SkySails POWER

AIRBORNE WIND ENERGY SYSTEMS

WIND POWER:
UNLEASHING ITS TRUE POTENTIAL

The Key to 100% Renewables

A total shift to renewable energy is among humanity's greatest challenges. In this global energy transition, wind power plays a crucial role. It is one of the most cost-efficient, abundant and environmentally friendly energy sources. But conventional wind technology is unable to exploit this resource where it is most potent: at high altitudes. Now, we offer an airborne system that revolutionizes how the wind is harnessed and converted into electricity. We believe it is the key that will unlock 100% renewables around the clock.

Power Kites: "Sending it" to New Heights

Automatic power kites are at our vision's core. They can harness the wind's untapped supplies at altitudes of up to 400 meters, and we were the first company in the world to develop an industrial application. SkySails kites are lightweight and highly efficient and will profoundly alter wind energy's impact in achieving the global energy transition.

LEADING WITH PURPOSE

Developing technologies that make the energy transition real has been a lifetime task for SkySails' Managing Director and Founder Stephan Wrage. Flying his kite at the beach as a teenager and impressed by its force, he wondered how to make use of this free and clean resource. Right after completing his engineering studies, he started by developing a solution that implements kites to tow vessels and reduces their fuel consumption. His endeavor to play one's part to achieve a more sustainable future also forms the baseline of our company.


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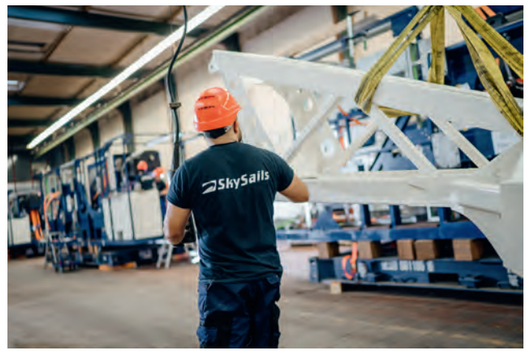
GREEN TECHNOLOGY MADE IN GERMANY

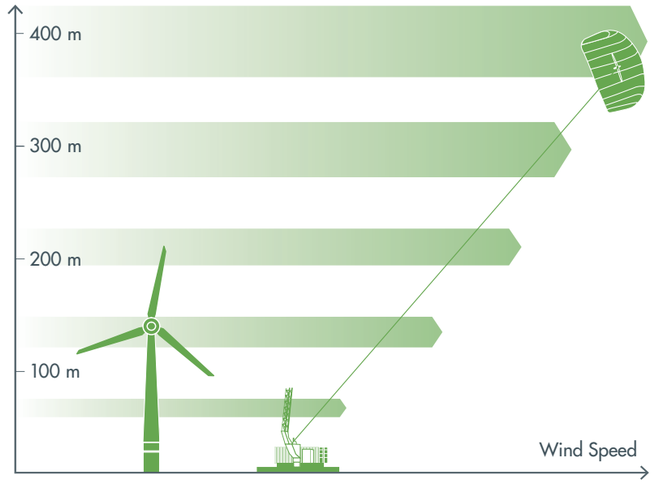
SkySails Power has a passion for wind energy. We are engineers, sailmakers, mechanics, software developers, service technicians and project engineers, and many of us are kiters or sailors in their free time. We share a motivation to provide clean energy solutions that accelerate the global shift to more renewables. As one, we develop, design, manufacture, market and service the Airborne Wind Energy Systems that make use of this free, clean, and potent energy source. Development and production happen in Northern Germany. Both our headquarters and our kite workshop are based in Hamburg. The former houses our engineers and software specialists that work on the permanent optimization of existing technologies and the development of new products. The latter is where sailmakers and textile engineers design our power kites, closely working with experienced European manufacturers.



OUR EXPERIENCE – A UNIQUE ADVANTAGE

SkySails Power GmbH is part of the SkySails group of companies. We draw on its unique experience from 20 years of developing and operating automatic kite systems. Several seagoing vessels already used the SkySails propulsion kite in the harshest day-to-day conditions. These kites, sometimes reaching 400m² in size, can substitute as much as two megawatts from the main engine and reduce fuel consumption by up to ten tons of fuel per day.

The ground station's assembly takes place at our production site in Seevetal near Hamburg. From the smallest screw to the heavy drivetrain, our industrial technicians and electricians have the right tools and know-how to set up a reliable product. Our complete range is developed and produced according to German VDE standards – a guarantee for the highest quality and safety.



AIRBORNE WIND ENERGY:

TAKING WIND POWER TO THE NEXT LEVEL

High-altitude wind is an enormous pool of energy that has long remained unused. Because all concepts to harness it involve a flying device attached to the ground on a line, the power it delivers is called airborne wind energy (AWE). Simple physics can explain why it is so promising: Whereas surface friction reduces wind speeds closer to the ground, the air can move uninhibited at higher altitudes. Depending on the location and time of day, speeds can be twice or even three times faster. The effect this has on generating electricity is increased because the wind's force calculates as the cube of its velocity. When the wind speed doubles, the power increases by $2^3 = 8$, when it triples, its force increases by $3^3 = 27$ times! This characteristic and additional advantages are what make airborne wind energy so vital in fulfilling the global energy transition.

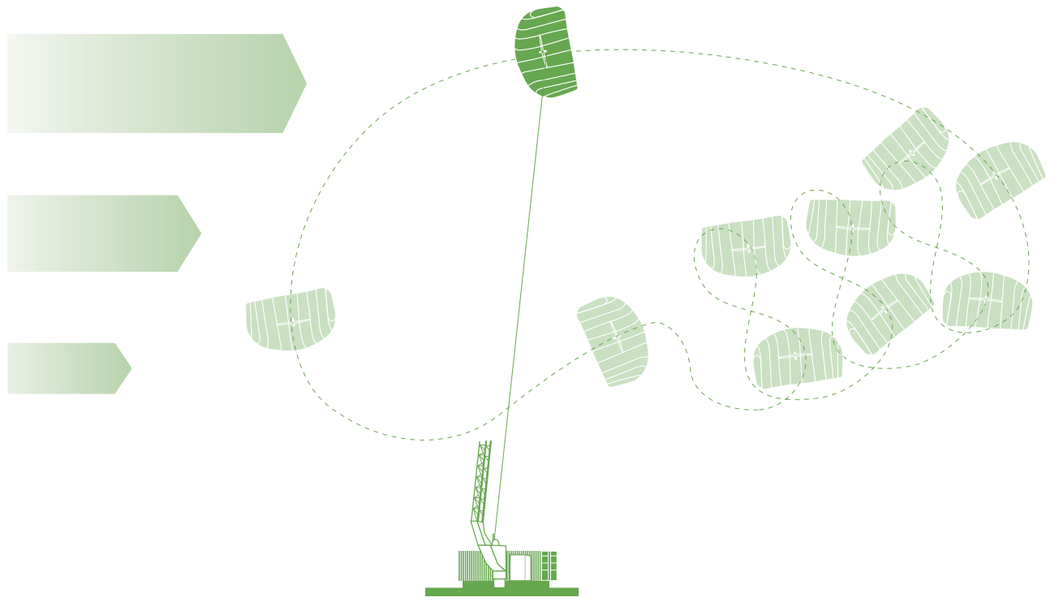
Airborne Wind Energy Systems have several other technical advantages:

Less material means lower costs: Airborne Wind Energy Systems don't require a massive steel structure as do conventional turbines. Instead, they rely on light fabric and ultra-durable fibers that take far fewer resources to produce. They drive down overall costs and minimize the carbon footprint.

Higher yields: High-altitude wind is more constant and steadier than air flowing closer to the ground. Airborne Wind Energy Systems always steer themselves to altitudes that are currently delivering the most reliable and steady airflow. This results in more hours running under full-load and an additionally increased yield overall.

Low environmental impact: Their slim and light design is less noticeable in the landscape and reduces shadow casting and noise emissions. All this has a minimal ecological impact and raises public acceptance.

Extremely flexible: The compact design and easy installation allows their deployment in a wide range of applications and areas that are difficult to access - both onshore and offshore.



HARVESTING HIGH-ALTITUDE WIND ENERGY WITH POWER KITES

THE KITE POWER CYCLE

Driven by the wind, the automatically controlled power kite rises in figures of eight. As it gains altitude, it unwinds a tether from a winch on the ground. The tractive force drives a generator inside the winch that produces electricity. This is called the “work phase”. Once the tether has reached its maximum extension, the autopilot steers the kite into a neutral position with minimal drag and lift. While consuming only a fraction of the energy generated during the work phase, the generator now acts as a motor and reels-in the tether.

The system continuously repeats this process, flying the kite at an altitude of 200 to 400 meters. The concept behind the kite power cycle is called the “yo-yo principle”. The energy generated by the Airborne Wind Energy System can be fed into the grid, stored in batteries, or directly consumed.

The power kite can land for maintenance or before forecasted weather extremes. Once it docks to the launch and landing mast, it is lowered to the ground, where it can be unmounted and stowed in a safe place.

1 KITE

The ram air kite is made of high-performance textiles with a reinforced ripstop weave. Air intakes and air brakes allow changing the aerodynamic profile during start, operation, and landing. Risers connect the kite's canopy to the control pod below. A line system inside the canopy allows reefing it for storage.

2 CONTROL POD

The control pod contains a system for controlling the flight path and navigation of the kite. It is powered by a ram air turbine. Several installed sensors measure all relevant signals required for a safe and autonomous system operation.

3 TETHER

The tether is the connection between the control pod and the winch inside the ground station. It is made of HMPE and specially developed for applications with a high demand for safety (e.g., cranes and lifts).

4 LAUNCH & LANDING MAST

A reliable and flexible launch and landing system is required to safely launch and land the power kite. The mast can be lowered to attach or unmount it completely.

5 GROUND STATION

A container houses the ground station for easy transport and installation.

6 DRIVE TRAIN

The drive train consists of the winch, gearbox, and generator. It converts the pulling force and velocity of the tether into electrical energy.

7 TRIPOD WITH RING MOUNT

A yaw system corrects the ground station alignment with the wind direction.

YOUR PATH TO ENERGY AUTONOMY

A Reliable Alternative to Conventional Energy Production

Airborne wind energy systems (AWES) tap into the wind's resources at altitudes of up to 400 meters. Uninhibited by surface friction, the wind at these heights is far more reliable than wind closer to the ground. Because of this, AWES can even deliver a high amount of full load hours and good yields. For the first time, a renewable power source is a viable alternative to conventional energy production. SkySails Power's AWES are a reliable and economical supplement to existing renewables such as wind turbines or solar installations and can even replace diesel generators.

Renewable Energy that's Available Everywhere

Thanks to their simple transportation and installation requirements, you can install our power kites everywhere. Remote islands and other inaccessible places are no longer without an alternative to conventional energy production. Our AWES can even be operated in hurricane and typhoon regions since they are easily retrieved and safely stowed away before a natural disaster.

USE CASE 1
HYBRIDIZATION OF DIESEL GENERATORS

Your Challenge

Generating electricity by burning diesel is commonplace in many emerging markets and rural areas. But energy systems based on diesel generators are subject to the whims of fluctuating fuel prices and transportation costs. They are also hazardous to the environment and have large CO_2 footprints. Relying solely on fossil fuels for electricity is proving to be increasingly insufficient in many different settings.

Our Solution

Our SkySails AWES allow hybridization of existing diesel energy systems. By adding a reliable source of sustainable wind energy, your generation costs are significantly reduced. The already existing infrastructure is relieved but can remain as a back-up. Hybridization therefore turns your system into an economic, safe and sustainable setup. The energy transition has never been easier!

USE CASE 2
HYBRIDIZATION OF SOLAR PARKS

Your Challenge

You are looking for a better economic viability of your PV plant? The integration of wind turbines into existing photovoltaic parks enables an optimization of the existing infrastructure, since the generation patterns of photovoltaic and wind energy systems complement each other. However, installations of conventional wind turbines in existing photovoltaic parks are scarce due to the resulting shadow effects and the necessity of important civil works.

Our Solution

For the first time, our innovative alternative allows for an integrated solar-wind approach without these disadvantages! By supplementing your energy system with airborne wind power, you will optimize the use of land and increase the capacity factor and the overall economic viability of your project. SkySails AWES do not cause significant shadow effects and have no negative influence on your PV plant's yield. The installation of our systems is simple and don't require any deep foundations. The internal consumption of your PV plant at night is easily covered by AWES.

USE CASE 3
AUTONOMOUS POWERING OF MEDIUM-SIZED CONSUMERS

Your Challenge

Your enterprise is located in a remote area or terrain that is difficult to access? You are looking for a baseload capable sustainable energy source? Then SkySails AWES is the most reliable innovation you have been looking for.

Our Solution

Medium-sized electricity consumers (400 – 1.000 MWh/a) can easily implement a SkySails AWES to self-produce a part of the electricity it takes to run their enterprise. Becoming autonomous through wind energy not only saves you vast expenditures on electricity, but it also guarantees significantly lowered emissions to help achieve a carbon neutral budget.

SKYSAILS POWER N-CLASS:

A REVOLUTION FOR ON-SHORE WIND POWER

Conventional renewables face many obstacles, especially in onshore wind power production. Difficulties arise due to the lack of appropriate construction surfaces, conflicts of use, or public acceptance problems. Thanks to their unique advantages, Airborne Wind Energy Systems (AWES) are a trendsetting solution to overcome these challenges. Based on decades of experience in using high-altitude winds for ship propulsion, SkySails Power has developed a revolutionary AWES that is compact, light, and easy to manufacture, transport, and operate. It can make clean and reliable onshore wind power available anywhere!

SKS PN-14: The Only Airborne Wind Energy System that is Ready to Order

Today, we are the first company in the world with Airborne Wind Energy Systems that are ready to order!

The SKS PN-14 onshore power system provides clean electricity wherever it is required:

- as a reliable island solution in remote areas lacking a stable grid connection
- as an economic and independent solution for industry, agriculture, tourism, or telecommunication infrastructure
- as a supplement to existing energy projects such as solar parks or wind farms (hybridization)

Green Power that's Available Anytime and Anywhere

The SKS PN-14 harnesses the powerful wind at an altitude of up to 400 meters. The system is safely employable in hurricane and typhoon regions, as it is easily retrieved and stowed away before these natural disasters occur. Thanks to its simple transportation and installation requirements, the SKS PN-14 can also be installed in places that are difficult to access. The SKS PN-14 achieves a high amount of full load hours, exceeding other renewable sources like wind or solar.

TECHNICAL DATA SKS PN-14	(1depending on site specific configuration)
Average cycle power/ rated power[1]	80 - 200 kW
Kite size (laid out)[1]	90 - 180 m²
Operating wind range	4 - 25 m/s
Tether length	800 m
Tether diameter	14 mm
Ground station	30 ft container

SKS Onshore Megawatt Class – the next generation of onshore wind power

The SKS Onshore Megawatt Class allows the deployment of Airborne Wind Energy Systems at an industrial scale. The next generation of SkySails AWES will be an ideal complement to conventional energy sources for larger-scale power consumption, especially in regions where wind turbines and solar parks cannot be deployed.

YOUR WAY TO A SUCCESSFUL PROJECT

As with any energy infrastructure project, airborne wind energy also requires a professional development process. Our team provides support in wind and site assessment. We assist in permit approvals, are onsite during installation and commissioning, and help train your personnel. Where necessary, the involvement of external experts can also be arranged.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POWER

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