Submission of Research Objective from SRLDC for FY 2025-26

1. **Research topic**

   Research & Development of a decision support tool for renewable energy resources redispatch from load despatch centres (**RE Dispatch System**)

2. **Lead of project-GM and above: (Name, Designation, & Department)**

   Harish Rathour, GM (SL & IT)

3. **Co-Ordinator of Project (Name, Designation, & Department):**
   i. Rajkumar Anumasula, DGM (SL)
   ii. L Sharath Chand, Chief Manager (SL)

4. **Key Problem Areas:**

   As of 30th November 2024, the installed electricity generating capacity in the country is 456 GW including 205 GW of RE generating capacity (including large hydro), which is about 40% of the total installed electricity generating capacity in the country. India has envisaged to increase the non-fossil fuel based installed electricity generation capacity to 500 GW by 2030. MNRE/SECI have identified Renewable Energy Zones (REZs) totalling to 181.5 GW (86 GW in SR) for likely benefits by the year 2030.

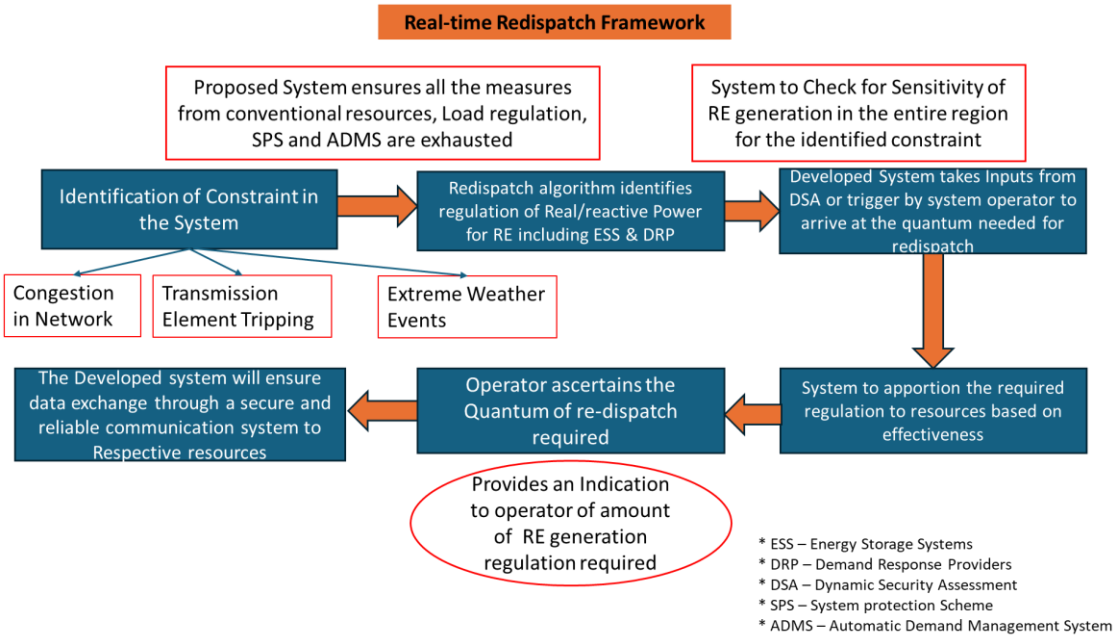
   The grid operation has become challenging with more RE penetration into the grid and especially during the high RE generation season i.e. from May to September. Persistent high frequency was observed in the India grid on 4th, 11th and 25th Aug 2024, with frequency remaining above 50.05 Hz for around 26%, 33% and 38% of the time respectively. Sustained high frequency operation is a threat to grid security. While shot-term (real time, day-ahead, and week-ahead) operational planning can offer only temporary relief, sustainable operator interventions are needed for managing high frequency in the long term. There should also be a decision support tool available with the grid operator to assess the current dispatch challenges and initiate redispatch of renewable energy generation as a last resort during sustained high frequency as grid security measure.

5. **Briefly outline of the methodology used for research:**

   It is proposed to undertake a research objective which would include design and development of a grid management decision support system for effective renewable energy management and grid security. Key objectives encompass the creation of a real-time redispatch framework, the design and implementation of an optimal renewable energy redispatch algorithm, and the development of a secure and reliable data exchange methods to ensure timely and accurate reception of decisions and instructions to RE resources including energy storage resources and demand response providers. These efforts aim to develop a real-time, automated, end-to-end redispatch system for load dispatch centres, enabling seamless and efficient integration of renewable energy

sources while ensuring grid security and reliability. The system is expected to facilitate smooth dispatch communication between Load Dispatch Centres (LDCs) and renewable energy (RE) plants, including energy storage systems and demand response providers. Furthermore, the system will automate redispatch instructions for curtailments based on real-time grid conditions, including extreme weather events and contingencies, as necessary. The developed tool will support real-time curtailment and rapid responses to grid contingencies and dispatch instructions, ensuring grid stability. By automating these processes

Research Approach:



The following is the proposed process for managing the renewable energy (RE) generation during constraints/congestion in the Power system:

i. The process shall begin by identifying constraints in the power system. These constraints could arise due to extreme weather events or loss of a transmission line (Line/HVDC)/generator outage or substation element (ICT/STATCOM) and result in Congestion like Corridor Violation or Overloading of other transmission lines or equipment beyond their capacity or a suggestion from the real time resource adequacy application.

ii. Subsequent to identification of the constraint, renewable energy generation redispatch (in terms of real or reactive power) to mitigate the issue and maintain system stability shall be established post all the measures taken from conventional resources, Load regulation, Triggering of SPS and Automatic Demand Management schemes.

iii. Inputs from applications like Dynamic Security Assessment (DSA) of SCADA/EMS or trigger by system operator acts as trigger for the developed system to arrive at the quantum needed for redispatch of the resources as whole control Area and same will be apportioned to RE resources including energy storage resources and demand response providers

iv. The proposed system shall assess the sensitivity of all the available RE resources including energy storage resources and demand response providers across multiple control areas for the identified constraint. Based on the computed sensitivities, the system will apportion to the RE resources including energy storage resources and demand response providers according to their effectiveness in mitigating the constraint, thus helping in prioritizing which RE stations needs to regulate its generation.

v. The proposed system shall calculate and apportion the amount of generation regulation (real or reactive power) required to alleviate the constraint in an optimal and effective manner. This provides a clear indication to the real time system operator in making informed and logical decisions for implementing the regulation.

vi. Based on the provided indication, the operator shall manually enter or ascertain the quantum of redispatch required to mitigate the constraint. The developed system should be able to communicate with the respective RE resources including energy storage resources and demand response providers of the required redispatch to their respective PPC, Wind Farm regulators/SCADA system.

vii. The system will ensure seamless interoperability with existing Load Dispatch Centre (LDC) systems, such as SCADA/EMS, as well as with Programmable Automation Controllers (PAC) and Power Plant Controller (PPC) systems at renewable energy plants or other resources. It is expected to incorporate robust cybersecurity measures to guarantee secure data exchange and communication channels while also providing Role based access to information provisioning to manage user access rights effectively.

viii. The Decision support tool shall support scalability by integrating with future renewable energy (RE) plants, considering high renewable penetration in the country. Additionally, it shall include logging all instructions and compliance actions for accountability and auditing, ultimately enhancing grid reliability by effectively managing the variability of renewable energy

6. Data Collection Methods:

The SCADA data available at SRLDC will be used as an input for the module. Test data shall be provided by SRLDC

7. Citation/References (Relevant Literature/Technical Papers):

i. An Intelligent Two-Stage Energy Dispatch Management System for Hybrid Power Plants: Impact of Machine Learning Deployment, Mostafa M. Shibl, (Student Member, IEEE), Loay S. Ismail, (Senior Member, IEEE), and Ahmed M. Massoud.

ii. Distributed Energy Dispatch of Electrical Energy Storage Systems Using Consensus Control Approach. Wenjing Xie, Xiaohua Xia.

iii. Optimal dispatching strategy for user-side integrated energy system considering multiservice of energy storage, Yixing Ding, Qingshan Xu, Jun Zhao, Xiaoding Yuan, Junping Yin.

iv. P. A. Dratsas, G. N. Psarros and S. A. Papathanassiou, "A Real-Time Redispatch Method to Evaluate the Contribution of Storage to Capacity Adequacy," in IEEE Transactions on Power Systems, vol. 39, no. 1, pp. 1274-1286, Jan. 2024, doi: 10.1109/TPWRS.2023.3243669.