TECHNOLOGY SCIENCE JOURNAL FOR TEENS

MAY 2017

Will artificial trees be the next power plants?

Authors:
Michael McCloskey, Curtis Mosher, Eric Henderson
Associate Editor:
Sasha Harris-Lovett

Some parts of the illustration are designed by Freepick.com

Abstract

Wind power is an important source of renewable energy, but some people are concerned that conventional wind turbines are too loud and too hazardous for birds and bats. We wanted to create a new kind of wind energy harvesting machine based on the jiggling motion of cottonwood tree leaves in the wind, which would be quieter and safer for wildlife.

After building and testing artificial cottonwood leaves that moved and created electricity in the wind, we found that they didn't produce enough energy to feasibly use for electricity production. We also tried building a cattail-like device to generate electricity when it swayed in the wind, but it also didn't produce enough energy to make it reasonable to use.

Though our research showed that artificial plants' jiggling or swaying isn't likely to be a cost-effective way to produce electricity, we think it could be fruitful to look into other plant-inspired designs for harvesting wind energy. We also are testing a new biological material known to convert mechanical to electrical energy more effectively than the ones used today. We also are testing a previously unexploited biological material known to convert mechanical to electrical energy far more effectively than the ones used today.

Introduction

Wind power has great potential as a renewable energy source, and the United States Department of Energy aims to get 20% of the country's energy from wind by 2030. To harness wind power and convert it to electricity, most current technologies use some kind of turbine – that is, they have the wind push propeller-like blades, whose motion is used to generate electricity (Fig. 1).

As of 2015, there were more than 300,000 wind turbines producing energy around the world, producing nearly 433 gigawatts of energy. In the United States alone, wind turbines provided enough energy for approximately 17.5 million households.

While wind turbines are effective at producing energy, they sometimes get a bad rap: some people are concerned that the rotating blades can kill birds and bats, many people find them unattractive, and neighbors sometimes also complain about the sound of the turbines spinning in the wind (at the base of an industrial-size windmill, it can be about as loud as a blender).

Figure 1:
Conventional three-blade wind turbines in Northern California (Photo credit: Richard Norgaard)

But turbines aren't the only way to capture wind energy. Plant leaves and branches moving in the wind also can produce energy: in a 10 mile per hour breeze, a cottonwood tree with 500,000 leaves could generate about 80 watts of energy through its leaf motion (Fig. 2). Although this is far less than energy in wind captured by a turbine sweeping the same area, it may be enough to charge batteries for home appliances.

We wondered: could we design a plant-like machine that would create electricity when its leaves vibrated or branches swayed in the wind? Electricity-creating artificial plants would likely pose less of a threat to birds and bats, and they would be able to produce electricity at lower wind speeds than turbines. In addition, they could potentially be used in cities, where cell-phone towers disguised as trees have been used for decades (Fig. 3). And wouldn't it be useful if the artificial leaves on those cell phone "trees" could make enough electricity for us to charge our appliance batteries?

Figure 2:
A cottonwood tree.
Can you tell by the zoomed in section where does the tree get its name from?
(Photo credit: Flickr **ellenm1** and George Chernilevsky)

Figure 3:
A cell phone tower in in the U.S. disguised as an artificial tree.

Methods

We built an artificial cottonwood tree, whose "leaves" were designed to generate electricity as they fluttered in the wind (Fig. 4). We chose the cottonwood design because the shape of the leaves is such that they flutter in a relatively orderly fashion (back and forth on one axis, rather than swaying and bouncing every which way), which is more efficient for electricity generation. We tried making both larger and smaller leaves to see which would work best to produce power, and we used a flattened leaf stalk like real cottonwoods have, to produce orderly motion. Then we tested our "tree" in a controlled wind tunnel to make sure the leaves' motion accurately mimicked that of real cottonwood leaves in the wind outdoors.

We also tried making artificial cattails, and testing them in the wind tunnel as well, to see if they would generate electricity when they swayed in the wind.

Please, see Figure 4 on Page 3

Results

Though both the artificial cottonwood tree leaves and the artificial cattails produced some electricity when they moved in the wind, neither produced enough energy to make them feasible to use for power production. We found that for the artificial cottonwood trees to produce 80 W of electricity (enough to power a garbage disposal) in about 12 miles per hour of wind, they would need between 10 million and 125 million synthetic leaves! Since these artificial leaves are not cheap to make, this is not a cost-effective way to produce energy.

Similarly, we would need acres of the cattail-like electricity generating devices we tested to produce enough power to run household appliances – also not a cost-effective way to make electricity.

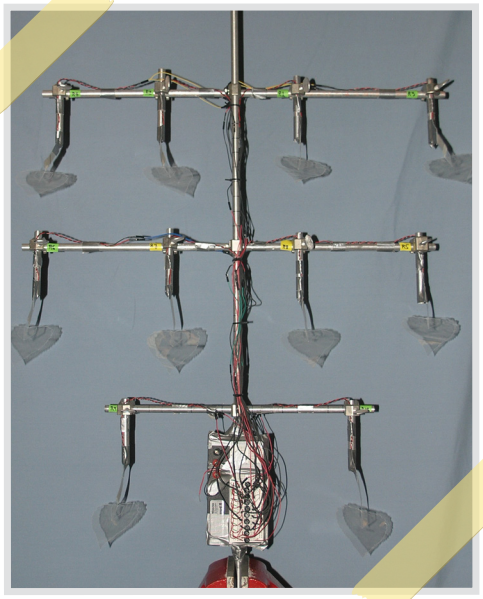

Figure 4:
The leaves on this electricity-generating "tree", inspired by shape of cottonwood tree leaves, produce electricity when they flutter in the wind.

Discussion

Though our research showed that the plant-based, biomimicry designs that we tested for harvesting wind energy were not currently feasible to use on a commercial scale, it is worth investigating other plant-based designs for converting wind power to electricity. Artificial plants that create electricity by harnessing energy from friction or from constricting flexible plastics could potentially provide a more cost-effective way to generate electricity from the wind. In addition, the development of new and different materials that could be used to build synthetic plants for wind energy harvesting could greatly improve their potential as mini power plants. Overall, we think that new technologies that mimic plants could be a useful complement to conventional wind turbines for harvesting wind energy.

Conclusion

Just because wind turbines are the main technology used now for producing wind power doesn't necessarily mean they are the best or the only way to get electricity from the wind's energy. As scientists, we are always testing out new ideas – and sometimes those ideas don't pan out the way we thought they would.

In this research project, we tested out botanically-inspired wind energy harvesting devices, but they didn't generate enough electricity to make them feasible to use. But the idea that things could be different, coming up with new designs, and rigorously testing them, is an important part of science.

REFERENCES

McCloskey, Michael A., Curtis L. Mosher, and Eric R. Henderson (2017) *Wind Energy Conversion by Plant-Inspired Designs*. PloS One
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0170022

Scientific American. (2009) *Power Plants: Artificial Trees That Harvest Sun and Wind to Generate Electricity*.
https://www.scientificamerican.com/article/artificial-trees-harvest-sun-and-wind-energy/

Wind 101: The Basics of Wind Energy
http://www.awea.org/wind-energy-101

Glossary of Key Terms

Biomimicry – Designing technologies based on biological systems, processes, or organisms.

Gigawatt – One billion watts.

Renewable energy – Electricity produced from sources that aren't depleted as they are used, like solar or wind power.

Watt – A measure of electrical power.

Wind turbine – A device used to convert wind energy into electricity, by using vanes or blades to catch the blowing wind to spin a rotor.

Check your understanding

1 Why is renewable energy important?

---

2 Why are scientists looking for alternatives to wind turbines for generating electricity from the wind?

---

3 Why did the scientists develop a technology that mimicked cottonwood tree leaves?

---

4 Imagine you are tasked with developing a new technology, other than wind turbines, to collect energy from the wind.
What kinds of designs would you build?
How would you test them?