Annexure-I

Category Name	Number of PDF Positions	Tentative topic on which the PDF is expected to work
A	**1**	Analysis and mitigation of electro-magnetic field environment of 1150 kV UHVAC transmission lines
B	**1**	At the Central Power Research Institute (CPRI), significant challenges persist in optimizing energy storage systems, particularly in lithium-ion batteries, sodium-ion batteries, solid-state batteries, and fuel cells. These technologies are essential for advancing renewable energy systems and electric vehicles (EVs), but they each face critical limitations. Lithium-ion batteries degrade over time due to temperature fluctuations, charge-discharge cycles, and state-of-charge (SOC) imbalance, reducing efficiency and lifespan. Solid-state batteries, though promising with higher energy densities and enhanced safety, struggle with material stability, scalability, and high production costs. Fuel cells, while offering a clean energy alternative, are hindered by efficiency losses, limited durability, and expensive catalysts. CPRI's research focuses on mitigating these issues by exploring new materials and optimizing system management. Specifically, it aims to enhance battery management systems (BMS) for better SOC control, improve thermal management, and extend the lifespan of energy storage technologies. In the case of solid-state batteries, CPRI investigates novel solid electrolytes and interfaces that can support higher performance. For fuel cells, the focus is on improving catalyst efficiency and reducing operational costs. By addressing these challenges, CPRI's research contributes to the development of more efficient, durable, and cost-effective energy storage solutions, essential for a sustainable energy for future.
C	**2**	1. Cyber security in power sector - SCADA, communication protocols, Cyber security standards used in power sector, communication network security, python, Linux, Kali Linux, VAPT test tools 2. Hardware security - embedded systems, firmware, semiconductor chips and electronic systems designs.
D	**2**	1**.** Design & Modelling of Renewable Energy Sources and their associated controls including PPC and SVG controls in RMS (PSS/E) model and EMT (PSCAD) models when evacuating the power into Weak Grids 2. Develop a platform for creating and simulating digital twins of power systems, integrating data from real-time monitoring systems

E	**2**	1**.** Design and Development of High Performance and Reliable Electric Drives for EV application. The Electric Vehicle Mission, conceptualized by Prime Minister's Science, Technology Innovation and Advisory Council, aims to reduce fossil fuel consumption, mitigate emissions, and facilitate production of Electric Vehicles in India. In line with this R&D works of Indian research scholars are focused to improve the performance and reliability of EV so that it becomes popular and adopted by the users in place Internal Combustion Engine (ICE) automobiles. From literature survey, it is found that lot of research works are focused on development of high-energy storage system, Power Management strategy incorporating regenerative braking, ultra-capacitor and wireless charging of energy storage. Less Research works is reported on reducing ripple torque of Brushless DC (BLDC) Motor and Permanent Magnet Synchronous Machine (PMSM) and improving the reliability of their insulation system. Three research gaps identified under problem statement of Design and Development of High Performance and Reliable Electric Drives for EV application are as follow: i. Development of a Novel Power Management Strategy to improve the performance of EVs. ii. Quantification/measurement of ripple torque and develop strategy to Reduce ripple torque. iii. Improving the reliability of the insulation system of EV considering steep front switching surges due to high frequency switching of power devices. 2. With the increase in the integration of renewable energy sources (RES) such as solar photovoltaic (PV) and wind energy into the power grid, power quality issues have become a significant concern. The distribution cables utilized for power trans mission from the RES System to grid suffers premature failures due to temperature rise due to harmonics, and over voltages developed in the system. In addition, proper design of cables and their installation also plays an important factor in its reliability. Hence, the problems to be addressed are evaluation of the effects of harmonic distortion and filter on power cables, their design and installation methods. It is also required to optimize cable laying and installation patterns to improve thermal management of the cables.

F	**1**	Failure Analysis of Composite Insulators in Tropical Indian Conditions
G	**1**	The Hydrogen and Ammonia synthesized through Green routes having the potential to replace natural gas for the gas turbines and also co-fired in coal fired power plants to replace coal to achieve de-carbonization. However there are challenges in respect of using hydrogen and ammonia for both gas turbines and co-firing. Hydrogen has the threat of potential flash back in the gas turbine combustors due to its high burning velocity. Ammonia has lower heating value, low burning velocity, higher risk of unstable combustion and the possibility of producing large quantities of NOx emissions because it contains nitrogen. Suitable blends of hydrogen and ammonia needs to be tried but the challenges will vary with the design and capacity of the gas turbine combustors. Combustors need to be designed to handle high hydrogen concentrations, prevent flashback and manage NOx emissions from ammonia while using Hydrogen – Ammonia Blends. In respect of co-firing with coal ammonia can alter the flue gas temperature and heat transfer characteristics and potentially affecting the overall performance of the boiler. There would possibilities that ammonia contains nitrogen may increase the NOx emissions and the ammonia slippage if not properly burned. The burner design and retrofittings are essential in the boiler to handle hydrogen and ammonia. Constant research is required in the area of developing prototypes and modeling using advanced CFD tools. The PDF will work in the research area of addressing the challenges pertaining to the full or partial replacement of natural gas and coal in gas turbines and PC boilers respectively using existing CFD facilities and other research facilities at CPRI.