Environmentally-Sustained Coal-Based Power Generation: what it takes?

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India's economic growth has become the envy of the world. The economic growth has been fueled by relatively inexpensive electric power i.e. from coal. As per the estimates of Geological Survey of India, the coal reserves stand at 290 billion tonnes. In last two decades, coal consumption and demand have grown dramatically. The power sector accounts for over 80% of the total coal consumption in the country (over 400 million tonnes in 2012-13; CEA, 2013) producing over 760676 million unit (MU) of electricity in 2012-13(CEA, 2013).The erstwhile Planning Commission had planned an addition of over 88,000 MW of power generation capacity in the 12th Plan period (2012-17). It appears coal will continue to be at the pinnacle of our energy supply for many years to come.

Coal mining and combustion severely degrade the environment and results in an intangible cost, which is often ignored. However, the solace is that environmental regulations have moved from laxity to stringency, particularly in the last decade. Public at large, now more aware of ill effects of coal-based power generation, argue not in my backyard. There are social issues as well. Resource depletion and pollution generation at some pristine area to feed guzzling air conditioners in Delhi or any other metro is neither justice nor equality. For sustenance of dominance of coal-based power generation, there are several issues those need to be addressed. For engineers, bureaucrats and policy makers, time is not to ostracize environmental and social issues but to act. Major environmental issues comprise air emissions and ash disposal. Emissions of air pollutants pose serious environmental concerns, and if not resolved, will cause degradation and can severely impact public and ecological health. Although environmental regulations may force pollution control actions, at times, laws are inadequate.

The important emissions from coal combustion include carbon dioxide (CO_2), nitrogen oxides (NO_x), sulfur dioxide (SO_2), air-borne inorganic particles such as flyash, and other trace elements, especially mercury. Through atmospheric chemistry, oxides of nitrogen and sulfur play an important role informing very fine particles along with ammonia and calcium, adding to already existing high levels of particulate pollution in our air. These ammonia-based particles may constitute up to 35 percent of total fine particles in air that we breathe.

Estimated emissions of major pollutants from coal-based power plants in the country are: 1.6 million tonnes of particulate matter, 1.5 million tonnes of NO_x and 3.0 million tonnes of SO_2 every year and whopping over 160 million tonnes of flyash generation. These are large quantities. If we do not recognize this enormous environmental issue and not invest in technology, we pay through increased human morbidity and mortality. As seen, the coal-based power generation produces massive amounts of sulfur and nitrogen oxides, the convenient alibi not to control these gaseous emissions is sulfur and nitrogen dioxide levels in air are low. Science tells that sulfur and nitrogen oxides convert into fine particles of sulfates and nitrates posing greater health problem than the precursor gases sulfur and nitrogen oxides.

Mercury is the single important toxic metal emitted from coal combustion. Although air concentration of mercury may be low and be in safe limits, the airborne mercury deposits in rivers, lakes, oceans, and move up in the food chain and pose major health risk. Although present in trace levels in coal, approximately 148tonnes of mercury is estimated to be released in India by the year 2021(UNEP, 2014). The issue of environmental pollution, especially that of mercury, is compounded in the areas those concentrate power plants. The Singrauli area has an installed capacity of over 20000 MW of power and expected to be infested with high mercury pollution. Engineers and regulators need to understand that cleanup after-the-fact is hugely expensive and only option that we are left with is to clean it up at the source.

Technology can deal with the environmental issues and can sustain long-term coal-based power generation without compromising environmental quality and public health. The high efficiency technologies (particulate control efficiency exceeding 99.9%) are ESPs and fabric filters. An ESP electrically charges the ash particles (mostly negative) in the fluegas stream and particle migrates towards grounded plates where it is collected. The ESP consists of a series of parallel vertical plates through which the flue gas passes. The charging electrode is between the collecting plates and charges the ash particles. The local specificities such as ash content in coal, resistivity of the ash, size of ash particles, moisture etc. are important considerations in designing the ESP. Indian coal has high ash content and resistivity and these concerns should be inclusive while designing the Indian-version of ESPs.

SO_2 removal technologies include wet flue gas desulfurization (FGD), dry FGD utilizing a spray dryer absorber and dry adsorbent (lime and lime stone) injection. Most SO_2 removal processes are engineered oxidation systems which convert SO_2into calcium sulfate (CaSO4: gypsum) which is removed in ESPs. In a De-NOx-ing (removal of NOx) system, NOx is reduced by ammonia (NH_3) or urea to nitrogen and water. Based on economic considerations, a suitable reducing agent can be selected out of ammonia like materials. This process is called Selective Catalytic Reduction (SCR). SCR De-NOx-ing system consists of reactor, injection system and the catalyst.

Mercury removal remains a challenge and technology is in its infancy, largely because of economic consideration. During high temperature combustion in the furnace the major part of mercury is volatized in the form of gaseous elemental mercury (Hg^0) and is not readily removed by existing air pollution control devices. Activated carbon is most effective adsorbent for removal of Hg^0 but at the same time not affordable; to remove one kilogram of mercury could cost USD 30,000–$85,000 (year 1995 $;Romero et. al, 2006). There is a need that we develop non carbon adsorbents such as zeolite, calcium-based sorbents, fly ash, chitosan and other organic/inorganic adsorbents to remove mercury.

The other issue often ignored is the utilization and management of ash. While the regulation for ash utilization has proved effective and currently we utilize about 60 percent of the generated ash, mostly in cement industry and highway construction. Flyash contains high levels of toxic heavy metals such as arsenic, lead, selenium, and other trace metals. The discharge of fly into surface waters can disturb the ecology of the region. The flyash escaping into the atmosphere from chimney or from ash ponds settles down in the vicinity of the power plant and over a long period can bring about considerable changes in soil characteristics in addition to posing health hazards and nuisance.

The cost of pollution control including ash management needs to be internalized in the installation cost of power plant and pollution control be integrated with other parts of the power plant. A broad cost break (can vary significantly) is for every MW, the installation cost is about Rs 7.0 crore (including particulate control). For SO_2 and NO_x control, an additional cost could be about 0.7 crore per MW, which is about 10 percent of the total cost. The cost of pollution control device may appear high but this possibly overshadows the cost of environmental degradation and cost of public health in terms of increased morbidity and mortality.

In view of the discussion above, all concerned, engineers, bureaucrats, and politicians have to come on board. Technologies for particulate and SO_2 removal are established, though not fully adopted in the country. Challenges remain for controlling NOx and mercury, especially from economic consideration. The focus of new generation of research should be on low cost non carbon mercury adsorbent which can effectively remove mercury. No alibi is acceptable for not controlling the emissions from power plants. Current and future technologies can provide effective solutions to arrest large air emissions. Adequate environmental protection can only sustain coal-based power generation in future.

It is apparent that fossil fuels will be with us until the alternatives can prove themselves. The intelligent strategy will be to invest in cleaning the coal combustion emissions for immediate benefits and at the same time let us *invest* in alternatives for future. Across the country, bright young entrepreneurs have ideas for alternatives to fossil fuels and to improve the efficiency of energy use. Let us move forth boldly to invest in the ideas that will carry the world to where we want to be.

References

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