There have been many efforts to build and fly a solar-powered aircraft that does not guzzle conventional fuels. Although some headway has been made, there is still a long way to go.

The world’s first official flight in a solar-powered, man-carrying aircraft took place on 29 April 1979. Technologists have been trying since long to look for greener ways of flying aircraft. And what can be greener than harnessing the energy of the sun to power aircraft.

A solar powered plane converts solar energy into electric energy through solar panels, which is used to turn the propellers. The solar panels are made up of photovoltaic cells, which convert sunlight into electricity. Photovoltaic cells are made up of semiconductor materials such as silicon and cadmium telluride. When this material comes into contact with sunlight, the absorbed energy excites the electrons and generates electricity.

Solar planes need a source of energy to power them at night. Usually electric batteries or fuel cells are used for this purpose. They can be re-charged during the day.

Solar Plane History
Solar plane history dates back to the 1970s when the 27 lb (12 kg) unmanned AstroFlight Sunrise, the result of an USA ARPA (Advanced Research Projects Agency) contract, made the world’s first solar-powered flight from Bicycle Lake, a dry lake bed on the Fort Irwin Military Reservation, on 4 November 1974. The improved Sunrise II flew on 27 September 1975 at Nellis Air Force Base.

Larry Mauro built the Mauro Solar Riser and accomplished the world’s first official flight in a solar-powered, man-carrying aircraft on 29 April 1979. The aircraft used photovoltaic cells that produced 350 watts at 30 volts, which charged a Hughes 500 helicopter battery, which in turn powered the electric motor. The aircraft was capable of powering the motor for 3 to 5 minutes, following a 1.5-hour charge, enabling it to reach a gliding altitude.

The Solar-Powered Aircraft Developments’ “Solar One” is a British mid-wing, experimental, manned solar-powered aircraft designed by David Williams was the third solar-powered aircraft to fly. A motor-glider type aircraft originally built as a pedal-powered airplane to attempt the Channel crossing, the airplane proved too heavy to be successfully powered by human power and was then converted to solar power, using an electric motor driven by batteries that were charged before flight by a solar cell array on the wing. The maiden flight of “Solar One” took place at Lasham Airfield; Hampshire on 13 June 1979.

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Channel to RAF Manston near London, flying for 5 hours and 23 minutes. Designed by Dr. Paul MacCready the Solar Challenger set an altitude record of 14,300 feet.

Comparison

There are some basic differences between traditional planes such as Boeing 747 or the military aircraft F-22A raptor and the solar powered planes. A commercial plane, such as Boeing 747-400, transports hundreds of passengers from one location to another with decent fuel mileage. Military aircrafts need to be fast, quiet and agile. Fuel efficiency is not of primary importance in military applications.

Solar planes on the other hand are mostly used for surveillance. The shape of these planes is very different as well. Solar planes have high aspect ratio (length/ span) wings as compared to commercial or military aircrafts. They are closer to sail planes in their wingspan.

Next, let’s compare the weight of different planes. NASA’s Helios solar plane weighs nearly 929 kg while Boeing 747-400 weighs nearly 397000 kg with cargo and F-22 weighs 37875 kg. Commercial airplanes need to transport passengers and cargo and therefore they need to have big fuselages and are very heavy. Military airplanes carry one or two people and need to have high maneuverability. Therefore, they are lighter.

Solar planes are even lighter as they are powered only by solar energy and cannot fly if made very heavy. Most of them are also not launched in the conventional way. Some are launched by hand with a running toss into the air.

Commercial and military airplanes use air-breathing engines for propulsion. One, two or four engines are used on these planes. Whereas, several electric propellers (up to 14) power solar planes.

The cruising speed of Helios is no more than 27 miles per hour while Boeing 747-400 cruises at 567 miles per hour. The farthest flight for a solar plane has been 163 miles per hour.

Solar planes, however, win in the category of longevity. Regular planes need to be re-fueled and hence they need to be grounded. There have been instances of re-fueling aircrafts using another plane while in flight but it is a very expensive task. Solar planes can remain in air for as long as the batteries continue to get charged by solar energy.

The amount of solar energy per square foot of panels in an hour is very less as compared to the energy produced...
Solar planes can help with reconnaissance and can observe a particular spot for days. Satellites can do some of these tasks but solar planes are closer to the ground and can see more detail with less expensive cameras. They are less expensive as compared to a satellite and can be moved as needed.

by one gallon (3.78 liters) of jet fuel. Solar panels convert nearly 10-20% of the total energy into electric energy used for propellers. Since the available power is very less, the solar planes are kept very light so that wind can lift them. They are made very thin and light.

Often carbon-fiber pipes are used for the frame with a strong fabric like Kevlar stretched across it. They run on batteries or fuel cells at night. The solar panels are spread all across the wing to utilize the entire open surface area.

Solar planes prefer to fly above the clouds in the Stratosphere (12 to 20 kilometers) where they can receive direct uninterrupted sunlight. During flight, the plane automatically switches between battery and solar as needed. During landing, both power sources are cut off so that it can glide down. They are usually very slow when coming down due to their lightweight and big wingspan.

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A solar plane costs nearly 20 million US dollars so they are still very expensive as compared to gliders due to the expensive solar panels, which comprise of nearly half of the total cost. Boeing 747, on the other hand, costs nearly 250 million US dollars.

As they are environment friendly, solar planes leave no carbon footprint. And since they fly at very low speeds, there is no threat to birds.

But one of the disadvantages is that solar planes need favorable weather conditions for takeoff. They can’t stay in Cumulus clouds or turbulent layers of the sky.

Let’s have a look at some solar planes.

**NASA Pathfinder, Centurion and Helios (United States)**


On 11 September 1995, Pathfinder set an unofficial altitude record for solar-powered aircraft of 50,000 feet (15,000 m) during a 12-hour flight from NASA Dryden. On 7 July 1997, Pathfinder raised the altitude record for solar–powered aircraft to 71,530 feet (21,800 m), which was also the record for propeller–driven aircraft. On 6 August 1998, Pathfinder
Plus raised the national altitude record to 80,201 feet (24,445 m) for solar-powered and propeller-driven aircraft.

Centurion was the third generation aircraft in the NASA Pathfinder series of electrical-powered flying wing unmanned aircraft. Centurion’s maiden flight took place at Rogers Dry Lake on 10 November 1998, and lasted a total of 1 hr and 24 minutes. The Centurion was later modified into the Helios Prototype, which piloted remotely by Greg Kendall reached an altitude of 96,863 feet (29,524 m) on 14 August 2001, a world record for sustained horizontal flight by a winged aircraft. Unfortunately, on 26 June 2003, the Helios Prototype broke up and fell into the Pacific Ocean during a remotely piloted systems checkout flight in preparation for an endurance test scheduled for the following month.

The NASA Helios Prototype was the fourth and final aircraft developed as part of an evolutionary series of solar- and fuel-cell-system-powered unmanned aerial vehicles. They were built to develop the technologies that would allow long-term, high-altitude aircraft to serve as “atmospheric satellites”, to perform atmospheric research tasks as well as serve as communications platforms.

Solair 1 and 2 (Germany)
Solair 1 and Solair 2 are two German-designed electric aircraft. The human piloted Solair 1 was developed by Günther Rochelt and employed 2499 wing-mounted solar cells, giving an output of 1.8 kilowatts (kW). This was equivalent to approximately 2.4 horsepower (hp), and 2.2 kW (3.0 hp).

The aircraft first flew at Unterwössen, Germany on 21 August 1983 for 5 hours and 41 minutes, “mostly on solar energy and also thermals”. The aircraft is now displayed at the German Museum in Munich.


Sunseeker Series (United States)
Solar Flight Inc.'s solar-powered airplane Sunseeker, piloted by Eric Raymond, became the first solar-powered airplane to cross the United States. It used a small battery pack charged by solar cells on the wings for takeoff, and then was able to fly directly on solar power.

Solar Impulse (Switzerland)
Solar Impulse (http://www.solarimpulse.com) is a Swiss long-range experimental solar-powered aircraft project, and also the name of the project’s two operational aircraft. The first short-hop (350 m) test flight of the Solar Impulse prototype was made on 3 December 2009. The prototype and its successor, Solar Impulse 2, are each powered by four electric motors. Energy from solar cells on the wings and horizontal stabilizer is stored in lithium polymer batteries and used to drive propellers. In 2010, it completed the first manned 24-hour flight completely powered by solar power.

In 2012, the Solar Impulse successfully completed an intercontinental flight, the first-ever by a solar plane, flying a 19-hour trip from Madrid, Spain, to Rabat, Morocco. The following year, the aircraft set a new world distance record for solar aviation on a flight from Phoenix, Arizona to Dallas-Fort Worth International Airport as part of its multi-segment trip across the United States.
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A second aircraft, completed in 2014, and named Solar Impulse 2 (Si2), carries more solar cells and more powerful engines, among other improvements. In March 2015, the plane began a circumnavigation of the Earth, departing from Abu Dhabi in the United Arab Emirates. The plane landed in Ahmedabad on March 10 around midnight and was stationed for six days. It maintained a minimum altitude of around 5,200 meters on its flight to Varanasi.

Its 17,248 solar cells and four lithium batteries, weighing 633 kg, supply the electric motors with enough renewable energy for a 24x7 flight, up to an altitude of 8,500 meters. It was originally scheduled to return to Abu Dhabi in August 2015, upon the completion of its multi-stage journey. However, due to battery damage, continuation of the flight beyond Hawaii has been postponed until April 2016.

QinetiQ Zephyr (United Kingdom)

The QinetiQ Zephyr is a lightweight solar-powered unmanned aerial vehicle engineered by the United Kingdom defense firm, QinetiQ. As of 23 July 2010, it holds the endurance record for an unmanned aerial vehicle of over two weeks (336 hours). It is made of carbon fiber-reinforced polymer construction, the 2010 version weighing 50 kg (110 lb) with a span of 22.5 meters. It uses sunlight to charge lithium-sulphur batteries during the day, which power the aircraft at night. The aircraft has been designed for use in observation and communications relay.

The 2008 Zephyr version flew for 82 hours, reaching 61,000 feet (19,000 m) in altitude in July 2008, the then unofficial world record for the longest duration unmanned flight. In July 2010, the 2010 version of the Zephyr made a world record unmanned aerial vehicle endurance flight of 336 hours, 22 minutes and 8 seconds (more than two weeks).

Soaring (China)

China’s first solar-powered aircraft “Soaring” was designed and built by Danny H. Y. Li and Zhao Yong in 1992. The body and wings are hand-built predominantly of carbon fiber, Kevlar and wood. The design uses winglets to increase the effective wingspan and reduce induced drag.

Dr. Swati Saxena has a PhD in Aerospace Engineering from the Penn State University, USA. Address in India: C/o Dr. Ashok Saxena, 204, Narain Towers, Agra-282002; Email: swati.saxena29@gmail.com