Dirisolar - airships

Peter Lobner, updated 19 June 2023

1. Introduction

Dirisolar was founded in 2009 by Philippe Tixier, the inventor of the flat-bottom airship, with the goal of developing relatively small, solar-powered airships for a range of applications, including very long-duration remote sensing, scientific exploration, and tourism. An objective is to make the first airship able to go around the world without refueling and with a freedom in the journey choice.

In 2012, Dirisolar signed six cooperation agreements with European firms for construction of the DS 1500 five-passenger, solar-powered airship. These firms are specialists in the following areas:

- Virtual prototyping
- Construction of electric motors and low noise propellers
- Fabrication of sails
- Manufacture of helium bags
- Solar collector system design

In December 2017, the new company Dirisolar SAS took over all the assets of the company Dirisolar and of the company Air Azur, which was founded in 2013 to be an operator of Dirisolar airships.

The Dirisolar website is here: http://dirisolar.com/Projets/home/

Special thanks to Philippe Tixier for his thoughtful input for this article.

2. General characteristics of Dirisolar airships

The key features and innovations in Dirisolar airships are summarized below.

- **Flat bottom with rigid aeroshell:** The shape of the envelope is asymmetrical. The top is curved while the bottom is almost a flat surface, with the traditional protruding gondola being replaced with a crew / passenger cabin located at the front of the airship. The benefits of the flat-bottomed airship are: (1) it improves airship handling in the wind close to the ground, enabling the airship to settle on the ground instead of being lifting by the wind, (2) the loading and unloading of passengers and cargo is easier than from a conventional gondola, and (3) it is easier to anchor / moor the airship for extended parking on the ground. The flat-bottom airship design concept and associated landing and mooring methods have been patented and recognized both in France (Official Title FR2978120 B1) and in the United States (US Patent 9415852 B2).

- **Hybrid lift:** With aerostatic lift alone, the airship is trimmed to be slightly heavier-than-air, weight exceeding lift by no more than 2%. When the airship is in forward flight, it flies nose-up to generate little aerodynamic lift. Vectored thrust from one vertical axis propeller provides the balance of lift when required, for instance in stationary flights.

- **Able to operate in strong winds:** Coupled with the greater near-ground stability derived from the flat-bottomed aeroshell and hybrid lift, vectored thrust enables the airship to operating in winds up to 50 kph (30 mph) without a team on the ground.

- **High operational availability:** The goal is 90%, which is much higher than typical airship availability. The ability to operate in moderate to heavy winds significantly reduces the impact of a bad weather on airship flight operations.

- **Solar powered, no carbon dioxide emissions:** The airship operates entirely on solar power, with an onboard electrical system supplying all propulsion and other airship systems and an energy storage system using ultralight batteries that can be

scaled to support long-duration missions. Operation of the airship generates no carbon dioxide emissions.

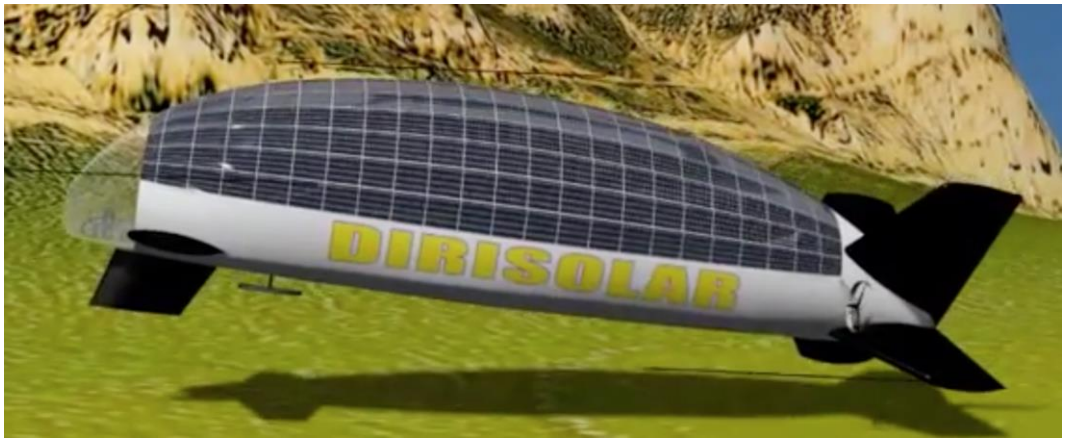
- **Low noise:** Modest-sized, all-electric Dirisolar airships are very quiet and should be able to operate in areas with noise restrictions that would block the use of heat engine-driven airships.
- **Minimum ground handling requirements:** A Dirisolar airship lands on the ground and is able to secure itself with systems on the airship and only modest effort by the crew. No other ground support staff are required.
- **Novel (and patented) anchoring device and landing and mooring method:** The unique devices and methods are covered by patents: France (Official Title FR2978120 B1) and in the United States (US Patent 9 415 852 B2).
- **Very low operating cost:** With no fuel costs, a small crew, and minimal requirements for an operating base, a Dirisolar airship should have operating costs much lower than competing alternatives, such as small fixed-wing aircraft.

A short video, “Dirisolar volez comme vous voulez / fly easy, fly forever,” describes the Dirisolar airship in French with English subtitles. You’ll find this video here: https://www.youtube.com/watch?v=rKFSfHUdzmk

A longer video, “Dirisolar DS 1500: Un dirigeable très innovant” (Dirisolar DS 1500: A very innovative rigid airship) in French and with more animation to illustrate the operation of the airship is available here: https://www.youtube.com/watch?v=l0Hz56oWf-M

3. Landing, anchoring and mooring a Dirisolar airship

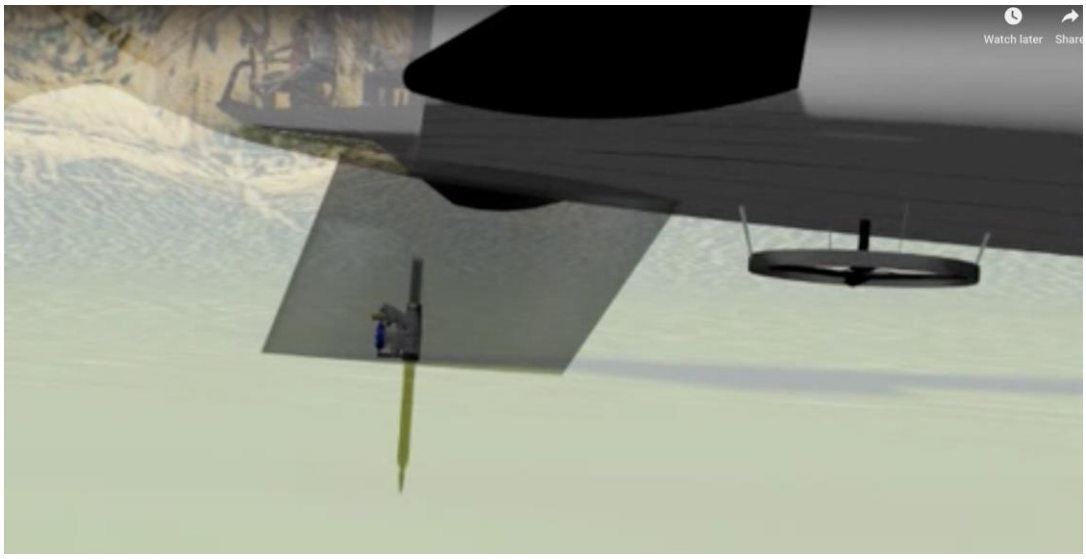
The two graphics below show a Dirisolar DS 900 airship landing in a nose-up attitude, which enables it touch down on the tail and then settle quickly to the ground.



Dirisolar airship approach (above) and landing (below).
Source: screenshots from Dirisolar video

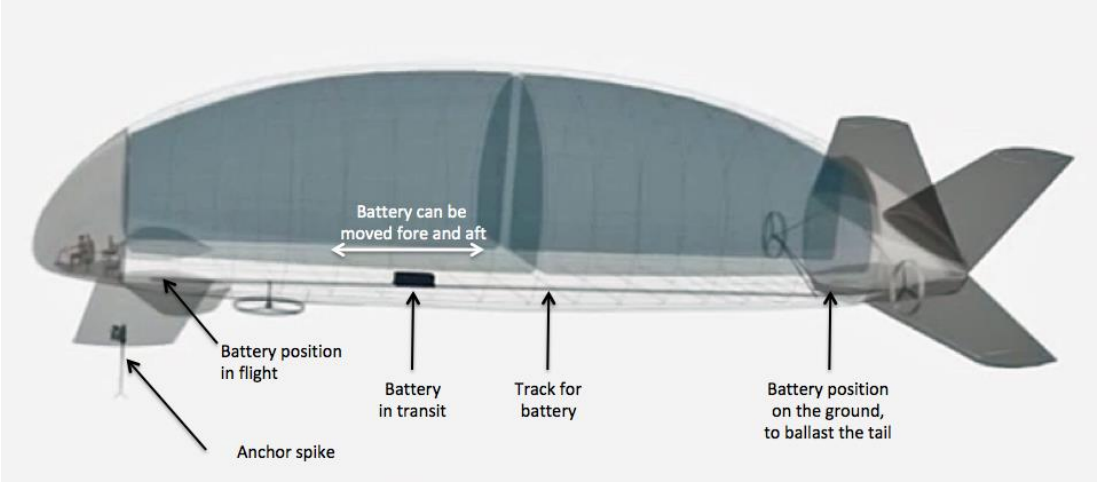
The following graphics show the post-landing sequence of events that will secure the airship on the ground:

- An anchor in the nose fin penetrates the ground to hold the nose down and serve as a pivot point
- Wheels attached to the tail control surfaces after landing allow the airship to be pointed into the wind, and
- The battery is moved from a position near the nose of the airship to the tail where it serves as ballast to prevent wind gusts from lifting the tail.



An anchor in the nose fin penetrates the ground after landing. Source: screenshot from Dirisolar video

Wheels attached to the rear stabilizers after landing allow the airship to "weathervane" into the wind. Source: screenshot from Dirisolar video



DS 900 airship internal arrangement shows the movable battery. Source: adapted from a screenshot from a Dirisolar video

4. DS 0.6 sub-scale concept demonstrator

The DS 0.6 sub-scale demonstrator was built by Pierre Yves Duchesne in 2010 with the goal of validating the advantages of a flat-bottomed airship. Basic characteristics of the DS 0.6 are as follows:

- Length: 2 meters (6.6 feet)
- Helium volume: 1.2 cubic meters (49.4 cubic feet)
- Flight speed: maximum 15 kph (9.3 mph)

Indoors flight tests were conducted at Mantes, France in June 2010. The DS 0.6 also participated in a 2011 indoor competition for radio-controlled airships in Meudon. Dirisolar received the Innovation Award at the Paris Air Show in June 2011 for the DS 0.6. The award was presented by France's Minister of Transport.

See a short video of an indoor test flight of the DS 0.6 here: http://dirisolar.com/Projets/projets/ds/

Two views of DS 0.6 in flight. Source: Dirisolar

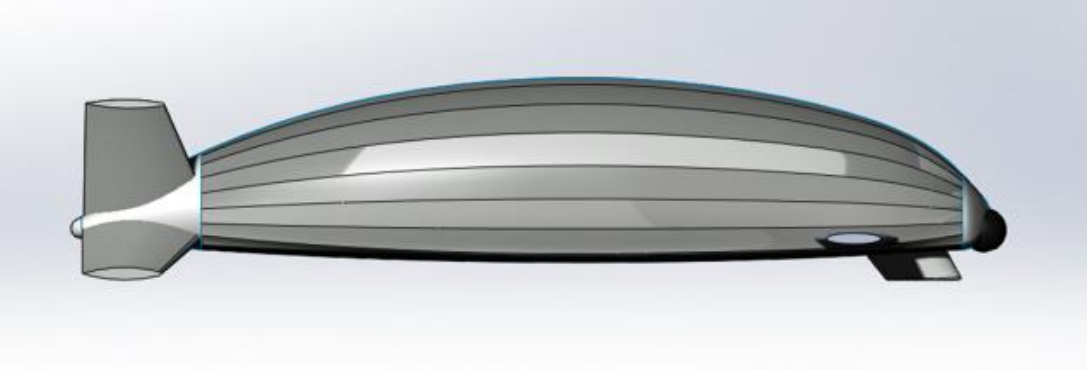
5. DS 12

The DS 12 is a small, remotely-operated drone airship intended for long-duration surveillance and monitoring missions. The small payload can accommodate video or other remote sensing systems and associated equipment for communication to a home base.

Rendering of DS 12 in flight. Source: Dirisolar

Basic characteristics of the DS 12 are as follows:

- Length : 8 meters (26.3 feet)
- Helium volume : 12 cubic meters (1,424 cubic feet)
- Payload: 1.5 kg (3.3 lb)
- Flight speed: maximum 45 kph (28 mph)
- Mission endurance: days



DS 12 profile view. Source: Dirisolar

6. DS 900

The DS 900 is a design for a small, two-place airship that met the French definition for an Ultra Light Motorized (ULM) Class 5 airship / aerostat. The DS 900 is intended for applications in scientific exploration and tourism.

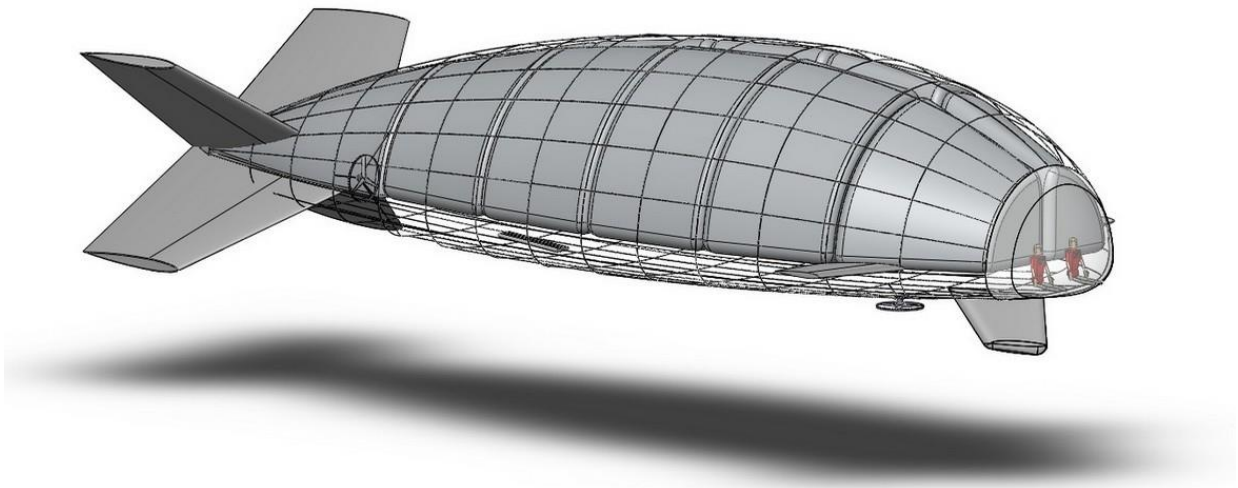
Basic characteristics of the DS 900 are as follows:

- Length: 30 meters (98 feet)
- Helium volume: 900 cubic meters (31,783 cubic feet)
- Payload: 150 kg (331 lb), for example two persons (pilot & passenger)
- Propulsion: 3 electric motor-driven propellers; 2 for propulsion and 1 for “levitation”

The preliminary studies of the full-size DS 900 design, which included modeling and analysis using computer-aided optimization (CAO) and computational fluid dynamics (CFD) software, were validated in 2011 during a formal design review. However, DS 900 development was suspended when it was determined that the larger DS 1500 would be a better match to customer needs in the intended markets.

Rendering of a DS 900 in flight. Source: Dirisolar

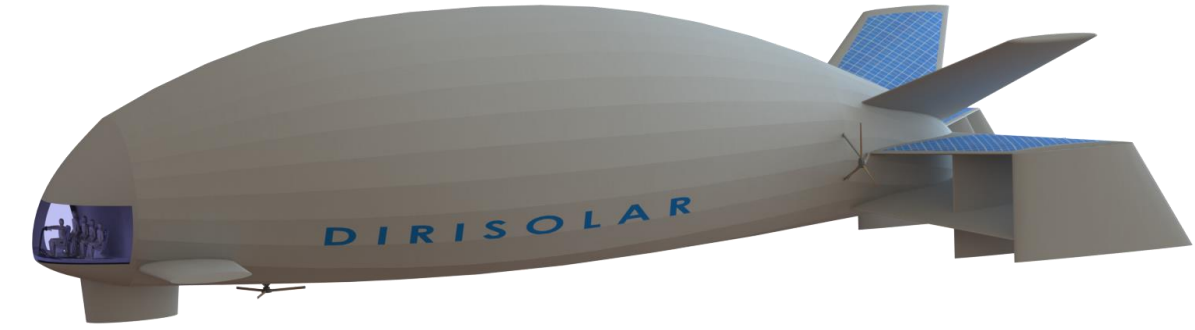
Rendering of a DS 900 showing the solar panels.
Source: screenshot from Dirisolar video



Structural elements and lifting gas cell arrangements in the DS 900.
Source: Dirisolar

7. DS 1500

After establishing its industrial team, Dirisolar formally launched the project to develop the larger, five passenger DS 1500 in 2013. In 2014, Dirisolar formed a partnership with ESI Group to use their Virtual Performance Simulation (VPS) software for DS 1500 virtual prototyping and optimization.



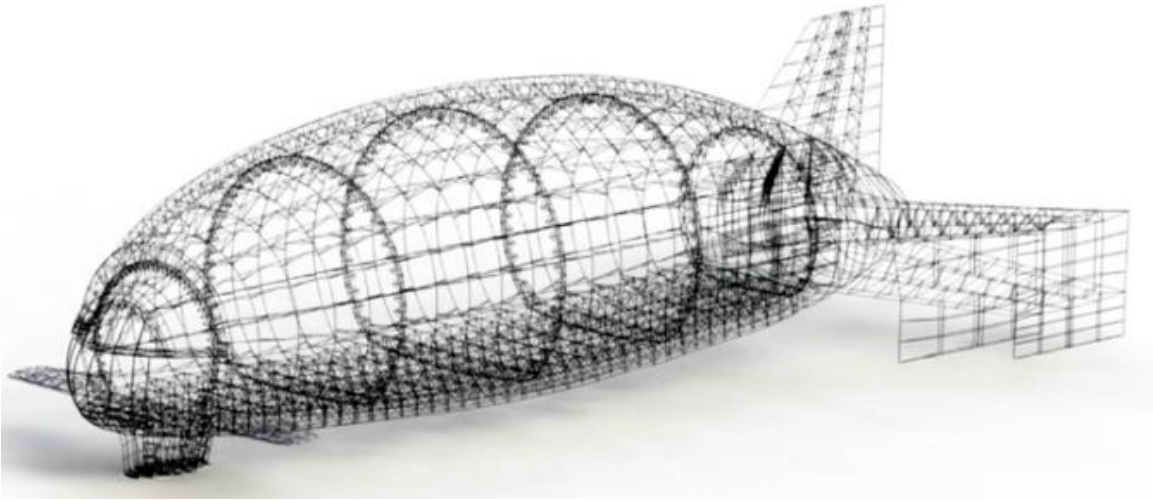
Two renderings of the DS 1500 (early design, V-tail).
Source: Dirisolar

Basic characteristics of the DS 1500 are as follows:

- Length: 50 m (164 feet)
- Helium volume: 1,800 cubic meters (63,566 cubic feet)
- Flight speed: hovering to a maximum 50 kph (31 mph)
- Payload: 450 kg (992 lb), for example five persons (pilot and four passengers) and small personal equipment
- Propulsion: 3 electric motor-driven propellers; 2 for propulsion and 1 for lifting force

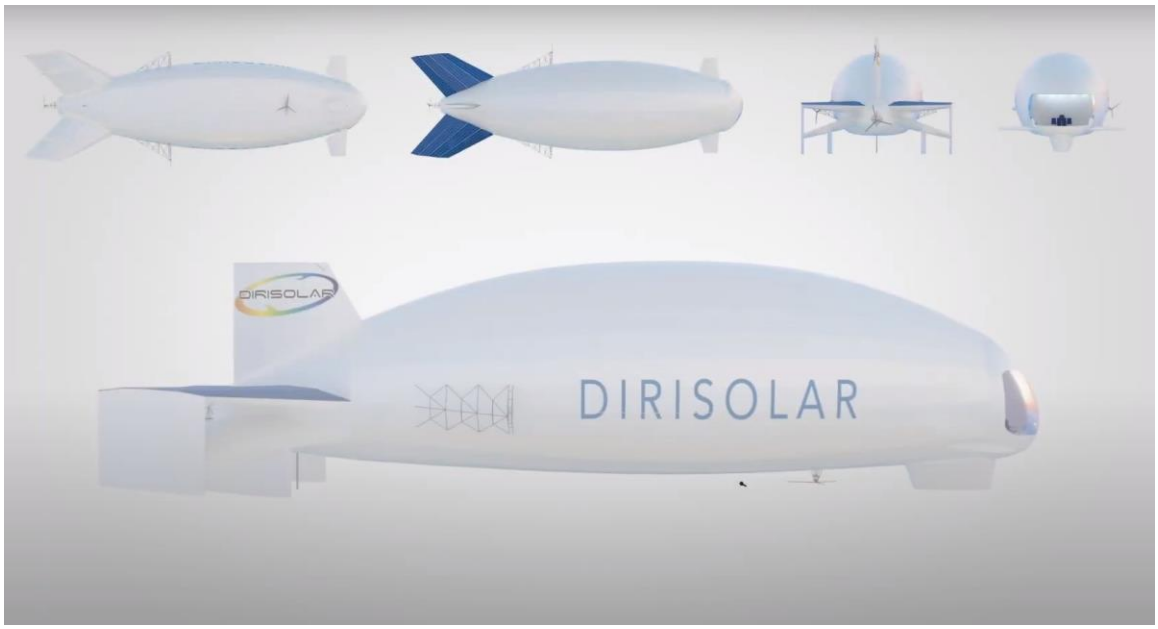
Regarding the structural design of the DS 1500, Dirisolar reports:

> "Its structure is completely standardized and uses only 7 components. This simplification keeps production costs low and ease of assembly. This also allows to design the entire device on the VPS software of our partner ESI Group and to simulate all the behaviors of the structure to comply with the requirements of the certification bodies. The structure weighs less than a ton."



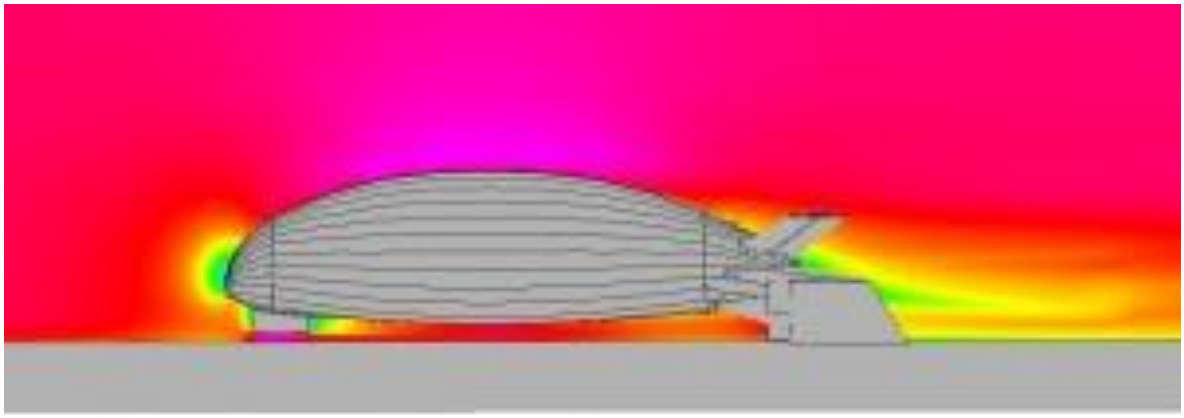
Structural diagram for a DS 1500 (current design, single tail fin). Source: Dirisolar.

Dirisolar claims that the DS 1500 design can be scaled up for larger airships.



Exterior views of the DS 1500 (current design, single tail fin).
Source: Dirisolar.

With suitable ground anchors, the DS 1500 is designed to ride out severe weather on the ground in winds up to 135 kph (84 mph), with no need for a hangar for protection.



Visualization of airflow around the
hull of a DS 1500 on the ground using MatLab. Source: Dirisolar.

Under the EU's Horizon 2020 program for funding research and innovation, Dirisolar proposed in 2016 to develop a drone version of the DS 1500 for agricultural aerial surveillance, with the goal of locating diseases and pests more efficiently than by methods currently used by that industry. Extremely long mission durations are possible with the solar-powered DS 1500 drone.

The short-term commercial objective of this project is the commissioning of one or more DS 1500 airships at Mont Saint Michel, France to conduct regular tourist flights in the vicinity. With high operational availability, Dirisolar expects that a DS 1500 can fly 20,000 passengers per year.

Rendering of a DS 1500 (early design, V-tail) in flight at Mont Saint Michel. Source: Dirisolar

Rendering of a DS 1500 with a single tail fin, which was introduced after 2019. Source: Dirisolar.

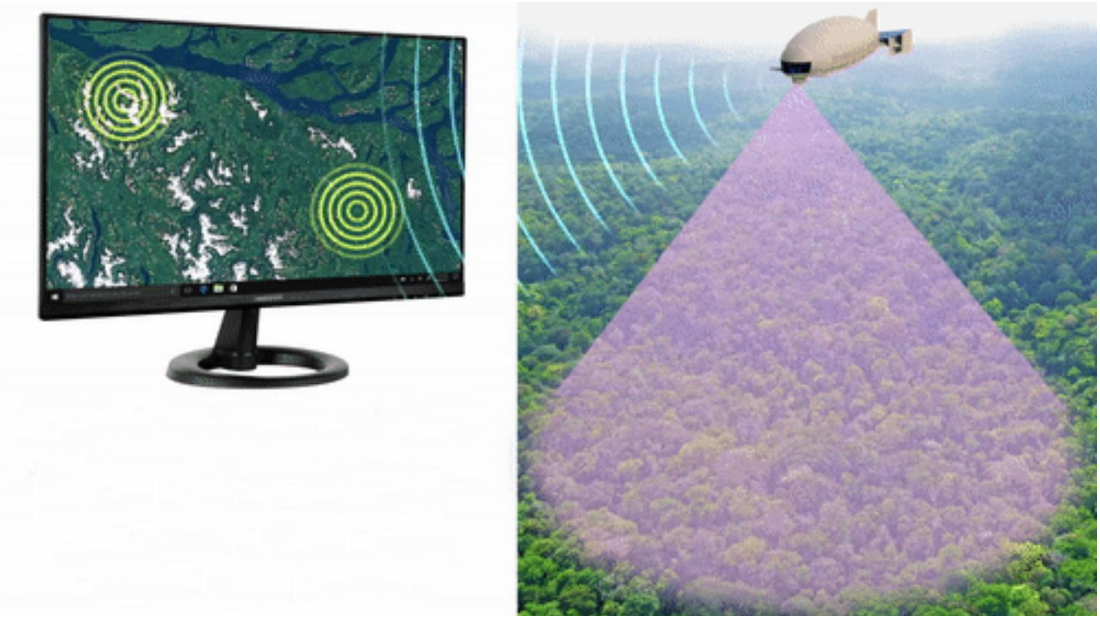
The DS 1500 also is targeted for local air tourism in scenic locations around the world. You can watch a short 2020 video, “Dirisolar Solar-powered airship” (2:45 minutes), which shows what a scenic tour in a DS 1500 would be like, here:
https://www.youtube.com/watch?v=QQzgjY8fmLs&t=9s

Two rendering of a DS 1500 in flight over the Grand Canyon.
Note the passenger seating in front of the pilot (below).
Source: Dirisolar

Two rendering of DS 1500 flights at scenic destinations.
Source: Dirisolar

The DS 1500 also can be configured for a wide variety of other missions, such as forest monitoring, utility infrastructure inspection (i.e., pipelines, electric transmission routes), anti-poaching surveillance, Earth observation / mapping, climatology research, and emergency response (i.e., communication relay, humanitarian flights carrying high-priority supplies and evacuating injured persons).

Rendering of a Dirisolar 1500 performing pipeline surveillance at low altitude. Source: Dirisolar



Dirisolar 1500 conducting a lidar mapping survey and transmitting data in real-time to a ground station. Source: Dirisolar

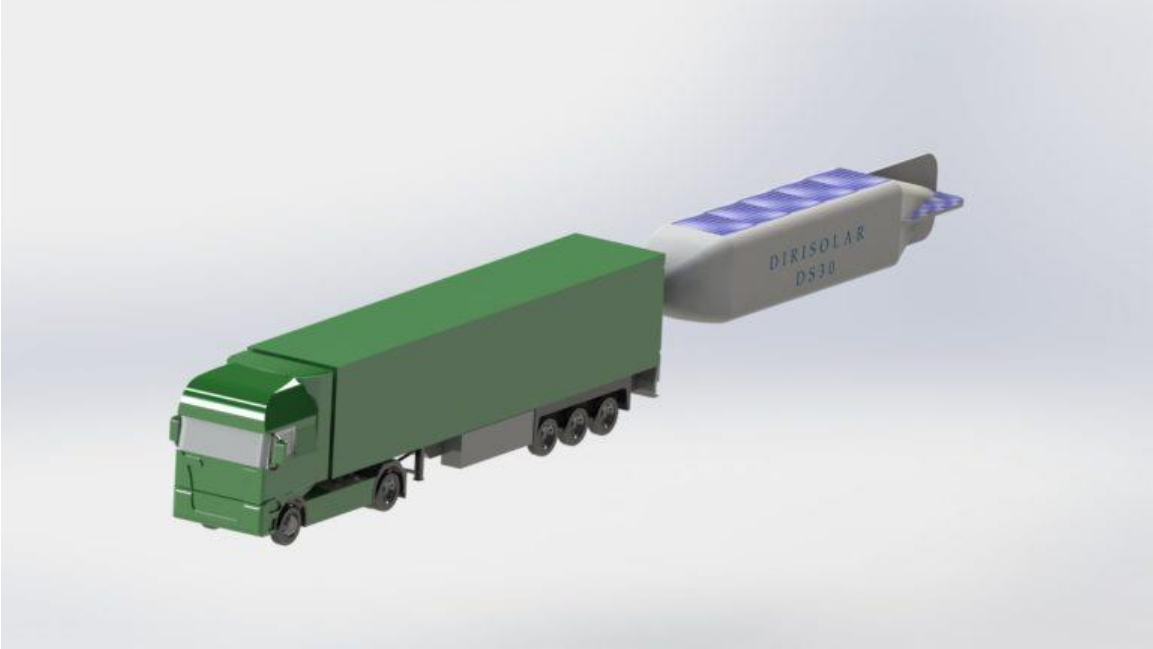
8. DS 30

The DS 30 is an entirely new solar-powered drone airship design that was introduced in 2020. The DS 30 is designed to perform remote observation missions with real-time communications to a ground station. Dirisolar notes the following features of this platform:

- Mobile platform with rapid deployment (fully assembled in a standard international shipping container)
- Autonomous flight operations
- Will not crash, even in the event of a major leak or failure
- Low operating cost

Rendering of the DS 30 in flight. Source: Dirisolar

European semi-trailers can carry a standard 40 foot international shipping container, which has interior dimensions of: 12.19 m long x 2.44 m wide x 2.59 m high (39'6" long x 7'9" wide x 7'10" high), with a usable volume of 67.7 m^3 (2,391 ft^3). These dimensions set the upper limits for the exterior dimensions and volume of the DS 30 drone airship. This maximum volume is comparable to the envelope volume of an Altus small drone blimp (70.0 m^3 / 2,400 ft^3), which has a payload capacity of 3.2 kg (7.1 pounds).



The unique rectangular cross-section of the DS 30 maximizes airship volume for fully-assembled transport in a standard shipping container. Source: Dirisolar

9. For more information

- "DIRISOLAR: A Futuristic Solar Powered Airship For The Family," TechnoCrazed, 16 April 2014: https://www.technocrazed.com/dirisolar-a-futuristic-solar-powered-airship-for-the-family-video
- Christian Curmel, "his Helium Filled Solar Powered Balloon Is the World's Next Aircraft for Tours," Autoevolution, 27 October 2020: https://www.autoevolution.com/news/this-helium-filled-solar-powered-balloon-is-the-world-s-next-aircraft-for-tours-150654.html
- Natasha Baccari, "Dirisolar Reclaims the Sky with Its Ecological Airship," ESI, 9 December 2020: https://blog.esi-group.com/dirisolar-reclaims-sky-its-ecological-airship

Patents

- Patent US9415852B2, "Airship, anchoring device, and landing and mooring method," filed 19 July 2012, granted 16 August 2016: https://patents.google.com/patent/US9415852B2/en?oq=US+Patent+9415852B2

- Patent US20140158819A1, “Airship, anchoring device, and landing and mooring method,” filed 19 July 2012, granted 16 August 2016: https://patents.google.com/patent/US20140158819A1/en?oq=20140158819
- Patent FR2978120B1, “Driable balloon, anchor device, and landing and mooring method,” filed 19 July 2011, granted 28 March 2014: https://patents.google.com/patent/FR2978120B1/en?oq=FR2978120B1

Videos

- “Séquence Utilisation Dirisolar,” (1:55 min, in French), posted by Dirisolar, 4 November 2013: http://dirisolar.com/Projets/projets/applications-f/
- “Dirisolar DS06 – Proof of Concept,” (1:09 min), posted by Dirisolar, 28 May 2020: https://www.youtube.com/watch?v=B2JfTWmm8n0
- “Dirisolar Solar-Powered Airship,” (2:45 min), posted by Dirisolar, 9 June 2020: https://www.youtube.com/watch?v=QQzgjY8fmLs
- “Dirisolar DS1500 MatLab Landing Simulation V2,” (0:57 min min), posted by Dirisolar, 5 June 2020: https://www.youtube.com/watch?v=K-WqssU5s5I

Other *Modern Airships* articles

- *Modern Airships - Part 1*: https://lynceans.org/all-posts/modern-airships-part-1/
- *Modern Airships - Part 2*: https://lynceans.org/all-posts/modern-airships-part-2/
    - Silicis Technologies - Altus small drone blimp
- *Modern Airships - Part 3*: https://lynceans.org/all-posts/modern-airships-part-3/