Government and industry have aggressively pushed the development of wind turbine technology. Horizontal-axis wind turbines (HAWT) have been widely adopted for commercial power generation, while there are numerous issues that decrease the cost-efficiency of medium and large size HAWT.

Because aerodynamic force is proportional to the wing area of a blade, it is difficult to maximize the effective wing area of a rotating blade as the size of the blade increases. The turbine blades must be long and slender, particularly near their tips to reduce centrifugal force and maintain structural integrity. This limits the effective wing area near the tip of the blade, where a considerable amount of aerodynamic torque is normally generated. Installation of long slender blades on a large-sized HAWT is particularly difficult, and requires special equipment that may not be easily operated in certain terrain. Contamination from dead bugs and birds near the leading edges of blades can reduce their aerodynamic efficiency by 50%, and cleaning the blades is not an easy task.

Technology Description

Dr. Liu has developed a wind-powered, electrical generator that has two wings attached to a frame on opposite sides of a central pivoting axis. The wings of the wind generator are attached horizontally to the central axis and oscillate about the central axis (see Figure 1 on next page). The angle of attack of the two wings is adjusted in a coordinated manner by a computerized controller that operates servomotors attached to the wings. As the wings and their supporting frame rotate about the central axis, they produce electricity, by turning a pivot rod attached to an electrical generator.

The wings can be made from light composite materials reducing the power required to adjust their angle of attack, and the wind speed needed to move them. This is because the two wings balance each other on opposite sides of the central axis, and wing loading is typically low during operation. This also allows the effective wing areas to be large, without requiring oversized support structures. The wings can be manufactured at a low cost because of their simple structure and geometric shape. All of this results in a highly efficient and cost-effective electricity generator.

Wind tunnel testing demonstrated that this winged oscillator is able to efficiently extract wind energy even at a wind speed of less than 5 m/s. In addition, the rated power of existing HAWT at their optimal wind speed of 12-14 m/s is comparable to the power generated by an equally-sized winged oscillator at 8-10 m/s.
wind speed (see Figure 2 on next page).

**Potential Benefits**

- Efficient at low wind speeds
- Greater power generation than HWAT at any wind speed
- Wings can be made of lightweight materials reducing size limitations and increasing mechanical efficiency
- The wings can be manufactured for a low cost

![Figure 1. Winged Oscillator.](image1)

![Figure 2. Power as a function of the actuator area (the size), where the data of HAWT are collected from manufacturers for comparison.](image2)