
# Flexible, responsive and remote inspections

PES caught up with Graham Walker, Marshall Architect, at Marshall, as he shares insights into Lilypad, an innovative ecosystem of resident UAVs designed to provide wind farm operators with flexible and responsive remote inspections. We wanted to ask him how Lilypad leverages BVLOS technology to enhance turbine maintenance.

**PES: Thanks for your time today, Graham. We'd like to discuss Lilypad and wondered whether you would mind briefly introducing it to our readers?**

**Graham Walker:** Of course. Lilypad is an ecosystem of resident UAVs providing safe and scalable remote inspection services for wind farm assets. Lilypad UAVs are tasked by a remote pilot to inspect turbine blades using beyond visual line of sight (BVLOS) technology. The remote pilot is based at an onshore ground control station.

For wind farm operators, Lilypad aims to provide flexible and responsive asset inspections, enabling earlier identification of faults. This gives them the opportunity to plan maintenance accordingly and increase turbine uptime.

We haven't stopped working since the last time we were featured in PES Wind! As we speak we are currently in final preparations for an extensive live demonstration of the ecosystem to show the value that it can offer wind farm operators.

**PES: It's great to hear you are preparing for demonstrations. Can you explain what these will look like and what has been involved in this preparation?**

**GW:** We will be conducting an inspection mission of a wind turbine's blades using the full ecosystem. This includes the UAV being launched from the enclosure to perform the automated mission before returning to the enclosure to upload data and swap the battery.

We have been working diligently on several key areas to prepare for a successful live demonstration of the full ecosystem. We have conducted extensive testing of the enclosure, covering everything from the battery swapping mechanism to ensuring the sensors work reliably for the drone landing, and the drone centering mechanisms. From a software perspective, we have tested the individual functions of the system to ensure it is seamlessly integrated into the drone.

Alongside testing, we have been working with the aviation authorities responsible for UK and German airspace to gain the required approvals for BVLOS drone operations and ensure it complies with safety regulations. Our preparation gives us the confidence to demonstrate a full mission from take-off and inspection to landing and data upload.

**PES: That sounds exciting! What would you say are the key milestones that have led to this point?**

**GW:** We really have taken Lilypad Offshore from concept to reality, passing every stage in between, so there have been a few milestones along our journey.

Our R&D team has focussed on applying its creativity and expertise to design systems that address practical problems and will deliver value in the future. Our extensive research led us to identify the concept, which was our first milestone. This concept has many opportunities for adding value to the market, using emerging technology in different applications for future development.

Thanks to our understanding of the offshore wind market and the challenges facing wind farm operators, we were able to feed those industry insights into the design process from the start and throughout.

Partnering with ISS Aerospace and sees.ai was another crucial milestone. Their expertise in drone hardware and BVLOS software, coupled with our expertise in integration, has been vital for designing and manufacturing an ecosystem that can function seamlessly in multiple environments.

More recently, navigating the process of obtaining the necessary approvals and licenses has been key to ensuring we have a viable product to take to market. Marshall has always stayed at the forefront of the latest developments when it comes to certification and testing, especially when it comes to safety-critical systems.

**PES: Thanks for sharing some of the journey with us. Coming back to the core of Lilypad, can you explain why the data gathered from an Lilypad inspection is so valuable for wind farm operators?**

**GW:** There are many ways wind farm operators can benefit from Lilypad.

Each Lilypad inspection UAV is remotely piloted and monitored BVLOS. So essentially once the UAV has been tasked, it is launched and flown to the required turbine, where it completes a fully automated inspection. It then returns to an enclosure to upload inspection data and swap batteries, so it can be ready for the next task in the shortest possible time. The data gathered from the inspection mission provides critical insights

into the condition and performance of a wind turbine that is invaluable for wind farm operators.

Lilypad is a system that is permanently deployed, so it can perform scheduled and on-demand inspections. This means that operators can meet their routine needs and predictively inspect their infrastructure, and quickly respond to events like lightning strikes and storms. Decoupling inspection from deploying specialist personnel to the wind farm in this way also means that mission schedules can be dynamically adjusted at short notice to take advantage of favourable weather conditions.

Predictive inspections can be carried out throughout the season, giving operators the opportunity to catch defects early, before they become too severe, and respond to potential emerging issues. This also means that maintenance can be scheduled around turbine uptime to ensure the most efficient use of assets. It can be more cost-effective to catch a small defect at the right time, rather than catching it later as it's grown into a bigger defect.

**PES: I would imagine there are many indirect benefits of the system?**

**GW:** Absolutely. Safety being the first one that comes to mind. This is especially important in this industry where the assets are offshore and subject to harsh conditions. Lilypad is remotely piloted from an onshore ground control station using BVLOS technology which means operators can conduct visual inspections of their assets without having to deploy people into the wind farm and in harm's way.

The data gathered from an inspection helps to inform decision making around repairs and maintenance of wind farm assets. This enables operators to make the right decisions about deploying people to the assets only when and where it is necessary to do so, reducing the number and duration of deployments offshore.

**PES: In what ways do you see the system evolving for the future?**

**GW:** There are many exciting avenues for the Lilypad ecosystem, and that has been obvious from the start. Offshore is an ideal first application, allowing it to play to its strengths using BVLOS technology, but the scale of opportunity is extensive. We're always keen to explore further and open to discussing potential uses in other applications who could benefit from the Lilypad ecosystem.

I see it as a very versatile concept, exploring more complex inspection or surveillance missions and different applications is a logical path for the future. As time goes on, we anticipate technological advancements, such as improved camera payload or drone range, will open opportunities to further improve the ecosystem. This will improve the performance of the system and the end user's experience by enhancing the data it can gather.

Throughout its development we have we have gained invaluable insights and expertise. We have leaned into our strengths in design, manufacture, certification, and testing. We have learned a large amount from organisations around us, especially to understand the wants and needs of end users. We have also fostered strong partnerships with both ISS Aerospace, cutting-edge UAV design experts, and sees.ai, state-of-the-art BVLOS software specialists.

We've already been asked by others in the industry to share our learnings from the Lilypad experience so far, which is something we're quite excited about. After all, we have covered a lot of new ground, and it hasn't always been a simple and straightforward journey. If we can somehow make things easier for others who are currently planning to start that journey themselves, that's absolutely something we want to do!

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