Artist rendition of how the EnviroMission solar updraft technology will look once it is built in La Paz County, Arizona. Graphics(2): EnviroMission

Tall and visionary

EnviroMission is set to build the tallest structure in North America with its innovative solar updraft tower design, which provides baseload power. The solar updraft tower uses a solar energy collector canopy and a central tower to generate an updraft airflow that drives the rotation of pressure-staged turbines at the base of the tower and generates electricity.

Nearly two decades ago, when Roger Davey, CEO of EnviroMission, first saw the solar updraft tower technology, he dreamt of the day that this innovative technology would become commercialized. Over the next two decades, after gaining rights to the technology, creating EnviroMission, and developing the technology, Davey and his company now have secured a power purchase agreement (PPA) with Southern California Public Power Authority (SCPPA) and are working hard to commercialize the technology. "What started off as a dream is now a very unhealthy obsession," says Davey, President of EnviroMission and son of CEO Roger Davey.

Davey's dream is now being put to the test. The goal for Davey and EnviroMission over the next few years is to get the first project built and prove the viability of the technology. "As a company, we have gone from a developer of a technology to a deliverer of a technology," says Roger Davey. "This is a very different scenario for a small company to manage." Much is riding on this first commercial-scale project because it has yet to be seen whether a solar updraft tower can produce commercial power. "That's the job for the next few years: delivering this first project and making sure it is done properly."

The solar updraft technology

Although a full-scale commercial plant has not yet been built, Roger Davey is confident that the company's design will work because the design is entirely based on well-understood and tested engineering, without the use of extremely high temperatures or many moving parts. In addition, the German government funded a small-scale demonstration plant that operated in Manzanares, Spain, from 1982 to 1989, which proved that the technology works.

The solar updraft tower consists of three main parts, the canopy, the tower, and the turbines. The canopy is a large circular greenhouse collector area, about 5,500 acres. The canopy is 10 feet (~3 m) off the ground on the outside of the collector area and slopes slightly upwards, to 50 feet (~15 m) off the

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ground at the centre. The canopy heats the air trapped under the canopy. The heated air rises and moves towards the centre of the field. The canopy will be made from ETFE plastic, which was designed to withstand high temperatures while maintaining strength, among other light-absorbing materials, says Chris Davey.

The tower, which acts like a large chimney, is located at the center of the greenhouse canopy and is the thermal engine for the technology. The tower creates a temperature differential between the cool air at the top and the heated air at the bottom. This creates the chimney effect, which sucks air from the bottom of the tower out of the top. This suction creates a 35 mph (56 km/h) wind at the base of the tower, which powers 32 turbines and generates electricity. The turbines work just like well-understood Kaplan turbines commonly used in hydroelectric power plants.

EnviroMission plans to build its first commercial solar updraft tower on public lands in La Paz County, Arizona. "If you imagine a sunny day in Arizona, where the outside temperature would be 40 degrees Celsius, the temperature under the collector would be 80 to 90 degrees Celsius and the temperature at the top of the tower would be 32 degrees Celsius," says Roger Davey. This creates the ideal temperature differential that EnviroMission desires.

Benefits of the technology

Also like hydro plants, the solar updraft tower technology is a passive system, with very few moving parts, so there are minimal ways in which this technology could go wrong, says Chris Davey. If one turbine goes out, the system still works. "Consistency of operation is critical for power plants and ours is consistent," says Chris Davey.

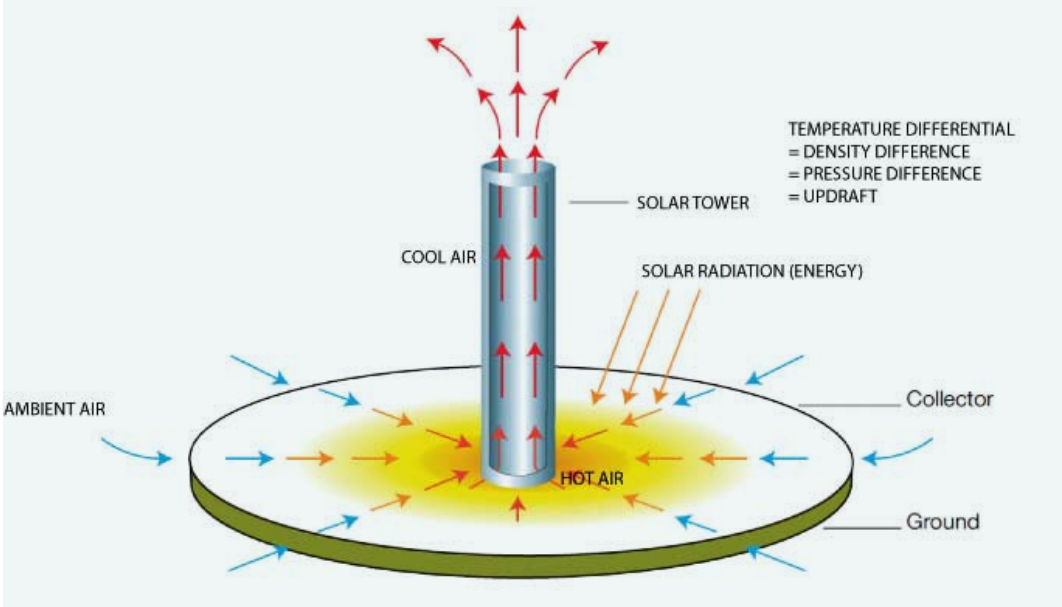
In fact, consistent plant operation – a high capacity factor – is one of the main benefits of the solar updraft tower design. Solar towers provide maximum output for 12-plus hours during the day, says Roger Davey. It continues to produce power even at night because there is still a temperature differential that creates an updraft airflow, but it isn't as strong, says Roger Davey. "Our plant will get a 60 percent capacity factor, meaning it will operate at maximum power 60 percent of the time," says Roger Davey. A coal-fired plant operates at about 80 percent efficiency, while wind and PV are somewhere between 20 and 30 percent. The solar updraft tower will operate much more like a coal-fired plant by providing more reliable, base-load power.

"We have tried to make our technology as competitive as it can be in a very uncompetitive and unlevel playing field. Fossil fuels receive considerably more financial support from the government compared to renewable energy," he says. EnviroMission is trying to compete in an unlevel playing field by creating a renewable energy base-load power source. Because the solar updraft tower acts like a base-load power source, it does not require a natural gas back-up system like other renewable energy facilities such as wind and PV.

In addition to a high capacity factor, the solar updraft tower uses absolutely no water in the production process. One of the main reasons that solar companies have trouble securing environmental permits for their power plant plans in the US Southwest, is water use. Because EnviroMission does not use any water, it hopes to be a more attractive technology to environmental groups interested in protecting fragile desert environments. "With this technology you don't have to worry about water use, costs of gas for back-up, or any other costs that a lot of other renewable energy technologies have to deal with," says Chris Davey. But the true cost of the tower will not be known until final designs and specifications have been completed for the first project.

The first solar updraft tower

Although site-specific designs have yet to be finalized, such as the exact tower and canopy dimensions,



The graphic displays how the solar canopy heats air, which creates a temperature differential that sucks air and passes through turbines to generate electricity.

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the tower is slotted to deliver 200 MW to SCPPA in California, but is constructed in La Paz County. In order to deliver a large amount of power, the tower has to be tall, likely about 2,500 feet (762 m). "That's about twice the size of the Empire State Building in New York and the tallest structure in North America," says Chris Davey. The height of the tower provides the updraft necessary to drive turbines to produce the desired output. The taller the tower, the larger the temperature differential and the faster the turbines will spin.

Once the final designs are ready, by March to June of 2012, EnviroMission will begin working on securing financing, doing grid connection studies, and finalizing necessary permits. "We have done initial environmental, heritage, and transmission studies and everything appears to be fine," says Davey. The site is located close to the grid, so the company does not have to complete a large transmission project to get the power plant connected. Although the tower requires a lot of land to generate heat, the flora and fauna underneath the canopy are left largely untouched, which will help the company when getting environmental permits for the project.

If the planning stage goes smoothly, Davey hopes to begin construction of the first tower in 2012 and start producing power by the beginning of 2015. After the first tower is built, EnviroMission plans to build a second tower in the same area.

It has already secured some partnerships to ensure that this project gets completed. The company has partnered with ARUP, a global group of design engineers, as well as with the US construction company, Hensel Phelps, Colorado. EnviroMission has also secured debt and equity finances from AGS Capital Group, Indiana.

The company could not say at this point how much the tower would cost because the final designs have not yet been finalized. It will be expensive, but Roger Davey is confident the company will secure the necessary financing. This first project will be more expensive than future solar tower projects because there is a big learning curve on the first project, says Roger Davey. But despite the high costs of the first project, the internal rate of return for the project is attractive enough to put it on the queue for financial viability, he says. After the first project, costs will decrease due to improved construction methodology

"The hydro scheme of the desert"

SUN & WIND ENERGY spoke with Roger Davey, CEO of EnviroMission, about his company and the first large scale project.

Roger Davey, CEO of EnviroMission, has developed this technology along with EnviroMission over the past 15 years.
Photo: EnviroMission

S&WE: Where did this technology idea come from? Who started it?
Roger Davey: Well I guess hot air has been rising for a long, long time. The technology originally was demonstrated in a plant in Manzanares in Spain in the 1980s. It was developed by a German engineering group and was funded by the German and Spanish governments. It was built to prove that the technology works – that hot air rises and that the height of the tower influenced the speed of the airflow – hence the driving of the turbine.

S&WE: So the height of the tower will affect the speed of the turbines spinning within the tower?
Davey: The height of the tower creates a temperature differential. The tower height creates the temperature gradient drop. If you can imagine, when you light a fire on a cold day, the chimney draws the smoke up the chimney because the air is cooler at the top. That's the effect we are creating, called "the chimney effect." We are creating the warm air around the base of the tower – and with cooler air naturally around the top of the tower – it generates the airflow.

S&WE: It's almost like a hydro plant turned on its side.
Davey: That's not a bad analogy. It's been referred to as the hydro scheme of the desert. We are using air instead of water. The air flows up the tower instead of water flowing down the chute.

S&WE: What are some of the benefits of the technology over other energy generation sources?
Davey: One of the main benefits is the high capacity factor. The tower produces power for long periods of time. We can also guarantee the output of our plant because we can produce power whenever there is a temperature differential. So we are more akin to the profile of a coal-fired plant with peaking ability instead of intermittent energy-flow that some renewable energy sources provide. And the one major difference with other solar technology is that we use zero water in the production process, while harnessing the heat from the sun.

S&WE: How far along are you in the development of the La Paz project?
Davey: Right now we are designing the project for the specific conditions at the site so that we can take that design to the financiers. We won't be at the financing stage until the final design is completed and priced. Financiers have already seen our PPA and everything looks as positive as it can be until we go through the final steps of getting it financed. This will probably be in March to June next year. Then we will hopefully be producing power by the first quarter of 2015.

S&WE: Are you looking at developing solar updraft towers in other parts of the world?

and material usage. “Not only will the price come down, but the performance will go up as materials get more sophisticated and new materials come available,” says Roger Davey. For example, advancements in pressurized turbine technology could have a large impact on the operation of solar updraft towers.

Once the first tower gets built and the true cost of this technology starts to come down, Chris Davey believes that the solar updraft tower could be a game-changer for the renewable energy industry. “We are cost-competitive today, we have a 60 percent capacity factor, we use no water, we have no emissions or toxicity, we have no storage issues, and we have industry leaders from construction, project management, and material sciences that are partnering with us,” says Chris Davey.

It is clear that EnviroMission has a lot to be hopeful about, but the company still has to execute its project and prove that it can deliver what it promises. “This project will get built, power will get delivered, it will be on the front page, it will capture people’s imagination,” says Chris Davey. “It captured mine and I hope it captures yours.”

Reid Smith and Lisa Cohn

Davey: Absolutely. We are ready for development in Australia, and we are looking at the Middle East and India. We also have an existing agreement in China. We are looking where the climatic conditions are correct, that the power pricing is correct, that grid connection is available, and that land is there to be utilized.

S&WE: What do you say when people question whether this technology can actually get built and generate energy?

Davey: In the very early days, we heard a lot of “can it be built,” or “you will never find anyone to build this.” The technology has been proven. The largest construction company in Australia publically announced that it could be built using traditional and conservative engineering and construction methodologies. The technology is sound and robust. There is no doubt that it can be built and that it works. It is a matter of building the first one, creating it commercially, and letting others follow.

S&WE: Why do you support this technology, personally?

Davey: Even if it had nothing to do with climate change, when you drive through coal air and see the dirt and smell the stink, it’s clear that we need something that can produce power on a competitive basis that is 100 percent clean and doesn’t use any of the most precious commodity on earth: water. Our job for the next few years is to deliver this first project and make sure it’s done properly.