladesh.

2.4.2 India

(a) Ongoing Solar projects in the country have been halted and developers are concerned about the delays faced by their projects, because of the production slowdown in China and the lockdown orders in India. India's solar PV installations are heavily dependent on Chinese PV module imports, almost 80 percent of the total volume. The overall cost of the projects will subsequently increase due to the pre-operative expenses. A time extension has been provided by the Ministry of New and Renewable Energy, GoI, for all the renewable energy projects impacted by the supply chain disruption due to the outbreak, under the force majeure clause.[38]

(b) ACME Solar cancelled the PPA with the Solar Energy Corporation of India Limited (SECI) and a long-term access agreement with the Power Grid Corporation of India Limited (PGCIL) due to COVID 19and its adverse impact on manufacturing facilities of suppliers since December 2019, including lockdowns in China and India. This PPA was to supply power at a record low tariff of Rs. 2.44 per unit. SECI and PGCIL have challenged the unilateral discontinuation of the agreement by ACME, and informed the regulatory authority that it is considering giving an extension to ACME.

(c) The restoration schedule (renovation and refurbishment) of three power stations, i.e., Chamera-II Power Station, Kishanganga Power Station, Loktak Power Station, has been affected due to movement restrictions imposed in the wake of the COVID-19 pandemic. An estimated loss of Rs. 119.43 crore is expected due to anticipated generation loss.[39]

(d) The construction of two hydro-electric projects of the National Hydroelectric Power Corporation, Parbati-II and Subansiri Lower, have been affected due to the lockdown. At Parbati-II, the construction activities were completely halted from March 23rd to April 22nd due to the lockdown announced to contain COVID-19. The shortage of labor may affect the construction schedule and increase the cost of the project .

2.4.3 Nepal

(a) The 756-MW, under-construction Tamor Storage Hydroelectric Project in the country's eastern provinces is getting delayed due to COVID-19. Employees of the Power Construction Corporation of China, responsible for the construction, went to China for New Year celebrations and could not come back because of the pandemic induced travel ban.

(b) The 400-kV substation for the $99 million, 179-mile, 400 kV Hetauda-Dhalkebar-Duhabi transmission line, which is part of the east-west backbone transmission system of Nepal, is also delayed due to non-availability of manpower and logistics related issues because of travel and transport ban. This line is a high priority project of NEA to address the power crisis in Nepal by importing power from India and transmitting this power within Nepal. Similarly, it will also help export excess power to India in the future.

(c) The 111-MW Rasuwagadhi Hydropower Project, the 140-MW Tanahu Hydropower Project and the 37-MW Upper Trishuli 3B Project have also been affected due to the COVID-19 crisis, because its engineering, procurement and construction (EPC) Contractor is Power China, and Toshiba Hydro Power (Hangzhou) Co., Ltd.—a Chinese subsidiary of Toshiba ESS—is the equipment supplier, based in China. Therefore, it is facing constraints of expert manpower availability and equipment supply due to the travel and transport ban to arrest the pandemic.

(d) According to IPPAN (Independent Power Producers of Nepal), the government's plan to add 1,000 MW of electricity in the current fiscal has been affected due to the pandemic, with only 123 MW being added this year. The pandemic has pushed back the completion date of nearly five dozen hydropower projects, with a total installed capacity of 3,000 MW, which are under construction through private investment.

38 https://www.business-standard.com/article/companies/acme-to-cancel-india-s-cheapest-solar-project-citing-covid-19-impact-120052000977_1.html)

39 https://www.outlookindia.com/newsscroll/nhpc-to-suffer-power-generation-loss-of-rs-11943-cr-due-to-lockdown/1850071)

(e) The upper Tamakoshi Hydroelectric Project is the largest under-construction hydropower plant in Nepal, located in Dolakha. In 2012, construction work began on the 456-megawatt run-of-the-river scheme. This project is also facing delays on account of COVID-19. The plant was expected to come into operation by mid-June 2020, but the operation deadline was pushed back due to the pandemic and is now expected to start generating power towards end of 2021.

2.4.4 Pakistan

The Government of Pakistan has deferred the privatization of two LNG based power plants of 2,500 megawatts, fueled by Qatar's LNG because of the ongoing COVID 19 crisis.

The Punjab Thermal Power 1263 MW under construction power plant in Haveli Bahadur Shah was put on halt.

A 660 KV high voltage transmission line from Matiari to Lahore which was under construction, was halted.

Summary of Impact on Regional Project Execution

During the pandemic, many projects under construction were held up due to commissioning challenges, unavailability of personnel or the government's orders on quarantine. New projects are not being considered as essential by the respective national governments of South Asia due to reduced electricity demand. Thus, the major impact of the delays in power plant construction would be the increase in cost of the projects, due to the interest during construction (IDC) component. Depending on the extent of time to which the projects are delayed, the cost would keep increasing. This may have an impact in the future, when electricity demand revives.

2.5 Impact on Grid Stability

Grid stability challenges would arise in the case of sudden unanticipated changes in demand in each country. The demand has actually gone down substantially after the declaration of lockdown in most countries, leaving the countries with surpluses for which the system operators have backed down generation, and controlled the rising system voltages by opening more high voltage transmission lines to contain the reactive power generation. In spite of the demand reduction being gradual, it was a challenge for system operators, which was adequately handled. Certain generating stations were either shut down or run at reduced generation, to cater to this reduced demand, depending on the priorities of each country.

There is also a need for renewed cooperation and support among the control centers of South Asian countries, especially during such critical periods. This would enable the different players of the grid to take decisions in a cohesive, coordinated and harmonious manner.

The safety and security of grid and centralized systems for smooth operation of the grid depend on manpower. Therefore, safety of manpower is one of the most important aspects during the COVID-19 pandemic. This is discussed separately in the subsection (2.6), 'Impact on Manpower Safety'.

What also needs to be done in such cases is to have an emergency plan, in case the system operators in the main control room get infected. A back-up plan of using the standby control room for system operations needs to be in place, and covered under the Disaster Management Plan for the power sector, till the main control room is sanitized. Since the control room is the nerve center for ensuring grid stability, special attention needs to be paid to this. This disaster management plan should be framed for the generation, transmission, distribution and system operation sector. Albeit this plan already exists for the Indian power sector, it does not include disaster management for pandemics. Therefore, disaster management plans should take pandemics into account, considering the widespread disruption they may cause.

Besides, in such constrained times, special care must be taken to ensure that anti-social elements do not take advantage of the situation and aggravate it through cyberattacks. Therefore, stringent cyber security measures need to be put in place and adhered to.

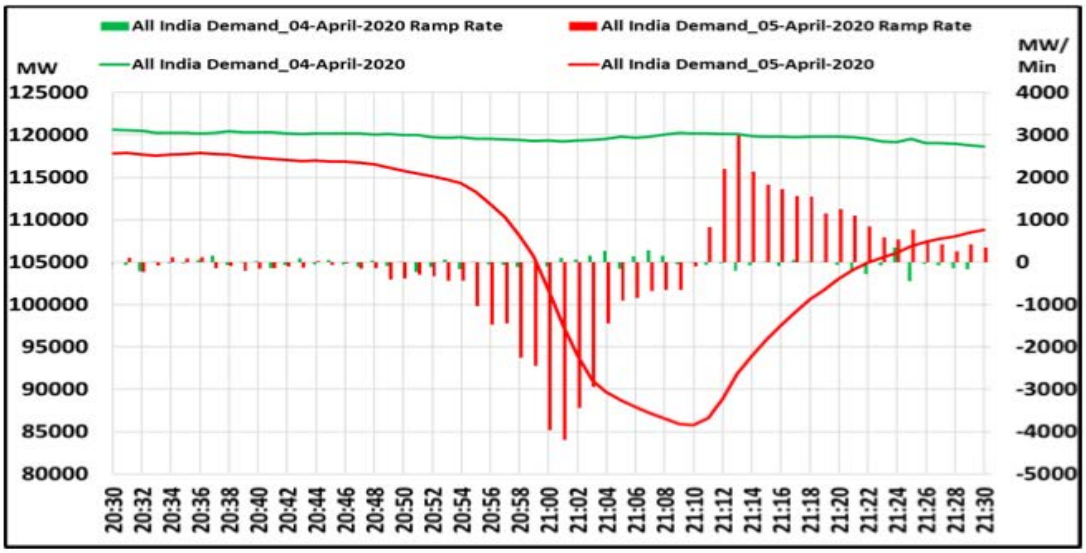
A special event occurred in India related to the COVID-19 lockdown, which required rigorous planning on behalf of the national system operator, along with the system operators of the states in India, as well as the system operators of the other South Asian nations. This is described below.

Pan India Lights Off Event 9 PM 9 Minutes on 5th April 2020

On the 10th day of the nationwide lockdown owing to the COVID-19 pandemic in India, Prime Minister Narendra Modi asked citizens to demonstrate a collective will and solidarity to fight the coronavirus by switching off lights for nine minutes from 9 p.m. on April 5, and lighting candles or diyas. This, however, posed a concern for grid stability (on account of the resultant frequency variation) in terms of managing the sudden reduction in demand almost instantly, as well as to manage the ramp up of demand, equally rapidly, in nine minutes. Detailed studies and discussions were conducted, and it was estimated that the reduction of load of lighting would be in the range of 12000-15000 MW. All states in India were requested to cooperate, as well as system operators of Bhutan and Bangladesh, who provided due assurance.

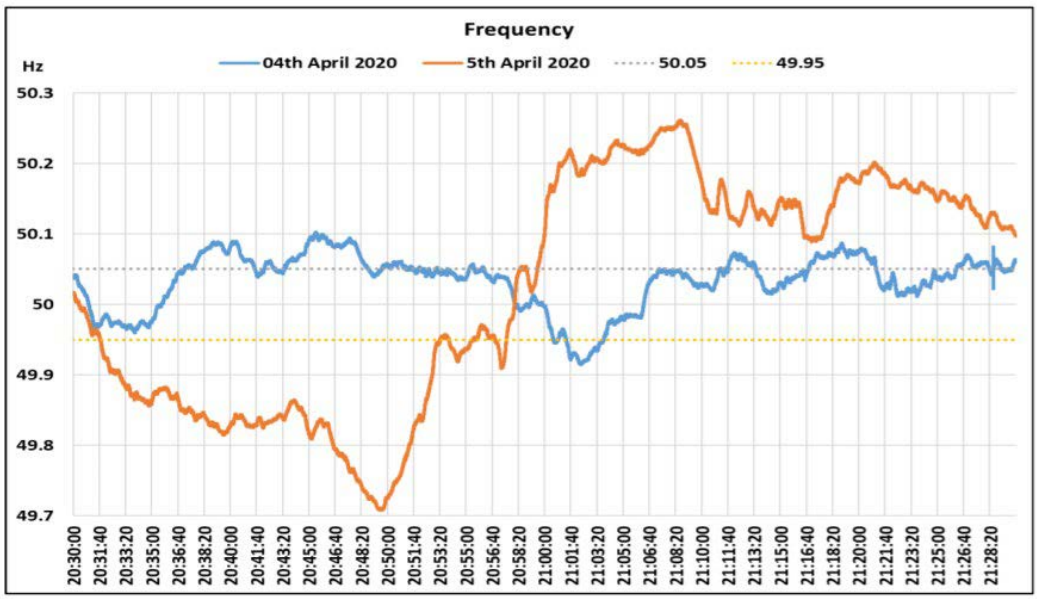
Fast ramping hydro and gas generation were used to control the system frequency. The demand actually fell by more than double the estimated amount, i.e., by 31089 MW, possibly because of the switching off of fans and other electrical appliances as well. Because of the thorough preparation and exercise in coordination with the system operators of the states, however, the exercise was conducted safely. The operating frequency stayed in the safe zone of 49.7 Hz to 50.25 Hz during the event (see Figure 25). The details of the change in all-India demand and system frequency during the event are shown below. During the event, support was also provided by the hydro stations from Bhutan in addressing the fast ramping down and ramping up of generation.

Figure 26[40]: Details of all-India demand and ramp rate during the "9 PM, 9 minutes" event, vis-à-vis the previous day



40 https://posoco.in/wp-content/uploads/2020/05/Report-on-Pan-India-Lights-Off-Event-9-PM-9-Minutes-on-5th-April-2020-1.pdf

Figure 27: Details of all-India system frequency during the "9 PM, 9 minutes" event vis-à-vis the previous day



2.6 Impact on Manpower Safety

All South Asian countries took steps to ensure protection of manpower (both on-field staff and office staff) in the generation plants, transmission and distribution systems, system operations, and all critical facilities. These nation-wise steps are given below.

2.6.1 Bangladesh

All power utilities in Bangladesh followed the guidelines published by the Department of Health on COVID-19 on wearing, using, removing and disposing/destroying masks, and technical guidelines for prevention and control of social and institutional transmission of the epidemic. They also maintained hygiene in sub-stations and other workplaces.

2.6.2 India

The steps taken by power utilities in India for safety of their manpower were largely through orders issued by the Health Ministry, various State Electricity Regulatory Commissions and the internal guidelines by the power utilities themselves. The Ministry of Health and Family Welfare, GoI, prescribed steps on social distancing, The Maharashtra Electricity Regulatory Commission allowed the State Distribution licensees to suspend non-essential services which require visiting consumer premises or meeting consumers in person, i.e., Meter reading, Billing, Offline Bill Collection at Bill Payment Centres, release of new connections etc. Consumers should be intimated through digital channels such as email, sms, mobile app about their estimated bill computed on average basis. Bill payment should be promoted through digital payment mode. NTPC, the largest power generating company in India, advised its employees to avoid face-to-face meetings and public gatherings to the extent feasible. The company provided face masks to all employees and personal protective equipment (PPE) as required. Temperature checks of all employees and visitors while entering and exiting the premises was made mandatory. Hand sanitizers were provided to all workers and staff and sanitization of work places and wash rooms was done regularly. Lists of do's and don'ts with regards to COVID-19 in its townships were circulated to all employees through different modes of campaigning like films and posters. Officials were advised to curtail visits to foreign countries to the extent possible. Employees at high risk of complications in the event of COVID-19 infection were allowed to work from home. NHPC issued a circular for keeping the employees safe, including avoiding touching various objects, as well as disinfection if the same is unavoidable. It also issued protocols for home entry after returning from work. NEEPCO issued a Standard Operating Procedure for Workplace and Township for Prevention and Containment of COVID 19, stating that masks should be provided to all employees and masks and

gloves to frontline officials. Physical meetings should be avoided. Thermal screening would have to be done for all employees while entering and leaving the premises. Similar steps were also taken by other power utilities in India.[41]

2.6.3 Pakistan

National Transmission and Despatch Co Ltd of Pakistan issued guidelines and advisory for manpower working in plants, suppliers' staff, and its logistics company to prevent the spread of Coronavirus.

All training programs were suspended till further orders and staff advised to avoid handshakes and maintain physical distancing. Biometric attendance was avoided during the period. To maintain hygiene, all office premises were sanitized and sanitizers were kept for office use. Employees who were on field and sites were compulsorily asked to use gloves and masks. Any employee with symptoms was tested, quarantined and isolated. Foreigners and outside visitors were to be avoided.

2.6.4 Nepal

Project workers for ongoing and existing plants were mandated to abide by the guidelines issued by the NEA to ensure safety of personnel working at sites. These included a 14-day quarantine for all personnel coming from other countries, temperature checks of workers taken in the mornings and evenings, separate arrangement for truck drivers and helpers made outside plants, and separate arrangement for supply of food, vegetables and meat made by the contractor.

2.6.5 Sri Lanka

None of the 26,000 staff of the power distribution division of CEB which supplies power to most of Sri Lanka was affected, as a result of taking proper precautions as advised by their health organization. They used minimum movement of staff, used video conferencing and remote monitoring, and left out the non-essential works. They employed minimum operations and maintenance (O&M) staff, and arranged accommodation and food in the power station for some personnel for a couple of months to ensure that they do not come into contact with infected people.

Summary of Regional Impact Analysis on Manpower Management

All the South Asian countries followed the health guidelines of their respective national governments. These were reflected in detailed instructions by the utilities, some of whom issued their own guidelines. These were diligently followed by the workers and staff, which enabled smooth operation of the power system in all the countries. Non-critical work was stopped to concentrate on more critical areas. Face masks and gloves were provided and, in some cases, PPE kits too. In Sri Lanka, arrangements were made for some O&M staff of power stations to stay in the power station for a few months and food was provided to them.

2.7 Impact on Utility Finance

The biggest sustained risk of the pandemic is expected to be the adverse financial impact on utilities. The finances of utilities were impacted due to reduced consumption as a result of the shutdown of industries and commercial establishments (high paying consumers). Additionally, consumption by low paying residential consumers increased during the period. In addition, there were issues of non or partial payment by consumers due to loss of economic livelihood, or inability of consumers to pay bills in person and limited use of digital modes of payment, etc. This resulted in liquidity issues for the DISCOMs, resulting in non-payment, or reduced payment, to generators and transmission companies.

The following section details the case on these aspects in each country.

2.7.1 Afghanistan

The decision to impose the lockdown was taken on March 21st, 2020, by the Government of Afghanistan. Following this, Da Afghanistan Breshna Sherkat (DABS), the national power utility of Afghanistan, observed a substantial decrease in revenue in Kabul. This was primarily due to the

41 https://www.ntpc.co.in/en/medi/covid-19-initiatives

movement restrictions and limited access to the banks for payment of bills by the consumers. The lockdown also affected the purchasing power of people to pay the bills.

It is evident that this situation considerably impacted the income of middle- and lower-class families, forcing people to spend money only on their basic needs, and not necessarily on electricity bills. Therefore, neither DABS nor the government was in a position to force people to pay the bills. On 12th April, DABS asked the government for a $50 million loan after announcing that they had lost 60 percent of their revenue due to the outbreak.

2.7.2 Bangladesh

The pandemic situation resulted in several power plants being shut down, as the available power generation exceeded the demand. Since the IPPs had to be paid capacity charges at the prescribed rate even if they do not purchase power from the established power plants, as well as other reasons described below, the power distribution sector faced huge financial losses during the COVID-19 lockdown period.

Considering the interests of the customers, the deadline for payment of electricity bills was extended to June 2020, without any surcharge or penalty. Due to the pandemic, a large part of the population, including low-income people, lost their jobs. Most consumers, including industrial, commercial and irrigation consumers, were not able to pay their bills. This hampered the revenue collection of power DISCOMs. As a result, DISCOMs were not able to pay their monthly bulk electricity bills to the Bangladesh Power Development Board (BPDB), the government generation utility, and wheeling charges to the transmission company on time. It was not possible for the BPDB to pay the electricity bills of IPPs without getting the price of bulk electricity from the DISCOMs/organizations. Therefore, the power sector as a whole faced a severe liquidity crisis.

Financial loss due to capacity charge:

During the lockdown period, around 4,000 MW of power plants in Bangladesh were idle. In the case of IPPs established in the private sector and power imported from India, capacity charge has to be paid at the prescribed rate as per the agreement even if they did not purchase electricity from the established power plants. According to BPDB estimates, an average capacity charge of Tk. 498 crore per month was required for 4,000 MW power plants. For the period March-December, 2020, the potential financial loss of BPDB worked out to be around Tk. 4,980 crore.[42]

Revenue deficit due to arrears of bulk electricity bills to utilities:

Due to the inability to collect bills from customers and waning revenue resulting from declining demand, DISCOMs were not able to pay for bulk electricity to BPDB on time. The following is the monthly calculation of the revenue deficit due to COVID 19, as estimated by BPDB, due to bulk electricity arrears to utilities:

Table -4 Reduction of Revenue Collection in Bangladesh[43]

Month	Total revenue expected (TK. Crores)	Revenue collection (TK. Crores)	Revenue deficit (TK. Crores)
(1)	(2)	(3)	(4)
March 2020	2,938	2,147 (73 percent)	791
April 2020	2,913	1,165 (40 percent)	1,748
May 2020	3,218	1,287 (40 percent)	1,931
Total	9,069	4,599 (51 percent)	4,470

Analysis of the above data shows that in the three months from March, 2020 to May, 2020, an average of about 51 percent of revenue was collected. As a result, the total fiscal deficit from March, 2020 to December, 2020 was estimated by BPDB to be Tk. 11,775 crore, including Tk. 5,777 crore by June, 2020 and another Tk. 5,998 crore by December, 2020.

42 https://www.bpdb.gov.bd/

43 Information obtained from BPDB in July 2021

The total financial loss to the power distribution sector due to the impact of Covid-19 across the country (Taka in crores) is given below:

Table -5: Total Financial Loss Estimated by BPDB from March 2020 to December 2020. (Information Obtained From BPDB).

Month	Financial loss for paying capacity charge	Revenue deficit due to arrears of electricity bill to utility	Probable total deficit amount
(1)	(2)	(3)	(4) = (2+3)
During March-June, 2020	1,992	5,777	7769
During July-December, 2020	2,988	5,998	8986
Total during March-December, 2020,	4,980	11,775	16755

2.7.3 Bhutan

The Royal Government of Bhutan introduced a deferment payment plan for industries, which resulted in a huge cash flow problem for BPCL (Bhutan Power Corporation Ltd.), the transmission and distribution utility of Bhutan. It witnessed a drop in collection efficiency from 97 percent in August 2020, to about 74 percent in November 2020.

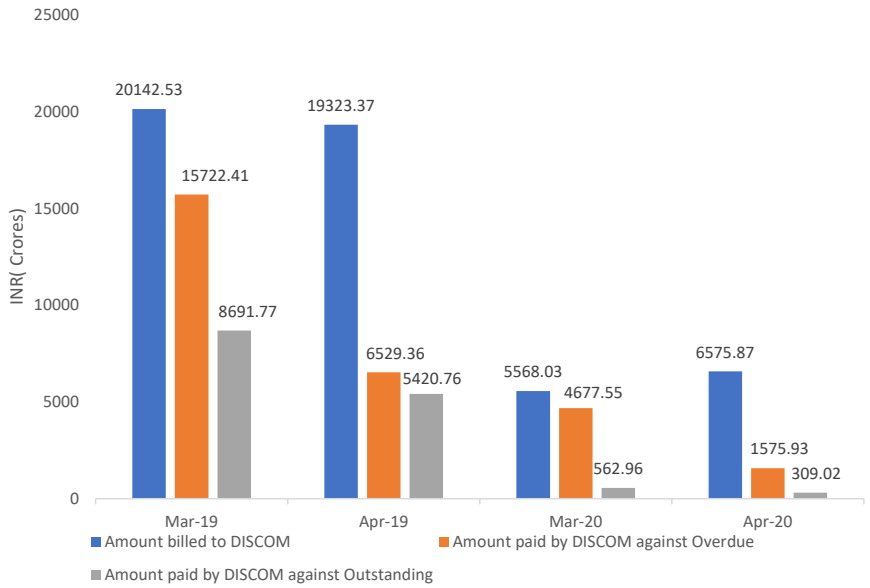
2.7.4 India

The lockdown declared by the GoI to monitor the COVID-19 pandemic resulted in the shutdown of the industrial and commercial establishments (barring essential ones) and the stoppage of passenger rail services. This adversely affected the market for electricity, as these segments account for around 50 percent of power demand.

According to regulations of most of the State Electricity Regulatory Commissions, the industrial and commercial consumers cross-subsidize the agricultural and residential consumers. Since the high paying consumers--the industrial and commercial consumers--reduced during the lockdown and low paying consumers--the residential consumers--increased, this reduced the revenue of the DISCOMS.

Collections have also reduced as compared to the same period in the previous year. This is shown in the figure below.

Figure 28: Amount billed to DISCOMS v/s outstanding and overdue payments[44]



44 https://praapti.in/

Power producers give 60 days' time to DISCOMs for paying bills for the supply of electricity. After that, the outstanding dues become overdue and generators charge penal interest on that in most cases. So, the DISCOMs first clear the overdue amount and then the outstanding amount. In the figure above, we can see there is ~ 72 percent (March) and ~66 percent (April) decline in the billing amount for the respective months in 2020, compared with 2019. The significant decline in the amount billed to DISCOMs is attributed to the lesser power offtaken by them, mainly the high paying consumers, on account of low demand due to COVID-19.

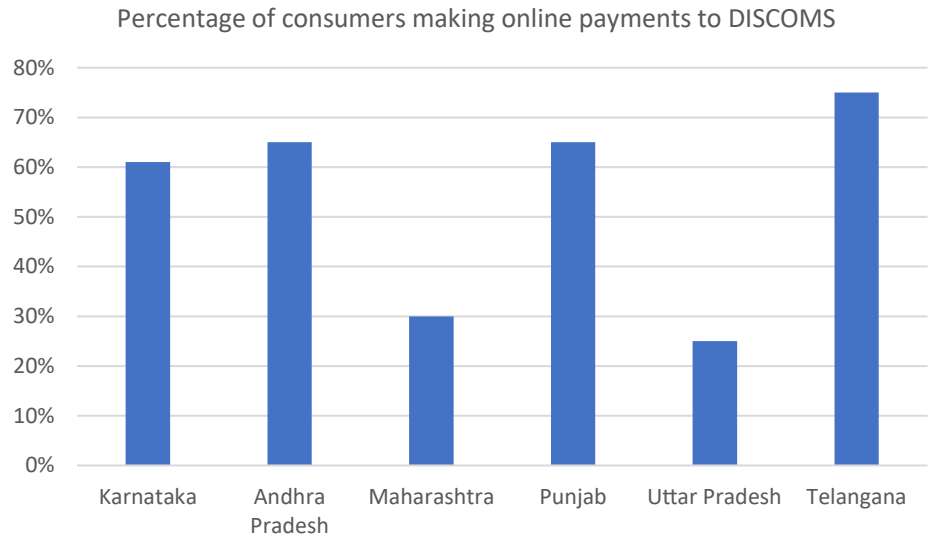
Against the 66 percent decline in the amount billed to DISCOMs in April 2020 (which was the first full month of lockdown in India) vis-a-vis April 2019, there was a decline of 76 percent in payment of ,m, and a decline of 94 percent in payment of outstanding dues, signifying the lesser amount collected. The amount collected for March 2020 was Rs. 5241 (4678+563) crores against a billing of Rs. 5568 crores, i.e., collection efficiency of 94 percent, whereas for April 2020, the amount collected was Rs. 1885 crores against a billing of Rs. 6576 crores, i.e., a collection efficiency of 29 percent, which shows the drastic reduction in collections and consequent adverse impact on the distribution utilities.

Issues in billing and collecting payments from consumers:

The income of DISCOMs was further affected by the fact that the majority were unable to adequately bill customers and receive payments on time. While DISCOMs started using automated meter-reading systems and smart meters, these covered only a small fraction of the domestic consumers.[45]

During the lockdown, billing and payment collection problems were exacerbated as the government temporarily terminated meter-reading (particularly in Maharashtra) and physical bill delivery activities across the country. Most DISCOMs billed consumers on average consumption in the previous months.[46]

Figure 29: Percentage of consumers making online payments to DISCOMS in some Indian states



Electronic payments are currently the easiest option for paying an electricity bill. Yet, only a few consumers (53 percent, as an average of six states) across the country are paying their electricity bills online.

As per the Confederation of Indian Industry (CII), DISCOMs are likely to suffer a net revenue loss of around Rs. 30,000 crore and face liquidity crunch of about Rs. 50,000 crore due to the nationwide lockdown.

The financial health of the already loss making DISCOMs would deteriorate further and stressed assets in the sector are expected to increase.

45 https://www.indiaspend.com/without-states-on-board-discom-reforms-could-fail/

46 http://www.derc.gov.in/Regulations/DERCRegulations/Regulations%202017/DERC%20(Supply%20Code%20and%20Performance%20Standards)%20Regulations,%202017/Regulations%20-%2007.07.2017.pdf

2.7.5 Nepal

Due to an approximately 30 percent drop in energy demand in Nepal, the revenue of NEA, the power utility of Nepal, took a hit as it still has to pay the IPPs even if the power is not used. They also had to spill water, even after taking all possible measures as there was no power import through cross-border links. This caused electricity to be wasted, resulting in a loss for NEA. Since all the IPP's hydropower are of run-of-river type, the matching of demand and supply (reduction of generation in this case) is done within NEA's power plants. The financial burden on NEA, therefore, aggravated. Moreover, NEA is morally bound to provide additional incentives to its employees working during this crisis.

Because of the reduction in the daily energy consumption pattern, NEA's monthly revenue shrank by around Rs. 1.8 billion, and it had to pay the power producers even if they did not sell to consumers. Besides these impacts on the financial health of NEA, revenue collection from the consumers, too, decreased abysmally. This led to a liquidity crisis for NEA to run its power plants, bear the minimum expenses of operation and maintenance of the system, and pay the IPPs for power procurement.

NEA published a notice to the IPPs generating power from their respective plants, indicating that payments against their monthly invoices will be delayed under the force majeure clause of the PPA. Based on a request from IPPs, the NEA considered looking for some flexible alternatives such as making advance payment to the IPPs, since raising and processing invoices are difficult amid the lockdowns in the country.[47]

Over the next few years, 131 hydropower projects with a combined generation capacity of 2,490 MW–double the current total generation in the country–are expected be added to the national grid. These projects, however, are likely to be delayed or impacted due to the coronavirus. Most were in the final stages of financial closure, with banks ready to move to construction. But with banks now receiving fewer deposits and the economy in a downward spiral due to COVID-19, the future looks uncertain.

Hydropower developers have asked banks to reduce interest rates and urged the government to provide a relief package for the power sector.

2.7.6 Pakistan

The lockdown resulted in a shift in energy demand from profitable customers, such as industries, toward less profitable segments (agricultural and residential), thereby adversely affecting the overall revenues of the power utility sector.

The monetary impact of this shift cost Pakistan close to PKR 40 billion. This situation was further exacerbated by lower recoveries as vulnerable residential customers, in the absence of real relief measures like refunds, resort to power theft due to their inability to pay bills, thus creating a liquidity crunch. The fall in the collection of bills during the lockdown was partly due to the instruction to not collect bills from consumers using less than 300 units for three months, as well as the government's decision to raise generation power tariffs under pressure from Chinese power producers demanding compensation for the exchange-rate losses due to the 10 percent fall in the value of the Pakistani Rupee. The ramifications for the power sector, which is an essential service, are stark. The working capital to finance regular operations was affected. In the long-term, viability and timelines of future projects, critical to meet growing consumer demand, is also likely to be affected. Pakistan's privatization drive was at the risk of being delayed due to the withdrawal of Chinese companies that had expressed interest in picking up some of the power plants put on the block.

The contracts that the country has signed with the IPPs mandate that they must be paid capacity charges, regardless of the consumption of electricity generated. In March 2020 alone, electricity consumption was down by 30 percent.

Relief measures for power consumers are expected to cost over PKR 380 billion, according to calculations made by the power division of the government.

47 The Himalayan Times and NEA

Summary of Impact on Utility Finances Across South Asian Countries

As can be seen above, the financial impacts faced by the distribution utilities worsened in part due to the inability to take actual meter readings in cases where electronic billing was unavailable, and therefore billing was done on an average basis. It was further aggravated due to non-collection of payment from the customers who did not pay electronically or where electronic mode of payment did not exist. Also, since many people lost their jobs, some utilities were lenient in not cutting supplies for a number of months. Another reason for the financial woes of utilities was the reduction in high paying customers due to the lockdown, and the subsequent increase in low paying customers (due to the cross subsidy element prevailing in most South Asian countries).

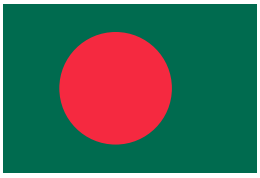
At the same time, the utilities had to pay capacity (fixed) charges, even if they did not draw power from the generating stations, or drew to a lesser extent, thereby resulting in a further burden for the DISCOMs.

Section 3-Measures Undertaken and Lessons Learnt

Measures undertaken by South Asian countries to mitigate the impacts of COVID-19 on the power sector are given below:

Afghanistan

- Force majeure was declared by DABS for all IPPs and neighboring countries.
- DABS contacted the neighboring countries through diplomatic channels to convey delay of payments for some days or months. In case the terms were not accepted by them, then the import of power would be decreased.
- All procurements by DABS were put on hold except for emergency items.
- DABS signed MoUs with telecommunication companies and mobile payments to start the collection of bills through mobile phone in door-to-door visits.
- DABS did not cut power of the customers for one month in case of unpaid bills.
- To facilitate the bills payment, various kiosks were erected at DABS' power junctions to at least maintain 50 percent revenue of DABS.
- To maintain the quality of services and ensure the supply of electricity, DABS staff continue to work. The staff has been provided with office transportation in consideration of their safety.
- The Afghan government waived electricity bills for select groups in the capital, Kabul, for two months amid the lockdown due to the coronavirus pandemic.



Bangladesh

- Dhaka Power Distribution Company (DPDC) Ltd., one of the biggest electricity DISCOMs in Bangladesh, exempted the late payment surcharge for consumers from February to June 2020. As a result, DPDC had to borrow money from the banks to pay the generators.
- DPDC formed a contingency plan to handle the pandemic, which included creating a special task force to supervise operations, a dedicated customer service center and a WhatsApp group to facilitate communication.
- More importance was given to safety measures of employees, including hygiene of sub-stations and employees.
- Expenditure was cut down as per priority.
- Online billing and collection systems were introduced to reduce arrears.
- Bangladesh Bank (BB), in March 2020 announced a moratorium on loan payments until 30th September, 2020.

Bhutan

- Power generation, transmission and distribution units/services were exempted from being shut down, as they are classified as essential services by the Government of Bhutan.
- The Government of Bhutan reduced its investment plans and delayed procurement plans due to supply chain problems, as most parts were sourced from third countries.
- Bhutan Power Corporation Limited (BPCL), the transmission and distribution utility of Bhutan, put a contingency plan in place to ensure operational continuity to quickly restore supply during interruptions.

- Standard operating procedures were developed for speedy mobilization of resources, and non-critical works were deferred.
- BPCL made continuous efforts to embrace digitalization and technology in its operations.

India

The following measures were taken by the GoI:

- Time extension granted in scheduled commissioning of renewable energy projects considering foreign supply chain disruptions: Ministry of New & Renewable Energy Office Memorandum dated March 20th, 2020. [48]
- Guidelines issued to ports on exemption from certain penalties and invoking force majeure. [49]
- Advisory issued on non-charging of ground rent beyond the allowed free period or any performance related penalty on non-containerized cargo during the COVID-19 pandemic. [50]
- Ministry of Power (GoI) issued advisory to carry out supply and construction work at power plants.[51]
- Ministry of Power issued advisory for essential operations of power plants and permission of movement of material needed by these plants to be maintained.[52]
- Ministry of Power issued advisory for the operation and maintenance of inter-state transmission network on 24x7 basis for providing uninterrupted service during the nation-wide lockdown.[53]
- Ministry of Power requested the Ministry of Coal and the Ministry of Railways, to allow power companies to purchase coal and rail freight without advance payment. These payments could be made on reciprocal arrangement of receiving payments from DISCOMS, within two working days[54]
- Coal India Ltd. (CIL) extended the time limit for payment for the coal booked by power stations.[55]
- The Finance Minister earmarked Rs 90,000/-crore as soft loan for the DISCOMs for enhancing liquidity and clearance of their outstanding dues of generators and transmission licensees, through the government-owned power finance companies, Power finance Corporation (PFC) and Rural Electrification Corporation Ltd. (REC).
- On the advice of the central government, the Central Electricity Regulatory Commission (CERC) reduced the rate for late payment surcharge payable by DISCOMs to power generators and transmission licensees to 1 percent per month during the lockdown, from 1.5 percent, till 30th June 2020.
- A number of state governments undertook steps such as extending the last date of paying electricity bills and deferment of fixed electricity charges levied on industrial and commercial consumers. They would be charged only for their actual electricity usage.

48 *https://mnre.gov.in/img/documents/uploads/file_f-1584701308078.pd*

49 *https://pib.gov.in/PressReleasePage.aspx?PRID=1609718*

50 *https://www.dgshipping.gov.in/WriteReadData/News/20200331075416087662 5DGSorder8of2020forAdvisoryonnon-chargingofanydemurrage,groundrentbeyondtheallowedfreeperiodoranyperformancerelatedpenaltyonnon-containerizedcargoduringtheperiodofeffectofCovid-1.pdf*

51 *https://powermin.nic.in/sites/default/files/webform/notices/MoP%20advisory%20dated%2020-04-2020_permission%20to%20construction%20activities.pdf*

52 *https://powermin.nic.in/sites/default/files/webform/notices/Essential_operation_of_power_generation.pdf*

53 *https://powermin.nic.in/sites/default/files/webform/notices/operation_and_Maintenance_of_Inter%20state_Transmission_N*

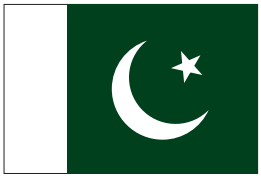
54 *https://economictimes.indiatimes.com/industry/energy/power/power-units-get-90-day-waiver-from-advance-freight-coal-payments/articleshow/74878930.cms?from=md*

55 *https://www.business-standard.com/article/companies/coronavirus-lockdown-coal-india-extends-payment-deadline-till-april-21-120040600742_1.htm*

Other than the steps taken by the government, private utilities also took steps to mitigate the impacts. For example, Tata Power Distribution Company Ltd. encouraged consumers to take photos of the meters for billing in the months of June and July, and send the same to the utility through WhatsApp, helping in getting actual meter readings.

Nepal

- The recently announced 2020/2021 fiscal budget attempted to ease the burden on the domestic users as well as commercial and industrial users by reducing the tariff. Domestic users would get up to 25 percent discount on consumption of 150 units or less, and 15 percent on consumption of 250 units or less. It has also made it tariff-free for those consumers who consume 10 units or less of electricity. For industrial consumers, the demand charge during the period of lockdown has been waived and a 50 percent discount on tariff provided during the off-peak time. Electricity use for irrigation, drinking water, electric transportation and household cooking are also encouraged with subsidies.
- NEA launched a mobile application on 7th June 2020, named NEA hotline service, and a web portal allowing customers to read their electricity meters installed in their homes. After reading their meters, the clients can clear their bills through various online payment services available in the market. The power utility launched the new application and other services amidst the coronavirus fear and the nationwide lockdown that prevented NEA meter readers from visiting customers' houses.



Pakistan

- The cabinet approved the deferment of monthly and quarterly fuel adjustments in the electricity bills for power consumers from April to June 2020 under the government relief package. The government provided PKR 110 billion relief to people in electricity bill payments.
- The National Electric Power Regulatory Authority (NEPRA) issued orders to K- Electric, the distribution company for Karachi, for billing consumers on an average basis during the COVID-19 period.

Sri Lanka

- The CEB, which supplies the bulk of electricity to Sri Lanka, took proper precautions as advised by their health organization. None of their 26,000 staff was affected due to the coronavirus.
- The CEB used minimum movement of staff, used video conferencing and remote monitoring, and left out the non-essential works. They employed minimum O&M staff and arranged for accommodation and food in the power generation station for a couple of months, maintaining adequate fuel stocks.
- The CEB launched a customer engagement campaign to explain how bills were calculated. Due to the campaign, many customers were satisfied and started paying up. Digital payment was also encouraged through various incentives.

Summary of Measures Taken at the Regional level

The biggest impact of COVID-19 on the South Asia power sector has been financial, mainly on the distribution utilities in South Asia. The challenges faced by the distribution utilities were more or less the same in all the countries of South Asia, i.e., stoppage of physical billing and reduced payment by consumers, while they still had to make payment to the generators and transmission companies for bulk purchase of power.

In most cases, the national governments came to the rescue of the distribution utilities and consumers by announcing deferment of fixed charges, extension of time of payment to consumers without penalties and payment by the DISCOMs to the generators with reduced penalties. The governments also provided funds to help the DISCOMs tide over the liquidity crisis.

The DISCOMs also took precautions to prevent spread of infection and avoid non-essential works, engaging with consumers to do self-meter readings and sending the images through WhatsApp and promoting payments digitally.

However, these are measures taken on the spur of the moment, as the nations were not prepared for such a pandemic. Taking lessons from this, a set of policy recommendations have been proposed to mitigate the risk on the power sector arising out of such pandemics. These are described in the following section.

Section 4 - A Broad-based Business Continuity Plan for the South Asian Power Sector Along with Recommended Policy Measures

Upon analysis, it is seen that the DISCOMs were adversely affected mainly due to three reasons:

- Power consumption in general reduced, because of the lockdown and the consequent closure of industries, commercial establishments, etc., with most people staying at home. The DISCOMs were stranded with long-term power purchase contracts, where they had to pay a two-part charge for fossil fuel-based plants, a fixed (capacity) charge whether they use electricity from that generating asset or not, and a variable (fuel) charge, depending on usage. Therefore, even though power demand went down, the DISCOMs had to pay the generators the full fixed charges.

- The second reason was due to their high paying consumers, i.e., industry and commercial establishments, stopping or reducing the consumption of power because of the shutdown. On the other hand, the consumption of their low paying consumers, i.e., residential consumers, increased. Thus, the revenue of the DISCOMs further reduced.

- The third reason was that consumers in a lockdown could not pay bills, if they did not have e-payment enabled or the DISCOM did not offer e-payment facility. Also, meter readers, who used to physically go and read meters, were not able to do so. As a result, DISCOMs had to resort to average billing. Some consumers could not pay due to financial constraints. All this further impacted the revenue collection of the DISCOMs.

Based on the above analyses, the following policy recommendations may be considered to help the governments of South Asia deal with COVID-19 as well as any future pandemic.

Policy Recommendations for South Asian Power Sector to Mitigate Effects of the Pandemic

1. **Regional Cooperation:** Regional cooperation efforts between the South Asian countries helped in meeting the reduced demand in Bangladesh and Nepal through reduction of import from India. Further cooperation initiatives in increasing trading of power in South Asia would help in optimal utilization of the power resources in South Asia. Water in hydro power stations in Nepal, which was spilt because of the lack of a trading framework in South Asia, could have been used for generation and sale to other countries and fossil fuel saved.

2. **Fair Sharing of Risk Due to Pandemics:** One of the biggest adverse financial impacts of a prolonged lockdown is the reduced utilization of power system assets due to reduction of demand. In order to ensure that the DISCOMs are not adversely financially affected by the prolonged effects of pandemics resulting in prolonged shutdowns, the risks of under-utilization need to be allocated judiciously. In all PPAs, there is a clause of force majeure to deal with unforeseen circumstances. In most of them, however, pandemics are not mentioned due to the very fact that no such event has happened for the last 100 years. So the legal interpretation of whether the pandemic is a force majeure sometimes becomes a challenge. Hence, it is recommended to ensure that the force majeure clause includes pandemics, in addition to other normal clauses, such as floods and earthquakes, that prevent a stakeholder (buyer or seller) from discharging its functions. Since it is neither the fault of the seller nor the buyer in a pandemic, however, the risks need to be shared equitably between the buyer and the seller. Similarly, risks would have to be judiciously allocated in the other agreements for operating a power plant, i.e., erection, testing and commissioning agreement, fuel and equipment supply agreement, engineering, procurement and construction (EPC) contracts, O&M agreements, project finance or land lease agreements, etc.

3. **Consumer Tariff Restructuring:** Analysis was carried out in some distribution utilities on the tariff structure of bulk power purchase by DISCOMs and retail power sale by them to the consumers. The bulk tariff for purchase of power by DISCOMs from generators consists of two parts: a fixed charge component and a variable/ fuel charge component. The fixed charge component of the tariff has to be paid by the distribution utility to the generator, irrespective of whether any energy has been drawn or not, and is related to the generating capacity booked by the DISCOM. It was seen that, by and large, the fixed charge (charge for blocking the generating capacity) by DISCOMs in generators was about 30-40 percent of the total charge paid to the generators, whereas the fixed charge recovered from the retail consumers was in the range of only about 10 percent. The detailed data is given in **Annexures VIII and IX**.

   Due to lesser sales because of the pandemic, DISCOMs were able to recover only the second part (variable component of tariff) from the consumers fully, since it pays this part to the generator only to the extent of energy drawn and also bills the consumer to the extent of energy supplied. This, therefore, is not like a back-to-back mechanism of payment from the consumer to the DISCOM and from the DISCOM to the generator. Therefore, in a case of reduced requirement, the DISCOM is not able to recover the full fixed charge and hence suffers financially.

   One of the recommendations to mitigate the risk of reduced demand due to the effect of the pandemic, therefore, is to change the retail tariff structure for consumers which is set by the regulators: that is, to put a higher percentage of the fixed component and reduce the variable charge component on the consumer tariff. This should come from the government policy. The ratio of the fixed charge to variable charge of cost of supply need not reflect the exact ratio of fixed charge to variable charge in bulk tariff, as this may not encourage the DISCOM to be efficient. But there can definitely be a higher component of fixed charge of, say, 20-30 percent.

4. **Replacement of Cross Subsidy With Direct Subsidy:** The other recommendation is to have a cost reflective tariff for all categories of consumers. During the pandemic, industries and commercial establishments closed down, with employees working from home over an extended period of time. Since many Asian countries have an element of cross subsidy in the tariff, with the tariffs of industries and commercial establishments higher than that of residential tariff, the revenues of the DISCOM would again take a hit. To avoid this, it would be better that the tariffs are cost reflective, and all consumers are charged tariffs reflective of the cost of supply. Since high tension (HT) industries are supplied electricity at high voltages, they do not use the low tension (LT) system, i.e., the household voltage infrastructure, and hence the cost of supply to industries actually come out lower than that of the cost of supply of household consumers. Under-privileged consumers, however, do need subsidy and this should be provided by the government. The subsidy can be deposited directly to the consumer's bank account, after they have paid the full tariff, instead of the DISCOM's revenue getting affected due to pandemics like this. Therefore, cross-subsidy should be replaced by direct subsidy.

5. **Financial Risk Mitigation:** In the absence of the above provisions, or till the time the policy measures are in place, the power sector stakeholders will have no option but to demand this lost money from the government, in order to survive. The government could provide these funds to tide over the liquidity problem of the DISCOMs through a soft loan, the repayment of which could be spread over some years. The power sector is so capital intensive and pervasive, that this would undoubtedly entail a huge outgo. Alternatively, they may take an insurance cover for the same in the future, and request for recovery of the insurance premium in the tariff from the regulator. A mix of these two options could distribute the risk.

6. **Cost Escalation Guidelines by Regulators:** Guidelines by the regulators to estimate the time overrun and cost overrun of power projects under construction should be pre-defined, in order to estimate the cost of escalation accurately for sharing of risks.

7. **Safety of the Employees/Working Conditions:** Electricity is an essential commodity and so its infrastructure has to be kept running. This can be ensured if the employees that operate the infrastructure are kept safe from the pandemic. In this context, the advisory from the country's apex health agency has to be followed while operating the infrastructure. Contactless services

should be encouraged. For example, instead of biometric attendance through fingerprint on a common fingerprint registering machine, there can either be a fingerprint registering device attached to each one's computer, or a facial recognition or radio frequency identification tag system.

8. **Digitalization:** It is crucial for the consumers to be able to get bills and pay bills remotely. Therefore, for any type of customer services, remote facility for consumers to access bills and to make payment should be available. Automatic meter readers or smart meters should be used for automatic meter reading and generation of electricity bills. Until these information technology devices are in place, bills based on average bills could be used.

9. **Executing Disaster Management Plan:** In case the main control center of the system operator has to be shut down due to certain conditions, an alternative arrangement should be made to maintain continuity of operations by setting up a temporary standby control center, with all the technical support. The disaster management plan for the power sector of each country must consider pandemic as one of the disasters.

10. **Enhancing Cybersecurity:** Supervisory Control and Data Acquisition (SCADA) or the communication infrastructure of any country faces the threat of getting hacked by international hackers. Even minor glitches in the system may pose a national threat. The power system utilities also face a shortage of IT experts in times like COVID-19, just like in any other sectors; so cyber security standards should be mandated in the generation, transmission and distribution segments, and a chief security officer (CSO) appointed by each utility, in line with government guidelines, if any. Utilities should be on the alert at all times and take prompt action to safeguard the network.

11. **Increased Use of Renewable Energy Sources:** South Asian countries should enhance energy security by utilizing renewable energy sources, as they do not have a fuel supply risk.

12. **Local Manufacturing:** Local manufacturing should be enhanced as far as equipment related to power plant is concerned, as this will not only reduce supply chain risk for equipment, in such pandemic situations, but also encourage the local economy. economy.

In conclusion, SAPS should adopt a broad regional framework for risk mitigation based on the concept of 'prevent, prepare, respond and recover resilience' to deal with the impact of COVID-19. The key steps for establishing such a framework would be:

Broad Regional Framework for Risk Mitigation of South Asian Power Sector

1. **Financial recovery**

- Prevention policy measures including-structuring the clause on force majeure in the PPAs, arrangements such as fuel supply agreements tariff restructuring at the retail level in terms of allocation of the fixed charge, and replacement of cross subsidy with direct subsidy (or by having a cost-reflective tariff).

- If the above policy measures are not in place, financial aid could be taken from the government or an insurance availed that also covers pandemics.

2. **Resilience as a key criterion for planning**

- Aim to improve resilience to ensure continuity of supply and sustainability of operations.

- Such resilience planning should take into account all forms of disruptions, including pandemics. For this, there should be a higher level of digitalization for operations. This can be achieved by:

    - Fast-tracking adoption of digital infrastructure, including approval processes, bid process management, workforce management, customer experience, etc.

    - Deploying digital solutions, including drones/unmanned aerial vehicles for asset monitoring, assets management analytics, and Internet of Things-based methods to track network indicators.

    - Implementing automatic meter reading wherever possible.

3. Workforce management

- Workforce to be trained and equipped to maintain business continuity, including formation of a disaster task force.
- Focus on the health, safety and well-being of employees.

4. Cyber security and risk management

- A well-defined cybersecurity policy classifying stakeholders based on risk and developed continuously, as per assessment of the monitoring and response plan.
- Proactive communication to create awareness related to cybersecurity risks amongst the workforce, customers, and other stakeholders to avoid pitfalls.

5. Deep customer engagement and management

- Using social media platforms and digital events for deeper customer engagement and value delivery to customers through proactive updates on vital information.

ANNEXURES

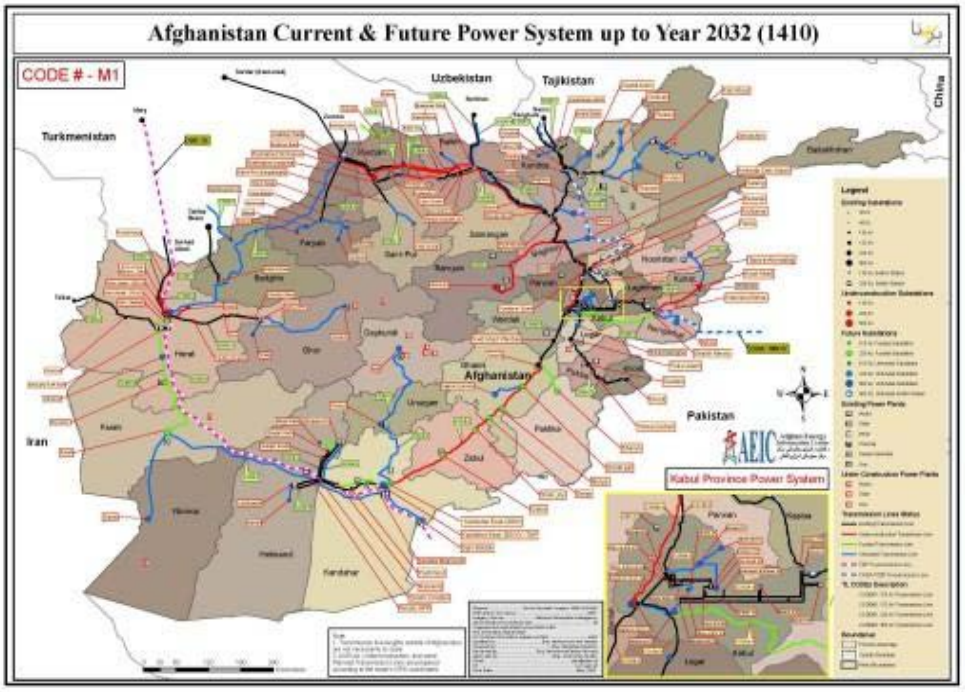
Annexure I

Afghanistan

According to the Afghanistan Planning and Policy Directorate and Da Afghanistan Breshna Sherkat (DABS), the national power utility of Afghanistan, the country generates around 640 Megawatt (MW) and imports 670 MW from its neighboring countries, Uzbekistan, Turkmenistan, Tajikistan and Iran. In terms of electrical energy, it imported 5000 MUs, against its own generation of 1000 MUs in 2019.

The electricity grid map of Afghanistan, showing interconnection with the neighboring countries, is shown in the figure below:

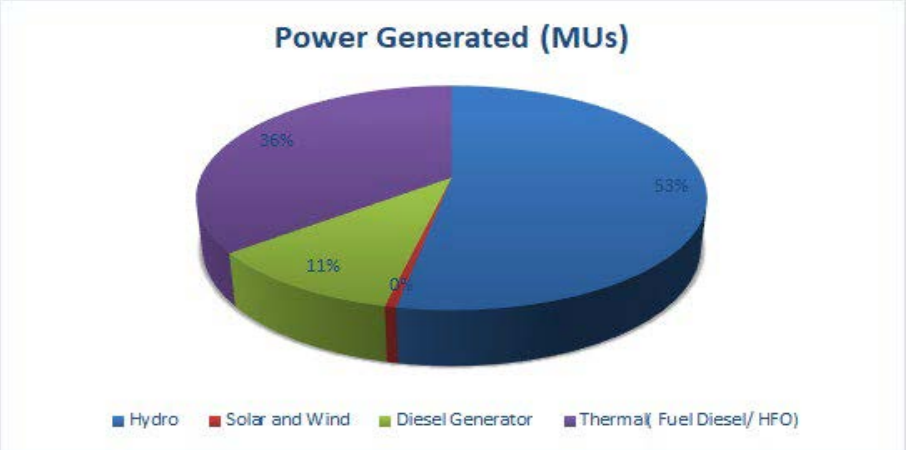
Figure 30: Afghanistan grid map, showing interconnections with neighboring countries



The source-wise domestic generation (over a year) is depicted below.

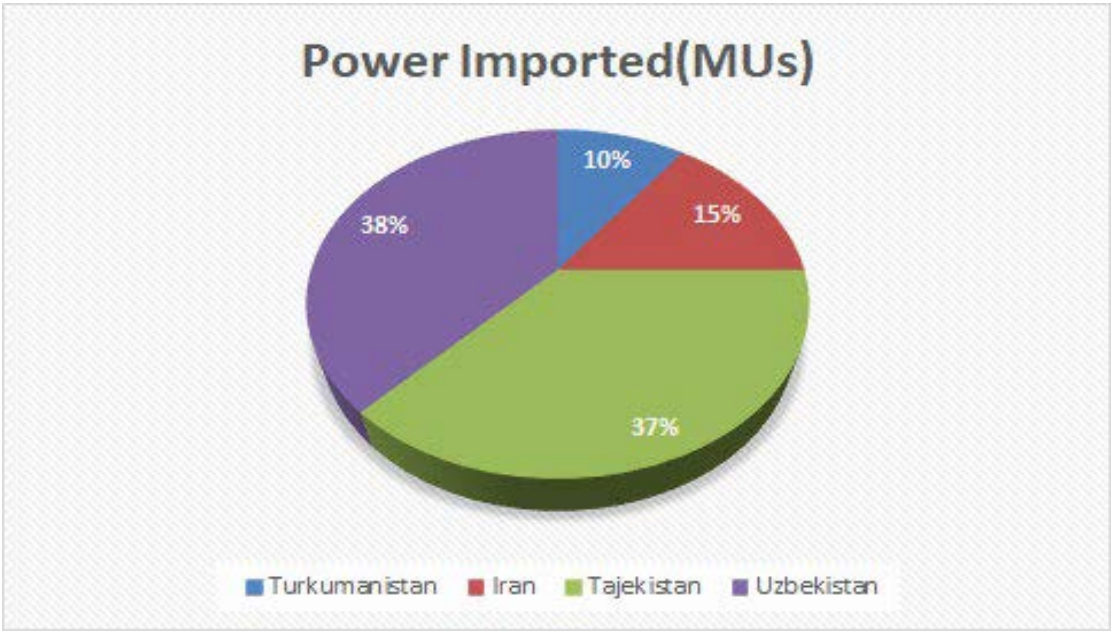
Generation type	Power generated (MUs) (2019)	Percentage
Hydro	529	52.9 percent
Solar and wind	6.1	0.6 percent
Diesel generator	108.7	10.9 percent
Thermal (Fuel-Diesel/ HFO)	356.2	35.6 percent
Total	**1000**	**100 percent**

[56] Figure 31. Source-wise domestic generation in Afghanistan (2019)



Country	Power imported (MUs) (2019)
Turkmenistan	500
Iran	750
Tajikistan	1850
Uzbekistan	1900
Total	5000

[57] Figure 32. Ratio of power imported from the four countries by Afghanistan (2019)



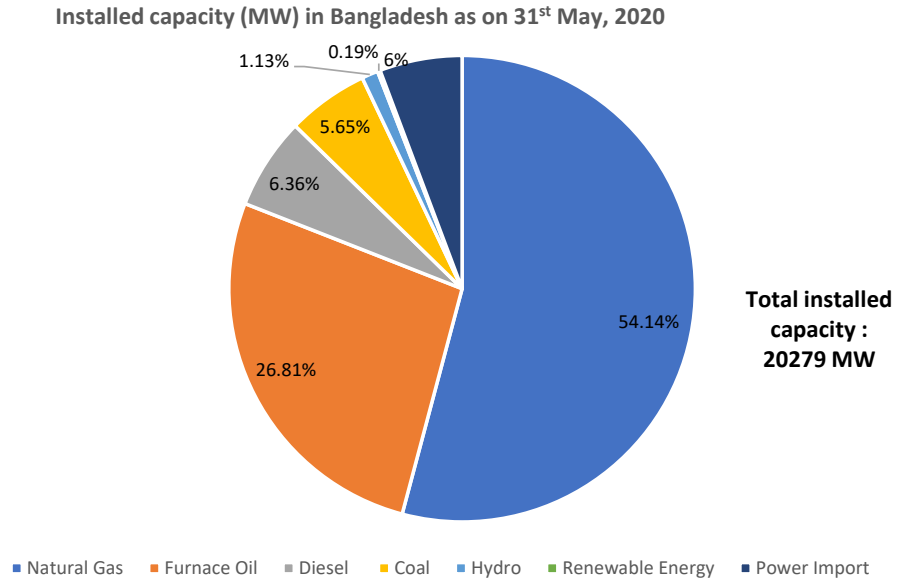
56 DABS Status during Covid-19 Pandemic–Report received from Afghanistan
57 DABS Status during Covid-19 Pandemic–Report received from Afghanistan

Annexure II

Bangladesh

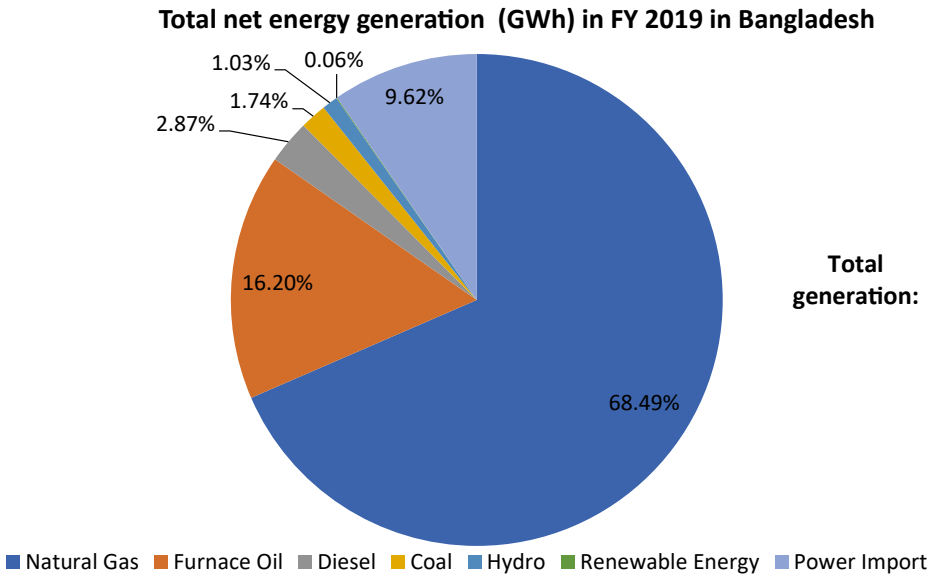
The installed capacity of various sources of generation, as on 31st May 2020, is depicted in Figure 5.

Figure 33: Installed capacity (MW) in Bangladesh, as on 31st May, 2020



Bangladesh had a net energy generation of 70533 GWh in 2018-19 and a peak demand of about 13000 MW in 2018-19, which comes in summer (April to June). The generation from various sources for the year 2018-19 is depicted in Figure 6.

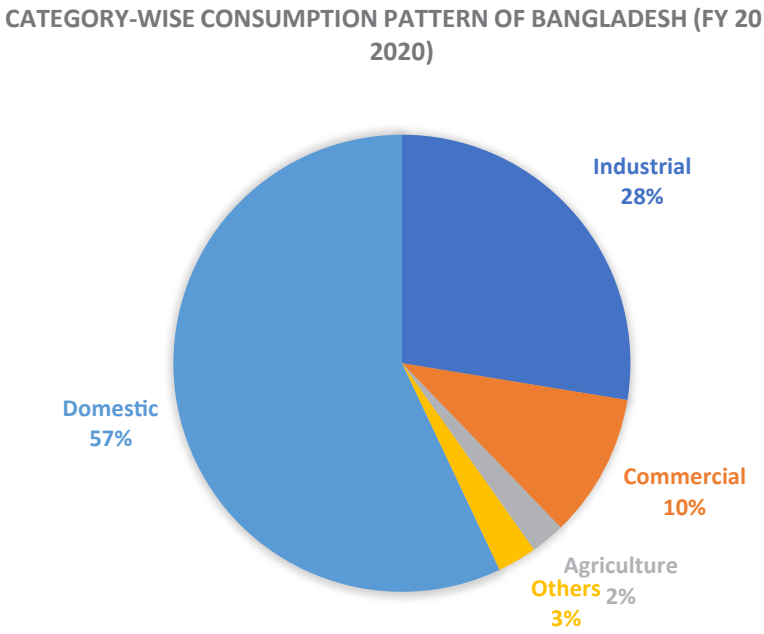
Figure 34: Total net energy generation (GWh) in Bangladesh, FY 2019[58]



Domestic or residential consumption is the highest consuming category in Bangladesh, followed by industrial and commercial categories, respectively. The category-wise consumption in Bangladesh for FY 2019 is given below.

58 https://www.bpdb.gov.bd/

Figure 35: Category-wise power consumption pattern in Bangladesh, FY 2019-20[59]



The reduction in consumer category-wise electricity consumption in April 2020 vis-à-vis April 2019, is depicted below:

Month	Consumer class based electricity sales (Million KWh)					
	Residential	Industry	Commercial	Irrigation	Other	Total
April, 2019	1,858	1,493	683	116	231	4,380
April, 2020	2004	965	455	151	161	3736
Sales decreased	146	-527	-228	35	-70	644
	8 percent	-35 percent	-33 percent	30 percent	-30 percent	-15 percent
May, 2019	2,325	1,581	756	43	258	4,971
May, 2020	2,299	1,097	515	55	182	4,147
Sales decreased	-25	-484	-250	12	-76	-823
	-1 percent	-31 percent	-33 percent	28 percent	-29 percent	-17 percent

Figure 36: Category-wise electricity consumption in Bangladesh, comparison between April 2019 vs. April 2020 & May 2019 vs. May 2020

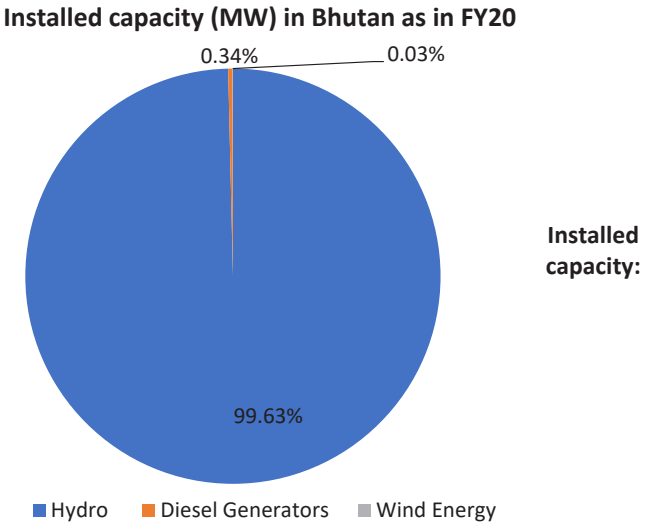
59 https://www.bpdb.gov.bd/

Annexure III

Bhutan

Bhutan has an installed capacity of 2342 MW, which is almost totally hydropower, with less than 1 percent from diesel and wind energy combined. The same is depicted below.

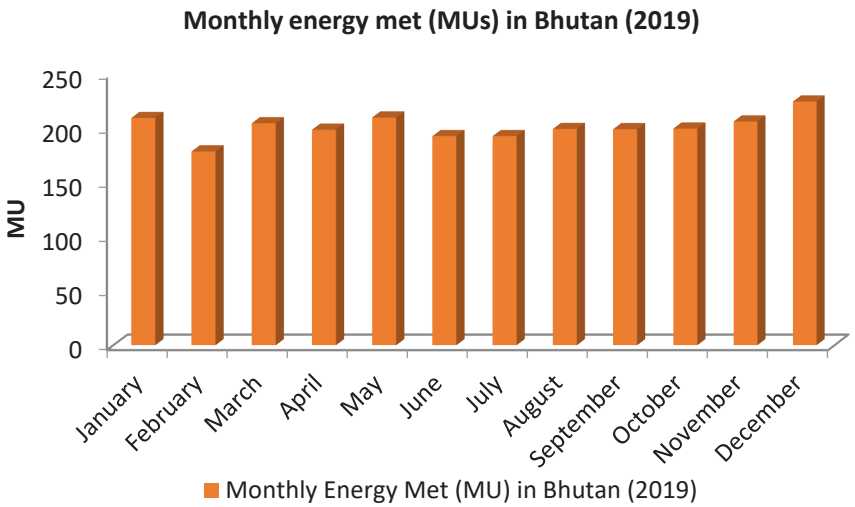
Figure 37: Installed capacity (MW) in Bhutan, as in FY20



Bhutan's peak demand in 2020 was about 420 MW. As per the international agreement for sale of power from Bhutan to India, all surplus power from hydro projects funded by India through grant/loan, which forms most of the generation, is exported to India.

The monthly electricity consumption pattern for Bhutan for 2019 is depicted below.

Figure 38: Monthly energy met (MUs) in Bhutan (2019)[60]

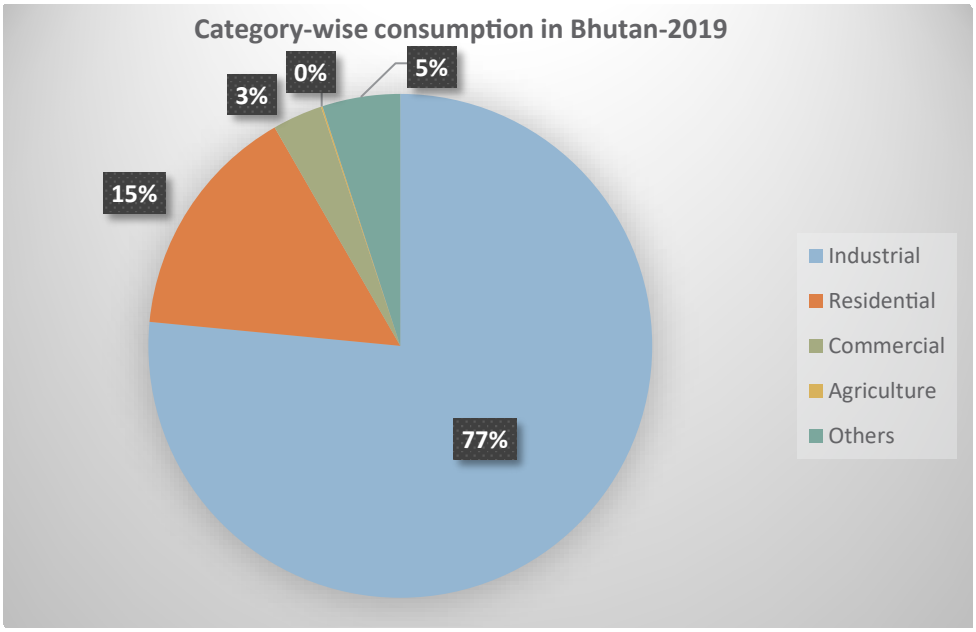


As can be seen from the figure, the peak consumption of Bhutan comes in the winter months of December and January, whereas the least consumption months are that of June and July. February is seen here as artificially low, since it has only 28 days.

The category-wise consumption of Bhutan for the year 2019 is given below:

60 https://bea.gov.bt/

Figure 39: Category-wise power consumption in Bhutan – 2019[61]



It can be seen from the above figure that industrial power consumption forms 77 percent of the consumption in Bhutan, the highly dominant category. Industries such as cement industries, ferro-alloys and ceramics have a share of 78 percent in the total energy demand of the industrial sector.[62]

61 https://bea.gov.bt/

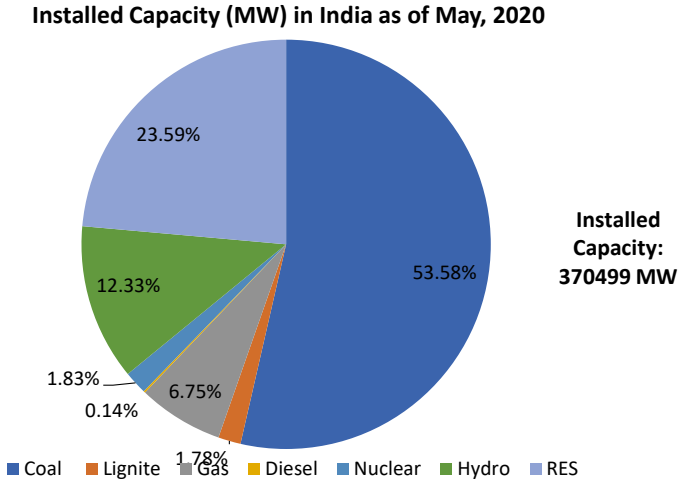
62 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RRA_Bhutan_2019.pdf

Annexure IV

India

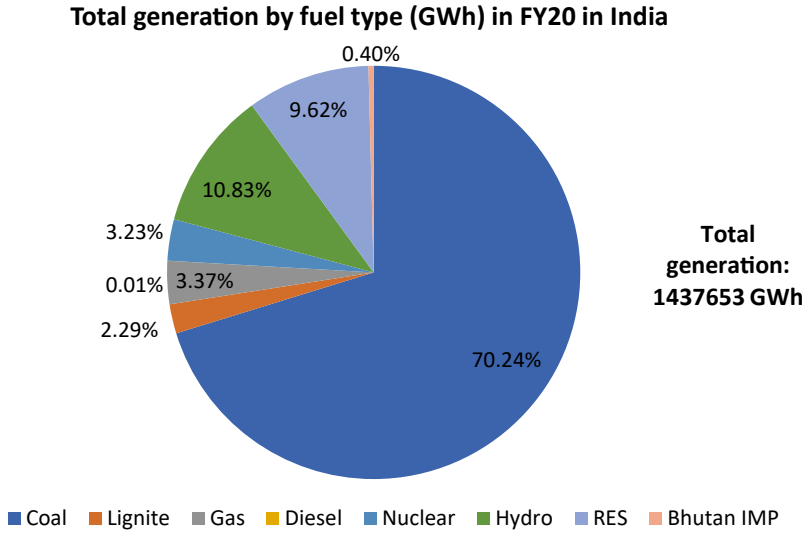
India has an installed capacity of 370 GW, as on 31st May, 2020, the largest share being that of coal-based power plants, followed by renewable energy sources and hydro power plants. The source-wise break-up of installed capacity as on 31st May, 2020 is depicted below. Coal-based generation forms the predominant form of generation in India in terms of installed capacity (54 percent), followed by renewables (24 percent), consisting of solar, wind, biomass and small hydro (up to 25 MW) capacity, and hydro capacity (12 percent).

Figure 40: Installed capacity (MW) in India, as of May, 2020



Due to the different plant load factors of the different sources of power, however, coal-based generation still dominates, followed by hydro power generation and generation from renewable energy sources, respectively. The source-wise break-up of generation for the year 2019-20 is depicted in Figure 13. Coal-based generation dominates the supply (70 percent), followed by hydro generation (11 percent) and renewables (10 percent).

[63] Figure 41: Total generation by fuel type (GWh) in India, FY20

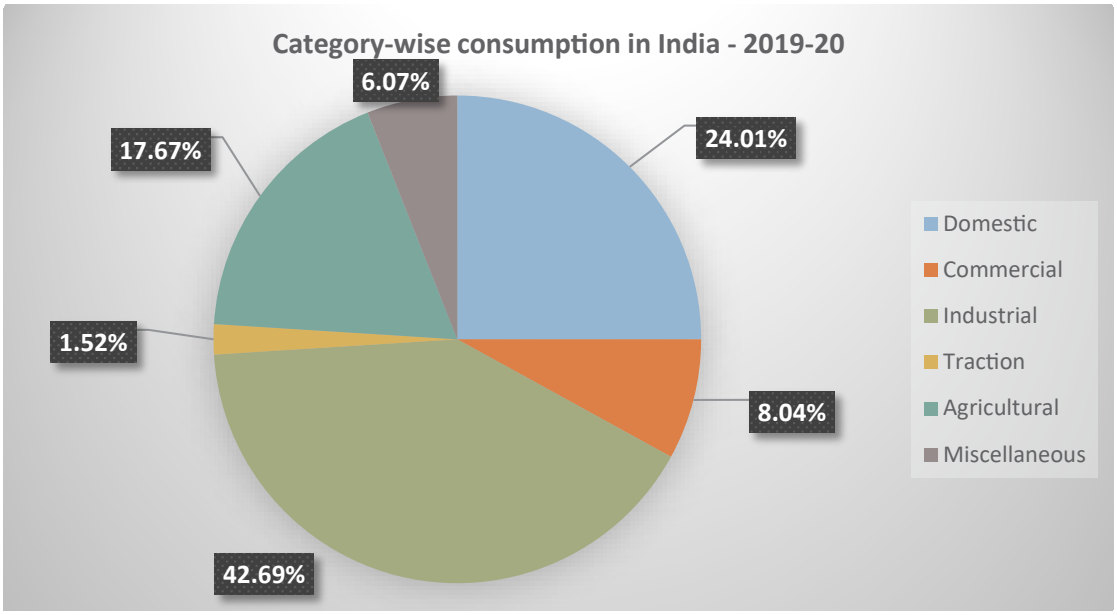


fuel type (GWh) in India, FY20

63 https://cea.nic.in/annual-report/?lang=en

Among the category-wise electricity consumption, industrial consumption is the dominant category, and together with the commercial category, takes up almost half the electricity consumption. The consumer category-wise consumption in India for the year 2019-20 is given in the chart below[64].

Figure 42: Category-wise consumption in India for the year 2019-20



It is seen from the above figure that industrial consumption is the dominant category and, together with the commercial category, takes up almost half the electricity consumption.

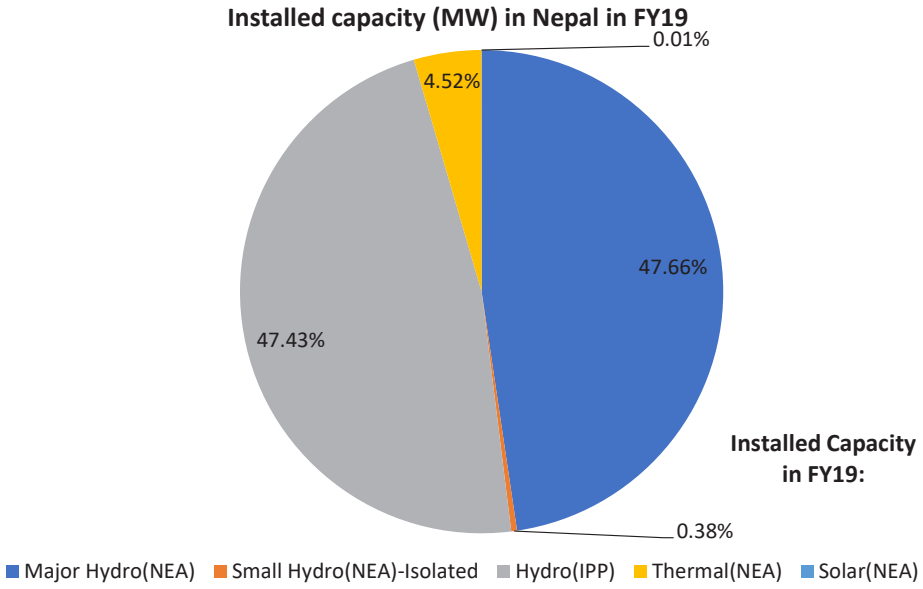
64 *https://cea.nic.in/annual-report/?lang=en*

Annexure V

Nepal

The installed generating capacity of Nepal is predominantly hydro, about half of which is owned by the government utility, NEA, and the other half by IPPs which belong to the private sector. Other than that, there is a miniscule percentage of thermal (diesel) and solar power. The source-wise installed capacity is depicted in the figure below.

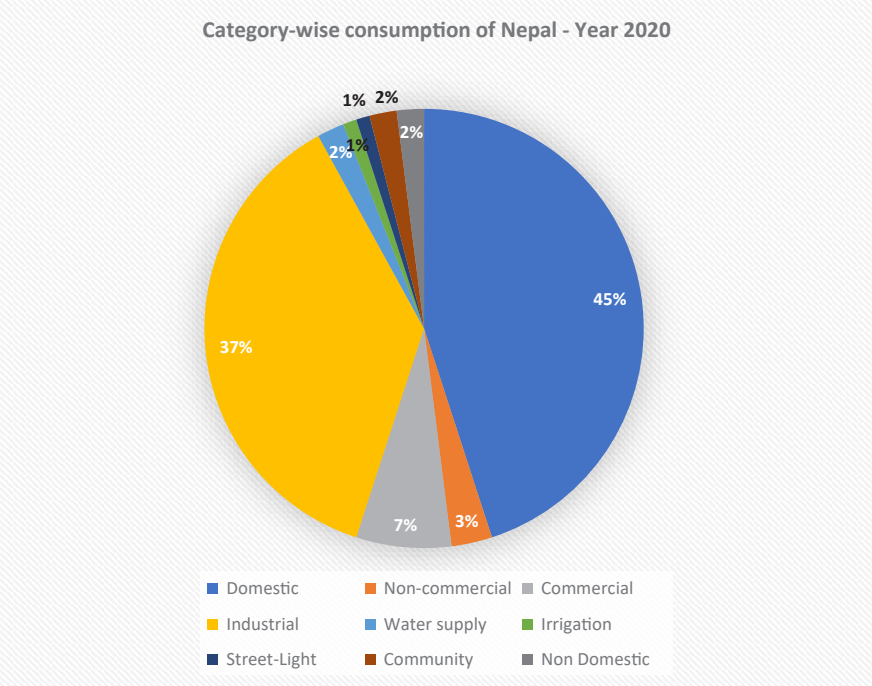
Figure 43: Installed capacity (MW) in Nepal in FY19



The generation in Nepal is almost 100 percent from hydro sources.

The maximum electricity consumption is for residential purposes, i.e., 45 percent, followed by industry at 37 percent and commercial at 7 percent. The consumer category-wise break-up is shown in the figure below.

Figure 44: Category-wise consumption of Nepal - Year 2020

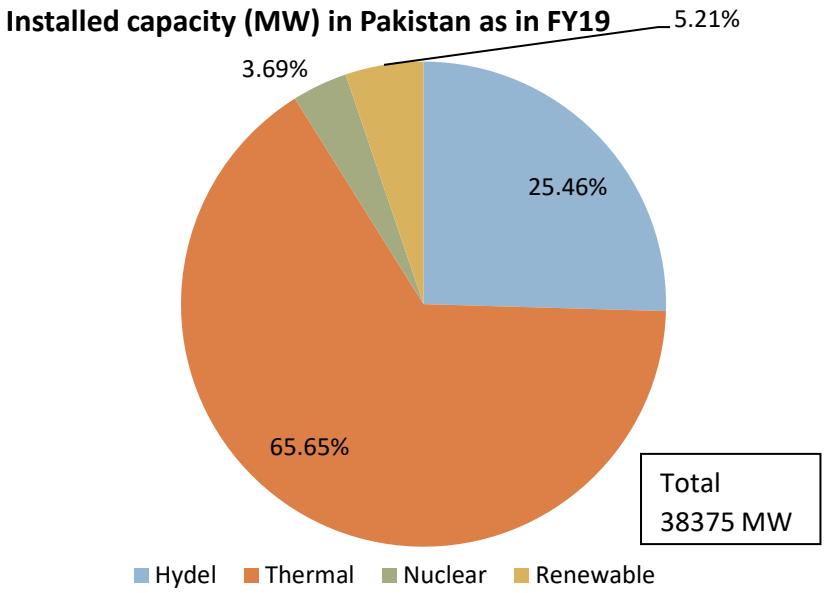


Annexure VI

Pakistan

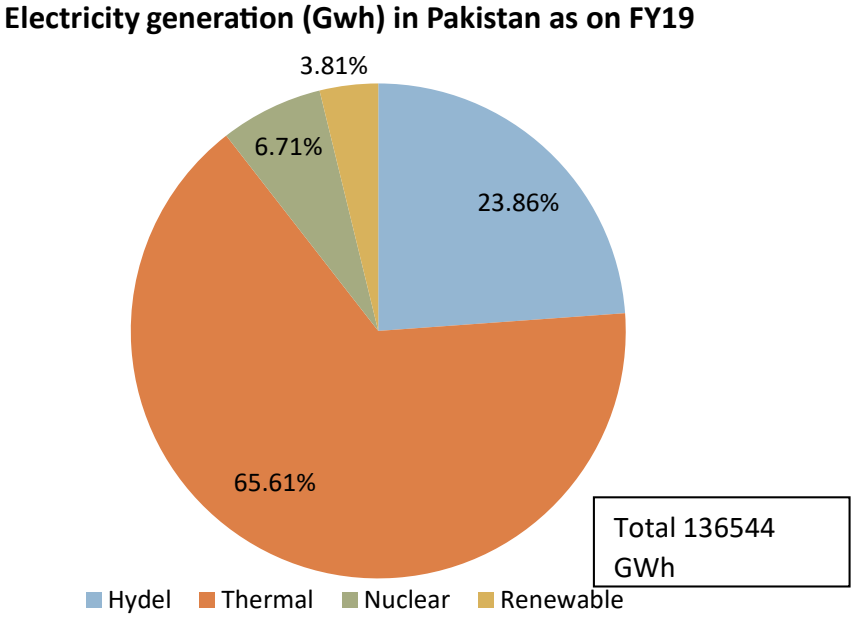
The installed generating capacity of Pakistan at the end of FY 2019 (July 2018 to June 2019), is depicted below. The country has an installed capacity of about 38375 MW, comprising mainly thermal generation (coal, oil and gas) and hydroelectric power. The thermal generation comprises mainly gas based plants, the balance being coal and liquid fuel (mainly furnace oil) based plants. The majority of thermal generation is owned by IPPs. The source-wise break-up is given below.

Figure 45[65]: Installed capacity (MW) in Pakistan, as in FY19



The generation from these sources for FY 2019 is given below.

Figure 46[66]: Electricity generation (GWh) in Pakistan as in FY19

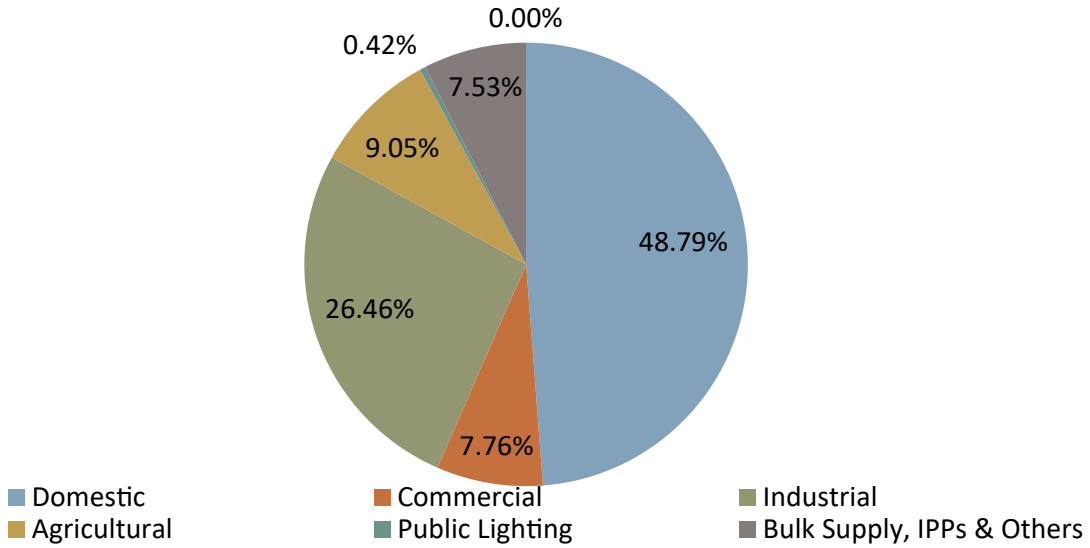


65 http://ntdc.gov.pk/
66 http://ntdc.gov.pk/

It is seen that thermal generation contributed 65 percent of the total generation in FY 2019, hydro 24 percent, nuclear 7 percent and renewables 4 percent.

The consumer-wise category consumption is given below.

Figure 47[67]: Consumption of energy by different economic groups in FY19 (NTDC & K-Electric)



The above figure shows that domestic consumption forms the majority of the electricity consumption, followed by the industrial category.

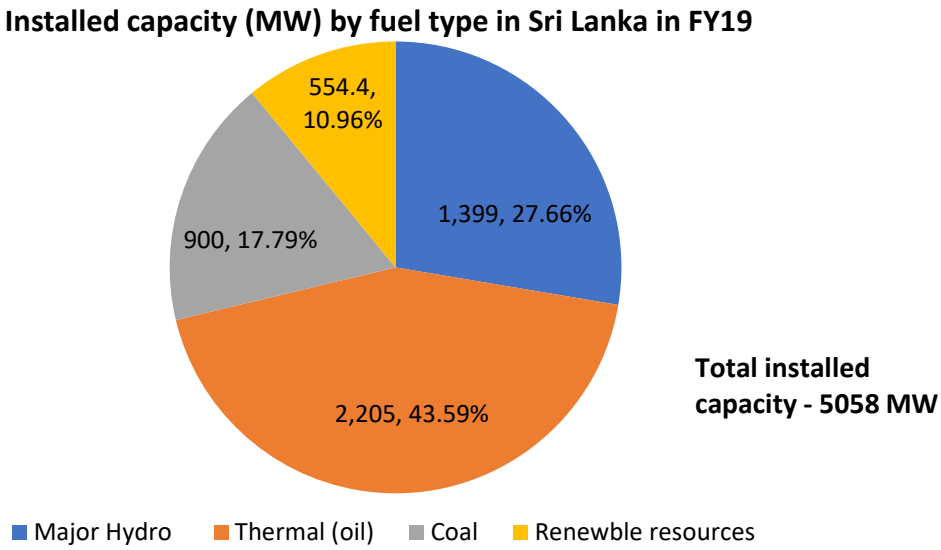
67 http://ntdc.gov.pk/

Annexure VII

Sri Lanka

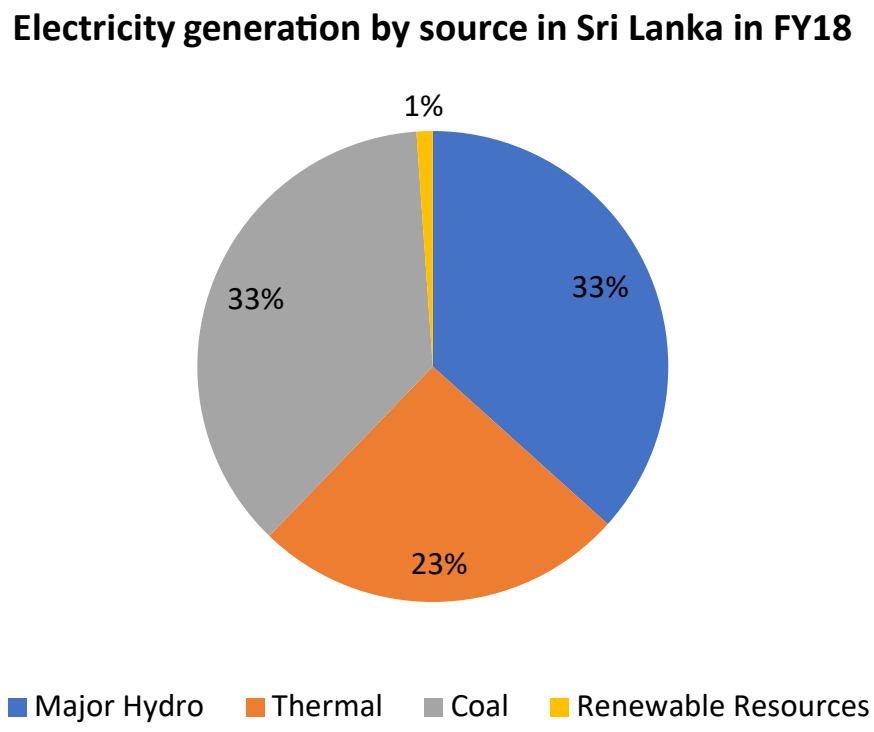
The source-wise break-up of the installed capacity of Sri Lanka, as in 2019, is depicted below.

Figure 48: Installed capacity (MW) by fuel type in Sri Lanka in FY19



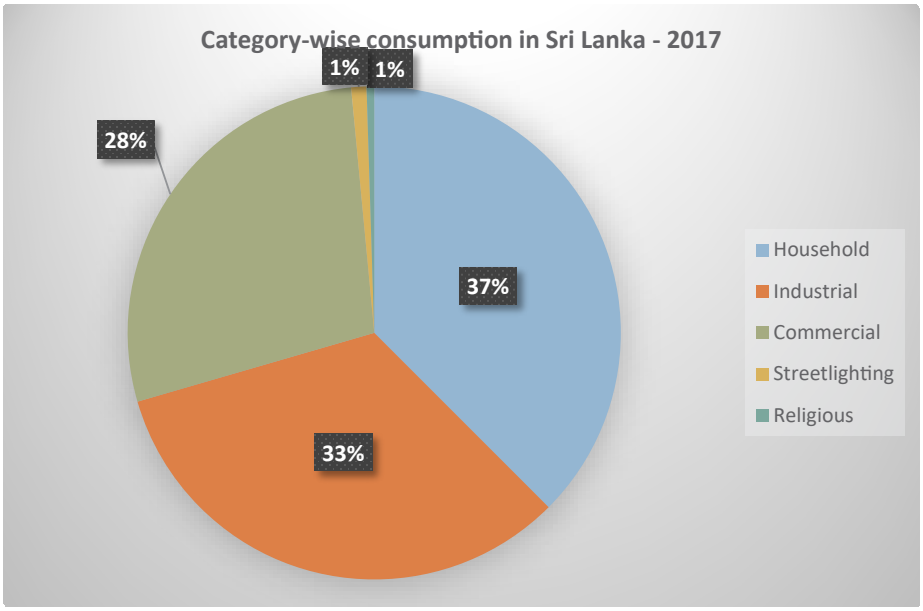
The thermal capacity consists of 2205 MW oil-based capacity (1504 MW owned by the government utility, Ceylon Electricity Board, and 701 MW by IPPs). The source-wise break-up of electricity generation in 2018 is depicted below.

Figure 49: Source-wise electricity generation in Sri Lanka, FY18



The consumer category-wise consumption for Sri Lanka for 2017 is depicted below.

Figure 50: Category-wise consumption in Sri Lanka - 2017



It is seen that household consumption forms the major part of the electricity consumption, followed by the industrial and commercial categories.

Annexure VIII

ANNEXURE- VIII[68]					
Year	Ratio of fixed charge to total charge in revenue collected from consumers by DISCOMS				
	Utility name	Revenue (Rs. Crore)		Total Revenue (TR) (Rs. Crore)	FC/TR (percent)
		Fixed charges (FC)	Variable charges (VC)		
FY 2021-22	**PSPCL (Punjab State Power Corporation Ltd.)**	2635.39	29089.78	31725.17	8.31 percent
FY 2020-21	**UHBVN (Uttar Haryana Bijli Vidyut Nigam)**	896.91	8610.38	9507.29	9.43 percent
FY 2020-21	**DHBVN (Dakshin Haryana Bijli Vidyut Nigam)**	1412.05	13375.78	14787.83	9.55 percent
FY 2019-20	**TPDDL (Tata Power Delhi Distribution Ltd.)**	4944.35	51075.94	56020.29	8.83 percent
FY 2020-21	**BSES-R (Bombay Suburban Electric Supply – Rajdhani)**	9888.7	102151.9	112040.58	8.83 percent

68 http://pserc.gov.in/pages/PSPCL-Tariff-Order-FY-2021-22-chapter6.pdf
https://herc.gov.in/WriteReadData/Orders/O20210330a.pdf
https://herc.gov.in/WriteReadData/Orders/O20210330a.pdf
http://www.derc.gov.in/sites/default/files/TPDDL%20-%20TARIFF%20ORDER%20FY%202020-21_0.pdf
http://www.derc.gov.in/sites/default/files/BRPL%20-%20TARIFF%20ORDER%20FY%202020-21_0.pdf

Annexure IX

ANNEXURE-IX[69]					
Year	Ratio of fixed charge to total charge in payments made to generators for bulk supply				
	Utility Name	**Revenue (Rs. Crore)**		**Total Revenue (TR) (Rs. Crore)**	**FC/TR (percent)**
		Fixed Charges (FC)	**Variable Charges (VC)**		
FY 2021-22	**PSPCL**	1268.31	1663.45	2931.76	43.26 percent
FY 2020-21	**UHBVN**	6852.00	18351.01	25203.004	27.19 percent
FY 2020-21	**DHBVN**	6852.00	18351.01	25203.004	27.19 percent
FY 2019-20	**TPDDL**	1613.48	2308.6	3922.08	41.14 percent
FY 2018-19	**BSES-R**	2130.71	4227.12	6357.83	33.51 percent

69 *http://pserc.gov.in/pages/PSPCL-Tariff-Order-FY-2021-22-chapter6.pdf*
https://herc.gov.in/WriteReadData/Orders/O20210330a.pdf
https://herc.gov.in/WriteReadData/Orders/O20210330a.pdf
http://www.derc.gov.in/sites/default/files/TPDDL%20-%20TARIFF%20ORDER%20FY%202020-21_0.pdf
http://www.derc.gov.in/sites/default/files/BRPL%20-%20TARIFF%20ORDER%20FY%202020-21

ABBREVIATIONS

BPDB	Bangladesh Power Development Board
BPCL	Bhutan Power Corporation Limited
BSES-R	Bombay Suburban Electric Supply – Rajdhani
CIL	Coal India Limited
CEB	Ceylon Electricity Board
CII	Confederation of Indian Industry
CERC	Central Electricity Regulatory Commission
CEA	Central Electricity Authority
CSO	Chief Security Officer
DABS	Da Afghanistan Breshna Sherkat
DPDC	Dhaka Power Distribution Company
DHBVN	Dakshin Haryana Bijli Vidyut Nigam
DISCOM	Distribution Company
GWH	Giga Watt Hours
GoI	Government of India
HVDC	High Voltage Direct Current
IPP	Independent Power Producers
IPPAN	Independent Power Producers Association of Nepal
INR	Indian Rupees
IRADe	Integrated Research and Action for Development
LNG	Liquified Natural Gas
MMSCFD	Million Standard Cubic Feet Per Day
MUs	Million Units
MVR	Maldivian Rufiyaa
MW	Mega Watt
MoP	Ministry Of Power
NEPRA	National Electric Power Regulatory Authority
NTPC	National Thermal Power Corporation
PPA	Power Purchase Agreement
PGCIL	Power Grid Corporation of India
PV	Photo Voltaic
PFC	Power Finance Corporation
PKR	Pakistani Rupees
PPRRF	Prevent Prepare Respond and Recover Resilience Framework
PPE	Personal Protective Equipment
PSPCL	Punjab State Power Corporation Ltd.
REC	Rural Electrification Corporation
RFID	Radio Frequency Identification
SCADA	Supervisory Control And Data Acquisition
SAPS	South Asian Power Sector
SECI	Solar Energy Corporation of India
SCCL	Singareni Collieries Company Limited
TPDDL	Tata Power Delhi Distribution
UAVs	Unmanned Arial Vehicles
UHBVN	Uttar Haryana Bijli Vidyut Nigam
USAID	United States Agency for International Development
WHO	World Health Organization

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 recently 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).

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.

About IRADe

IRADe, located in Delhi, is a non-profit and fully autonomous institute for advance research. IRADe's multidisciplinary research and policy analysis aid action programs. It is a hub for a network of diverse stakeholders. Established in 2002, the institute is recognized as an R&D organization by the Department of Scientific and Industrial Research and Ministry of Science and Technology of the Government of India. The Ministry of Urban Development has accorded IRADe the status of Centre of Excellence for Urban Development and Climate Change. Through the SARI/EI program, IRADe is pushing the envelope for sustainable energy access through experts and members from South Asia.

For more information, please visit the SARI/EI project website:

Website: https: //sari-energy.org/

Follow us: Twitter: @SARI_EI_2022