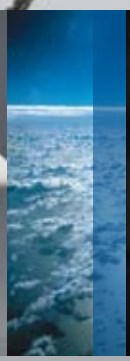
AROUND THE WORLD IN A SOLAR AIRPLANE

SOLAR**IMPULSE**



INVENTING THE **FUTURE**

READY FOR THE FIRST TEST FLIGHTS

For six years, from initial concept to finished product, structure and materials specialists, engineers, physicists andcomputer scientists have been working together to build a revolutionary aircraft.

On the eve of the first tests, the suspense is enormous. How will a wing of such size, and yet so light, behave in flight? Will Solar Impulse be able to defy the long nights using solar energy alone?

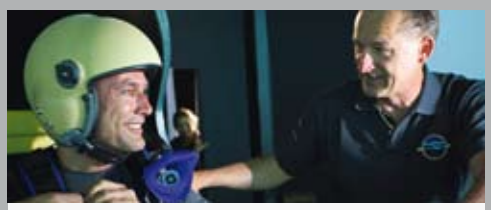
In its quest for the ultimate in technological performance and symbolic force, Solar Impulse has set out on the difficult and risk-strewn path trodden by all pioneers. Flying day and night without fuel should demonstrate the immense potential of renewable energies for inducing the changes needed in order to achieve better use of energy resources and greater respect for the environment.

«Meeting a challenge of this magnitude is possible only by taking maximum advantage of solar energy. Every watt counts, and we are looking to track down every way we can save energy. Only the most advanced solutions, most of them never applied before, will permit this. We believe we have found them by combining the experience and summing the potential of every team member.»

André Borschberg

TRAJECTORY

Solar Impulse continues a long tradition of exploration, adventure and scientific development. By initiating this challenge, Bertrand Piccard is continuing his family's tradition of adventure, from the exploration of the stratosphere and the ocean depths to his own round-the-world balloon flight. Joining him in this adventure is a team headed by André Borschberg, whose competence guarantees the success of the project, and partners who are also keen to invent the future. The challenges of our world can only be met by those with a pioneering spirit who go looking for new solutions outside our current habits and certainties.



A TANDEM AT THE CONTROLS

Two men, both pioneers and innovators, both pilots, are the driving force behind Solar Impulse: Bertrand Piccard, psychiatrist and aeronaut, who made the first non-stop round-the-world balloon flight, is the initiator and chairman. André Borschberg, an engineer and graduate in management science, trained as a fighter pilot and a professional airplane and helicopter pilot, is the CEO. The former's avant-gardist vision and the latter's entrepreneurial experience are an ideal combination.

AN EPIC IN STAGES

After 6 years from the first concept to the finished prototype, the HB-SIA solar aircraft will need to be put through its paces, before starting out on its 36 hour flight, which is a major objective of the project. From flea-hops to circuits, several months will be needed before undertaking the first night flight.
A second aircraft will then be built and, starting in 2012, will retrace, using solar energy, some of the great firsts in the history of flight. After the crossings of the USA and the Atlantic, the culminating point will be the tour of the world in five stages.

THE ZERO FUEL AIRPLANE

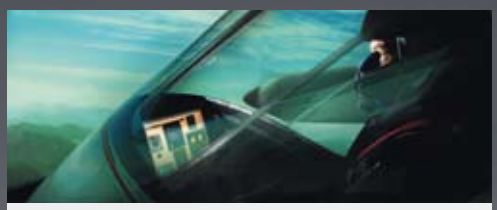
> **The wingspan of an Airbus A340,** in order to minimize induced drag and offer the largest possible surface for the solar cells
> **The weight of a family car,** every unnecessary gram has been eliminated in order to build a super-light aircraft
> **The power of a scooter,** after the extreme optimization of the entire energy chain
> **The fulfillment of a vision**

«If an aircraft is able to fly day and night without fuel, propelled only by solar energy, let no one claim that it is impossible to do the same thing for motor vehicles, heating and air conditioning systems and computers. This project voices our conviction that a pioneering spirit with political vision can together change society and bring about an end to fossil fuel dependency.»

Bertrand Piccard

VISION

Solar Impulse believes in the force of symbols. By writing a new page of aviation history with solar energy, by way of a round-the-world flight without fuel or pollution, Solar Impulse is determined to actively promote the cause of renewable energies and the energy efficiency that new technologies are offering. The Solar Impulse initiative is both scientific, with all the research it implies, and philosophical, by virtue of its concern to stir society in order to be sparing of our planet's energy resources.



CHALLENGE

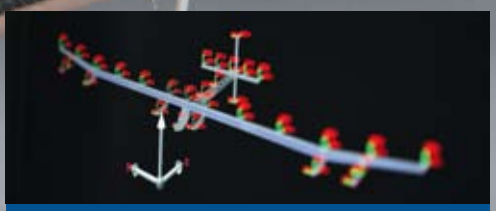
To produce an aircraft which will take off and fly, under its own power, both day and night, entirely propelled by solar energy, is an unachievable challenge without drastically reducing energy consumption. Solar Impulse's 50 engineers and technicians, supported by a hundred or so experts and advisers, have had to apply totally new aeronautical solutions. Whilst not the first solar aircraft project, Solar Impulse is certainly the most ambitious: the HB-SIA prototype should be the first aircraft to come close to perpetual flight.

AIRPLANE

With the giant wingspan of an Airbus A340 and its proportionally miniscule weight, the HB-SIA prototype presents construction and aerodynamic features never before encountered. Carbon fibre structure, propulsion chain, flight domain and instrumentation, everything has been rethought and designed to save energy, resist high altitude factors hostile to both materials and pilot, and to combine the constraints of weight with the imperatives of resistance.

NIGHT FLYING THANKS TO THE SUN!

THE ZERO FUEL AIRPLANE



TESTS AND VIRTUAL FLIGHTS

Calculations, tests and simulations are an integral part of each step of the construction process. Wing charge and vibration tests have served to fine-tune the models developed by the engineers, and move forward step by step in a totally unknown field. To control an aircraft with such totally new features, the pilots are having to adapt to a flight behaviour very different to that of other aircraft types. A simulator has been specially developed to familiarize them with the aerodynamics and flight mechanics of the HB-SIA. The pilots' capability has already been tested during a 25 hour virtual flight in the tiny 1.3m^3 cockpit.

ENERGY CAPTURING AND STORAGE

The 11,628 monocrystalline silicon cells, each 150 microns thick, have been selected for their lightness, flexibility and efficiency. At 22%, their energy efficiency could have been higher, but the additional weight would have penalized the aircraft during night flight. In this, the most critical stage, the major constraint of the project is storing energy in the lithium polymer batteries. At the present stage, the maximum energy density is 220 Wh/kg. The accumulators needed for night flight weigh 400 kg, equal to ¼ of the total weight of the aircraft. Success is therefore possible only by maximizing aerodynamic performance and optimizing the energy chain.

STRUCTURE AND MATERIALS

Attaining a 63.40 m wingspan with the necessary rigidity, lightness and flight controllability and with just 1,600 kg take-off weight is a challenge that has never before been met in aeronautics. Solar Impulse is built round a carbon fibre-honeycomb composite using a sandwich structure. The upper wing surface is covered with a skin of encapsulated solar cells, and the undersides of the wings with a high resistance flexible film. 120 carbon fibre ribs placed at 50 cm intervals profile these two layers and give the body its aerodynamic shape.

ONE PROTOTYPE, THREE OBJECTIVES

> Validating the results of the computer simulations, the technological choices and the construction technologies;

> Testing an unexplored domain of flight, as no aircraft has yet succeeded in flying with this combination of size, weight and speed;

> Demonstrating the efficiency of the energy system by being able to fly right through the night after storing sufficient solar energy during the daytime.

The lessons learned from the prototype HB-SIA will be used in the design and technical choices of the HB-SIB, the aircraft that will attempt to fly round the world.

PROPULSION SYSTEM

Beneath the wings are four gondolas, each containing a 10 HP motor, a lithium polymer battery set and a management system controlling charge/discharge and temperature. The thermal insulation has been designed to conserve the heat radiated by the batteries and to keep them functioning despite the -40°C encountered at 8,500 metres. Each engine is fitted with a reducer that limits the rotation of each 3.5 metre diameter, twin-bladed propeller within the range of 200-4,000 rpm.

ENERGY RESOURCES

At midday, each m² of land surface receives the equivalent of 1,000 watts, or 1.3 horsepower of light power. Over 24 hours this averages out at just 250 W/m². With 200m² of photovoltaic cells and 12% total efficiency of the propulsion chain, the aircraft's engines achieve on average just 8 HP or 6 KW – roughly the amount of power the Wright brothers had available to them in 1903 when they made their first powered flight. And it is with this energy, optimized from the solar panel to the propeller by the efforts of an entire team, that Solar Impulse is striving to fly day and night without fuel!

TECHNCIAL DATASHEET

Wingspan 63.40 m

Length 21.85 m

Height 6.40 m

Motor power 4 x 10 HP electric engines

Solar cells 11,628 (10,748 on the wing, 880 on the horizontal stabilizer)

Average flying speed 70 km/h

Maximum altitude 8,500 m (27,900 ft)

Weight 1,600 kg

Take-off speed 35 km/h

UNCONDITIONAL PARTNERS

Solar Impulse brings together an entire family of partners who share the project's pioneering spirit, guarantee its feasibility and are committed to promoting renewable energies.

Solar Impulse's partners all have a pioneering spirit, a long-term vision and a desire to explore new horizons. Above all they share the basic values of this human adventure: exploration, technological innovation, entrepreneurial excellence, passion, teamwork, dream and emotion. Like Solar Impulse's initiators, they want to use these values to promote renewable energies and the technology necessary for protecting the environment. They are contributing to the success of this adventure by financing the aircraft and providing support in their particular fields of expertise.

MAIN PARTNERS

Solvay

The first main partner to sign up for the Solar Impulse adventure was Solvay. This international chemicals and pharmaceuticals group is well known for its plastics and polymers and for its development of new materials and innovative technological solutions.

Omega

From the moon to the sun. For Omega, partnering this challenge is an opportunity to set out once again on the route of the pioneers and re-live an adventure which combines passion and avant-garde technological innovation, whilst bringing to the project its own expertise in micromechanics and microelectronics.

Deutsche Bank

A door to the world of finance and industry, Deutsche Bank brings to the project its experience of sustainable development, its passion for performance and its long-term vision which lend credibility to the fundamental and necessary link between economics and ecology.

OFFICIAL PARTNERS

Altran

The project's engineering partner, a leader in innovation consulting, is making available to Solar Impulse its human resources and its multidisciplinary, multisectoral expertise.

Swisscom

The national telecommunications partner, Swisscom is developing the tools which will permit communication between the aircraft and mission control at any place around the world.

OFFICIAL SUPPORTERS

The Geneva company SEMPER, the first company to back the project, and the Clarins Group are supporting the technology vision, the thrust for innovation and the respect of the environment that Solar Impulse is championing. BKW/FMK (Forces Motrices Bernoises), Toyota Switzerland and SIG (Services Industriels de Genève) are supporting the project at national level.

INSTITUTIONAL AND AERONAUTICS PARTNERS

Following the 2003 feasibility study, the EPFL (Ecole Polytechnique Fédérale de Lausanne) became the Official Scientific Advisor, bringing to the project the competence of its various laboratories. For these knowledge explorers, Solar Impulse represents a field of very high level research with innumerable potential applications.

Solar Impulse can also count on the know-how and experience of major aerospace players, such as the European Space Agency (ESA), Dassault Aviation and IATA (International Air Transport Association), which have welcomed the solar energy adventure with open arms.

OFFICIAL SUPPLIERS

Victorinox – SolarMax – La Semeuse (coffee) – Hirslanden (medical advices) – Abächerli (printing) – SQS.

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