R&D FOR THE INDIAN POWER SECTOR & INVITATION FOR RESEARCH PROPOSALS

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INTRODUCTION

The Indian Power Sector is opening up new opportunities for innovations with the introduction of reforms, globalization and liberalization policy of the government. The power system planners have given utmost importance to energy sector since beginning and there has been a manifold increase in installed generation capacity and transmission networks. With increase in system expansion stability and security problems have become challenging. It is of vital importance to focus our attention now on ways and means to build expertise within the country, to find solutions for the problems existing in the system and also for the problems that may arise in the future. Research in phased manner is needed to bridge the knowledge and technology gaps, more so due to changes in technology happening at a more profound and faster pace in the new millennium. Depleting energy resources and environmental pollution are the biggest challenges facing the Indian power sector. Hence, there is an emergent need for developing efficient power plants which are eco-friendly. The modern power plant should be capable of making optimum and effective use of depleting resources like coal, and natural gas. Development of hydro and renewable sources of energy needs to be encouraged due to their inherent advantages.

Power Sector being highly technology intensive, Research and Development (R&D) plays a major role in the developmental plans, especially while considering introduction of new and advanced Technologies for strengthening the power sector. The adoption and absorption of new technologies in a phased manner is essential towards a balanced growth of this Sector. It is of vital importance to focus our attention now on ways and means to build expertise within the country, to find solutions for the problems existing in the system and also for the problems that may arise in the future. To absorb high technology, the indigenous R&D base is important to understand the various technicalities involved to apply the same to Indian environment.

The Ministry of Power has been encouraging R&D through Research Scheme on Power (RSOP) and National Perspective Plan (NPP) R&D. Realizing the fact that Power Sector is highly technology intensive and Research and Development (R&D) plays a major role in the developmental plans, especially while considering introduction of new and advanced Technologies for strengthening of our power sector, lot of emphasis has been laid on expansion and sustenance of R&D in Indian Power sector. Adoption and absorption of new technologies in a phased manner is essential towards a balanced growth of this Sector. However, focus will be on evolving ways and means to build expertise within the country and to find solutions for the problems existing in the system and also for the problems that may arise in the future.

To absorb high end technologies, national level R&D base is important to understand the various technologies and their advancement to work in the Indian environment. Collaborative Research in a phased manner is needed to bridge the gap between knowledge and technology and to build expertise to find solutions for the problems existing in the system and also for problems that may arise in the future. There is a need to form

a proactive and collaborative R&D Policy to develop innovative solutions to strengthen the Indian Power Sector through networking with research organizations, academic institutions and the power industry.

The Research Scheme on Power is intended for Research initiatives at utility level, but it can also involve academia and the industry. It has kept up the spirit of R&D in the utilities and significant contributions have come out of this scheme. The ambitious plans of MoP for rapid expansion of R&D in Indian Power sector is realized through this scheme. Collaborative R&D was initiated with active participation of private industry/academia/ research institute under the National Perspective Plan R&D Scheme. The R&D initiatives under RSOP and NPP have shown significant and high impact R&D outputs.

The Report of Working Group on Power for the 12th Plan has documented the expectations of the Indian Power Sector during the plan period. The major areas of concern in all the thrust areas of Power have been identified and need for proactive and collaborative R&D involving industry, utility, academia, research institutes and statutory institutions have been underlined and emphasized for growth of the Power sector.

R&D IN POWER SECTOR

R&D in the power sector is presently in the domain of following organizations:

- R&D under MoP: National Perspective Plan (NPP) for R&D in Indian Power Sector, Research Scheme on Power (RSoP), and Research projects of CPRI.
- R&D Wings of Corporations like the BHEL, NTPC, NHPC, SJVNL, PGCIL and other units of the Ministry of Power (MoP)
- R&D in private sector

INFRASTRUCTURE DEVELOPMENT FOR R&D IN POWER SECTOR

The in-house R&D setups of major utilities like NTPC, NHPC and POWERGRID address introduction and absorption of new technology by applied research primarily through project routes. Major manufacturers like BHEL, Crompton Greaves, and EMCO have their own R&D set up, focusing on product development. Central Power Research Institute (CPRI) is provided with capital funds from the Ministry of Power for in-house research as well as funds to coordinate and manage MoP's research schemes. Central Electricity Authority has a role in identification of appropriate new technologies for the country. Twelve projects are in progress under National Perspective Plan (NPP) on R&D, which are collaborative research projects involving more than one organisation. The R&D policy of the Government is to promote R&D projects that help the nation to become self reliant in technology. In addition to NPP, R&D projects of outlay of Rs 50 lakhs and below is encouraged under the Research Scheme on Power.

PROPOSED R&D PLAN FOR 12TH PLAN

In the present scenario it is proposed to categorize the R&D initiatives into four different conventional sectors, viz. Generation, Transmission, Distribution and Environment. Under each Sector different technologies are listed for development of prototypes and pilot plant demonstration. The different areas in these sectors are:

a. Generation Sector:

- Thermal and Fuel
- Hydro
- Renewable Energy and Distributed Generation

b. Transmission sector

The adoption and absorption of new technologies in transmission sector can be implemented by further classification in to following sub-sections:

- Design and development of equipment, real time simulators and controllers
- Creation of data-bank
- Automation
- Pilot plant/Demonstration
- Development of alternative materials
- Equipment performance
- Biological effects
- Concept proving / Exploratory studies

c. Distribution sector:

- Smart Grid, Distributed generation

d. Environment

- Clean Development Mechanism
- Bulk utilization of fly ash
- SOx, NOx, and mercury control.

RESEARCH AREAS

The rapid growth of power industry in India has opened up challenging opportunities for innovation and creation not only in technical areas but also in the area of operational management. At the same time, it has brought a lot of challenges to power engineers and researchers to handle bulk power transmission from remote areas, security problems for the grids and environmental issues.

The system planning and operation is mainly concerning major thrust areas such as: Generation, Transmission, Distribution, New & Renewables, Materials Technology and Energy Efficiency. For reliable and secure operation of the system, and to be in phase with the technological developments, research in these areas is required in phased manner. New and challenging areas for research are discussed as follows:

2.1 In **Thermal Generation**, important aspects that needs special attention is on improving the performance of existing thermal power plants, solving problems related to diagnostic measures for condition monitoring of equipment, improving the plant availability, reliability, efficiency & safety, beneficiation of coal and fly ash utilization. Indian coal having high ash content, new technologies related to clean coal technology and environmental implications, needs special attention. It is also essential to adopt new technologies such as: Supercritical boilers for power generation,Ultra Super Critical (USC) IGCC Technology, Green technology approaches to thermal generation and Gasification of solid and liquid fuels for power generation. The major problems for the low efficiencies in steam turbine are due to aerodynamic & secondary losses due to inadequate blade profiles (geometry) and other clearances of the last stage blades. The other problems are erosion of blades, deposition on blades, breaking of blades, leakages from condenser, feed water heaters, valves, man hole gaskets, etc. Thus, there is a need for addressing parasitic losses, auxiliary losses and also gain in the thermodynamic efficiency. Also, efficiency of the existing Indian thermal power plants can be improved by addressing the coal quality impact and implementing effective dynamic combustion balancing approach.

Other areas include Waste Heat Recovery Systems, Artificial Neural Network based Power Plant Optimization, Advisory and feasibility of integrating Supervisory Controls Development of advanced NDT based diagnostics and inspection tools for condition assessment of plant components. Hydro Generation: Integrated Operation of Cascade Hydro power Plants ,Optimization Studies for Exploitation of Hydro Potential Technological Advancement in Investigation of Hydro Projects and use of GIS/GPS Technology for Spilt Runners/Site

Fabrication of Runners Development of Facilities for Large Size/Weight Casting and Forging Facilities Modernization of Automation.

2.2 The **Hydro power** base available in the country has grown commensurate with the requirements so far and has been geared to take up all types of hydro-electric power development. For obtaining high reliability operation of the forthcoming large hydro electric power projects, it is essential to keep pace with the technological development and improvements taking place in the developed countries. Also, considering the problems of silt erosion damages, which are typical for Indian conditions, corrosion etc in the existing hydro power stations, the required technology development in hydro power sector needs a big thrust. Hydrocarbon resource limits are bound to force the world away from fossil fuels in coming decades. In addition, the environmental and health burdens arising out of the use of hydrocarbons may force mankind towards clean energy systems. Stabilizing atmospheric carbon dioxide concentrations at safe levels will require 60 to 80% reduction in carbon emissions over the current levels. The problem in India is not just limited to hydrocarbon resources and carbon-dioxide emissions, but also in meeting increasing demand for electricity in the future. There is need for electric power industry to look at other technologies of power generation through solar, wind, biomass, fuel cells, geothermal etc.

2.3 The **Transmission** system requires adequate and timely investment and also efficient and coordinated action to develop a robust and integrated system. The Indian Power System is growing steadily. Network expansion should be planned and implemented keeping in view the anticipated transmission needs. To match with the growing demand, transmission system is also expanding with an over lay of 765 kV AC lines on existing 400 kV System, high capacity long distance HVDC system, high capacity long distance HVAC system, adoption of FACTS devices, such as TCSC wherever feasible on 400 kV and 220 kV lines etc. With the formation of regional grid and interregional ties to form ultimately the National Grid, the Power System is becoming more and more complex. Side by side with this growth, requirement of high security and reliable operation of large generating plants with EHV and UHV transmission network assumes tremendous importance in maintaining Power System Stability for better grid management. Other areas include development of Smart transmission grid,development of equipment for 1200kV and 765kV AC System Compact Transmission Line support using FRP, Development of high temperature electrical conductors for Transmission lines Design and development of Seismic Resistant Substation, pollution and Lightning mapping studies: Creating Data Repository/bank, Automated Emergency Restoration System (ERS),

The severe cascading blackouts that have been seen in many parts of the world highlight the vulnerability of large AC systems. Instances of grid failure due to: pollution flashover have come to notice on 400 kV single circuit lines during fog conditions, inadequate reactive power support, voltage instability, power swings etc. A firewall preventing the spread of such disturbances can be accomplished using measures to avoid voltage instability, relay coordination, design transmission line insulators suitable for varied environmental and pollution conditions, adopting FACTS controls, HVDC connections, which makes an important contribution in controlling power transmission, safe guarding stability and containing disturbances. Technologies such as FACTS and HVDC transmission have played a crucial role in alleviating transmission system constraints.

To facilitate orderly growth and development of the power sector and also for reliable and secure operation of the grid, adequate margins in transmission system should be planned. While planning new generation capacities, requirement of associated transmission capacity would need to be examined to avoid mismatch between generation and transmission. A well planned and

strong transmission system will ensure optimal utilization of transmission capacities, which would help in cost effective delivery of power. With steeply increasing costs of power generation, it is more attractive to invest in system improvements that might reduce losses in T&D, than investing in additional capacity.

2.4 Distribution system needs careful attention in the areas such as reduction in losses, metering, distribution automation, planning, harmonic pollution, custom power devices, demand side management etc. High Voltage Distribution System is an effective method for reduction of technical losses and improved voltage profile. Encourage LT/HT ratio keeping in view techno economic considerations. Application of IT has great potential in reducing technical & commercial losses. Integrated resource planning and demand side management also needs special attention and implementation. Substantial efforts are required for capacity building, so that the present day Distribution system would be transformed into a modern day distribution system namely Smart grid. Smart grid represents a vision for a digital upgrade of Power Distribution system to both optimize current operation as well as open up new avenues for alternative energy production.

Design and development of High Temperature Superconducting transformers, and compact transformers in distribution systems needs careful attention and applied research in this area in phased manner is proposed.

Other key areas such as Customer level intelligent automation system, Computer aided monitoring and control of Distribution Transformers, Substation and feeder level automation, Data communication system for Distribution Automation, Distribution Control Centre (DCC) software, greater Substation and Feeder Level Automation, Intelligent Electronic Devices (IEDs), Smart Metering are to be developed and deployed.

2.5 New and Renewable Energy Sources: Technologies related to Wind, Biomass, Solar, Geo thermal, Fuel Cells are identified under this thrust area. Research focus is on grid connectivity of large wind mills, self healing wind connected micro grids, distributed generation and large use of ethanol for energy products. Development of micro & mini grids and larger penetration of renewable energy is an important area for research. Better and efficient designs of Primary converters, electrical and thermal storage with enhanced charge-discharge efficiencies are required.

2.6 Energy Efficiency: Considerable amount of energy can be saved through energy efficiency and demand side management measures. Periodic energy audits have to be made for power intensive industries under the Energy Conservation Act. Emphasis on standards and labeling of appliances needs to be given priority. Thus the topics that require careful attention are: (i) Demand Side Management (ii) Standards and Labeling and (iii) Load Management. Also, an attempt to design and develop energy storage devices for applications is an emerging area in power sector.

Energy storage technologies that have been developed or are under development for electric power applications include pumped hydropower, compressed air energy storage, batteries, super capacitors, flywheels, and superconducting magnetic energy storage. Design, Development, Testing & Evaluation of Short Term and Long Term Response of Energy Storage Devices, is important aspect.

At a discrete level, flywheel energy storage modules offer unique performance characteristics suitable for many applications. It is technically feasible to combine the best feature of high-speed flywheel energy storage with proven developments in high-power electronics.

Energy storage technologies such as Redox Flow Batteries have a large role to play in the electricity grid of the future. There is a need for development of novel storage technologies, to meet requirements associated with (i) The effective production and

delivery of electric power (ii) The provision of secure, high-quality power at end-user sites and (iii) Support of renewable and distributed energy resources. Super capacitors represent one of the latest innovations in the field of storage of electrical energy. The most important advantage of SMES is that the time delay during charge and discharge which is quite short.

RESEARCH INITIATIVES

Various schemes for R&D with funding from the Ministry of Power are being undertaken that are highlighted below:

1) Research Scheme On Power (RSOP) Projects

These project proposals are invited from power utilities,academia, industries as well as research institutes. The proposals are approved by an expert committee of RSOP chaired by the Director General, CPRI. CPRI is managing this scheme since 2001.

The scheme basically aims to provide funds for carrying out need based research in power sector including solving of operational problems encountered in the power system. Preference is given for projects with association of utilities.

Relevance of RSOP in Indian power sector:

Over the years, RSOP has evolved as a key instrument to deal with the operational and local specific issues of state level power utilities. In many of these initiatives, the R&D element is comparatively less. Consequently the average investment in any RSOP project is not much. Nonetheless, it has kept the innovative sprit alive at the utility level in its efforts to find out local specific solutions.

2) National Perspective Plan (NPP) for R&D in Indian Power Sector

The Ministry of Power (MoP), Government of India, under its Plan Scheme 'National Perspective Plan (NPP) for R&D in Indian Power Sector' is promoting research concerning power sector issues. The research project proposals are concerning to development of New Product / Process Development leading to filed implementation

There is requirement for strong economic, environmental and social incentives to leverage Plant centric R&D driven re-organization of existing power units and innovative technology driven enlargement of capacity that develops all modes of production, transmission and distribution and incentive based demand side management including end use energy efficiency. Power Sector, being highly technology intensive, Research and Development (R&D) plays a major role in the developmental plans, especially when Technology upgradation is considered for strengthening the power sector.

The crucial R&D needs required to bridge the technology gaps in various subsections of power sector (Generation, Transmission & Distribution), are identified and prioritized. The R&D is to be aimed at either improving design of an individual plant component and/or evolving cost efficient overall process. R&D needs also include taking advantage of the advances in IT, electronics and communication to improve the control & instrumentation system, data acquisition system and monitoring of system performance parameters.

RESEARCH CONTINGENCY

The Research Contingency fund is provided by the Ministry of Power, Govt. of India for taking up research projects in the various divisions and units of CPRI. These projects are intended for augmentation of Research and testing facilities, proposing improvements/new techniques in testing/diagnostic methods/research studies etc, product / process Improvements and improvement in product standardization.

RESEARCH SCHEME ON POWER (RSOP)
(MINISTRY OF POWER, GOVERNMENT OF INDIA)

INVITATION FOR RESEARCH PROPOSALS

The Ministry of Power (MoP), Government of India, under its Plan Scheme 'Research Scheme on Power (RSoP) for R&D in Indian Power Sector' is promoting research and development for Indian Power sector. The research project proposals should focus on development of New Products / Process Development/Technology development/filed implementation and absorption. The scheme is being managed by Central Power Research Institute, Bangalore, under the guidance and supervision of expert committee on RSoP (ECRSoP)

The R&D programme under RSoP supports activities aimed at developing and integrating technologies to evolve technology systems both in the advanced and emerging areas and in traditional sectors/areas of Power Engineering namely: Generation (Hydro and thermal), Transmission, Distributed Generation, Energy and environment, etc. Under the Programme, feasibility of fresh ideas/concepts is assessed for their potential conversion into useful technology/ product. Applications of R&D for socio-economic benefits are consciously promoted under this programme.

The primary objective of the Programme is to facilitate and support the activities of Power Utilities, techniques/technology aimed at specific end use for the Indian Power Sector. The Programme stresses on clearly identifying the needs for development of the technology so that the developmental effort could be useful to the target beneficiary. It envisages active user involvement and association in the development efforts. The objective is that the products/technologies developed under the RSoPProgramme become useful for the benefit of the people at large. The specific objectives of this R&D Programme for the Indian Power sector are

- develop and integrate technologies in identified areas
- promote modern/advanced technologies for socio-economic problem solving;
- promote modernization of traditional technologies, tools and skills;
- facilitate enhancing quality and performance of Power systems;
- Promote activities aimed at improving technology, technique, material, methods and other appropriate activities conducive for development of technology status in Power Sector

Research Proposals with the technical and financial involvement of Power Utilities, manufacturers, CPSU's and state PSU's etc., in collaboration with Academia and Research Institutes are welcome.

Further details of the scheme are available on website: ***http//cpri.in***

The Research proposals can be submitted any time throughout the year.

NATIONAL PERSPECTIVE PLAN R&D
(MINISTRY OF POWER, GOVERNMENT OF INDIA)

INVITATION FOR RESEARCH PROPOSALS

The Ministry of Power (MoP), Government of India, under its Plan Scheme 'National Perspective Plan (NPP) for R&D in Indian Power Sector' is promoting research and development for Indian Power sector. The research project proposals should focus on development of New Products / Process Development/Technology development/ filed implementation and absorption. The scheme is being jointly managed by Central Electric Authority (CEA) New Delhi and Central Power Research Institute, Bangalore, under the guidance and supervision of Standing Committee on R&D (SCRD).

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