REDUCING CARBON EMISSIONS
FOR A GREENER TOMORROW

INDIAN CHAMBER OF COMMERCE

FutureStation
Going Beyond

Low Carbon Pathway for Power Sector

As per www.ourworldindata.org, India's absolute CO_2 emissions were 2.44 billion tons in 2020. Out of these, the power sector in India accounts for **49 per cent of total CO_2 emissions**, compared with the global average of 41 per cent. The fuel-wise power generation, in India, is depicted in the table below (as on 30/06/2022 – Central Electricity Authority).

Generation Mix as per Fuel (as on 30/06/2022 – CEA)

Category	Installed Generation Capacity (MW)	% of share in Total
FOSSIL FUEL		
Coal	204080	50.7
Lignite	6620	1.6
Gas	24856	6.2
Diesel	510	0.1
Total Fossil Fuel	236065	58.5%
Non Fossil Fuel		
Hydro	46850	11.6
Wind	40788	10.1
Solar	57706	14.3
Biomass / Cogen	10206	2.5
Waste to Energy	477	0.1
Small Hydro	4888	1.2
Nuclear	6780	1.7
Total Fossil Fuel	167694	41.5%

In order to bring down the emission contribution from the power generation sector, the focus has to shift to the bottom of the above table. In the non-fossil category, wind and solar have been the major contributors, whereas the other categories have been very minimal. It is these other categories that need to be given a huge impetus, as they can be a good replacement for the firm power that is provided by fossil fuels. Although, wind and solar can be made into firm power if they are integrated with storage. In the subsequent sections of this paper, we will evaluate the various options for the power sector to transit to a low carbon path.

Power sector is divided mainly into three section viz. generation, transmission and distribution. The latter two are smaller contributors to the emissions from the power sector but as the saying goes 'every drop counts'.

Distribution

The distribution section is the end consumer section and the major low carbon methodology is to use high efficiency appliances and reduce consumption. For the use of high efficiency appliances there are programs like Demand Side Management (DSM) that are promoted by the DISCOMs. These need to be expanded further and every DISCOM should be mandated to execute these. The second aspect of reducing consumption is a more personal characteristic. However, there are start-ups that have put in products in place wherein one can see the load, consumption, expected bill and

many other features on their smart phones. With this, the consumer gets aware and can take actions to reduce his consumption. By using high efficiency appliances and reducing consumption, the units consumed will be reduced, thereby reducing the emissions. At the end of the day 'every drop counts'.

Transmission

The transmission section in the power sector has minimal quantified emissions but the impacts of any of these emissions is very large. Typically, sulphur hexafluoride(SF_6) is the gas that is used as an electrical insulator in the Gas Insulated Switchgears (GIS). SF_6 has the worst Global Warming potential among the GHGs and a small quantified leakage has a large contribution to the equivalent CO_2 emissions. Hence the industry has already developed replacements for this high Global Warming potential among the GHGs insulator gas. Gases like Fluoroketones, Fluoronitriles, dichlorotrifluoroethane could be good replacements for SF_6 and are commercially available in the market. The industry could consult with the GIS OEMs and replace SF_6 with these non GHG insulating gases and eliminate GHG contributions from the transmission section. Although the quantity is small, but, at the end of the day 'every drop counts'.

Generation

The generation section of the power sector contributes the largest to the CO_2 emissions. This is obvious as we have nearly 59% generation based on fossil fuel. Further, these plants are catering to the base load and hence would have a higher capacity factor. India being abundant with coal, the cost of generation using coal is also palatable to the end consumer and to the policy makers. However, to address this global challenge of Climate Change and its impacts of flood, drought, heat waves etc. we will have to pay a price for our power to be clean. Although this additional cost will be incremental, it would obviously have a long term benefits for the generations to come. There are many ways that the low carbon pathway can be treaded. Some of these aspects have been discussed in the subsequent paragraphs.

There are large number of power plants across the country of different capacities and age. The new plants would be designed and implemented with the latest technology and efficiency. It is the old plants that would have a good opportunity to improve their operational efficiency. A complete energy audit of the plants would give an idea of the various avenues, wherein old equipment could be replaced with new efficient equipment, thereby improving the operational efficiency of the entire power plant. These interventions would surely require financing and one could analyses the financial benefits based on the energy saved and the amount of energy available for sale. This reduction in captive consumption will also help in reducing the carbon emissions of the power plant.

India is not abundant with natural gas and has to rely on imports for gas based power generation. Gas based power generation has a higher and relatively lower CO_2 emission per unit of power generated. Relying on imported Natural gas for power generation would be a big risk on the long term viability of the gas based power plant. In case there is the need of building a new thermal plant, using coal, the technology using oxy-fuel combustion could be adopted, using the super-critical CO_2 cycle. Such a power plant has an efficiency equivalent to a gas based power plant and gives pure CO_2 as an emission, which could be reused.

Another possibility for coal based thermal power plants to reduce their carbon footprint is by blending biomass based pellets with the coal. Waste Biomass or even sustainably grown biomass could be pelletized and blended with the coal in the existing power plant boilers. The pellets could be white pellets or torrefied pellets to meet the specific boiler requirement. The blending will require a detailed analysis and study to determine the maximum blend that the power plant infrastructure can handle without sacrificing on efficiencies and generation. Biomass blending would reduce the carbon footprint of the power plant. It should be ascertained if there is a carbon benefit in blending pellets, after taking into account the carbon footprint of the pelletizing unit and transport of the pellets, with the carbon emissions of the power plant.

Coal based power plants can bring in circularity with one of their waste materials via ash. Currently, the IS1489-1 permits only 25% of ash to be blended with cement to make Pozzolanic Portland Cement. The power industry can work alongside the cement industry to update these specifications, so that ash could be physically and chemically activated. This activated ash could be blended to a high percentage with cement. This would be a low carbon pathway for the cement industry, which would be supported by the power industry. Based on policy, the carbon saved by the cement industry could be shared with the power industry, benefitting both.

Another area that could contribute significantly to the low carbon path of the power sector is to invest in distributed generation, based on the resources that are available. Biomass, biogas, small hydro projects could be set-up by the large generators in a distributed manner and promote local entrepreneurs. These plants could be in tens of MWs and get integrated to the grid. The advantage would be that the local resources would be utilized and benefit the local society. The large generators will have the know-how and ownership of these distributed generation plants. The complete operation and maintenance of these distributed plants can be taken up by these local entrepreneurs.

As long as mankind exists, waste will be a resource that will be generated. This is a resource that needs to be tapped further to convert the waste into power. In mega cities the amount of waste that is generated is huge and can be utilized as a resource to make power. Waste to energy plants can meet the baseload requirements. However, the technology selection for this resource would have to be very specific as the characteristics of waste changes from city to city. It may be pertinent to note that the Central Electricity Regulatory Commission has also issued a separate tariff for waste to energy power and mandated that the local DISCOM cannot refuse to purchase this power. Over time, there have been some unpleasant experiences in this space, across the country. However, there are some success stories as well and greater focus and municipal will can make this into a good source of low carbon power generation.

Globally, nuclear generation is considered as a clean generation. Currently, nuclear generation is mainly controlled by the government agencies and hence it has been a challenge for the other generators to enter this space. Most of the current nuclear generation has been using fission. Small breeder reactors and new technologies with nuclear fusion are being demonstrated to utilize local resources that are available within the country. Such an opportunity, will not call for various treaties and use of local nuclear fuel.

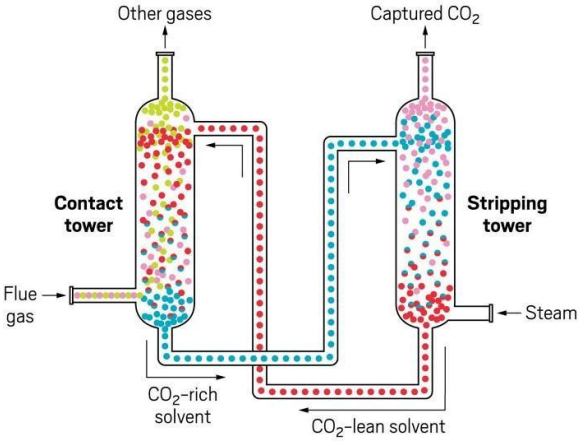
The first thought that comes to mind is to switch to wind and solar. However, one needs to realize that power from these resources is infirm and depends on the resource. One way that this infirm

power can be made into firm power is by integrating energy storage with this power. Short term energy storage can be in the form of electricity, whereas long term energy storage has to change form. However, when considering storage, one needs to take into account the long cycles that any storage system can offer. Gravity storage, underground hydraulic storage under pressure, pumped hydro storage are some of the storage mechanisms that need to be integrated with wind and solar. No doubt that these storage systems are CAPEX intensive. However, since they have infinite cycles of charge – discharge, their life is very long and work out competitive in the levelized cost of energy. Other small short term storage for specific purposes can be done using chemical batteries. It may be pertinent to note that spent batteries will have to be disposed at the end of their life and would contribute to the hazardous waste, until and unless completely recycled and reused.

Long term storage could be in the form of hydrogen. This is an area that is picking up rapidly and a generator can plan the inclusion of hydrogen in their portfolio, integrating it with wind and solar. Typically in wind and solar, there is a capacity that is contracted to be injected into the grid. Anything more than that will be dumped. It is this dumped renewable energy that can be used to convert the electricity to hydrogen. Noted that the hydrogen generation infrastructure is currently expensive. With the progress that is being made, globally, in the hydrogen space, the cost of equipment will also reduce over time. A renewable energy farm could install an excess capacity and operate the hydrogen generation at a capacity factor of 75% and whenever they have to dump the renewable power, the capacity factor will go up and the annual capacity factor could be in the 90s. This way there will be electricity generation using renewable resources and energy storage for other applications in the form of hydrogen.

End of the Pipe

As of yet, various forms of generation methodologies have been discussed which could contribute in working towards the low carbon pathway. However, there would still be CO_2 emissions from the thermal power plants. To address this aspect, there is the technology termed as Carbon Capture. Carbon Capture is not a new technology, as it has been used in the fertilizer industry for quite a few years. However, its application into the power sector has been relatively new. Various technology providers have been working on different solvents and methodologies to make Caron Capture as economical as possible. The levelized cost of CO_2 from a Carbon Capture plant has dropped down significantly over the years and is at ~US$40 per ton. Anyway, it is still a cost and hence CO_2 Valorization is key to make this a viable technology for application.



Valorization of CO_2 cannot be applied using one single solution. A number of different solutions ought to be put together to make this a viable opportunity. CO_2 can be fed into algal plants to make value added products like Omega 3 acids or nutraceuticals. Both these are very high value products but have a limited volume. Gas fermentation of CO_2 could make acetic acid, which is another raw material for many downstream industries. However, it is large volume but low cost. CO_2 could also be fed into a closed greenhouse and it has been proven to increase the yield of produce. CO_2 can be

blended with concrete to increase its strength. Part of the captured CO_2 can be further purified and made into dry ice or sold to the beverage industry. Innovative methods of CO_2 valorization are being worked on. It was recently reported that the 100% of the CO_2 was converted to ethylene using a catalyst and renewable electricity. There are many other options for valorization of CO_2. However, all may not be feasible as some need to be done in close proximity of the capture plant and some could take in transport up to a certain distance. Generators ought to keep a tab on the various developments of CO_2 valorization and help in commercializing them.

Carbon Sinks

At the end of the day, one has to accept the fact that not all the CO_2 emitted anthropogenically can be addressed. Herein is the last resort to develop Carbon Sinks to cater to this balance CO_2. There are vast areas of land that are barren or degraded forests. CO_2 emitters could work along with government and local population to develop these carbon sinks. Probably, these could become a source of livelihood for the local population and also help in abating the balance CO_2. It may be pertinent to note that the carbon sinks take some time to sequester the carbon and hence the development of sinks has a longer gestation period. The above image is proof that barren land can be converted into dense vegetation. Residents of Karech in Rajasthan sought help from the Foundation of Ecological Security to restore wastelands through community efforts and save their village from desertification and loss of livelihood. Such a community and industry effort could help the local community and provide the necessary carbon sink for the emitter.

Conclusion

In the above text, a number of options have been mentioned. The power sector or power companies need to select some of these options and could add on other options and develop a pathway that would help them walk the low carbon pathway, over time. Keeping in mind their growth strategy different scenarios with different options can be modeled to determine if the path chosen is actually the low carbon pathway. There may be some technologies that are still not competitive e.g. CO_2 Valorization or Hydrogen generation and such technologies could be deployed in the later part of the pathway. This will also help the power companies to plan, develop partnerships and raise funds for the deployment of actions along the pathway.

Impacts of climate change are increasing on a daily basis across the globe with floods, droughts, heat waves, forest fires etc. It would be a great move by the power sector or companies to develop their low carbon pathway and also put it up in the public domain. This will also help and prepare the consumers that electricity may not come cheap in the future as it is a matter of keeping this planet for the generations to come and hence, we will have to pay that incremental price, now.

INDIAN CHAMBER OF COMMERCE

About Indian Chamber of Commerce

Founded in 1925, Indian Chamber of Commerce (ICC) is the leading and only National Chamber of Commerce operating from Kolkata, and one of the most pro-active and forward-looking Chambers in the country today. Its membership spans some of the most prominent and major industrial groups in India.

ICC had made its humble contribution in the pre-independence era during 1925 – 1947 towards promotion of Indian businesses and Swadeshi movement. Post Independence, ICC had the honour of engaging closely on Economic development and Reforms with Govt. of India. ICC had the privilege of hosting Session with Indian Prime Ministers like Shri Lal Bahadur Shashtri, Smt. Indira Gandhi, Shri Chandra Shekhar Azad, Shri Atal Bihari Vajpayee and several other leaders.

Recently, ICC was fortunate to host a Session with Shri Narendra Modi, Hon'ble Prime Minister of India on 11th June 2020.

Set up by a group of pioneering industrialists led by Mr G D Birla, the Indian Chamber of Commerce was closely associated with the Indian Freedom Movement, as the first organised voice of indigenous Indian Industry. Several of the distinguished industry leaders in India, such as Mr. B M Birla, Sir Ardeshir Dalal, Sir Badridas Goenka, Mr. S P Jain, Lala Karam Chand Thapar, Mr. Russi Mody, Mr. Ashok Jain, Mr. Sanjiv Goenka, have led the ICC as its President.

ICC is the only Chamber from India to win the first prize in World Chambers Competition in Quebec, Canada.

The Indian Chamber of Commerce headquartered in Kolkata, over the last few years has truly emerged as a national Chamber of repute, with full-fledged offices in New Delhi, Mumbai, Guwahati, Siliguri, Agartala, Ranchi, Bhubaneshwar, Hyderabad, Tamilnadu & Patna functioning efficiently, and building meaningful synergies among Industry and Government by addressing strategic issues of national significance

About FutureStation

Futurestation Advisors LLP (www.futurestn.com) is an ESG Advisory and Assurance firm, serving clients in **Value Creation through ESG.** The firm is a platform of highly experienced professionals across industry sectors and leading consulting firms. With presence in Delhi, Hyderabad, Kolkata and Mumbai, the firm is serving clients in India, Europe and the USA.

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Sydney is an Executive Director of Futurestation. He is former Chief of Business Collaboration and Clean Technology & Applied Research at Tata Power Company Limited with 25 years experience in energy sector. He piloted and demonstrated next generation technologies like Fuel Cell, In-situ hydrogen generation, AI&ML application for load predictions, gasification, pyrolysis, Distributed Generation, Waste to Energy etc.