Research and Technology Platforms in Electricity Generation from Coal in India- an Historical Perspective

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Electricity sector: Historical perspective

The phenomenal growth in electricity generation in India is truly an amazing story. Starting with just about 1300 Mw of power generation after independence in 1947 to the current installed capacity exceeding 130,000 Mw in generation-transmission-distribution network and 40,000 Mw in captive generation form – and these numbers are growing- is an indicator of the quantum leap this sector has undergone in the past six decades. However, the demand for electricity is growing at a faster pace than the supply resulting in a huge overall shortage exceeding 8% - peak shortage in excess of 12%- causing a major bottleneck in India's development. There are over a lakh of villages without electricity. Of all the infrastructural necessities, electricity occupies a major part and deficit in the availability of it is proving lethal to India's ambition of becoming a global super power by 2030 (Goldman Sachs report, 2005)

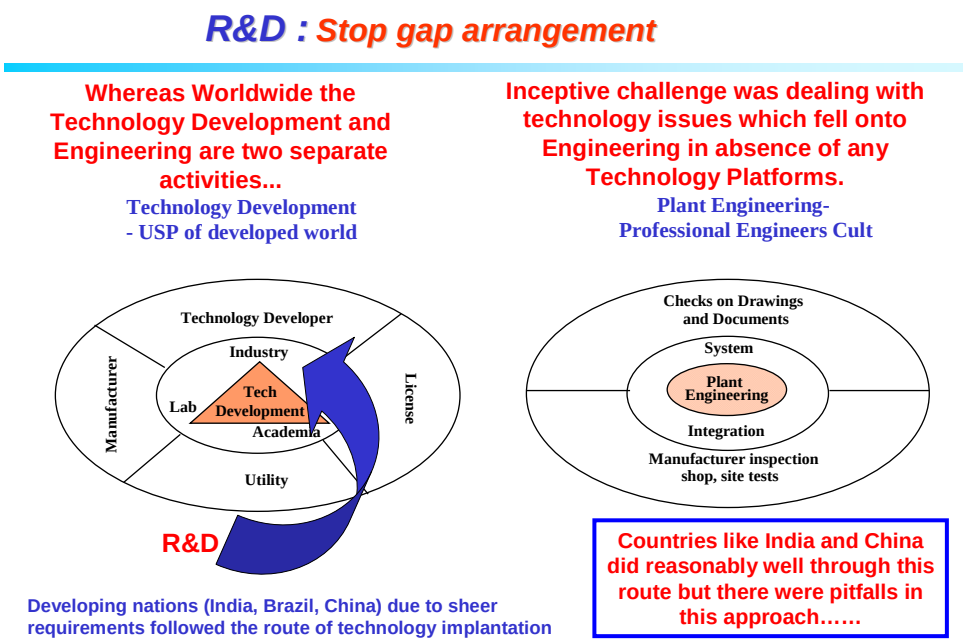
Several studies on what is wrong with electricity sector in India and what needs to be done are carried out and there are corrective measures being taken. The major impediments for fast forwarding the reforms in electricity sector are identified and policy initiatives are underway albeit in half measure. This needs to be understood from a historic perspective and from the way the electricity (power) sector is positioned in the federal structure of this country. The monolithic formations of state electricity boards, the political interferences in running of these boards, inefficiencies and mal practices in the distribution sectors, resource constrain and a complete lack of well defined overall policy instructions contributed in no small measures in making electricity sector one of the major impediment in India's growth story. Added to this in good measure is weaker availability of fuels for generation sector and the increasing dependence on coal. Coal sector development is yet another story which has contributed to the current woes of electricity sector. The purpose of this paper is not to dwell on these issues which have been well debated – and several new initiatives are being taken both electricity sector and coal mining sector- but to bring in the third dimension of Technology platforms in this vital sector.

Technology platforms: Lack of fundamental model on technology development

Traditionally, the sector has grown from 1300 Mw to 130,000 +40,000 Mw based on coal as the backbone of generation sector. About 68% of electricity comes from coal based thermal power generating plants, the rest (27%) from hydro, gas based combined cycles. Balance 5% comes from Nuclear and wind. Initially the state electricity boards were responsible for setting up the generation plants with an exception of Tata's in western part -Mumbai (Bombay in those days) and DVC in eastern part contributing in a limited way. However, post 1975, with the dismal performance of the state sector – there were

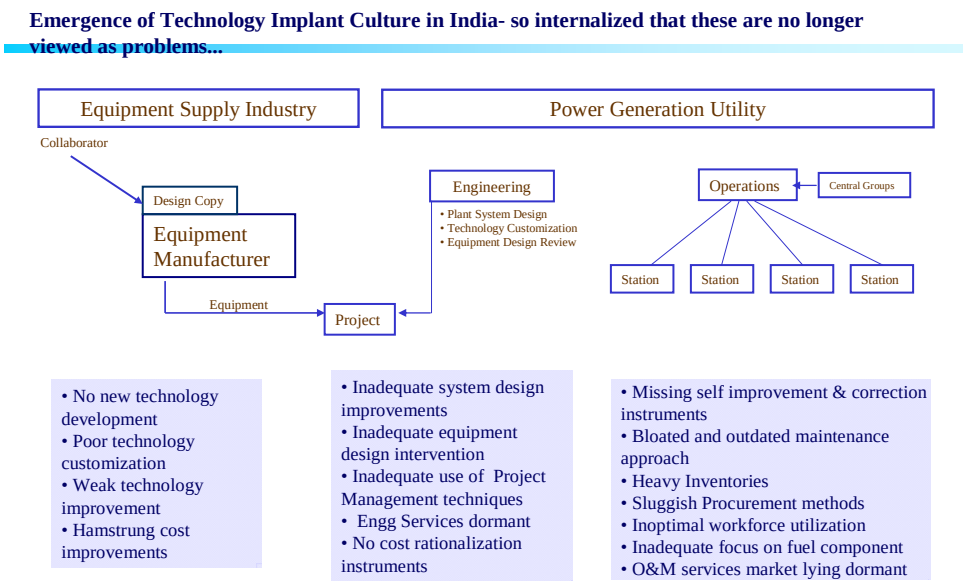
few states which were exceptionally efficient - central government intervened and set up the public sector units to take up the generation of electricity. This was perhaps the first turn around of the Indian electricity sector and soon the impressive performance from the central sectors created a positive response and paved way for a complete overhaul of the electricity sector as a whole leading to the current national electricity policy. Systematic dismantling of the monolithic state electricity boards- there are many hick-ups in this process, introduction of merchant power plants, power trading, establishment of Ultra Mega Power Projects for large capacity additions, Accelerated Power Development Programme, Distribution reforms, National grid for transmission, RGVVY (Rajiv Gandhi Vidutikaran Yojana electricity for all by 2012) and rapid capacity additions are major policy and strategic initiatives being taken in electricity sector. The process seems quite exhaustive.

The only way India could build such an impressive capacity is to import the technologies from abroad and set up the plants and operate and maintain them. In this process, very little technology absorption or diffusion in real sense took place. The western or developed world model for technology coming from the stables of academia and research institutions or the Japanese model of reverse engineering and fine tuning of the technology – and indeed making them better than the parent-was completely missed in India. The S&T base and limited availability of high quality engineering education in early sixties till eighties did not help in the cause of research driving the technology. Figure 1 shows the missing link in the technology development in electricity sector in India as compared to the developed world. When India started building its engineering manpower – and today India produces over a million graduates in science and engineering – the focus entirely got shifted from research in engineering sciences to that of plant engineering and project management. This did have its flip side and in that India could therefore build large capacity plants and operate & maintain them very well. The high capacity factors achieved in many of our power generating plants bears a testimony that even with such adverse quality of coal, today the operating power plants achieve a capacity utilization plants in excess of 90% with average exceeding 70%. Even the cost of setting up if the plants are considerably low due to the lower manufacturing costs.



Plant engineering as the major core for development:

Figure 2 depicts the way electricity generating plants (utilities) are positioned with respect to equipment supply industry. Notable absence is the technology development plat forms in this linkage.



India has made impressive progress in science and technology and today is considered as one of the leading nations in soft ware technologies, nuclear, space and some niche areas like pharmaceuticals and automobiles parts. There are cutting edge research going on in the field of nuclear science and space. India is almost considered as developed nation in these fields and in-fact is a leading member of major global R&D efforts like CERN project for particle physics and basic research on investigation of structure of universe or the ITER project on fusion power as ultimate perpetual source of energy. There are well established world class renowned institutions like BARC, TIFR, IPR, VSSRC which are engaged in research in their respective areas which are perhaps second to none kind. Even the emerging filed of biotechnology, India is proud producers of several bio-technology based products thanks again to a research happening both in private and public arena.

Poor R&D infrastructure in electricity sector:

The electricity sector for the reasons mentioned above completely missed such development. The rapid need to develop capacities in electricity sector, sensitivity of the cost of electricity – huge political interference in this sector- resulted in the focus being always short term in nature. It is surprising that there is no national level R&D institution –like in nuclear, space and biotechnology- dedicated to electricity sector. Some institutions in the public domain –erstwhile CFRI +CMRI, CPRI – were relegated to doing peripheral research which later on turned out to be more of testing houses focused on testing and calibration for earning some money. BHEL built an impressive R&D in the initial years but with limited technologies could come out of its stable. The reasons again is the lack of the basic model of academia – research and industry triangle and the import culture which was deeply ingrained in the mindset of the technology managers which led to resistance for accepting yet-to-be-proven technologies. Apparent free access to technologies in this sector dampened the spirit of indigenous development.

Future strategy in R&D:

India is growing at a rapid pace at an yearly rate of 8-9% GDP growth. This has necessitated the need of increased energy supply both in electricity as well as transport sector. India needs to quadruple its energy supply by four fold and towards that the integrated energy policy (IEP) document prepared by the planning commission of India (available on its web site) reflects the challenges being faced in meeting the demand of electricity from the current 130,000 Mw +40,000 Mw to about 817,000 Mw- a mammoth task indeed. Coal will constitute a major source with more than 60% of electricity being met by coal alone. The poor and dwindling resource of coal in India is yet another issue which hurts the electricity sector. The high ash content with high alpha quartz value adds up a big challenge for efficiency and reliability of the power generation. In-fact, this is one area which requires customization of the technology for meeting the challenge of Indian coal and climate (high surface condenser temperature due to high cooling water temperature) – both in-terms of design of boilers as well as the materials which form the pressure part components handling highly abrasive ash particles.

Growing concern of climate is yet another issue which is a third dimension which brings a completely new perspective to the entire issue of power generation through coal as a fuel. The tell tale indicators are clearly evident and this will increase in the coming years forcing the global community to take definitive action for handling climate change issues. India's perspective in this is pretty clear – per capita emission of carbon will be always contained in India to a value less than the global average and certainly lower than the average of the developed world.

Thus, increasing demand of electricity, dwindling availability of fuel and climate change will result in Indian electricity generation from coal taking a very different pathway which will be technology oriented all the way. This is where there is a changing perspective with respect to policy level initiatives for bringing the R&D in the forefront in following areas.

1. Efficiency enhancement: Efficiency in the entire value chain from mining of coal to demand side management of electricity will be a major plank which will be the key driver in this segment. Use of low grade heat, reduction in auxiliary power consumption, advanced controls, super critical technologies, water conservation etc. are the areas where academic institutions and R&D laboratories will work with power industry to develop India centric technologies.
2. Fuel management technologies: Technologies in coal washing, coal utilization, gasification to produce power through a combined cycle with integrated facility for conversion of coal into liquid fuels will be the other area where there will be focus for undertaking R&D which is specific to Indian conditions.
3. Clean energy technologies: Technologies in renewable energy systems like solar, wind, hydro and biomass will certainly form backbone of future technologies and India will take all the steps necessary to meet this challenge. This calls for a mission based approach with global collaboration and models are being developed for meeting this challenge.

Thus, electricity generation in general from all the sources including from coal is undergoing a major shift and this will spurt large scale activities in technology front with research coming from academia and research institutions all over the globe. The public-private partnership models will also undergo a sea change with private sector quickly taking up the central stage with generous hand holding by the government and public sector enterprises.

Promise of International Collaboration

The pathways for clean coal technology are country specific: primarily because of the evolution of technologies and also the nature of the coal occurrences in these countries. India is particularly handicapped by the poor but abundantly available coal quality. Clean coal technologies therefore from India's perspective will be those where we can enhance higher efficiency given adverse tropical climate and poor coal quality using such technologies like economical beneficiation of coal or develop technologies which can

handle abrasive coal ash. India has taken a tentative step towards super critical technology with high ash coal and it is extremely critical that global experience in commissioning and stabilization of these plants during the formative years in developed world may be shared with Indian utilities.

IGCC is yet another technology which quality of coal plays an important part. Fluid bed gasification technology which appears most appropriate for high ash coal of type prevalent in Indian sub continent has lot of developmental needs. The design, scale up, control system designs are the issues pertaining to IGCC which requires high end technology collaboration with leading global institutes.

Along with gasification unit, equally important are the gas clean up system, hydrogen island, where once again there are major differences which call for different types of gas clean up technologies. IGCC technology which can become a torchbearer for clean coal technology needs a paradigm challenging technological development. These developments must happen very fast if IGCC technology will have to proliferate. Nothing short of global collaborative program will be able to make this happen.

CCS is yet another field of clean coal technology development. Low sulphurs coal has different connotation compared with high ash coal when post combustion gas clean up technology is concerned. The cost of carbon capture, sequestration in acceptable type of geological formations and over all safety and monitoring for CCS are other issues crying for solutions to be found.

At a global level, there is consensus about coal being the major fossil fuel which will last for several more decades and hence the humanity will continue to use it. To make it clean and still make it economically feasible for different types of coal call for a mission based program akin to Manhattan project where multi-disciplinary multi-country teams will put their act together in an environment where intellectual property ownership will be global.

A new strategy will be essential to make this happen."