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POWER QUALITY SOLUTIONS FOR THE DIGITAL ECONOMY

An Interview with Deepak Divan, President
SoftSwitching Technologies

Deepak Divan, President of SoftSwitching Technologies, defines the power technology market, articulately drawing the distinction between power reliability and power quality segments. Dr. Divan's company is focused on the power quality problems of the semiconductor, fiber optic cable and automotive manufacturing industries. Dr. Divan explains why he believes widescale adoption of fuel cells may be years away still.

Gerson Lehrman Group: How do you define the power technology market?

Deepak Divan: It's a conglomeration of companies that are positioning themselves in the power technology market. In my mind, those companies that are actively using power electronics and smart controls to squeeze more out of the grid, to better condition the grid, to better support industrial processes. All these fall under the umbrella of what I would call a power technology company.

And within that, there are many different market segments that one can think of -- everything from power quality, power reliability, distributed generation, alternate energy sources. I think all of these, in some form or the other, link up with what is being called the power technology market.

GLG: The terms "power quality" and "power reliability" are being used interchangeably by many. Is power quality the same as power reliability? And, if not, how do you differentiate these two sectors?

D. Divan: Power quality and reliability, in my mind, are actually very distinct components of this market. Power reliability is best described by the classic definition that the utilities really look at: interruptions. So, the utilities measure power reliability in how much time the utility has continued to supply power to the customers. And these interruptions are measured, typically, in anything ranging from a few seconds to a few minutes and more. And the definition of an interruption varies significantly from utility to utility within the U.S.

And the way I think about it is in the old economy many of the processes were really susceptible to interruptions more than anything else. When the power goes down, clearly you have a loss of productivity and function. And many of the solutions that were forwarded included things like backup generators and UPS systems. Many of those were targeting the power reliability market much more than the power quality market.

The power quality market is concerned with much shorter duration power disturbances that occur on the grid. Typically, the grid does not get disconnected. And if it does, it's disconnected for a very short time -- typically fractions of a second -- and is reconnected.

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If you look at the physics of the problem, it's very clear that power quality disturbances are the dominant form of disturbance that occurs on the grid. For instance, you get a lightning strike on some part of the grid and maybe within a thousand feet of that location you have a voltage spike because of the strike, and you need a surge suppressor to take care of that. But, during the process of that lightning discharge going to ground, you end up creating a fault on the utility grid. The result of that fault is really a voltage sag or voltage dip that is experienced for maybe 50 miles to 100 miles around that location.

So, for a customer that is connected at any random location on the utility grid, the

probability is a lot higher that that customer will actually experience a voltage sag than a spike.

When a utility experiences a fault, they have protective gear, such switch gear and circuit breakers, which operate to protect the part of the line where the fault is actually occurring. And so even if you have a hard fault that cannot be cleared, the actual outage is experienced by a very small part of the grid.

So, the probability's much smaller that people will experience an outage than the fact that they would experience a voltage sag.

This has been verified by many independent studies. The most extensive of those was conducted by the Electric Power Research Institute, a consortium of all the electric utilities in the country. EPRI did a study over a two and a half year period and confirmed what everybody expected: over 92 percent of the events that were seen on the utility grid were actually voltage sags.

So, in my mind, the power quality and the power reliability markets are very distinct. Their economic drivers are very distinct; the physical characteristics are very distinct.

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For instance, in the power quality area, you don't require an energy source of any kind. You require a very quick turn on, because the events tend to be less than a fraction of a second in duration and you need to come in and keep the equipment up. Clearly in the digital economy -- not just data centers but also machines on the manufacturing floor in critical processes which are all now digitally controlled -- power quality events can cause substantial disruption of productivity.

GLG: What percentage of commercial and industrial equipment using utility power is old economy gear and what percentage is this highly sensitive, digital economy gear today?

D. Divan: I think you see the percentage vary from industry sector to industry sector. And you see it increasing dramatically in every industry sector.

Almost all the high-value processes, including semiconductor manufacturing, fiber optic cable manufacturing, automotive manufacturing, all of the continuous processes today use some form of digital electronics and power electronics in the control implementation.

So, this covers everything from computer centers, data centers, chip manufacturing facilities, cable manufacturing facilities, plastics manufacturing. All of these facilities today use an increasing amount of the new digital electronics. All of these have some level of sensitivity.

Those that have the highest cost of downtime, such as the chip manufacturers, are certainly aware of the problem because their cost is so great when they go down that they do everything they can to mitigate that problem. And that's clearly where we are seeing much of our early penetration.

But, we are also seeing penetration in the broader industrial market. We've sold to companies like Mars, the candy manufacturer. But, they're a continuous process. And when they have downtime, they have a fairly high cost associated with it. And we have a solution that seems to be low enough in cost that it can actually solve their problem. So, we are spanning a fairly high range in terms of value that customers put on power quality.

We asked one of the managers of a steel mill in Cincinnati if he has any voltage sag problems. This steel mill has two sections of its plant, one that is more than 30 or 40 years old and the other one that is brand new, about five years old. He says the old part of the plant virtually never has a voltage-sag-related problem. And the new part of the plant is has got 10 to 20 events a year where they shut down because of a voltage sag.

Again, even in the old economy, where the old equipment is in place they have much lower levels of sensitivity to power quality issues; but, the newer equipment has a much higher level of sensitivity to it.

The question is how do you educate them on the process. The biggest problem is that people are not aware of the power quality event occurrences. Traditional power meters do not give this kind of information. And most people do not have the more expensive equipment that is required to pinpoint short occurrences.

So, in the absence of that broad level of information, how do these people make a reasonable ROI calculation? How do they even educate themselves?

GLG: How do you identify potential candidates for SoftSwitching Technologies' products?

D. Divan: We've focused on what we consider the high-value segment first. The high-value segment is distinguished by a couple of very interesting characteristics. Most of them tend to be aware of the issues. That's because their cost of downtime is high. Also, they usually have spent the additional money they need to get connected to what I would call a premium grid, which is a high-voltage utility connection -- 230,000 volts or higher. Companies connected to a premium grid tend to have virtually no downtime, -- very reliable power connections with virtually no outage being reported for 20-30 years some times. But, they have a lot of voltage sags.

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So, most of the companies in the high-value segment have studied the quality of the power coming in to their facility and they understand exactly what the issue is. If we at SoftSwitching Technologies can make a connection with them, then the sale is a very easy sale for us.

We've identified three high-value segments where the pain of a power quality occurrence is highest, and it's no secret that these are semiconductor chip manufacturing, telecom fiber cable manufacturing, and automotive manufacturing.

We have specifically targeted these three industries and are making significant inroads. This really narrows the list of potential customers down and we can essentially do a door-to-door type of contact and sell.

Additionally, we have worked very closely with many of the largest utilities. We've done several demonstration projects with EPRI, **American Electric Power**, Houston Light and Power, **Reliant Energy**, **Southern Company** and TVA. These have all been aimed at getting the utilities comfortable with the solution and then using the utility more as a validater and a lead generator for us. And this has been fairly successful.

We've also got a group of resellers that we've put into place. And we are actually brand labeling our product for Square D and that's giving us further inroads into their associates and customers' facilities.

GLG: What are you doing to broaden awareness of power quality issues, such as voltage sags?

D. Divan: We see that as being our number one challenge and number one point where we've focused a lot of our energy. We've seen this in spades.

Lucent Technologies has monitored their power quality for seven years and they knew exactly what they were looking for in terms of a solution. When they saw our solution, everything clicked into place and it was a no-brainer. You go to another customer who doesn't have that information and ask him if he has a power problem, and he says, "Nope." So, it's a very hard, uphill battle from there.

We've known from the beginning that if we could only have a little black box we could just give away to our customers that would identify all the power quality problems for them, we could be a lot further along in terms of getting them educated.

So, we've developed a little black box. We call it call it i-Node, and we are going to be distributing that as widely as possible to establish what we call an intelligent grid, the i-Grid.

The i-Grid will handle ultimately over 50,000 monitors around the U.S. connected to the utility grid in various points. It will relay information back to our local server and make that information universally available through a Web site to everybody.

I think that's a very powerful tool. As we've explored the launch of that, we've had very strong interest. It will knock down this barrier, which is the lack of information on power quality and reliability events that are occurring across the country in the utility grid.

GLG: Describe SoftSwitching Technologies' solution. How intrusive is your solution? How difficult is it to implement your solution for customers?

"The fab houses have had problems with voltage sags for a long time and their cost of downtime is so high that they've actually been using UPSs."

D. Divan: All the fiber optic cable manufacturers, including Lucent, **Pirelli**, **Corning**, **Asahi**, are pulling anywhere from 10 to 300 fiber optic cables into one bundle and these bundles are made specifically to customer order and could be ordered anywhere from 5000 feet to 30,000 feet in length. And as they are rolling that final bundle together, if they get a voltage sag, it breaks the cable and they have to scrap that whole thing and start from scratch again.

So, they could see losses that range in the hundreds of thousands of dollars per event. The solution is you take one of our machines and put it in between their machine and the utility grid and you effectively have solved all their problems. It's an on-site implementation. It goes between the utility grid and the piece of equipment that is actually suffering the problem.

Semiconductor tool manufacturers, such as **Applied Materials**, **Novellus**, **FSI**, **KLA-Tencor**, are making tools that the fab houses are buying. The fab houses have had problems with voltage sags for a long time and their cost of downtime is so high that they've actually been using UPSs.

The problem with UPSs is that you end up having each tool protected by a UPS. So, you have hundreds of different UPSs in the facility, each of them with a set of batteries that is in a different state of charge, discharge, or different point of life. When the power quality event actually occurs, there's some part of the system that isn't protected.

SEMI, the Semiconductors Equipment Manufacturers International, has developed SEMI F-47, a voltage sag standard instituted late in 1999.

Because we are working off the same physics that the semiconductor tool manufacturers are, it turns out that just putting our equipment in front of their equipment provides complete protection. So, that's a very good inroad that we have into the semiconductor chip manufacturer market.

GLG: With respect to the power quality market, what are the alternative solutions to the DySC line of products -- SMES and PQ-SMES of **American Superconductor**, flywheels?

D. Divan: There are two ways of looking at it.

On one end, our biggest competition is a piece of wire. Because if you do nothing about it, you only have problems a certain number of times. And if you can live with it or if you have no cost of downtime, then that's your solution.

The parameter that drives people to using the solution is really their cost of downtime and the frequency of downtime that they experience. As you move up that chain, you find that different solutions make sense.

In the premium grid market that we are targeting, we find that we provide the highest value for the money. And there's a very interesting reason for that. We see that all the events that they experience tend to be short duration and do not require significant energy

storage. So, we configure a solution which has only one stage of power electronics in it and that's the lowest-cost solution that you can implement.

Now you take a solution such as SMES or flywheels, and in addition to the power electronics that you require anyway, you have to add the energy storage and the power conditioning circuitry for that. So, you can see that that's a delta cost adder that in the premium market does not buy you any additional protection. So, in that market we have a significant competitive advantage going in.

In the normal grid market, it now becomes more dollar comparisons. The solution costs more and provides a little more protection. The numbers that we have seen coming out of the distribution power quality study that EPRI conducted suggests that 92 percent of all the problems would be covered by our product; an additional 4 percent would be covered by a full UPS and energy storage solution; and to cover the remaining 4 percent you would require a mixture of our solution, energy storage, as well as an energy source such as a backup generator.

So, there's really a layering of costs depending on the type of protection that you're actually looking for.

We are focused on the high-end of the market because of the premium grid connection; we are focused on the industrial end of the market where UPSs cannot be applied very well and we provide 92 percent of the protection at a much lower cost point than anybody else can.

GLG: You've defined the segment between a power quality solution and a power reliability solution as the bridge. The bridge demands energy storage coupled with power conditioners and power electronics. Which power electronic manufacturers are working on the bridge solution?

D. Divan: I classify the bridge as a separate connection because everybody requires the power quality circuitry. So, that's almost a stand-alone. Then you have to interface that with the storage component and the power conditioning that we talked about. So, the bridge is almost never sold by itself because it doesn't provide the functionality the end user requires. It always has to be married with the power quality component.

If you look at the people who are doing that, certainly two companies spring to mind today. One is American Superconductor with their SMES systems, although those are only targeted at multi-megawatt -- five megawatts and up – users. And then there's **Active Power**, which is a flywheel energy storage type of system. Some of the regenerative fuel cells also tend to look a little bit like storage systems, but really it's not the sort of storage that they are targeting.

We are certainly working to make sure that as we move forward we will offer products that provide the bridge into the power reliability market.

GLG: You've written that SoftSwitching is poised to apply its work in power quality electronics to the distributed resources market. How far from commercial application and widespread adoption are fuel cells and micro turbines? How do you define the market for distributed resources?

"I believe that fuel cells are going to be a very significant technology for the future. Timing is always very hard to predict."

D. Divan: I believe that fuel cells are going to be a very significant technology for the future. Timing is always very hard to predict.

There are significant infrastructure developments that are required before the technology can become really mainstream in the way the market wants to see. That does not mean that there will not be very substantial, niche applications that will emerge in the near term. In fact, we are working with some of the market leaders in developing the full power conditioning system for a fuel cell UPS that is expected to hit the market in the near term. So, we are very well positioned in that area. But because of our agreements, I cannot

disclose the name of our partners in that until later in this year.

GLG: When you mention that a big determinant of the deployment and adoption is going to be the implementation of some infrastructure, what kind of infrastructure is needed?

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D. Divan: There are several levels to it. For a product to be commoditized, which is really going to be required before fuel cells can enter the mainstream of our economic life, there's a whole infrastructure of component suppliers that need to be developed, for instance.

And then, if it becomes a hydrogen fuel cell that becomes the dominant technology, then there's the hydrogen infrastructure that needs to be put in place, as well.

So, there's several layers and levels to it that need to be resolved, and it's anybody's guess what kind of time frame that'll happen over, what kind of investment is going to be required. Certainly there's some very significant dollars that are battling for that ground right now.

GLG: So, in the short term do you see other applications that can be an intermediary deployment of some of this technology that's being developed.

D. Divan: Absolutely. I think there are good niche applications. And, as I said, we're working with some of the market leaders in that area, too.

Deepak Divan, PhD, founded SoftSwitching Technologies in 1995 and serves as the company's President and CEO. Dr. Divan formerly served as the Associate Director of the Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC), a leading industry consortium located at UW-Madison, Madison, Wisconsin. Dr. Divan has completed research and product development projects for several organizations including: GE, Best Power, Kohler, Ford, Hughes, GM Reliance Electric, United Technologies, ABB Ansaldo, York International, Sundstrand, NASA and the Air Force.

Companies mentioned in this interview:
Lucent Technologies, Mars, Southern Company, American Electric Power, Houston Light & Power, TVA, Square D, Corning, Pirelli, Asahi, Applied Materials, Novellus, FSI, KLA-Tencor, American Superconductor, Active Power

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