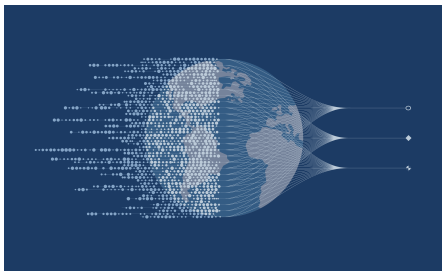

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# Sustainable Power Systems for Enhanced International Monitoring Systems Operations

The International Monitoring System (IMS) of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) operates in remote and challenging environments, where a reliable power supply is critical to ensure uninterrupted nuclear-test-ban monitoring. This study proposes integrating solar panel based power systems with real time monitoring technologies to enhance operational sustainability and efficiency. By utilizing MQTT as a proposed data transmission protocol with Quality of Service (QoS) type 2, power system parameters—such as current, voltage, State of Health (SoH), and State of Charge (SoC)—can be transmitted securely and reliably to central servers for analysis. The proposed system emphasizes renewable energy utilization, combining solar power with advanced diagnostics to reduce environmental impact and ensure long term operational stability. Additionally, implementing real time performance monitoring enables proactive maintenance, minimizing downtime and enhancing the reliability of remote stations. These innovations aim to address challenges such as energy fluctuations and power storage inefficiencies in autonomous IMS operations. Drawing inspiration from field-tested systems in meteorological monitoring stations, this proposal highlights a scalable and adaptable framework for IMS stations. By adopting these advancements, CTBTO could significantly strengthen its monitoring network's resilience and sustainability, contributing to global efforts in nuclear-test-ban verification while supporting broader goals of environmental responsibility and technological innovation.

## E-mail

hendrisatriawd@bmkg.go.id

## In-person or online preference

**Primary author:** WD, Hendri Satria (Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG))

**Co-authors:** QOTHRUNADA, Dewi Tamara (Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG)); NILASARI, Evi (Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG))

**Presenter:** WD, Hendri Satria (Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG))

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