

Centre for Collaborative and Advanced Research

This center established in CPRI, Bangalore is aimed to function as a center of excellence in collaborative and advanced research in the power sector. The infrastructure for electric power generation, transmission and distribution is aging and requires significant research and development and the introduction of new technologies. Talents and strengths of CPRI based scientist and engineers will be used to close the gap between fundamental research and pre-commercial development programs.

Each technical group will focus on a key area in the power sector and provide a network of coordinated research activity through collaboration with national and international laboratories and industries. The main aim is to encourage an integrated approach to innovation through cross-disciplinary projects. Using the combined technological capabilities of CPRI and other agencies, it is aimed to generate cutting edge research that can be quickly translated into practical application.

This center of excellence would also provide the education and training necessary to create and maintain an educated work force for fields currently experiencing personnel shortages. In response to the shortage of engineers and scientists in areas of power generation, transmission, distribution and utilization a comprehensive educational and research program is required. CCAR infrastructure must be more effectively utilized to provide education and training and support continuing education programs.

The Center for Collaborative and Advanced Research (CCAR) would have a research consortium that includes universities and other research organizations. The goals of CCAR are to create an environment in which universities, industry and R&D institutions work together to promote and enable collaboration, to provide a forum for exchange of information and ideas, and to create solution to complex and diverse problem facing the electrical power industry. CCAR is especially interested in technical problems associated with the new institutional arrangements that are occurring under a restructured regulated power industry.

The aim of CCAR is to promote research cooperation with industries in the fields of power system, power electronics etc. The institution – industry consortium can further integrate the research and education resources within CPRI and serves as a platform for research collaboration. CCAR will also cooperate with other power engineering related institutes to advocate these fields of study and boost participation of research scholars.

To exchange views on need based research programmes between the R&D institution and industries, CCAR shall organize the annual review meeting and short courses on various topics. Engineering from industrial partners can participate in these events to catch up on the latest development of power technologies, and also to visit the laboratory facilities of the CPRI to see the progress of the research work.

1.0 OBJECTIVE

- To provide integrated infrastructure for experts professionals and researchers to work in CPRI laboratories.
- To bring together the research faculty and researchers interested in associating with R&D for Indian power sector.
- To create conducive environment for collaborative research between R&D Institutions, Industry and academicians.
- To execute projects based on multi-disciplinary expertise from different institutions.
- CCAR would create specialized teams for R&D by networking with institutions and experts in India and abroad.
- To promote research leadership in the R&D departments of various central and state utilities.
- Mobilize funding for R&D based on various schemes such as National Perspective plan for R&D of MoP, CPRI's research schemes, DST and DSIR. International research funding agencies such DFID, EPRI, CIDA, etc. would benefit by availing CCAR services.
- To facilitate dissemination of expertise through continuing education initiatives
- To be the nodal centre for R&D in power sector
- Development of innovative concepts and technologies in power engineering to assist product development of high quality, performance and efficiency.
- To integrate available technologies in Power, IT, communication for monitoring, testing and advanced control.
- To provide power engineering education to develop future engineers with leadership skills.
- To develop of a close partnership with power industry and academia.
- To promote research activities where faculty and sponsored candidates from industry can collaborate on wide variety of projects.
- Development of advanced and innovative concepts and technologies in engineering and economics with high quality, performance and efficiency in electric infrastructures of the future.
- Multi-dimensional technologies innovation with associated technologies in Power, IT, communication for monitoring , testing and advanced control
- Innovation of power engineering in education to develop future engineers with the leadership and engineering skill to meet the challenges in the broad context of industry and society.
- Development of a close partnership with power industry in technology transfer and educational innovation.
- The center promotes a multi-disciplinary educational experience through common courses seminars, and professional projects. The multi-disciplinary theme extends to research activities where faculty and research from all programs collaborate on wide variety of projects.
- The center promotes and supports the education of power engineering. It is focused on bringing fresh minds perspective to CCAR through industry interaction, enabling awareness of and planning, for future industry challenges. It shall work to encourage greater numbers of into power engineering, to establish strong relationships between CPRI and industry and academic to increase the quality and number of power engineering, and create and foster power engineering innovation and research.

1.1 Approach

- To provide good infrastructure for researchers to stay and work on identified areas using CPRI's laboratories, library etc.
- To empanel experts to associate with research and consultancy projects.

- To attract sponsored research projects from professional organizations.
- Networking with Academic institutions, Utilities and industry.
- To have an arrangement with academic institutions to extend recognition leading to post-graduate diploma/degree to be run by CPRI.
- To have arrangement with IISc, IITs, NITs and universities for external registration for officers from PSUs for higher qualifications.
- Opportunities for PSU's like the NTPC, NHPC, Power-grid and various GENCOs, TRANSCOs and DISCOMs to send their engineers for research work in application areas.
- Conduct Post-Graduate Diploma and Certificate courses for engineers from PSUs.

2.0 RESEARCH AT GLOBAL LEVEL

Research center is the key for any utility or industry to sustain its technology development to remain in competitive market. For example: CESI is the research center for ENEL, which is a utility in Italy. Similarly, for Hydro Quebec the

research is supported through IREQ. The leading companies like ABB, GE, AREVA etc have their own research centers, and function in a business mode.

With ever increasing development in technological advances and competitiveness, no single organization can afford to possess the requisite expertise. Research today requires multidisciplinary approaches, thus necessitating pooling of expertise. Thus opening up of 'Collaborative Research' schemes is on win-win logic. *The CCAR functional strategy for Collaborative Research is depicted in Figure 1.*

Based on the limited survey, to know the modalities how the collaborative research work is carried out at different centers reveal unified philosophy as: (The gist of such collaborative research centers is given in Annexure 1).

- Taking up multi-disciplinary research
- Partnership basis
- Participation of utilities, industry and academia

With this background it is proposed to drive research at CPRI, a collaborative multi-disciplinary research with participation from Utilities,

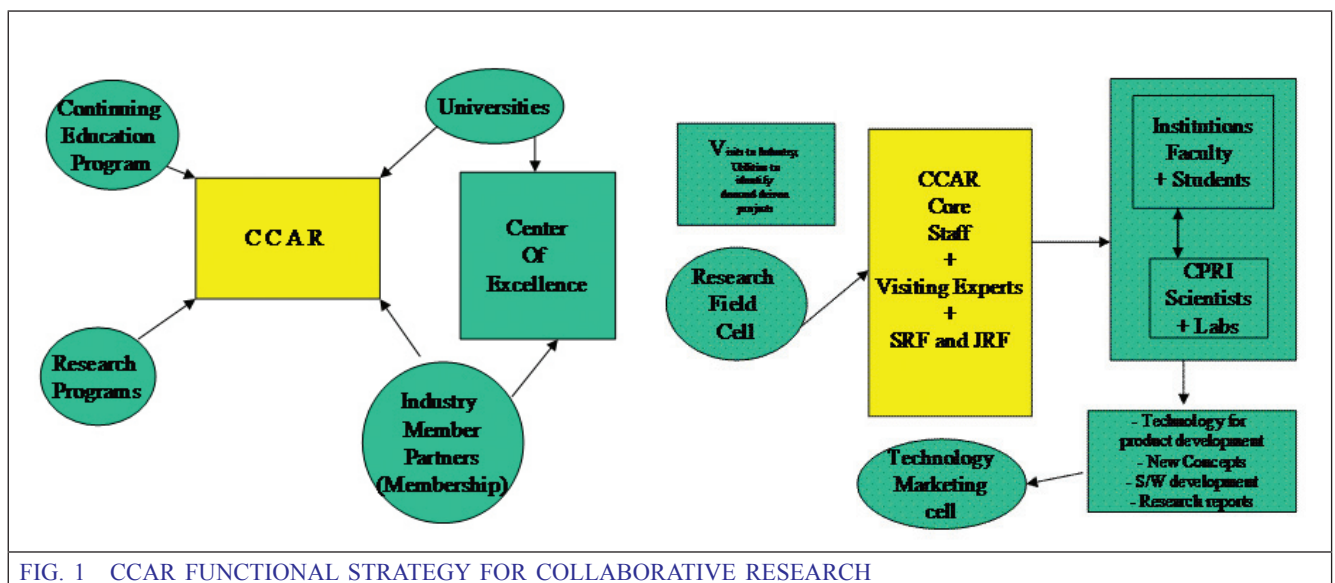


FIG. 1 CCAR FUNCTIONAL STRATEGY FOR COLLABORATIVE RESEARCH

Industry and Academia, through the Centre for Collaborative and Advanced Research (CCAR). Research activities of various divisions of CPRI and laboratories shall be supported through CCAR. With world class facilities available, the CPRI laboratories shall be a hub for testing and design validation of research.

The utilities and industry become a member partner in CPRI research and support its applied research activity. The academia expertise shall be the partner in executing research projects. CPRI expertise and laboratory facilities shall be the driving force in carrying out research and testing activities.

3.0 ROLE OF CENTRE FOR COLLABORATIVE AND ADVANCED RESEARCH (CCAR)

The Indian power sector is facing major challenges with introduction of reforms and restructuring policy of the Government. It is also undergoing large system expansion. Despite the importance attached to the energy sector by our planners we continue to face energy and peak power shortages. Besides power shortages, even the quality of power supply in respect to reliability, stability and security is not ensured. It is considered vitally important to focus on ways and means to build expertise within the country to find the solutions to the problems existing in the system and also for the problems that may arise in the future.

Many utilities in India require research facilities and man power to address the various issues and problems in the context of expansion and restructuring of the power sector. There is a need to look ahead to recognize and address problems that would arise in the future. CCAR would be a nodal center to provide unified services in the form of collaborative research in advanced areas. Therefore, R&D is essential and required to bridge the knowledge and technology gaps. This is more so due to changes in technology are occurring at a faster pace today.

Many organizations under Ministry of Power such as CEA, NTPC, POWERGRID, NHPC, NEEPCO, BBMB, SJVNS, THDC, NPTI, DVC and BHEL, NPCIL would be benefited by CCAR.

4.0 GOVERNANCE OF CCAR RESEARCH ACTIVITIES

Research Development and Application Group: Main thrust areas in power sector: Generation, Transmission, Distribution, New and Renewable energy, Energy Conservation and Information Technology. In order to take up relevant research projects with available expertise and facilities is proposed to group various laboratories of CPRI under these thrust areas. Each thrust area will be supported by researchers at different levels.

Research Management Group: The research management group is essential in the era competitive world. This group would comprise of: Business Development, Field research cell, Marketing, Technology application and transfer, IPR issues, etc.

Research Support Services: Professionals to maintain funds and administration shall be covered under this.

R&D group: The CCAR research coordination shall be carried out by R&D group drawn from various divisions of CPRI. The group would coordinate the technical progress of all research projects and identify the need based projects.

Researchers: The researcher's team would consist of visiting experts, research faculty, practicing engineers from PSUs, SRF/JRF and research scholars.

High Level Committee (HLC): Research initiative at CCAR shall be steered by high level committee. The members of the high level committee are representatives from academics, industry and utilities. DG, CPRI is the Chairman of high level committee. The tenure of members of HLC is two years.

5.0 CCAR NETWORKING WITH ACADEMIC INSTITUTIONS

One of the objectives of CCAR is to provide necessary facilities and liaison with reputed universities, NITs, IITs, IISc, etc. CCAR, CPRI shall have MoU with these leading academic institutions. Under this MoU, the sponsored candidates from central sector public sector undertakings, state utilities and other organizations under Ministry of Power, will get an opportunity to pursue higher studies leading to Master's/Doctoral programmes.

- Scheme to enable experienced professionals from CPSUs under MoP and state utilities to acquire higher qualification or work on identified research projects through *Networking with Academic Institutions*.

CPRI/CCAR has entered into MoU with IIT, Roorkee, IIT-Madras, Banaras Hindu University, Jadavpur University, Bengal Engineering and Science University, National Institute of Technology – Warangal, National Institute of Technology – Surathkal and University of Saskatchewan, Canada. The MoU covers academic activity leading to higher qualifications to sponsored candidates from PSUs under MoP, Collaborative research and continuing education through short-term courses relevant to Indian power sector.



MoU WITH IIT-ROORKEE



MoU WITH BESU



MoU WITH BHU



MoU WITH NIT-WARANGAL



MoU WITH JADHAVPUR UNIVERSITY



MoU WITH NIT-SURATHKAL

6.0 COLLABORATIVE RESEARCH AT CCAR

The CCAR would endeavor to propose, manage and execute projects in the form of collaborative research by networking other institutions and industry. This is considered essential because of the following facts:

- (i) No single organization can afford the necessary breadth of expertise
- (ii) Research issues today require multidisciplinary approaches, thus leading to pooling of expertise.

CPRI would work in close coordination with other research laboratories, defense labs and industries for research leading to product improvements in power sector, development of prototypes and other sponsored projects. Industries shall be approached to refer their materials or product related problems which can be improved by testing in CPRI laboratories.

7.0 COLLABORATION THROUGH CCAR

- Seeks innovative solutions to challenges facing its members and industry as a whole as the industry evolves toward mode decentralized market-based decision-making
- Facilitates access to highly experienced faculty and high quality students
- Stimulates productive interchange of ideas among university and industry professionals
- Leverages research funding from Utilities and Industrial members.
- Prepares current and future professionals for the new power industry

CCAR academic researchers at universities across the country specialize in power system, applied mathematics, power electronics, control theory, computing etc. they provide research services and products that add value to industry, and that support efficient and effective provision of electricity services while meeting environmental requirements.

The CCAR draws on university capabilities to creatively address these challenges CCAR coordinates with multiple universities and utilities to:

- Engage in forward thinking about future scenarios for the industry and the challenge that might arise from them.
- Conduct research for innovative solution to these challenges using multidisciplinary research expertise in a multi-campus work environment.

- Facilitate interchange of ideas and collaboration among academia, industry.
- Leadership in developing innovation in power engineering and economics.
- Leadership in developing international collaboration among universities and industry.
- Educate the next generation of power industry engineers.

CCAR provides:

- Efficient access to experienced university researchers in an array of relevant disciplines.
- Leading-edge research in cost-effective projects jointly developed by industry leaders and university experts.
- High quality education of future power engineers.

The multi-disciplinary expertise of CCAR researchers includes power system, material engineers, control theory, power electronics etc. CCAR partners with multinational and public organizations that provide integrated energy services, transmission and distribution services, power system planning, control, market management services and public policy development.

8.0 RESEARCH ACTIVITIES (AT CCAR)

The objectives of CCAR are to carryout and coordinate advanced research relevant to power sector and related areas.

Research shall be encouraged through team effort. Team of researchers shall be: Visiting Experts, Research Faculty, JRF, SRF, and Practicing Engineers from utilities and Research Scholars.

Researchers of different levels are selected as described below. A panel of selected professionals is maintained for appointment at suitable time.

Researchers at all levels shall be working in close association keeping overall objective of CCAR and power sector.

8.1 CPRI – Laboratories

CCAR derives its core strength in R&D essentially from the units and laboratories of CPRI. The institute has world class facilities for carrying out research and development in the power sector and possesses highly skilled and experienced professionals in all facets of Power Engineering. CCAR would essentially look toward these laboratories of CPRI for performing its role as elucidated in its objective. These efforts would be backed up by MoU institutions and research centers outside CPRI. The CPRI laboratories in return, would be looking in cutting-edge technologies and keep abreast of the latest technological developments.

8.2 Visiting Experts at CCAR

CCAR encourages experts to visit and share their knowledge with CPRI officers, in ongoing research and consultancy projects. Eminent faculties from India and abroad shall be invited to come on exchange programs or sabbatical leave to stay at CCAR and guide research work.

CPRI officers concerned with the project and researchers shall form the team to work with visiting expert. After the tenure of the visiting expert, CPRI shall continue the project, and may take suggestions through e-mail, etc.

8.3 The following experts visited CCAR and associated with divisions in on-going research projects

1. Prof. V K Sood, Canada
2. Prof. P C S Krishnaiah, Canada
3. Prof. John Vithaythil, Canada
4. Prof. M P Pai, USA
5. Prof. Rajesh Karki, University of Saskatchewan, Canada

6. Prof. Janak Ekanayaka, University of Perideniya, Sri Lanka
7. Dr. A M Kulkarni, IIT, Bombay
8. Prof. S S Murthy, IIT, New Delhi
9. Prof. Upul Fernando, UK
10. Prof. P V Ravi Kumar, USA
11. Prof. Vengrinovich, Belarus
12. Dr. Rajender Prashad, University of Alberta, Canada

8.4 JRF/SRF AT CCAR

CCAR engages SRF/JRF for carrying out research projects. The projects are executed at various divisions.

The JRFs/SRFs can enhance academic qualifications and contribute to practical research problems of power sector. And if required by CPRI, get engaged in consultancy assignments. CCAR shall facilitate with Universities, NITs and IITs for academic linkage.

8.5 Practicing Engineers from PSUs at CCAR

CCAR encourages practicing engineers to participate actively in ongoing research projects of practical nature. The experience and approach to the problems gained over the years by the engineers from utilities need to be utilized in relevant projects.

8.6 Research Scholars

Research scholars at Universities, NITs, IITs and CPRI are also encouraged to take up research projects with direct reference to power sector projects. The researchers shall be at different levels such as: who have completed Ph.D, pursuing Ph.D or have completed master degree. The requirement of Research Scholars is notified by writing to leading academic institutions like IITs, NITs and CPRI web site.

8.7 Computer Centre

A computer centre with 12 latest PCs was facilitated to researchers to work. This facility is provided to all researchers, with standard softwares like MATLAB etc.

9.0 RESEARCH AND DEVELOPMENT PROGRAM (DEMAND DRIVEN PROJECTS)

CCAR's comprehensive research program spans markets, transmission and distribution technologies, and system to find opportunities for advancing high performance electric power system through innovative and collaborative research. The research programs are divided into distinct, but inter related research stems such as Transmission technology, distribution technology, Systems Research, Materials engineering, Combustion research, ICT for power sector, etc.

Each technical group will focus on a key area in the power sector and provide a network of coordinated research activity through collaboration with national and international laboratories and industries. The main aim is to encourage an integrated approach to innovation through cross-disciplinary projects. Using the combined technological capabilities of CPRI and other agencies, it is aimed to generate cutting edge research that can be quickly translated into practical application.

To carryout the research through CCAR, highly qualified professionals at different levels is required. *The research theme areas are broadly classified as follows*

- ✦ Generation
- ✦ Transmission
- ✦ Distribution
- ✦ Non-Conventional Energy
- ✦ Energy-Environment
- ✦ Information Technology

Research stem committees: Each research stem has a committee that organizes its research activities. Industrial members join researchers as stem committee members to set research projects, organize projects, and facilitate/expedite high quality research. The stem committee members would interact with CPRI labs and center of excellence, where research work is in progress. Interaction is properly accounted; in terms of revenue, IPR and other related matters.



EXCHANGE OF MoU BETWEEN PROJECT COORDINATOR AND PROJECT IMPLEMENTING ORGANISATION, BEFORE THE PRESENCE OF DIRECTOR GENERAL, CPRI, AND DR. J J PATEL, VICE PRESIDENT CROMPTON GREAVES LTD., MUMBAI

10.0 DELIVERABLES

Research output will be in different forms such as:

- ✦ Technology for product development
- ✦ Development of new concepts and improved efficiency

- ✦ Software package development for real-time applications
- ✦ Research technical reports
- ✦ Technology transfer royalty
- ✦ Consultation on technology implementation
- ✦ Training programme

11.0 FIELD RESEARCH CELL

The research field cell with inter-disciplinary background is essential. This cell shall make visits to utilities, industry to identify the demand driven projects, with all relevant details to prepare detailed project reports for submission to core staff. Thus this role in identifying the new technologies needed is the key issue.

12.0 TECHNOLOGY MARKETING CELL

The research output is continuously made available to engineering industry through this cell. This cell will also keep track of the industry requirements and maintain contacts with consultants for technology implementation.

13.0 COURSES OFFERED AT CCAR

CCAR shall conduct courses relevant to power sector. The National level course will help in developing a cadre of competent engineers having the requisite knowledge on the subject, to take up challenges in improving the standards of power system operation. The following is brief list of post-graduate diploma courses:

- The Post Graduate diploma courses shall be designed to obtain higher technical know and qualification for engineering graduates. The course mainly aims to give practical approach and give confidence to take up operational problems and challenges.
 - (a) 'Testing and Maintenance' of Electrical Equipments.
 - (b) For *Electricity Regulatory Commissions*



ONE YEAR COURSE – 1ST BATCH

- (c) 'DSM and IT base solutions'
- (d) 'Power System Switchgear, Protection'
- (e) 'Metering' – Distribution system
- (f) Power Trading – Power pools and Power markets
- (g) Data warehousing and Data Mining Technologies

- ✦ planning a career change
- ✦ have a university degree and wish to enhance their education in a specific field

'A win-win for both academia and industry', while continuing with its successful initiatives to boost the quantity and the quality of power engineering research.

Certificate and Diploma programs are designed to develop the knowledge and skills required to be successful in specific careers.

Programs will be of interest to professionals who are:

- ✦ working in the field and wish to upgrade their skills and/or receive a formal credential

13.1 Course on 'Testing and Maintenance of Electrical Equipment'

CCAR has started a course on 'Testing and Maintenance of Electrical Equipment' for practicing engineers. The course covers: Substation, Transformers, Switchgear, High Voltage testing, High Power testing, Power Capacitors, Power cables, Insulating Oils, Transmission Lines, Power System grounding and Protection.

The course is designed in two modules. Module 1: covers testing aspects and Module 2: covers Maintenance aspects of electrical equipment.

The participants for the course are sponsored candidates from: West Bengal Distribution Company Ltd, Tata Power, Delhi Transco Ltd, NHPC Ltd, Chattisgarh State Electricity Distribution Company Ltd, Maharashtra State Electricity Distribution Co Ltd. Total participants are 35.



FACULTY CHAMBERS

CCAR has visited Power-Grid, NHPC and NTPC before the start of the course, and gave presentation about the course content. Views and requirements of these PSUs have been considered while preparing the course lecture notes.

13.2 Short term courses, Tutorials and Workshops

Another activity of CCAR is to organize short – term courses, Tutorials and Workshops for practicing engineers from PSU's and utilities. The course contents shall designed in such a way that, the participants can get first hand information on the subject with relevance to practical applications. This is to disseminate information and earn revenue for the organization.

Objective: This type of courses on short-term basis is arranged mainly to update the knowledge of the practicing engineers with latest developments in the concerned subject/topic. At the same time, at the end of the course, it is expected that the participants will work further to be useful for their parent organizations.

Duration of the course: In general the duration of the course can be ranging between 1 to 3 weeks, considering five working days in a week. Detailed notes on the course contents shall be provided.

Faculty: To organize this type of specialized courses to practicing engineers, guest faculty shall be invited, apart from CPRI experts.

Intake: In order to give personal attention and allow more time to discuss practical and operational issues, it is recommended to take about twenty five participants per course.

Certificate: CCAR, CPRI shall issue participation certificate to all participants.

Course fees: Prescribed fees shall be collected to meet the running expenditure.

Benefits: It is expected that, practicing engineers gain practical and theoretical inputs from this course, which is useful in solving practical problems.



14.0 CCAR PUBLICATIONS

The research work carried out at CCAR shall be brought out in the form of research reports for wider circulation. The research report shall also specify the future directions of work. This would help researchers to investigate the problems in depth and maintain continuity of work.

The researchers at CCAR are also encouraged to write technical books, monographs etc on specified topics. CCAR shall such activities undertaken by experts in the field and researchers.

The books released from CCAR shall be termed as 'POWER ENGINEERING SERIES'. Under this series, important topics relevant to power sector shall be covered. CCAR also considers the seminars, workshops, tutorials and outcome of research work etc organized in CPRI for this purpose.

CCAR has prepared lecture notes for the course on 'Testing and Maintenance of Electrical Equipment'. The course notes are under the caption of 'Power Engineering Series'.

15.0 CPRI-COLLABORATIVE RESEARCH CENTERS-INTERNATIONAL

International cooperation in research is an essential prerequisite for the international competitiveness. The advancement of international cooperation in the programme aims to establish and extend international networks between the centres

and research partners abroad. In this direction CCAR has signed MoU with University of Saskatchewan, Canada.

In order to expand CCAR activities outside the country, CCAR would jointly work with similar collaborative research centers as listed in Annexure 1.

In order to foster international contacts and enable the centers to present their findings on an international level, CCAR must have enough resources to support the centers with funding for travel, colloquia and visiting researchers.

Requirements for the integration of international partners include: the scientific excellence of the foreign partner, a significant thematic contribution to the general concept, and substantial added value for the centre. At the same time, adequate consideration must be given to the project's goal of establishing structures at the centre's host university. The critical components required for a local Collaborative Research Centre must be available at the host university.

CCAR with Partner University assumes that projects will place a recognizable and substantial focus on building infrastructure at the host universities. This would pave way for CCAR becoming truly a global center for Collaborative Research in Power Sector.

The 'Centre for Collaborative and Advanced Research (CCAR)' has been established to support collaborative advanced research relevant to power sector. The CCAR encourages an integrated approach to innovation through inter-disciplinary projects. Using the combined technological capabilities of universities, utilities and research organization aims to generate cutting-edge research that can be quickly translated into practical application.

The CCAR is a university cooperative research center that addresses these challenges in

theme areas relevant to power sector. Finding innovative and efficient solutions requires an unprecedented level of expertise, communication and cooperation between university and industry and R&D Institution.

Center activities such as seminars and workshops, are designed to foster rapid technology transfer, these activities take place with participation of academic institutions, electrical power industry experts, research institution, etc. Thus center objectives are to serve its industrial members through delivery of tangible research results, continuing education, conferences and short courses.

With establishment of CCAR, in order to initiate research activities the authorities approved the research contingency project titled 'Building up Research Infrastructure Facility at CCAR'. CCAR facilitated in inviting visiting experts, recruiting researchers, conducting brain storming sessions and conferences.

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