

Application: 6083

HydroBot -

Page: General Information

Provide information about the company to be considered for the award. If you will be nominating an individual, specify the nominee’s employer.

Name of Organization/Company

PLN NUSANTARA POWER

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Additional Contacts

I would also like to have others receive emails about the disposition of our entries.

Page: Entry Information

Entry Title

HydroBot -

Category

K04. Technology Breakthrough of the Year - Energy Technology

Technology Breakthrough of the Year Submission Format

Written Answers

a. Briefly describe the organization that achieved the nominated technology breakthrough: its history and past performance (up to 200 words). Required

PT PLN Nusantara Power – Brantas Power Plant is one of Indonesia’s leading energy producers and part of the national electricity company PLN (Persero). As the operator of multiple hydroelectric power plants, the unit plays a vital role in supporting the country’s commitment to expand renewable energy and reduce carbon emissions. Located in East Java, the Brantas Power Plant manages 13 hydropower stations and 28 generation units, providing clean and sustainable electricity to the region.

Renowned for its forward-looking approach, PLN Nusantara Power is a champion of digital transformation and the Fourth Industrial Revolution (4IR), actively piloting and scaling technologies that enhance operational resilience, customer satisfaction, and environmental performance. In 2024, the organization’s application to the World Economic Forum’s Global Lighthouse Network successfully advanced to the site assessment stage—an achievement that reflects its strong commitment to deploying impactful and innovative digital technologies. HydroBot was one of five key digital innovations submitted as part of the Lighthouse application and remains the flagship example of practical AI deployment at the operational level.

This focus has enabled the Brantas unit to turn hydrological uncertainty into a source of opportunity—combining digital capability with field expertise to meet national goals and deliver measurable impact.

b. Outline the nominated technology breakthrough. Be sure to describe it in terms that someone with limited knowledge of the technology can understand and appreciate (up to 250 words). Required

HydroBot is an innovative AI-driven virtual assistant specifically designed to optimize hydropower plant operations. Traditionally, operators relied on experience and intuition when managing reservoirs—deciding when to open gates, run turbines, or prepare for potential flooding. This intuition-driven approach often resulted in inefficiencies, misinterpretations, water wastage, and missed opportunities for energy generation, particularly during unpredictable weather events.

Addressing these challenges, HydroBot employs artificial intelligence, specifically the Extra Trees Regressor model selected for its superior accuracy based on RMSE and R² scores. It analyzes real-time weather forecasts, historical hydrological data, telemetry inputs, and river sensor information to accurately predict reservoir inflows several hours in advance. This predictive capability allows operators to proactively manage water resources, determine optimal loading conditions to enhance green energy production, and ensures timely and optimal decision-making based on data rather than intuition alone.

HydroBot delivers actionable insights through an intuitive user interface, featuring a dashboard, embedded chat assistant, and mobile-based PWA. Operators receive automated alerts when inflows approach critical thresholds such as potential overflows or low reservoir levels, enabling prompt and informed responses whether onsite or remotely.

Beyond enhancing electricity production, HydroBot also supports broader community water management needs, including irrigation and local water use. Since its launch in March 2023, the system has been successfully implemented across four hydropower plants, preventing 196 million cubic meters of water spillage, generating an additional 19.2 GWh of electricity, and reducing over 21,000 tons of CO₂ emissions. HydroBot simplifies complex operational decisions, standardizing best practices across plants and operators.

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**c. Explain why the technology breakthrough you have highlighted is unique or significant (up to 250 words). Required**

HydroBot is a transformative and practical AI solution built for the hydropower sector—a field where digital innovation is typically slow and fragmented. Unlike many AI tools created in labs, HydroBot was developed and deployed in real-world environments to solve pressing operational challenges affecting energy reliability, equipment safety, and sustainability.

The breakthrough lies in its integration of three key technologies: machine learning-based inflow forecasting, a conversational interface using natural language processing (NLP), and automated operational workflows. Together, these elements turn complex hydrological data into clear, actionable recommendations—eliminating the guesswork traditionally required from operators.

Its predictive models are periodically retrained as more data—like inflow records, weather patterns, and reservoir levels—become available. This keeps the system relevant and adaptive to seasonal or climate-related changes. To further support operational decisions, HydroBot features a Retrieval-Augmented Generation (RAG) engine that gives operators access to institutional knowledge such as Standard Operating Procedures (SOPs), Work Instructions, technical manuals, and terminologies.

Built fully in-house, HydroBot runs on a cost-effective, containerized architecture using platforms like n8n. This makes it lightweight, scalable, and easy to maintain without relying on external vendors. Most importantly, in just one year of deployment, it has helped prevent environmental losses, increased power output, and reduced emissions—showing that AI, when built for real users with real needs, can drive lasting impact in sustainable energy.

**d. Reference any attachments of supporting materials throughout this nomination and how they provide evidence of the claims you have made in this nomination (up to 250 words). Optional**

1. Press Release: PLN Nusantara Power Dominates LIKE 2024 Innovation Competition — Official announcement highlighting HydroBot's award in the Incremental Application category, reinforcing its impact and industry recognition.

2. Innovation Report: Details HydroBot's problem statement, design process, and measurable impacts, including 196 million m<sup>3</sup> of water saved, 19.2 GWh additional energy generated, and 21,944.46 tons of CO<sub>2</sub> avoided. (hydrobot\_en.pptx)

3. System Architecture Slides: Showcases the AI model pipeline, data flow, and interface mockups including the dashboard, chat assistant, and mobile PWA. (hydrobot system.pptx)

4. Screenshots and Dashboards: Offer visual evidence of HydroBot's practical interface and real-time decision support in operation. (hydrobot system.pptx)

4. Performance Comparison Chart: Demonstrates why the Extra Trees Regressor model was selected, outperforming other algorithms in RMSE and  $R^2$  evaluation metrics. (hydrobot system.pptx)

5. Training and SOP Documentation: Describes internal capacity-building programs and outlines institutional integration of SOPs and Work Instructions into HydroBot's RAG-based assistant. (IK Pengoperasian Aplikasi HydroBot.pdf)

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**Would you like to add an additional supporting document?**



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**Would you like to add an additional supporting document?**

No

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