Photo Credit: Cool Earth Solar

December 5, 2008

Cool Earth Is Scaling Up Solar Energy Generation

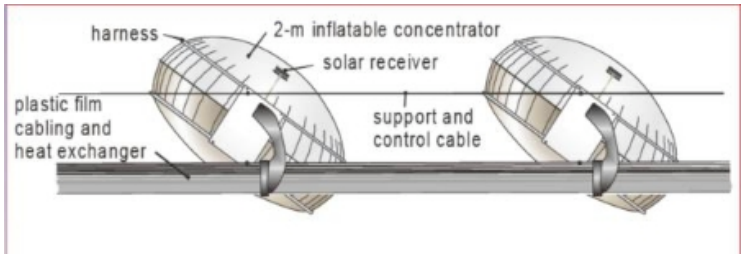
by Marsha W. Johnston, Contributor

California, United States [RenewableEnergyWorld.com]

Imagine a 1-megawatt solar power plant that has nothing to do with vast swaths of PV panels or mirrored troughs in a barren desert environment that require new transmission lines to population centers. Instead, picture a rolling, grassy field populated with 500 vertical poles that each hold two 8-foot-wide balloons. While cows graze among the poles, the large recyclable plastic balloons, each with a mirrored inside surface, truss and concentrated solar cell, follow the sun's transit thanks to a small electric motor. A utility substation is nearby.

While balloons deployed across the land collecting solar energy is indeed a happy image, CEO Rob Lamkin would argue that the true serendipity of the startup firm's technology has a more important source. "Enough solar hits the earth in an hour to power the world for a year. But flat panel PV installed is US $8 to $9 a watt, whereas our prototype is US $1/watt," he says.

By using cheap, abundant thin film plastic as its primary technology component, Cool Earth has avoided the problem of being able to manufacture the PV required to generate enough solar energy to meet demand and reduce carbon. "The size of the energy problem is in TERA-watts and right now, there are less than 10 gigawatts of PV installed. China puts in that much coal-fired generation in a few weeks," Lamkin says. "We need to ramp solar up to be doing gigawatts, or we are going to lose. A lot of people have figured out that we don't make near enough PV. We would have to install 10 gigawatts of PV *every four days* until 2030 to get to carbon neutrality."



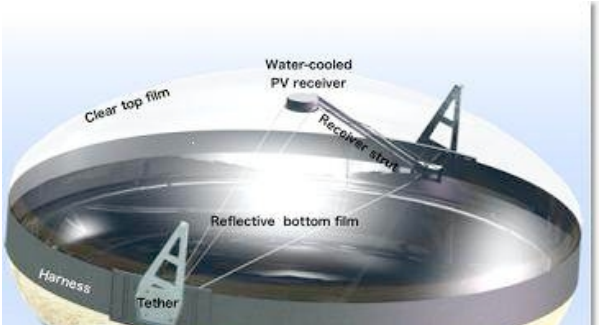
The balloon-concentrator cell collector is the brainchild of Dr. Eric Cummings, an award-winning graduate of Caltech and principal investigator at Sandia National Labs. At a 2003 Department of Energy meeting of leading scientists and Nobel Peace Prize winners, Cummings was shocked to realize that even the best scientific minds seemed unable to find solutions to the unprecedented, urgent energy crisis. Most of their solutions were either not economically feasible using current technology or required a scientific leap that simply hadn't yet occurred.

Cummings gave himself a mission to devise a solution to the global energy crisis that incorporated existing technologies or commonly used materials. After tinkering with ideas for months, Cummings decided to reverse his approach: Instead of devising a solar technology and fitting materials into it, he would calculate what materials could scale up enormously and create a technology to fit them. "I realized we couldn't use rare elements. In fact, the materials had to be among the most abundant in nature or industry," he said.

His answer: Plastic thin film was the only material with a great enough supply to solve the energy dilemma head-on. "If you used all of the plastic produced in a year to make just our solar collector balloons, they would generate 3 terawatts of energy, which is the Earth's total demand," Lamkin notes.

The idea of inflated concentrators arose quickly from Cummings' determination that only a two-dimensional concentrator of thin film plastic would provide enough concentration of solar rays onto the solar cell.

By the end of the summer of 2005, having decided he could not manufacture the balloons, Cummings bought a bunch of 18-cent, 18-inch-diameter party balloons. Inflating them to different diameters, he traced their shadows on the wall, and digitized and ran them through mathematical analysis to trace the trajectories of the sun's rays along the inner concavity of the balloons.



At this point, Cummings discovered that bonding a clear and reflective half together at the balloon's equator created a far more efficient concentrator than he had expected. As a final touch, he added a batten (a rigid ring) around the balloon's hemisphere that almost doubled the

concentrator's reflecting power and focus.

The plastic PV thin film mirror is Cool Earth's main patent, the breakthrough, says Lamkin. "The plastic thin film makes a perfect curved mirror, which is very expensive to do with other materials," he says. "When optics guys see it, they usually say, `Someone ***must*** have already done that! Why didn't I think of it?'"

The first utility-connected Cool Earth project is scheduled to go online during the first half of 2009, a 1.5-MW plant on 12 to 13 acres near Tracy, CA. It is being financed with the firm's US $21 million in Series A financing. The off-taker "probably will be a northern California utility," says Lamkin.

Finding future sites will be easier than for other solar power plants, he says, because, at an installed cost of US $1 per watt and thus lower project ROI, "it doesn't have to have maximum insolation [rate of delivery of solar radiation per unit of horizontal surface]" and the type of site it seeks is typically close to transmission.

One of the downsides to the technology is that the balloons cannot be placed on rooftops because the technology was designed to be utility-scale, not residential.

In addition, a Cool Earth plant must be manned to maintain the active flow of air and water among the balloons to ensure maximum power production and cooling. The circulation of air and water is fully automated, with micro-controllers monitoring individual balloon air pressure and the closed-loop circulation of 1 gallon of water flow per minute. But if a balloon is taking too much air because it has a leak, a signal light will go on, and maintenance personnel must patch it.

"When you add it all up, we will have a lot of O&M [operations and maintenance] items running. For 10 MW, 70 acres, we would expect to have 7 or 8 people working that plant," says Lamkin. He adds that the number of air and water pumps they install has not been determined and will depend on location, such as in the desert, where they might need a shorter water line, or what kind of deals they get on air pumps.

The balloon films are rated to last 5 years outdoors, but Cool Earth says it will replace them every year.

Paul Wormser, director of engineering at Sharp Solar and co-founder of Konarka Technologies who also worked on commercializing solar technologies from University of Massachusetts labs, wonders if the plant O&M could prove to be Cool Earth's undoing.

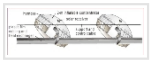
Acknowledging that he has only read about, not seen or tested, Cool Earth's technology, he said, "even if you have a genuine technological breakthrough, very few startups succeed because they don't have all of the things needed to make it happen. It's not enough to have a high-efficiency cell, new lens, or inflatable collector. You have to be able to deliver kilowatt hours. The reality is that no one will know if they have properly estimated maintenance costs until they've done a few systems."

Wormser also cited a "looming shortage" of the solar concentrator cells Cool Earth collectors use, which Lamkin disputes. "We're not seeing a shortage of solar concentrator cells, and analysts are telling us there will be a surplus in the near term," Lamkin says, adding that Cool Earth is talking to both Emcor and Spectralab, but not making any deals until it completes the development of its special PV receiver.

Marsha Johnston is a freelance writer based in California specializing in renewable energies, conservation and sustainable development.

For a detailed conversation with Rob Lamkin, CEO of Cool Earth Solar, listen to the November 6th edition of the *Inside Renewable Energy* podcast.

Image Gallery (4)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Reader Comments (32) Post A New Comment

jim-tanner-69899 December 5, 2008

I truly support grass growing under solar installations.
Electrical companies often use bare rock and lots of herbicide to keep their installations clean and orderly.

What Ms. Johnston ignores is that grass is a high-sunlight plant. When you shade it, other plants, even trees sometimes work their way into the path of a good plan.

This plan has a lot of variables in wind, orientation, cell inflation, etc. that have the potential to reduce its efficiency.

Comment 1 of 32

brian-ballek-52819 December 5, 2008

This concept does seem to have something to offer:
- utilities will appreciate the lower up front costs, leading to much lower financing costs over the life of the plant
- communities and their politicians might very well consider the manned nature of the plants a plus as it equals job-creation
- farmers and land-use planners will like the ability to generate power on land without sacrificing its original purpose, e.g. agriculture

But the maintenance sounds like a killer to me. The water and air-flow control will require moving parts (that eventually break no matter what) plus electronic controlls (usually trickier and more costly than could ever seem possible). And I think it might be difficult to patch a balloon during daylight hours -- those concentrators should get quite hot.

And then of course there is the issue with wind storms. The solar cell inside the balloon, suspended by a small arm, doesn't seem like it would tolerate much turbulence. Can the balloons be deflated, retracted, and secured when high winds threaten?

Comment 2 of 32

brian-ballek-52819 December 5, 2008

Jim,

I wouldn't worry too much about getting enough sun for the grass. Here in Germany, there are a lot of large installations relying on fixed, tilted modules that *completely* block the sun...which is in short supply anyway given German insolation levels. And even then, the grass under the modules grows so fast that the cost of mowing it has to be figured into the sales proposals.

Comment 3 of 32

adrian-akau-36758 December 5, 2008

I am wondering if a similar technique could be adapted to make solar troughs for use with concentrated solar thermal. Solar thermal troughs presently require strong support structures for the parabolic glass and the use of thin film reflectors might serve to reduce structural requirements. The use of much larger reflectives sections might also lower manufacturing and maintenence costs and the lightness of the structure would make the tracking easier.

adrianakau2aol.com

Comment 4 of 32

stop-killin-our-wilderness-136265 December 5, 2008

anyone wonder about the enormous waste of replacing these balloons every year? are they recycled? re-used?

with all that replacement and all that O & M, they need to discuss apples and apples. the reason PV is so expensive is because the ENTIRE 30 YEAR LIFE-CYCLE PRICE FOR 100% OF OUTPUT is laid out once, up front. so, what is the actual, per kwh price of these, including O & M, downtime, water, and 30 sets of full replacements?

i appreciate that they are lighter on the land, and don't require wholesale destruction of the ecosystem they sit in.

as an aside, i take exception to the "barren desert environment" comment, though, since many of the sites under consideration for destruction by Big Solar are carbon sinks that are very rich in biodiversity, and only become barren as a result of Big Solar's "greening" of them with metals, chemicals, herbicides, bulldozers, dynamite, wells, gas lines, roads, giant GHG-emitting powerlines, etc.. the land around Joshua Tree National Park is under siege, for example, and it is gorgeous and full of plants, animals, geology and cultural resources.

anyhow, let's see how these numbers work...

Comment 5 of 32

b-nicholson-160206 December 6, 2008

This idea is half-baked. Air cooling must replace water cooling or just don't accept so much heat in the first place, reflect away the IR (hopefully back out of the greenhouse atmosphere). Individual passive refrigerators would be doable as refrigerants can be transparent. Smaller or larger balloons could work better. Optimize by linear programming.
Ditching the absurd and unnecessary flag poles would save a lot, too. Increase the voltage and use thinner wires down the buoyancy maintenance tubes. Float the balloons and utilize an internal sun-facing mechanism based upon turgidity/flacidity like flowers instead of the goofy exterior cables.
FEMA should fund these as local solar generators for victims in need. Basically they stopped working/thinking way too soon.

Comment 6 of 32

john-sotack-156579 December 7, 2008

It looks like a nice starting point. However, it bothers me that a continuous (annual) supply of plastic is required. In this sense, it uses up limited resources (in this case the resources used to produce plastic).

I

Comment 7 of 32

dominic-jermano-62365 December 10, 2008

Here is my invention: The Sunpress C4H10 Elextrix:

http://my.nowpublic.com/world/new-energy-breakthrough-sunpress-c4h10-elextrix-not-be-confused-solar-power

Actually it is Geothermal Development in Reverse. Aerothermal Development.

Comment 8 of 32

gregor-giebel-154595 December 10, 2008

I wonder whether you could just lay them on a flat surface and have some internal robot rover move around to pin the proper side to the bottom. This might eventually destroy the reflective surface though...

Also, B Nicholson is right, coating the transparent side with an IR blocker seems like a good idea to reduce the heat loading.

Comment 9 of 32

mark-yinger-146792 December 10, 2008

is there any way to implement a solar/wind capturing dual system, thus making use of space and capturing maximum energy in minimual spaces ?? or could collector panels be installed on windmill stations ??

Comment 10 of 32

charlie-monk-62083 December 10, 2008

I like the idea from Adrian Akau. Adapt this to solar thermal troughs using a sausage shape with a rigid backbone. No need for all the cooling complications. Tilt mechanism would be as for other solar troughs but much much more lightweight and cheap.

Comment 11 of 32

winfield-schmitt-113149 December 10, 2008

I see no reason these devices could not be somehow integrated with existing and new-construction 345KV towers that criss-cross the country. Complete integration of the grid with it's generating assests. Of course I'm sure there's a government regulation somewhere that would prevent such an obvious common-sense idea from happening (unless you bribe the right people of course....)

Comment 12 of 32

jeffrey-viola-83115 December 10, 2008

My observations: I find it telling that every time an article is published about some new potential technology, the naysayers-nit pickers and Chicken Little Sky Is Falling types post negative "can't be done" comments, and that the vast majority are Americans. Meanwhile someone from Germany, which is rapidly becoming a country powered by solar energy, and becoming a leader in producing automated equipment to assemble solar panels, takes a practical point of view (i.e. mow the grass). Is it any wonder the Big 3 and Detroit are going into the toilet.... Americans need to stop being critics and become inventors and manufacturers AGAIN!

Comment 13 of 32

john-saari-51615 December 10, 2008

Great effort to place a new solar collection system on line! We need new systems now with less negative comments about why not to use it. We need all efforts to stave off a lack of expensive energy. The US needs to take the technological lead for new tech energy systems instead of trying to throw road blocks in the way. Not only would this provide jobs but bring about a new avenue to a better economy.

Comment 14 of 32

john-harlan-81273 December 10, 2008

Buck a watt installed? Better give these guys a chance here. If the prototype installed for a buck a watt, they have lots of room to work out the bugs!

Comment 15 of 32

fireofenergy-150745 December 10, 2008

It is better to MEGAWATT than to kill a watt! And the only way to do that on a large scale with present tech is by concentrated solar thermal power. That is because only CSP (and advanced geothermal) can provide CLEAN baseload power. If we do not sacrifice some of the desert, then we will have no choice but to face post oil crises and massive human dieoffs (not to mention an anoxic world due to global warming)!

Any RE tech is good up to the point where intermittancy can be absorbed into baseload. If it can not store its electricity, then it is only good for about 20% of our energy supply...

Comment 16 of 32

dennis-houghton-41194 December 10, 2008

Response to #13
You are correct that huge arrays of these or other solar PV devices could be "somehow" integrated into the existing grid. The deterrent is primarily economic. While power line corridors are highly regulated by government agencies including Homeland Security, the most formidable obstacles are the laws of physics of electromagnetism. Very high voltages can be induced in equipment that is not properly grounded, such as floating metal films and conductors. Those induced voltages will also manifest as harmonic AC currents in the DC production circuit requiring specialized, expensive regulation equipment before being connected to the grid. Sounds like free energy! Not exactly, it is actually very expensive.
A 345KV line offers few locations for interconnection and has expensive inverter, transformer and switch equipment requirements.

Locating systems with high maintenance requirements in an area where maintenance will be difficult and dangerous is not common sense.

Comment 17 of 32

tony-chen-164544 December 10, 2008

There's more information about Cool Earth Solar concentrators and use of plastic films here: http://www.coolearthsolar.com /faq#Our%20Technology

Comment 18 of 32

ric-evans-59805 December 10, 2008

Why would you not scale this for the home owner? Most people I know that are interested in supplying their own power simply can't afford it. By reducing the overall cost by 80 percent or so you open up a lot of doors.

Dominic Jermano: great concept but how do you get the gas back to 11F without expending more enrgy than your making? Some form of refrigeration must be needed

Comment 19 of 32

william-hughes-66196 December 10, 2008

Grass is no problem. Put in a small flock of sheep. If woody plants start to grow, add a few goats. If really desperate and thorny vegetation appears, add a camel.

Comment 20 of 32

dominic-jermano-62365 December 10, 2008

Hi Ric,

Actually it does not need to return back to 11 degrees. The pipe panel will always be at a higher temp, than inside the turbine case. That is enough drop in temp to foment recirculation. Depending on what the climate is like such as in the summer, Liquid Nitrogen can be used in its binary capacity, so when the C4H10 reaches the turbine, it spins off and hits a piped contained condenser of Liquid Nitrogen, which would drop its temp below 11 degrees. No energy is used. It is based upon gas heated pressure creation, while using cold gas Liquid Nitrogen to condense.

It is rather similar to using a Still in making Alcohol or ethanol. Instead of a fire to heat the C4H10 the suns heat does it. Instead of using cool water to change the steamed ethanol into a liquid, I use Liquid Nitrogen instead. The C4H10 condenses and is recirculated.

If need be magnifying glass or plastic is wrapped over the pipe panel. This would give the inside pipe panel a greenhouse effect thus enhancing the heat resource to keep the C4H10 at and above its boiling temperature.

You won't find much information on this topic..it is a brand new concept. Essentially this idea would work in generating electricity in a moving battery electric car. The heat from the Electric Motor, and creating electric heat output from generator applied wheels along with human body occupants in the car, would keep the C4H10 always at an above boiling temp...This would give the need requirements to spin the turbine, keeping the batteries of the car charged. Any excess from over charging the batteries could be switched to direct drive on to the motor.

Thanks for reading.

I think all ideas are good to look and ponder up. It really comes down to preference and advantages. ..people are hoping to see what they get for the investment risk, and or own individual personal use. I like this concept.. because it is about using heat. Something the earth has a lot of.

Comment 21 of 32

jay-rosenberg-53116 December 11, 2008

We are engaged in producing usable solar thermal power: Heat, A/C, and electricity, all at very low cost, and high efficiencies - with proprietary designs in the collectors, "plumbing", and powerblock. $.05/kWh is our objective. CEO-Sannerprojects, Inc Sannerwind@gmail.com

Comment 22 of 32

matt-karber-163571 December 12, 2008

Give these guys a chance. "Left-field" ideas work more often than we admit. Once they get the product in place, the market will sort out a lot of the details. Field experience will teach the Cool Earth people a lot, and they can adjust the concept/product as needed.
By the way, Mr. Viola makes a good point. The USA used to be known for its "can-do" attitude. It made a success out of ordinary people like Thomas Edison and Henry Ford. We need to bring that attitude back. History has much to teach us, if we take the time to learn. That learning may be critical to our survival.
"Opportunity is often missed because it comes dressed in coveralls and looks like work." - Thomas Edison

Comment 23 of 32

glenn-fay-164845 December 12, 2008

I see this as a breakthrough and a step along the path of continually evolving technology that will help move us away from poison power. We may be able to sythesize new polymers from biodiesel, which is better than burning it and producing carbon dioxide. Keep up the great work and I look forward to new developments.

Comment 24 of 32

fireofenergy-150745 December 13, 2008

Response to #17
Can't believe you think it's too "hard" to deal with the high voltage issues. Humanity has been doing it for about a century. If we are to overcome this post oil crisis/global warming/economic turndown thing, we must MAKE ourselves overcome the stupid little issues like being afraid of decades old tech and not gaining a short term buck. More stupid things are not wanting to build a 21st century green grid complete with the ability to charge up a nation full of e cars and being afraid of covering 20% of the desert with mirrors (or balloon like) concentrators.

Cool Earth, keep going strong!

Comment 25 of 32

dennis-houghton-41194 December 14, 2008

Response to #25

I do not think it is too hard to deal with the inductive effects of high voltage power lines. I said it was too expensive to put solar arrays under them when there are other options. Inter-system inductive and capacitive reactances are real problems, not "stupid" little issues. In our vast experience of 100 years of electromagnetic experimentation we have killed many people and burned many structures developing better products and systems. Solar PV is a "decades old tech" which is the most valuable energy producing resource on the planet, when applied appropriately as a distributed system. Ignorant and stupid are not the same thing.

Comment 26 of 32

douglas-greenwood-165165 December 17, 2008

Assuming that the $1/watt number includes the cost of yearly replacements and other maintenance (including cooling, etc.), it is easy to calculate a ROI on this.

Assume: 10 cents/KWh, 8 hours generation/day, 365 days/year, and 1 KW/1000 watts

The amount of income generated is:

10 x 8 x 365 / 1000 = 29.2 cents per year. For a $1 investment that is a whopping 29.2% return. If this were deployed in homes and cooled with water, then the coolant could be used to recharge hot water heaters for an even better return.

The trick is maintenance. Can they really achieve $1/watt? If you spend $1 for 1 watt of power, how long do you get that watt? - a month, a year, 5 years? Clearly if it is for 1 year, you lose money. If all maintenance and replacement has already been paid for, you make money.

Just what are the facts?

Comment 27 of 32

steven-palla-165166 December 17, 2008

you need to find an advanced material like a very efficient thermocouple to convert the infrared light to electricity. Could the right material convert the heat effectively enough to electricity that it could actually cool the collector?

It would be sheer madness to create a solar collector and waste all the heat energy! You're kind of throwing out the baby with the bath water!

Why does the PV cell have to be so close to the reflector? Couldn't you have an optical device refocus the light both infrared and other wavelengths into a beam targeting a larger conversion device that could split the wavelengths and shunt them to a respective converter i.e. thermal and PV. This kind of material must be the target of the research.

What comes to mind here is some kind of film that is composed of translucent, ceramic/polymeric beads that both conduct generated PV electric but also reflect the IR spectrum to a thermal collection point some distance away like a solar furnace. Let me know what you think!

Comment 28 of 32

steven-palla-165166 December 17, 2008

response to comment #21 you've got me going here, How about a large blown up tubular doughnut, one clear side the other a PV cell material, combined with a distillable liquid that evaporates from solar heating and condenses on a shaded or air cooled side creating a solar powered water wheel effect solving the cooling problem while still serving as a collector and a turbine. I know I've seen the design concept before some where.

The key concept here is to lag together the multiple sources of energy, Photoelectric, thermal, and turbine effects in a way that takes the waste of one process and uses it as a way to propel the next phase of energy extraction/conversion.

Comment 29 of 32

steven-palla-165166 December 17, 2008

RE:comment 29 see, Wally Minto's Wonder Wheel, popular science magazine....who could forget

Comment 30 of 32

steven-woodcock-74971 December 18, 2008

A brilliant idea indeed! This one's got legs.

Comment 31 of 32

siphon-06-149213 September 11, 2009

I wondered about the maintenance cost, so did a short calculation:

10 MW electrical, operating at 20% capacity factor (conservative estimate) is around 17,500 MWh electricity per year.

8 workers costing the company 40,000 dollars per year is 320,000 dollars. That's generous since much would be near minimum wage simple maintenance, however let's give the workers a good living.

320,000 dollars divided by 17,500 MWh is a cost of 18 dollars per MWh.

This is less than 2 cents per kWh!

Replacement cost of plastic would be trivial compared to wage. If these guys can deliver for 1-2 dollars per Watt at the system installed level, then it's going to be big!

Comment 32 of 32

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