

# **Adaptive High-Performance Optimization Tool for Real-time Operation of Renewable-based Virtual Power Plants**

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## **Abstract-**

**This paper presents an adaptive high-performance optimization tool for the real-time operation of Renewable-based Virtual Power Plants (RVPPs). The increasing integration of Renewable Energy Sources (RESs) into power systems introduces challenges due to their intermittent nature. Aggregating RES units into RVPPs creates a more controllable and competitive entity for energy market participation. However, real-time operation, particularly for ancillary services like Frequency Containment Reserve and automatic Frequency Restoration Reserve, remains challenging since the offered delivery of such ancillary services needs to be guaranteed at all times. In this paper, the proposed Adaptive High-performance Optimal Real-time operation Algorithm (AHORA) addresses these challenges by executing re-dispatches every four seconds, mitigating internal and external disturbances while ensuring compliance with System Operator requirements. The framework supports both event-driven and periodic activation strategies, enabling dynamic adaptation to system changes. Real-time implementation of the operation framework is carried out using OPAL-RT real-time simulator, verifying the RVPP's ability to meet the demands of real-time applications effectively. Test results demonstrate that AHORA achieves a minimum of 85% of the required regulation in worst case disturbances and maintains service provision within a stringent 4-second window. The findings demonstrate AHORA's practical applicability in enhancing the reliability and efficiency of renewable energy integration into modern power grids, providing a robust solution for managing the complexities of RVPP real-time operation.**

**Index Terms-** Ancillary Service Provision, Automatic Frequency Restoration Reserve, Renewable Energy Sources, Real-Time Optimal Operation, Real-Time simulation, Renewable-based Virtual Power Plant

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