- ***Brand: DOOSAN***
- ***Maker: Doosan Mobility Innovation (DMI)***
- ***Model: Hydrogen fuel-cell Drone (DP30 & DS30)***

Technology Overview

DP30 (Fuel-cell Powerpack) with DS30 (Drone body) is the world's first commercialized hydrogen fuel-cell drone which enables long endurance flight for various industrial applications. With a hydrogen fuel-cell drone, 2 hours flight time is possible since the energy density of fuel-cell system is 3 to 4 times higher than that of batteries.

DP30 is a complete fuel-cell system for drone which provides long endurance and high reliability. DMI has developed an ultralight fuel-cell with a proven durability by using reliable parts that are also used in hydrogen vehicles, with the Doosan group's long experience in fuel-cell business. Therefore DMI offers a 1,000-hour or 1-year warranty and a real-time monitoring system, allowing users to maintain their products in the ideal condition. Moreover, DMI has developed its own hydrogen supply solution for DP30 users, making it easy to replace hydrogen fuel in the field with a simple and fast process.

DS30 is designed to take advantage of all the efficiencies of DP30, with the maximum flight time of 2 hours and the maximum payload of 5 kg. DS30 has a water-drop shape that minimizes drag and it is made of octocopter type to enable a stable flight. In addition, based on LTE communication, users can control drones regardless of distance and monitor their status in real time. It is also possible to return home automatically after completing missions in BVLOS and to stop over at a nearby landing point, or return to its home point when the remaining amount of hydrogen is insufficient, helping to guarantee a safe flight experience.

Technical Specification

DP30 (Hydrogen fuel-cell Powerpack)

Product	DP30	Dimension (L x W x H)	613 x 590 x 290 mm
Rated Power	2.6kw	Hydrogen Pressure	0~350bar
Weight (DP30)	12.35kg	Operating Temperature	0 to 35 ℃
Weight (Stack)	3.4kg (1.7kg x 2)	Hybrid Battery	LiPo (2,600mAh x 2)

- ***Long Endurance:*** Due to the high energy density of fuel-cell system, DP30 can fly longer with more payloads than battery technology.
  : Maximum flight time 120min (without payload), Flight time 90min (with 4.5kg payload)
- ***Ultralight:*** For bipolar plates, which make up the largest portion of the stack's weight, DMI applies ultra-thin metallic bipolar plates developed with proprietary technology and successfully reduces the weight.
- ***Durability***: The main material used in the stack is MEA (Membrane Electrode Assembly), which has excellent energy output and durability even at high temperatures and low humidity.
- ***Safety:*** hybrid batteries provide redundancy to enable emergency landing in the event of operational problems.
- ***Versatility:*** DP30 is offered as a modular package kit, which allows users to customize so as to suit many commercial drone platforms.

DS30 (Drone Body for Hydrogen Fuel-cell Powerpack)

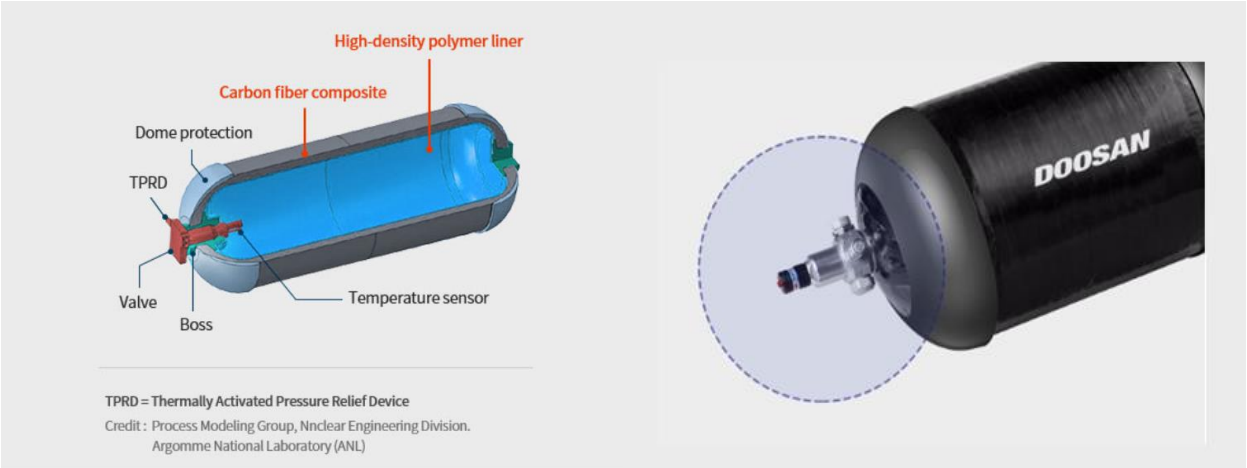
Product	DS30	Flight Time	120min (without payload)
Max Payload	4.5 kg	Max Speed	10 m/s
Dimension (L x W x H)	- Unfolded : 2,600 x 2,600 x 796 mm - Folded : 863 x 863 x 626 mm		
Airframe Weight	8.6 kg	Max Takeoff Weight	24.99 kg
Operating Temperature	-10 to 40 ℃	Rated Power	2.6KW

- ***Optimal for DP30:*** When used in the combination with the DMI fuel cell POWERPACK (DP30), DS30 is designed specially to provide aerodynamically and electrically optimal performance.
- ***Efficiency:*** DS30 has disc loading of less than 40lbs/ft^2 even at its maximum takeoff weight combined with fuel, enabling the product to be flown for even longer when used together with the DP30.
- ***Versatility:*** Users can customize the optimal product specifications for their missions by selecting the hydrogen tanks for each application. For example, users can select a 10.8 L hydrogen tank for longer flight time or a 7 L hydrogen tank for higher payload.
- ***Easy transportation & storage:*** DS30 can be folded and transported by SUV, and DMI provides a hard case for users to carry DS30 more safely and with convenience.

Hydrogen tank

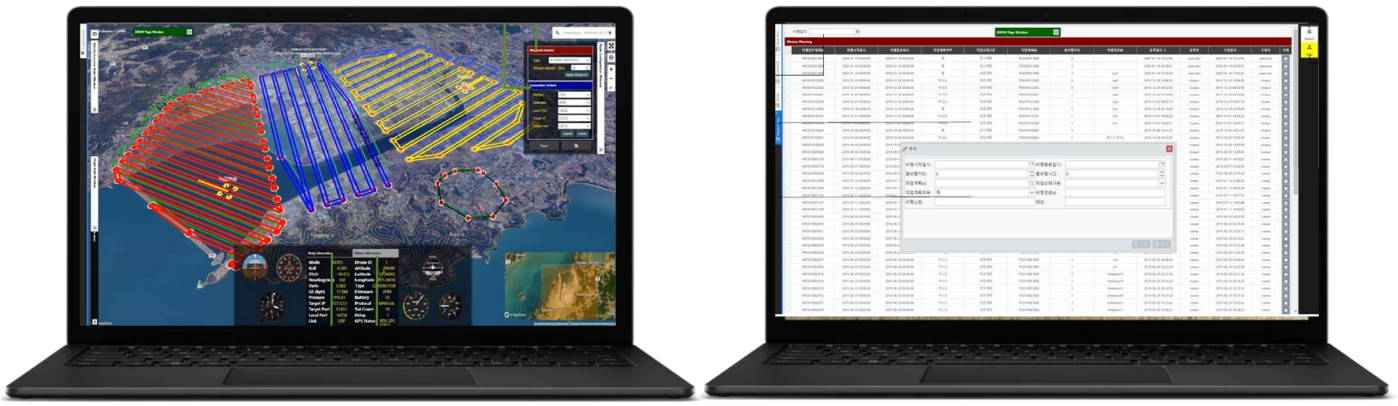
Type		Type 4		Type 3
Volume		10.8L (365oz)	7L (237oz)	7L (237oz)
Weight		4.3kg (9.5lb)	3.2kg (7.1lb)	2.9kg (6.4lb)
Service Pressure		0~350bar (0~5,076psi)		
Certifications (In-progress)	Cylinder	ISO11119-3(CSA), AC418(KGS), CE(TUV), TC(Canada), DOT(USA)		China Only (Rep, ISO11119-2)
	Valve	HPRD-1(CSA), HGV3-1(CSA), AA311(KGS), ISO10297(TPED)		

- ***Safety:*** It is certified with a variety of safety tests by certification bodies such as dropping tanks from 150m or shooting the tanks.
- ***Lightweight:*** DMI develops ultralight hydrogen tanks by optimizing the design of carbon fiber winding for use in DP30.
- ***Efficient storage:*** High storage pressure (350bar) allows the tanks to store more energy in the same volume.
- ***Easy to use:*** It is designed as a plug and play product, so the quick-coupler allows anyone to easily install and replace hydrogen tanks on the DP30



Ground Control System

DMI’s Ground Control System (GCS) is the software solution for safely operating and monitoring hydrogen fuel-cell drones and effectively planning and managing mission flights.



- ***Web-based solution:*** DMI's GCS is a web-based system, so it's fast and easy to use with anyone's laptop without extra installation needed.
- ***3D Flight Plan Management***: It uses 3D spatial information to intuitively plan flight missions and supports automated mission planning that is optimized by simulation.
- ***Multi-drone Operation***: By connecting multiple drones to one GCS at the same time, one company can efficiently manage and operate fleets.
- ***Beyond Visual Range Flight***: Based on LTE communication, the GCS supports connection with drones without distance limits.
- ***Efficient Fleet Management***: Users can manage drones by companies or by workers, thereby effectively managing multiple drones based on individual criteria & requirements.
- ***Real-time Weather Information***: Users can get climate information in real time, such as temperature and humidity, and geomagnetic field, minimizing the risk of unexpected weather conditions
- ***Upload/Download Flight Mission***: All routes/waypoint settings can be saved to any PC and exported for future use. The data is also uploaded to DMI DB center, which makes preventive maintenance possible.
- ***Compatibility with Pixhawk-based Drones:*** The GCS is compatible with not only DMI’s hydrogen fuel-cell drone but also with all Pixhawk-based drones**.**
- ***Real-time Monitoring System:*** Users can check every status of fuel-cell Power packs (DP30) as well as drones in real time (e.g. Remaining amount of hydrogen, Output voltage of DP30, etc.)

Payload Module

[Note] The FC compatible with each payload is colored as follows.

A3 ***Pixhawk***

Camera

Flir Duo Pro R

Dual-Sensor Thermal Camera

Zenmuse X Series

3-axis 4K Camera

Zenmuse XT

Dual-Sensor Thermal Camera

Zenmuse Z Series

3~30X Zoom Camera

Gimbal & Compatible Cameras

Gremsy S1

Plug-n-play platforms for various industrial camera

Ronin MX

Plug-n-play platforms for various industrial camera

CAMERA COMPATIBILITY


Flir DUO Pro R


Flir DUO Pro


Flir DUO


Flir Vue Pro R


Flir Vue Pro


Flir Vue


Wiris Pro


Wiris Security


CWSI Camera


Wiris


Wiris Mini


TeAx Fusion


TeAx Fusion Zoom


Keii HL2-640


RED Edge


RED Edge M


Sony DSC-QX10


Sony DSC-QX30


BMMCC


Sony A5xxx Series


Sony A6xxx Series


Sony RX100 Series

Other Payloads

Velodyne Lidar

Lidar for Geospatial Data Collection

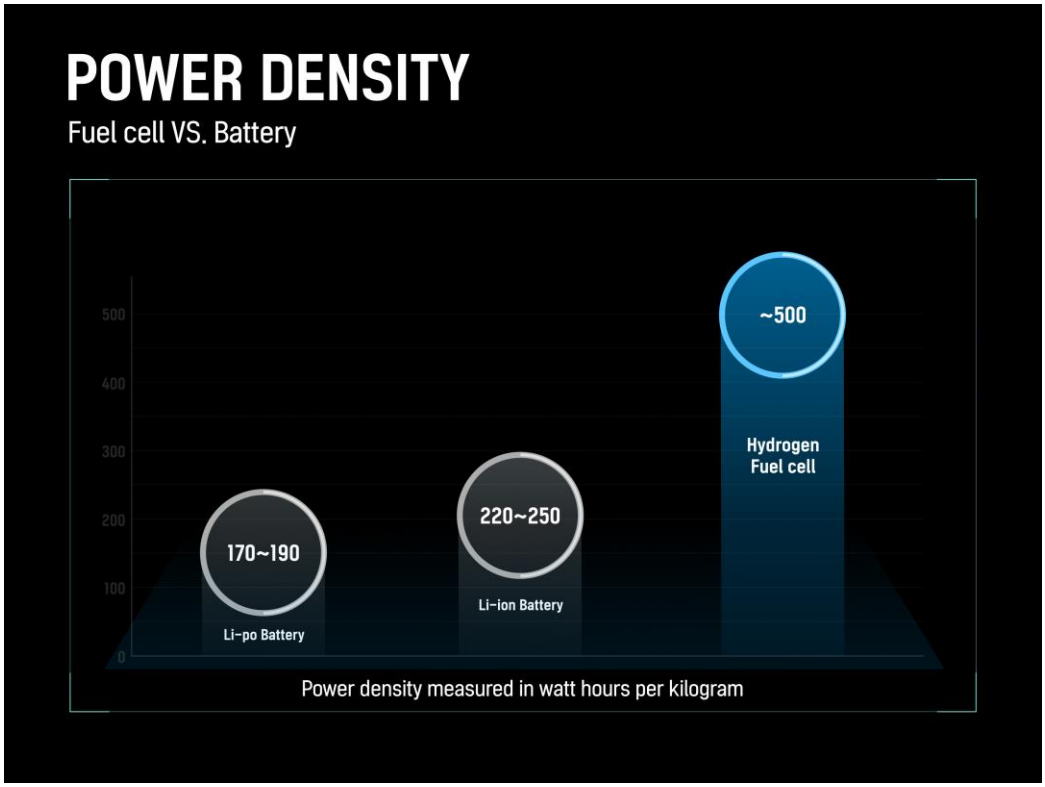
Micasense

Radiometric Thermal Camera for Agriculture management

Technology Advantage

LONG ENDURANCE, the key for the drones to be used in the industrial applications

By applying hydrogen fuel-cell technology to commercial drones, it is possible for drones to fly up to two hours. Since fuel-cell, unlike batteries, does not simply store energy but generates it, the energy density of a fuel cell drone is 3 to 4 times higher than that of battery drones.

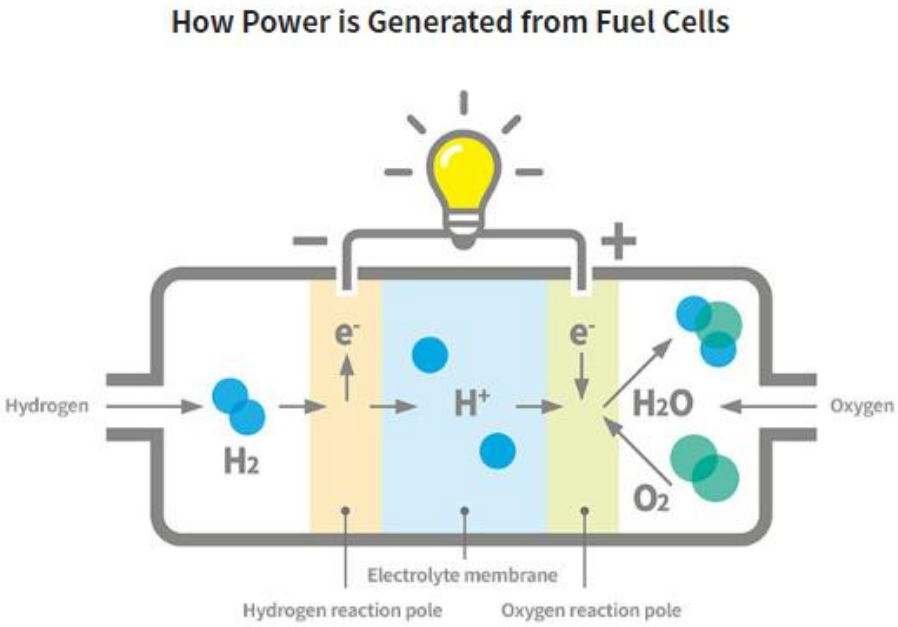


However, when considering the practical efficiency of drones performing the missions, the hydrogen fuel cell drone's productivity is not just 3 to 4 times but 6 to 8 times higher than that of battery drones, because hydrogen fuel-cell drones can save landing times and take off times needed to replace batteries. For example, when drones are used for pipeline inspection, hydrogen fuel-cell drones can inspect 40km of pipelines and return to home point, whereas battery drones can inspect them at most 6km.

Therefore DMI's DP30 with DS30, the world's first mass-produced hydrogen fuel-cell drone, will be the key for industrialization of drone industry.

A Clean and Quite Solution

DMI's DP30 with DS30 uses hydrogen as a fuel, which is a green technology with almost zero pollutant emissions. The mechanism of fuel-cell system is to utilize the chemical reaction between hydrogen and oxygen in the air. When hydrogen from the tank meets oxygen in the air, it generates electricity and pure moisture. Hydrogen is an abundant, inexpensive, and safe, above all, environmentally friendly natural element.



In addition, the noise level of fuel-cell drones is relatively low compared to that of other types of drones because hydrogen fuel-cell drones generate no noise other than the sound of motors in operation. In fact, when flying over 50m, the hydrogen fuel cell drone's noise level is around 50dB, while the gasoline drone's reaches nearly over 80 dB.

Therefore, when comparing a hydrogen fuel-cell drone with a gasoline drone, even though the flight time is quite similar for both type, hydrogen drone is an environmentally friendly and quite solution.

Proven Reliability

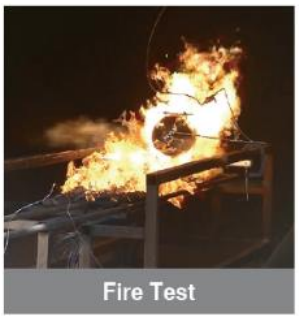
DP30 with DS30 has proven reliability, so that Doosan Mobility Innovation guarantees 1,000-hours or 1-year warranty. Fuel cells have a lifetime of over 1000 hours with no degradation, with little to no maintenance, all trackable via Doosan's real-time monitoring system. Users can monitor the status of the system by using DMI digital platform in real-time and also download flight reports.

Moreover, DMI's hydrogen tanks passed not only certification tests but also a variety of safety tests simulating drone flights. To be certified as a hydrogen tank, it must pass numerous safety

tests including fire test and rupture test. Having passed the rigorous safety tests of certification bodies, DMI provides safe & reliable hydrogen tanks.


150M Drop Test


Penetration Test


Fire Test


Internal Pressure Test

Department Of Transportation U.S.A

DOT

Transports Canada

TC

Transfortable Pressure Equipment Directive

TPED


ISO 11119-3:2013

ANSI/CSA HGV3.1-2015

ANSI/CSA HPRD1-2013


ANSI NGV 2-2007

KGS AA311 2017

Finally DMI has established the quality management system that verifies the quality of parts and products throughout the development phase, the production phase, and the after-sales phase, producing the world's first and the most reliable fuel-cell powerpack for drones, and thoroughly responding to the potential issues.

Unmanned Automated Production Line of DMI

The world's first hydrogen fuel cell drone automation line with an annual production capacity of 2,000 units.

DMI's Quality Management System

Phase 1: Development	Phase 2: Production	Phase 3: Aftermarket
- Production Part Approval Process - Product test system (Performance/ Environment/ Reliability/ Integration)	- Periodic inspection of partners' plant - Internal process inspection (Import/ Process/ Product/ Shipment	- Field service system - Flow management system for initial quality

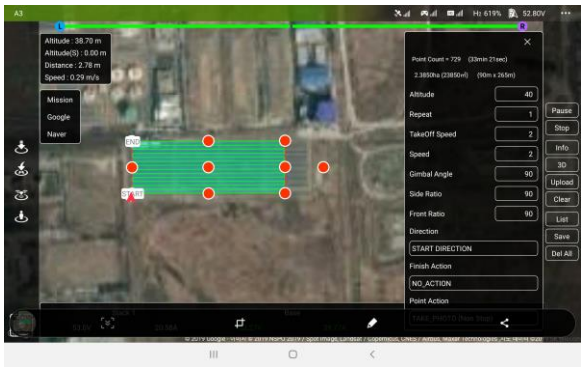
Total Solution Provider

DMI provides not only innovative hydrogen fuel-cell drones but also related software and solutions. From hydrogen supply solutions specific to each application, such as autonomous solar farm inspection, DMI offers the total solution to maximize customer convenience.

DMI is the only fuel cell company that established hydrogen supply infrastructure, which enables customers to simply replace a used tank with a newly filled one. DMI offers three options.

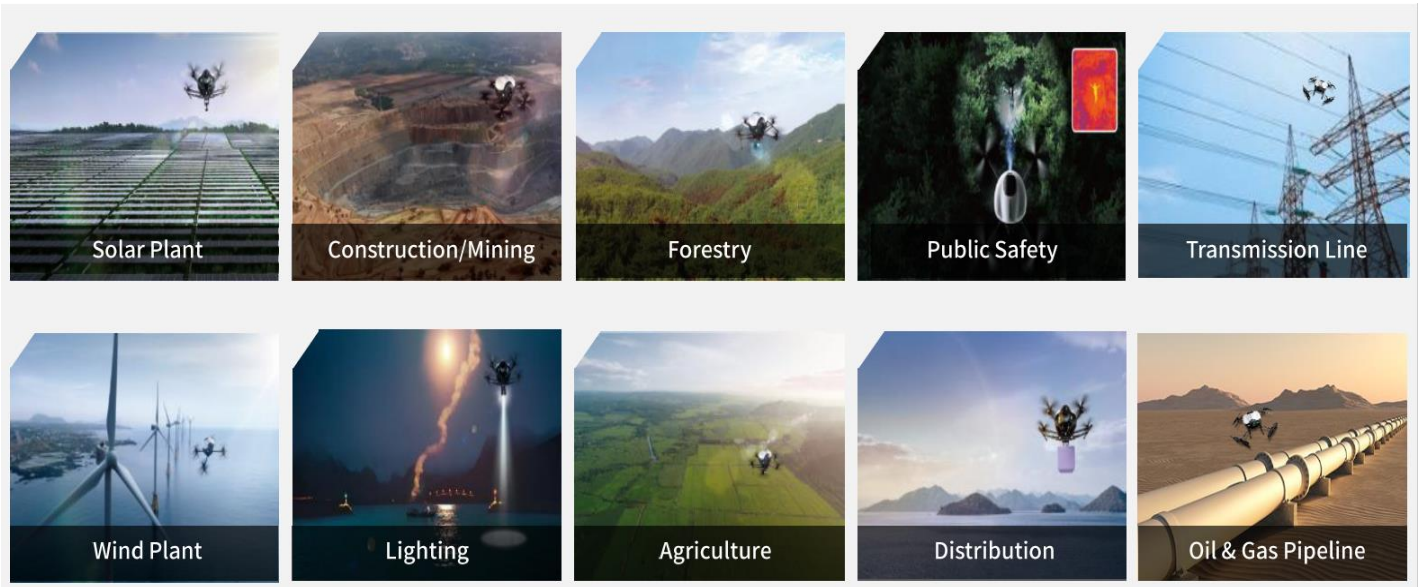
- First, DMI charges and delivers the tanks through the partnership with hydrogen companies around the world. Users can order hydrogen easily on PC and via mobile phone anywhere at any time. Then hydrogen partners will deliver filled tanks and collect the empty ones.
- Second, DMI provides a bulk hydrogen tank and charging system on site, allowing customers to refill drone tanks on their sites.
- Third, DMI provides on-site hydrogen generation system for large-scale users so that customers can generate hydrogen and refill drone tanks themselves.

Moreover, DMI provides end-to-end solutions for each application with various partners who are the experts in each applications. Currently DMI has been developing the inspection solutions for pipeline and solar farm application through which users can get insights into the issues at any point with fully-automated solutions. Customers can plan the autonomous flight mission through DMI's GCS, and the information collected by the drone will automatically be analyzed using AI technology, finally getting users to automatically have the final inspection results.



Deployment Experience

Based on the advantage of long endurance, DP30 with DS30 has been used in various industrial fields.



USA

Emergency Delivery

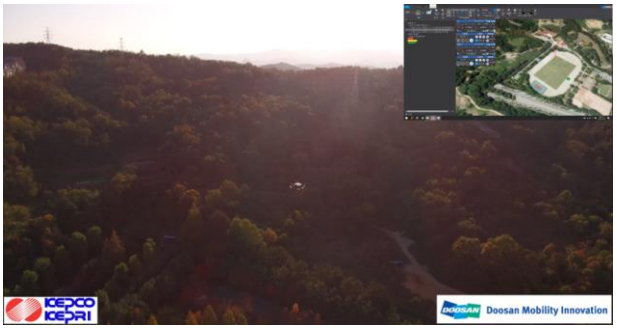
- Applied in US Government Organizations for Disease Control for the emergency delivery of blood and vaccine in case of transportation disruptions due to typhoons
- Completed the 43-mile flight in 1 hour and 43 minutes, crossing between St. Croix and St. Thomas with the blood samples. The tank had nearly 30 minutes of hydrogen gas remaining upon landing

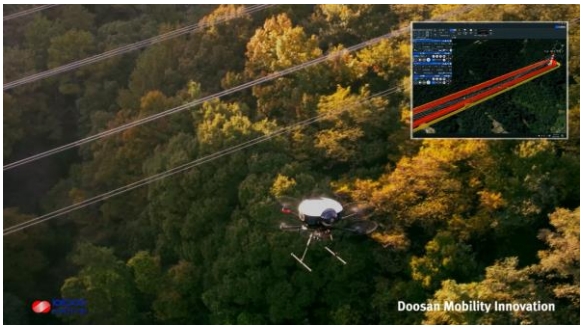
(https://youtu.be/R3Yo4eaJ8o4)

South Korea

Inspection of Transmission Line

- Applied in Korea Electric Power Company for inspection of transmission lines with the infrared camera based on autonomous mission flight
- DP30 with DS30 is able to inspect more than 20km of transmission lines in one flight

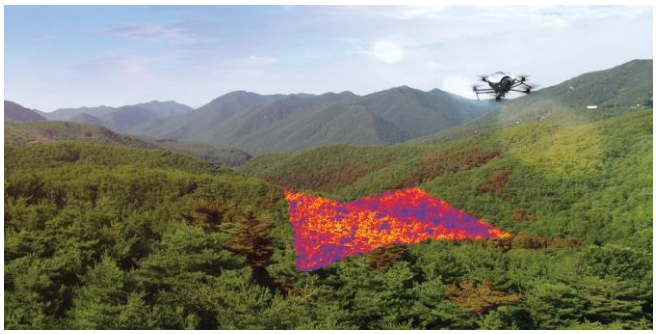




(https://youtu.be/jRw5kffD4hY)

Monitoring of the forestry

- Applied in Korea Forest Service for monitoring in the purpose of pest prevention and analyzing the status of forests
- DP30 with DS30 is able to monitor more than 60,000m^2 of forests area in one flight



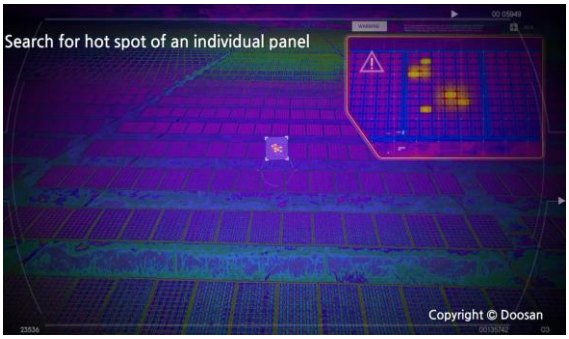
Monitoring of the water resource

- Applied in Korea Water Resources Corporation for monitoring watershed to manage dead fish in the river, broadcast evacuation in the case of disaster and to inspect infrastructure near river
- Succeeded in monitoring 20km of Nakdong River in one flight


(https://www.youtube.com/watch?v=5R4sYlqJuH0)

Inspection of Solar Plants

- Applied in Solar Power Plant Maintenance Company to monitor solar plants larger than 98MW
- DMI's Solar Farm Solution makes it possible to detect the malfunction cells automatically with AI technology

Rwanda

Emergency Delivery

- Applied in Rwanda Government for emergency delivery of blood
- DP30 with DS30 is able to transport more than 40 km of round trips


(https://www.youtube.com/watch?v=3vPk-kHjrRI)