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Drones as a New Layer of Intelligence in Power Infrastructure Inspection

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Abstract
The rapid evolution of drones, or Remotely Piloted Aircraft Systems (RPAS), is reshaping how infrastructure industries approach inspection, maintenance, and asset management. In the power sector, RPAS have become an increasingly practical tool for outdoor applications, including transmission tower inspection, distribution line monitoring, power plant exterior surveys, and the visual assessment of hard-to-reach assets. Capabilities that were technically difficult or operationally expensive a decade ago are now accessible to a broader range of operators, driven by advances in flight stability, imaging sensors, data processing, and automation.

However, while outdoor drone inspection has matured and, in some areas, become commoditized, indoor and GPS-denied environments remain a challenging and underexplored frontier. Unlike outdoor use cases, where drones primarily extend human reach, indoor RPAS are increasingly deployed in spaces where human access is physically impossible, unsafe, or economically inefficient. These include narrow, dark, and structurally complex environments such as boilers, ducts, confined industrial spaces, and critical facilities within power infrastructure.

This presentation explores how RPAS can serve not merely as flying cameras, but as a new layer of intelligence for power infrastructure inspection. Drawing on emerging applications in Japan, Europe, and other advanced infrastructure markets, it highlights the growing role of small, specialized drones designed for confined-space operations. Such systems are opening new possibilities for high-value inspections, from internal boiler surveys and duct inspections to extreme cases such as highly specialized robotic observation inside the damaged reactor structures at Fukushima Daiichi Nuclear Power Station.

The presentation argues that the next phase of drone adoption in the power sector will be defined not only by improved flight performance, but by the integration of robotics, data acquisition, AI-assisted analysis, and asset management workflows. As the industry moves from preventive maintenance toward predictive maintenance, the visual, thermal, spatial, and contextual data collected by RPAS can help detect early signs of deterioration, support risk-based maintenance, and improve engineering decisions. As power infrastructure continues to age and inspection requirements become more complex, RPAS will contribute to safer operations, reduced downtime, and deeper visibility into previously inaccessible areas. In this context, drones should no longer be understood simply as inspection tools, but as an emerging intelligence layer connecting physical infrastructure, robotics, and digital decision-making.