Stanford eCorner

Moore's Law: A New Weapon in the Solar Arsenal

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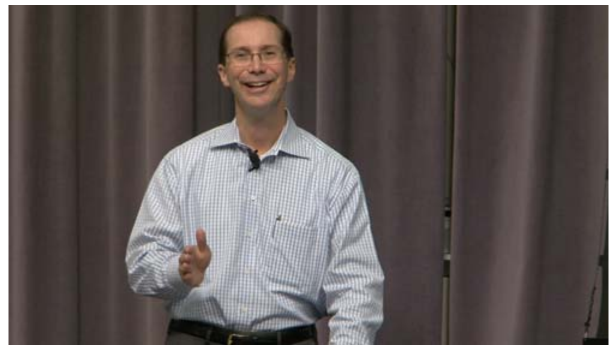
Bill Gross, chairman of eSolar and founder of Idealab, discusses how Moore's Law provides a new weapon in the fight to make solar energy technologies more productive and cost-competitive. After examining current solar energy harnessing techniques, Gross focused his attention on applying Moore's Law to high-efficiency solar conversion systems. eSolar was founded to work on the development of these ideas. In this clip, Gross describes the technology behind eSolar's current solutions.



Transcript

I think the opportunity is so big that we have to invest heavily in all these areas. I know a lot of that investment is going on here. I'm going to talk to you about one particular new weapon that I think we have in the solar arsenal to try and get there. This new weapon in the solar arsenal, I feel, is Moore's Law. Let me talk to you about some other resources and their trend lines. If you look at coal, it's going up. Oil is going up. Natural gas is going up. Steel, gold, metals, everything, food, corn, rice, everything is going up. The one thing that's going down consistently over the years, the price of computing power is going down so much while everything else in the world is going up because everything else is a scarce resource.

Computing power, the way we've been able to use our brain power to fit more in less space means that cost is going down so dramatically. How can we use this? How can we use Moore's Law to drive down the price of solar energy? I started thinking about that a lot. I started thinking about how could I take the one thing that's going down in price and apply that to solar? You can't apply Moore's Law to PV panels, to photovoltaic cells, because PV panels don't have microprocessors on them or in them. They're not taking advantage of the density that Moore's Law brings. They're taking advantage of maybe a slight reduction in the cost of silicon. But that's again a natural resource that's not going down. PV cells are based on area of usage. You just need a lot of area. Well, that means you have to use all of the heavy, intensive energy process and chemical process to make the cells on a large area basis. Well, we need to come up with some way to apply Moore's Law that doesn't need the area, some way we can use a small microprocessor to leverage against something that's big.

So, that's what I started working on. I took a look at the taxonomy of all the different types of solar things. Over here on the left, you have photovoltaic techniques, silicon panels, thin film panels, concentrated PV panels. Over here on the right, solar thermal. You have dishes and troughs, parabolic troughs and linear fresnels, concentrators and power tower. I looked at all these things. Way over here, this has the highest efficiency, the solar power tower. The solar thermal power tower has the highest efficiency of solar conversion in the high 30 percent you can get. So, I figured if there's any place to try and apply Moore's Law, it would be way over here on the right. That's what I want to try and do.

How do you apply Moore's Law to this high-efficiency solar conversion system? So, this is the company we're creating to do that. It's called eSolar. There's a picture of an eSolar plant in southern California. I'll talk to you how we apply Moore's Law to this. The typical solar power plant at the solar thermal concentration takes a large mirror, a big parabolic mirror, that is about the size of a tennis court and tries to track in two axes to concentrate sunlight to a single tower. But that requires huge construction in the field. We thought, "What if you take that mirror and break it up into lots of tiny mirrors?" Now, all of those would have to be controlled separately because they all have to move differently over the day to redirect their light to a single point. They're not all moving together. They're moving differently. But that's exactly what microprocessors would be good at.

What if we put a microprocessor in every single mirror? So, compared to doing this big assembly in cranes, an assembly in the field because this is larger than can be shipped. This is larger than a shipping container. Each of these things could be smaller, we could deliver it. And this is what we came up with. A system that comes out. These things get pulled out of a shipping container. They get unfolded like an accordion onto the field and get bolted down to a bunch of ballasts that are sitting on the ground and just use a regular wrench to tighten down, so just regular hand tools. We get rid of all the heavy equipment. Then, you walk down the aisles and put the mirrors on. They're all crooked and in different angles and everything like that.

But we're going to use software to try and straighten that all out. This is what it looks like at the ground level. You can see these racks that have all the wiring in it in advance, double-access actuators and some plain old one-square-meter flat mirrors. So, we don't have to curve the mirrors anymore. We don't have to make a parabola in metal and in glass. We're now going to make a parabola in software. We're going to concentrate the sunlight dynamically with software. And the way we do that is this. We, again, take advantage of Moore's Law, too. Today you can buy high-resolution sensors.

You can put on some towers in the corner. Those sensors can look at all the mirrors and really detect every single mirror with an image recognition pick out each mirror, with a GPS time clock figure out the time of day and where the sun is and look at the reflected beam coming out of each mirror and in real time compute the angle of every mirror. We can do it way, way higher precision than you ever could by observing where the mirror is the way it has been done in the past. Now it requires a $2 microprocessor in every mirror. But a $2 microprocessor is now negligible, an off-the-shelf product. Even 10 years ago, it cost $5000 per mirror and you couldn't have done it. But today it costs $2, which is unbelievable it has happened that Moore's Law allows this to take place. We can point the mirrors much more precisely, which means higher temperatures and higher efficiency, less spillage of light at the receiver. We can just get much, much more cost-effectiveness because we can have lighter structures, less steel and less labor, all made up for by microprocessors. So, what it looks like as an example, when you first put down this row of mirrors, this may be hard to see back there, but on the left because the ground is a little bit not flat, because the metal has thermal expansions, a little bit crooked, because the mirrors have end stops that aren't exactly aligned, the best you can do with lining this up, the mirrors are accurate plus or minus about three degrees.

But then, after you run the software and command the mirrors to go flat, you can see here this row is accurate to a 20th of a degree. About the most accurate anybody ever achieved with this method was half a degree and now we're at 20th of a degree. So, we're 10 times more accurate just with a $2 microprocessor in every single mirror. So, it really, really has cost a big difference in cost, a big difference in performance. This is what the whole plant looks like. Here's rows of mirrors. You can see the parabola is made and all of the mirrors are all slightly curved. All the light from the sun is reflected up to the tower. Up at the tower, it's immensely hot. And then, we make a steam then run a steam turbine at high efficiency and take the electricity and go into the grid.

This is a five-megawatt plant, this one in Palmdale, California. We now have an order for a 1000-megawatt in India and 2000-megawatt in China. The one in India is already under construction. China will begin next year. You can imagine how proud I am of this. I started with my little tiny stuff back in high school to be able to walk in a field like this. It's an eerie feeling actually because it's very quiet. You don't really hear much because there's these little tiny motor actuators moving the mirrors. The steam, of course, you don't hear any of that in the tower. There's an immense amount of thermal energy up at the top of the tower.

It's very, very bright. But it's a really, really amazing sight to see, to be able to take Moore's Law, apply it to an old idea but really drive down the cost and hopefully get us there. We're within striking distance of the price of fossil fuels right now. With some additional storage techniques and additional production, we should be able to get to the price of fossil fuels in just three to five years. Now this is just one way of doing it. There's many, many ways. We encourage all of them. But I was just really excited to share with you this one particular angle of how you can take entrepreneurship, Moore's Law and technology, apply it to relatively static field and solar energy and try and make a new way to try arbitrage technologies to try and make a breakthrough.