



Strategic Research Agenda

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List of Acronyms

CREEC	Centre for Research
ERA	Electricity Regulatory Authority
O&M	Operational Maintenance
SRA	Strategic Research Agenda
UEDCL	Uganda Electricity Distribution Company
UEGCL	Uganda Electricity Generation Company
UETCL	Uganda Electricity Generation Company
ICT	Information and Communication Technology
SBD	Strategy and Business Development



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I.0 Introduction

1.1 Preamble

Research and Development (R&D) is vital to UEGCL's on-going efforts to improve its technologies, operations, and ultimately, client and stakeholder satisfaction. R&D provides a means to develop solutions to improve processes, procedures and methods that are usually employed in the day-to-day running of UEGCL's business. In doing so, this would contribute to process improvement, better service delivery, streamlining of activities, expansion of company revenue stream, brand image recognition and also differentiate the company from local and international competition. Providing well-researched solutions or technologies directly culminates into efficient resource utilization as well as providing long-lasting products and solutions.

UEGCL acknowledges that an effectively managed R&D program is a valuable company resource. Long-term outcomes from UEGCL's R&D program would include savings to operations (reduced manpower needs, improved project implementation and system operation, improved service delivery, lower bids, enhanced risk management, etc.), benefits to the public and increased knowledge and skills for both UEGCL and Uganda at large. A robust research program will serve several departments within UEGCL, our customers, stakeholders, and business partners, in understanding and maximizing the economic benefit of all projects in progress, as well as those already in operation at UEGCL. This is usually achieved through well-researched cost saving mechanisms that are part of all infrastructure projects. This will be enabled by an all-inclusive research agenda, both in the short and long-run.

1.1 UEGCL Strategic Research Direction

UEGCL has in its 5-year Strategic Plan (2018 -2023) identified Research and Development as a key strategic goal to achieve its corporate mission of sustainably generating reliable, quality and affordable electricity for social – economic development. In line with this goal, the company initiated a Research and Development Port-folio which is aimed at among other things – promoting research, innovation, knowledge sharing and intellectual growth. UEGCL understands that, with the start of Operation and Maintenance (O&M) at Isimba (and Karuma, yet to be added), R&D is expected to form a key component in the day-to-day management of the power plants. Moreover, international best practice identifies research and development as a key ingredient for the growth, profitability, and sustainability of Electricity companies such as UEGCL.

Research and development is a key pillar for innovation within the company. UEGCL has now taken on the operation and maintenance of hydro power plants, and in the near future, it will have similar energy enterprises under its scope, such as Namanve Thermal Power Station. Research and Development thence

becomes of exceptional importance in all activities of UEGCL. Research at UEGCL will be aimed at providing solutions for immediate, short-term, and long-term challenges that the company is likely to face in its diverse areas of operation. Priority research themes have been solicited from all units and departments of UEGCL to ensure an all-inclusive Research Agenda.

1.2 Purpose of strategic research Agenda

This document establishes UEGCL programs and describes the relevant research themes, specific topics, and priority areas of research necessary for the sustainable generation of electricity, as well the advancement of electricity generation infrastructure. In addition, the related supporting infrastructure of electricity generation at UEGCL has also been identified as key areas for Research and Development, in this document. The Research Agenda will help in identifying, addressing, and tackling the different research challenges that UEGCL may face from time to time, through providing research – based solutions and innovations. This document highlights key areas of research across all UEGCL activities, both core and non-core activities. It serves to adopt, adjust, upgrade and apply the basic company-wide goals and objectives with a research alignment that integrates economic, social, and technological ideals of UEGCL.

2.0 UEGCL Research Agenda

UEGCL has developed a focused Research Agenda that is multi-disciplinary in nature and is intended to draw on both internal and external expertise. UEGCL staff will be encouraged to identify challenges and further conduct research on how these challenges could be solved. This Research Agenda is motivated by the currently existing challenges, not only at UEGCL, but in the electricity generation sector as a whole. In addition, the urge for continuous improvements in our systems and processes to increase efficiency are all key drivers of this Research Agenda. To achieve this, this Research Agenda will be supported by an encompassing research and innovation policy, company-wide research culture, capability and capacity building, research infrastructure and management strategy, innovation incentive framework, as well as research financing, among others. It is expected that this Research Agenda will open up opportunities for collaboration and partnerships with key stakeholders in industry and academia, not only in Uganda, but across the globe several research domains will also be shared with universities such as Makerere University, and our other research partners like CREEC, CNR, ICH, and EDF.

1.3 UEGCL Research Programs

Research Programs are the institutional frameworks for research activities within UEGCL. The Programs will provide a top-level view of the research activities, themes, capacity development and overall research requirements. The programs will house projects which are both long term or short term. The programs will provide a consistent reporting framework for the research activities. Funding will also be sought for each program autonomously. Each program will have its own value adding strategic partners data infrastructure at the different sites. The impact of various will also be directly measured at program Level. Detail of research programs are provided in the Appendix

2.2 Strategic Research Programs

- I) Program for climate change impacts, mitigation strategies for hydropower
- II) Program for Structure Integrity and Seismic Hazard monitoring for Hydropower Infrastructure
- III) Program for Water Level Monitoring of the Nile Cascade, Nalubaale HPP to Karuma HPP
- IV) Program for Water weed Management on the Nile cascade
- V) Program for community Transformation through Research
- VI) Program for Sustainability of Hydropower
- VII) Program for floating solar on Hydropower Reservoirs
- VIII) Program for Concrete studies in hydropower
- IX) Program for Emerging/Cross cutting Issues and Challenges

2.3 Solicitation of Research Themes – Identifying priority areas

In the development of this Research Agenda, all departments and units within UEGCL were solicited for research themes and topics. This was intended to develop an all-inclusive research agenda cognitive of all functional activities of UEGCL (core and non-core). This research agenda is thus representative of the Projects, Operations, Strategy and Business Development, Human Resource and Administration, Internal Audit, Procurement and Disposal Unit, Legal and Board Affairs, Communication and Corporate Affairs, Finance and Accounts, Risk, ICT and Transport units and departments. Each department has identified research areas, activities, gaps, and needs across the key aspects of their activities – both tangible and intangible. This Research Agenda has also been developed in recognition of UEGCL’s relevant stakeholders’ interests and respective collaborative arrangements. Research proposals that focus on specific problems related to UEGCL’s operations will be given priority in terms of funding. Self-funded research will be considered so long as there is a link with the UEGCL operations.

2.4 Strategic Research Domains

This Research Agenda outlines priority research areas to be developed, expected outcomes, as well as suggested innovative/research ideas. It also recognises that different research areas envisaged by UEGCL cannot be tackled in isolation, and seeks to provide an overall perspective on the associated relationships.

The main research themes identified for UEGCL are:

- Sustainable development of power generation facilities
- Energy sector regulation/challenges
- Energy supply-demand balance
- Best industrial O&M practices of power generation facilities and associated infrastructure
- Natural resources utilization and conservation
- Climate change impact on power generation
- Renewable energy development [Solar, Wind, Geothermal, Biomass, Hydro]
- Environmental challenges in electricity generation
- Staff motivation and retention
- Contract management and procurement
- Construction management
- Performance management
- Environment, Health, and Safety (EHS)
- Dam safety, Surveillance and Systems Engineering
- Utility operational efficiency
- Optimal Scheduling and Generation Planning
- Remote operation and cyber security in power infrastructure systems
- Emerging technologies (technical and non-technical)

- System automation – across all activities of UEGCL
- Dispute resolution and arbitration
- Staff performance and appraisal
- Corporate branding, management, and alignment
- Operation and process re-engineering
- Audit and Finance
- Business strategy and development
- Project implementation and supervision
- Infrastructure maintenance, Structural Health Monitoring, Forensics, and Decommissions
- Concrete Technology (ASR mitigation, Cracking at Karuma/ Isimba, Advanced repair methods, etc.)
- Post-construction impacts of Hydropower Plants
- QMS (ISO), i.e. Asset management, Environment, Quality, etc.
- Measurement of Project Success
- Enterprise Risk Management
- Transformational Leadership (Change management, succession planning, talent identification and retention, strategy execution, etc.)

In addition to the major research domains, Table I of the appendix details some of the more specific research challenges and innovative ideas suggested across all departments in UEGCL. These and more will be used to guide this Research Agenda.

2.5 Targets of the Research Agenda

One of the main tasks of the Research Agenda is to analyse and categorise the currently existing research gaps within the different departments at UEGCL. The Research Agenda is expected to harmonise cross-cutting research interests among the departments and units, for example between PDU and Projects, ICT and Operations, etc. The Research Agenda will target to provide a holistic approach of the contribution of research to the overall activities of UEGCL. It will capitalise on the short-term wins leading to process improvements within the various departments, while remaining focussed on the long-term goals and objectives of UEGCL.

3.0 Enabling Framework

3.1 Research and Innovation policy

The UEGCL Research Agenda will be enabled and supported by an exhaustive research and innovation policy and manual. The policy document describes the functions of UEGCL's Research and Development Unit and presents an R&D management process designed to incorporate the departments' needs and goals into a cohesive program that benefits the entire company. It includes discussion of research project development, research administration and management, training, implementation, external research program support, and company funding requirements/options.

The Research & Development Manual fulfils the company's requirements to assure the applicability of UEGCL' research outputs in meeting client goals as well as the profitability of the company. The Manual is designed to be a guide in the conducting of research projects at UEGCL, whether intramural, collaborative, or contract research projects.

3.2 Research Infrastructure

Research and Development is based on a supporting infrastructure (both hardware and software). This infrastructure will be fundamental in realising the benefits of research. UEGCL has set-up project laboratories, such as at the Karuma project site. It is expected that additional infrastructure will be rolled out as R&D becomes commonplace at UEGCL. The planned hydropower training/resource centre will equally be fundamental in supporting UEGCL's research activities.

3.3 Management Strategies

UEGCL has provided for an organisational structure that will enable the coordination and management of the research process and findings, implementation of outcomes, knowledge sharing and dissemination, etc. This falls under the Research and Business Development Unit, Department of Strategy and Business Development (See Figure 1).

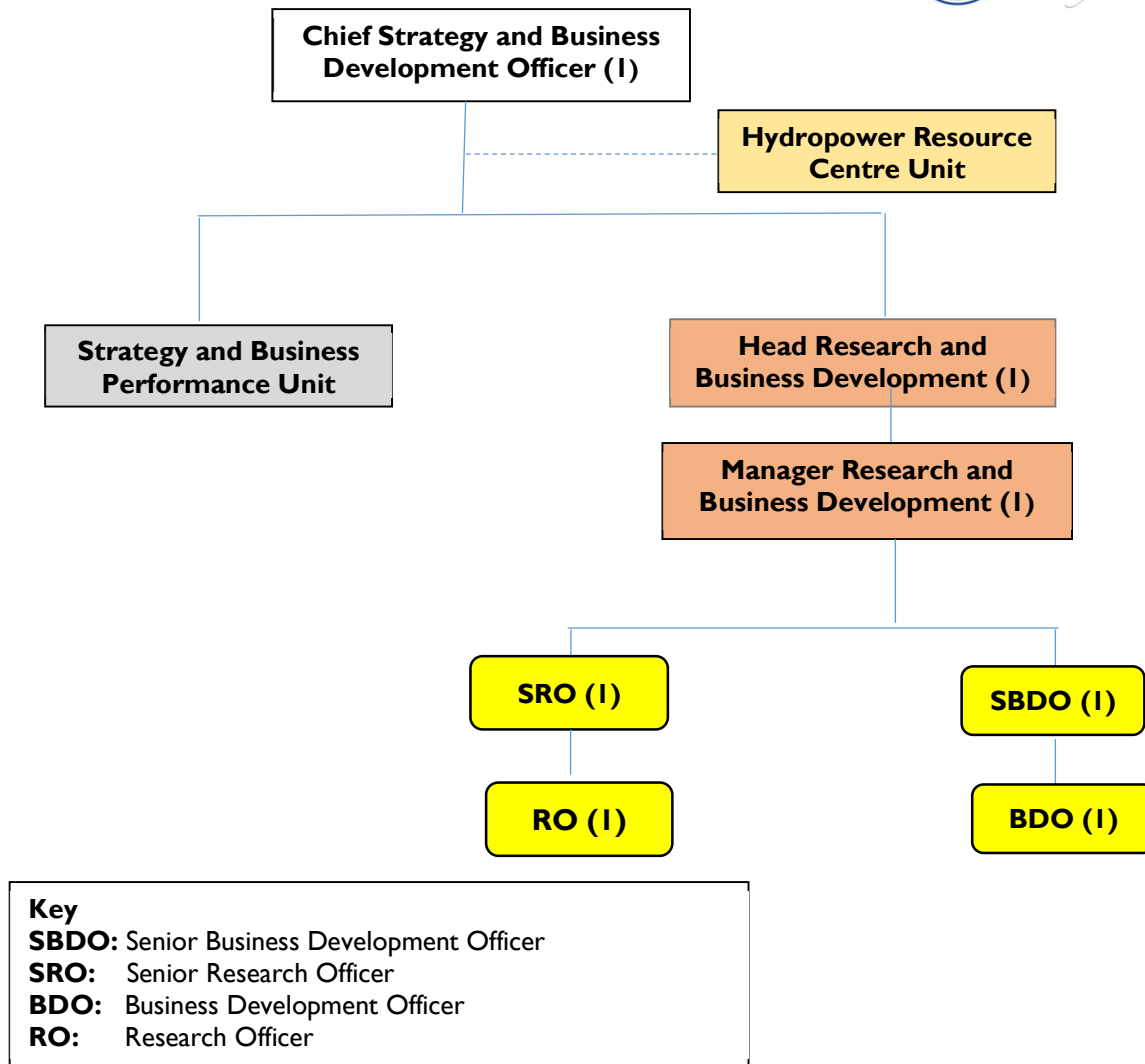


Figure 1: Management structure of Research and Development at UEGCL

3.4 Research Culture/ knowledge sharing

The research culture at UEGCL will be critical in supporting Research and Development. As such, a research culture embedded in all areas of UEGCL operations will be an enabling environment for the realisation of this Research Agenda. The Research Agenda has been developed in recognition of all potential research areas in UEGCL (both core and non-core), as highlighted in section 5.

3.5 Building Capacity and Capability

UEGCL’s Research Agenda is intended to be supported through research capacity building programs within the company. In addition, UEGCL will reach out to also benefit from the capacity and capability of its diverse

stakeholders with which it has working relationships / collaborations. UEGCL has signed several memoranda of understanding with different organisations with developed research capacity and capability. UEGCL will continue to establish appropriate partnerships with institutions that support its Research Agenda and contribute to building UEGCL's capacity in research and development.

3.6 Incentive Framework

The UEGCL Research Incentive Framework or Scheme will be aimed at encouraging all staff (and non-staff) engaging in research that is aligned to UEGCL's core businesses. A companywide research incentive framework shall support all research activities by way of motivation of internal individuals engaged in research. This framework shall form part of the UEGCL Research Policy and Manual.

4.0 Collaboration

Research collaborations have been identified as a key enabler of this Research Agenda. UEGCL will build on its already existing collaborations with the different institutions to realise this Research Agenda.

Key partners that have MOUs with UEGCL

- Centre for Research in Energy and Energy Conservation (CREEC)
- College of Engineering Design and Technology (CEDAT)
- International Collation on Large Dams (ICOLD)

strategic partners will be established for each of the Core Research programs like

- climate change
- sustainable Energy
- Flood and Water Level Management
- Seismic hazard Monitoring

5.0 Future Research Requirements

UEGCL will from time to time conduct a foresight study of its research needs and requirements. Such a study will highlight and be guided by changes in technology, environment, economy, as well as both local and regional demand/supply dynamics, etc. Such a study will shape a more strategic Research Agenda addressing future needs in electricity generation, and other activities of UEGCL.

5.1 Delivery of the Research Agenda

In the long-term, the overwhelming need is for research to be truly integrative and provide opportunities that explore all forms and activities of UEGCL (core and non-core). Future research will involve collaboration and work across boundaries, disciplines, concepts, theories, and methods. More specifically, support for large collaborative research projects, networking activities and support for new research ideas is necessary, including opportunities for UEGCL staff to spend time working in other organisations, or with other disciplines, etc. UEGCL research activities will have to explore new areas, and where appropriate, utilise creative or innovative approaches – in both the core and non-core aspects of UEGCL business. This will include applying and embedding new technologies and tools, and also the use of other methods. Although it will be necessary for research to be undertaken in partnership with several/different stakeholders, consideration shall mostly be made to address the UEGCL Research Agenda.

Priority areas for delivery of UEGCL's Research Agenda

- Collaborative and transdisciplinary/interdisciplinary research
- Knowledge exchange (best practice and experience)
- Involvement of partners
- Applying and embedding new technologies and tools
- Exploring new methods and areas of research
- Strategies/policies

5.2 Research Budget

UEGCL recognises that research is part and parcel of the activities of the company, and is directly related to the growth and development of the company. The Research Agenda will be financed through an annual budget commitment from UEGCL. Additionally, external resources will be mobilized to support specific research areas via grants, or similar. These additional resources may be mobilised from development

Rev: 01

Issue Date: Jan 2018

ID: UEGCL/SB



APPENDIX-UEGCL RESEARCH PROGRAMS

Program	Justification	Objective	Research Themes	Research Activities/Projects	Current Initiatives	Life Span of Centre, M&E and Reporting
Program for climate change impacts, mitigation strategies for hydropower	<p>Climate change is an existential threat to generation infrastructure.</p> <p>The program will directly be involved in participating in general climate change discussions, research forums, monitoring climate change, collaborating with partners, and Capacity development for climate change research.</p>	To provide updated information regarding climate change impacts to the generation infrastructure	Climate Change Impact on Hydropower	<ul style="list-style-type: none"> -Rollout of External research challenge -Source for funding from stake holders to finance climate change research -Spear head/ Participate in Engagement with stake holders on climate change studies -Develop MOU with climate Strategic partners -Review, Analyse and synthesis data from stakeholders regarding climate change and communicate critical aspects to management or other internal concerned forums 	<p>Engagement of research stake holders (Can be held on line)</p> <p>Roll-out of external Research Challenge 2021</p> <p>MOU with climate change partners</p> <p>Joint proposal submitted with university of Texas for climate change impacts on the Nile cascade and Victoria submitted to NASA</p>	<p>Long-term requiring largely a monitoring role.</p> <p>Status of climate change data will be disseminated bi-annually. Through an annually and also through the website. Other dissemination platforms include mass media or Journals basing on magnitude of data</p>
Program for Structure Integrity and Seismic Hazard monitoring for	Karuma is in the western arm of the rift valley which is a continental divergent rift and is active	To monitor and provide mitigation strategies to integrity of	Earthquake monitoring for Dam safety: A	-Sourcing for Funding for Earthquake monitoring equipment at Karuma Equipment	Hold a brainstorming session to discuss earthquake dangers to hydropower infrastructure	<p>Long-Term</p> <p>Requiring monitoring role</p>

<p>Hydropower Infrastructure</p>	<p>The geology report indicates that the dam is located in a fault line. This research centre will be directly charged with monitoring of seismic activities and reporting on any potential threats to the hydropower infrastructure</p> <p>The hydraulic gates of Isimba are currently faced with vibrations. Also, one of the piers is experiences vibrations which could directly affect its service life. The program will be charged with monitoring and developing mitigation strategies</p> <p>Seepage is also a big threat to Hydropower infrastructure. The program will focus on review of seepage data from the sites</p>	<p>the Hydraulic structures at the different dam sites</p>	<p>focus on Karuma HPP</p> <p>Vibrations of Hydraulic gates and Piers: A focus on Isimba HPP</p>	<ul style="list-style-type: none"> -Establishment of earthquake Monitoring equipment for Karuma. - Setup a data system for the Isimba instrumentation, Piezometers, Seepage equipment - Brain storming sessions to discuss the vibrations of the Vibrations at Isimba HPP. - Source for funding for vibration monitoring equipment - Capacity development proposals in vibrations and acoustic for hydropower Infrastructures - Develop partnerships for vibration studies with institutions in the field of Hydropower 	<p>Brainstorming session on the vibrations of Isimba</p> <p>Develop a proposal for vibration monitoring equipment.</p> <p>Develop seepage database</p> <p>Annual Data Review workshop</p>	<p>Annual geological update with update on Seismic risk to be disseminated bi-annually through a report.</p> <p>Long-Term requiring annual status reviews.</p> <p>Annual reports on the Seepage of the Hydropower infrastructure.</p> <p>Annual reporting of Vibrations of Isimba</p>
<p>Program for Water Level Monitoring of the Nile Cascade, Nalubaale HPP to Karuma HPP</p>	<p>The infrastructure on the cascade is highly sensitive to water levels. The Resource centre will be directly involved with monitoring water levels and identifying any potential risk to the cascade</p>	<p>To provide a platform for real time information regarding water levels across the cascade</p>		<ul style="list-style-type: none"> -Development of a water Level Management tool for cascade to supplement current weblink -Development of ANN model for forecasting for proactive management -Establish water level monitoring resource unit. Unit to receive data from the flood 	<p>Development of Water Level Management Tool for the Cascade</p> <p>Development of Water Level forecasting models</p> <p>Host the UEGCL water level monitoring Database on the research server</p>	<p>Long-Term Requiring Quarterly updates</p> <p>Reporting on the long-term observations of the water levels on the cascade</p>

				forecasting data. The resource unit will also collaborate data sharing with other stakeholders and also provide quarterly updates on the website.	Review of Karuma Hydraulic Model Proposal for flood Management system submitted to AFD	
Program for Water weed Management on the Nile cascade	Water weed has for long been a pending issue on the Nile cascade. Lots of money are spent annually on cleaning the water weed. This Centre will lead in the development of infrastructure for value addition in water hyacinth such as development of biodigesters at the sites	To develop water weed management infrastructure	Water Hyacinth for water weeds on the UEGCL reservoirs	<ul style="list-style-type: none"> -Develop funding proposal for Water weed management Resource centre. -Capacity development in water weed management -Collaboration with potential partners 	<p>Development of MOU with CREC</p> <p>A Proposal for funding the water weed management program to be submitted</p>	<p>Medium Term.</p> <p>Resource centre will largely focus on establishing the water weed infrastructure.</p> <p>Research unit can then only be involved in infrastructure management and any other further research requirements.</p>
Program for community Transformation through Research	To coordinate research initiatives that directly enhance visibility of Research at UEGCL by patterning with key stakeholders	To partner with local communities through community development project that promote renewable energy development	Promote renewable energy in communities through research	Develop MOUs with partners that promote energy in communities.	<p>Development of MOU with CREC</p> <p>Planned CDAP activity on Cook Stoves</p>	<p>Long term</p> <p>Initiatives will be evaluated on a bi-annual basis. Initiatives can directly target UEGCL activities</p>

Program for Sustainability of Hydropower	<p>-The program will focus on monitoring the economic variables that directly affect UEGCL business.</p> <p>-Tariff changes and impact to UEGCL</p> <p>-Energy demand monitoring.</p> <p>-SWOT monitoring</p> <p>-Policy changes</p>	<p>To take lead in monitoring external parameters that directly affect UEGCL Business</p>	<p>Sustainability of renewable energy</p>	<p>To establish a data centre housing all current energy producer</p> <p>-Energy tariffs</p> <p>-Energy demand forecasts and realized from stake holders</p> <p>-Monitoring of SWOT parameters that affect UEGCL strategy as per strategic parameters</p> <p>-Identify policy changes that directly affect UEGCL</p>	<p>Housing of Financial Model developed by AFD.</p> <p>Database for Parameters for financial management</p> <p>Review and update of LCOE model development by Energy mix study</p> <p>Develop collaborations for FNPV, EIRR and NPV studies</p>	<p>Long term</p> <p>Updates to strategy Team regarding movements around the UEGCL environment.</p>
Program for Concrete studies in hydropower	<p>The program will coordinate research in the concrete across the dams. The program will aim to avoid the challenges that befall Naluubale-HPP across the hydropower infrastructure. The program will also focus concrete quality studies and innovation initiatives</p> <p>A number of concrete defects have already been observed at Isimba right from development stage. The program will directly engage in concrete quality Management</p>	<p>To monitor critical concrete parameters across the Hydropower infrastructure</p>	<p>Concrete for Hydropower infrastructure</p>	<p>-Establishing a concrete monitoring data unit for the cascade.</p> <p>-The program will aim at obtaining funding for concrete monitoring instrumentation.</p>	<p>Brain storming session for the state of concrete at the dams</p>	<p>Annual report on state of concrete at the different dams</p>

Programs for Operational Efficiency	<p>This centre will focus on monitoring the efficiencies and availability of Hydropower infrastructure</p> <p>The program will take lead in improving the operational efficiencies of the equipment</p>	<p>To improve operational efficiency of hydro-mechanical equipment</p>	<p>Improving operational efficiency</p>	<p>Development of predictive maintenance programs</p> <p>Development of machine down time database</p> <p>Monitoring of maintenance costs</p> <p>Brain storming activities to address the operational issues</p>	<p>Development of database of operational issues</p>	<p>Quarterly on emerging operational issues</p>
Program for floating solar on Hydropower Reservoirs	<p>Floating solar is a new solar harvesting technology that has taken trend around the world. Floating solar provides a way to effectively utilize hydropower power reservoirs</p> <p>The program will be directly involved in studies related to the floating reservoirs and Hydropower infrastructure.</p>	<p>To enhance floating solar generation and efficient Reservoir Usage</p>	<p>Diversification of UEGCL Hydro-energy Portfolio</p>	<p>Sourcing for funding for floating solar studies</p> <p>Establishing a data monitoring centre for floating solar</p> <p>Sourcing for Funding for instrumentation of solar plant</p>	<p>Presentation at conference hydro-solar conference on the floating solar potential on the hydropower reservoirs</p>	<p>Long Term</p> <p>Annual advancement of hydro-solar technologies can be disseminated via the various UEGCL platform</p>
Emerging/Cross cutting Issues Challenges	<p>This centre will handle emerging issues that affect the organization and are cross cutting issues such as covid-19</p>	<p>To provide a platform for quick responses to emerging issues</p>	<p>Research as solution for Emerging issues</p>	<p>Organize a brainstorming session to quickly brainstorm emerging issue</p> <p>Taking emerging issue directly through research circles either internally or externally.</p>	<p>Impact of Covid-19 on electricity Generation.</p>	<p>Long term</p> <p>Quarterly reporting on emerging issues</p>

