

Any power, any speed

As president and CEO of The Switch, Jukka-Pekka Mäkinen heads-up one of the industry's most pioneering companies. With a focus on drive train technology for renewable and industrial applications, the organisation is highly visible in the solar, marine and – of course – wind sectors. One of PES magazine's original interviewees, he returns for an illuminating Q&A.



Jukka-Pekka Mäkinen

PES: Welcome back to PES. It's been a while since we last spoke – how has the company evolved in the last few years? And how has business been? Where are you seeing signs of growth right now?

Jukka-Pekka Mäkinen: The Switch wants to demonstrate that wind power energy can be produced cost effectively with advanced technology. The company's success is largely due to its advanced permanent magnet generator (PMG) technology, which has enabled the company to become a pioneer in the international wind power market.

The Switch strongly believes that renewable energy offers a solution to future energy needs. To become a reality, the most important factor is to produce high quality energy at the lowest possible cost. With wind power, quality is more important than quantity.

We are committed to increase the annual energy production of wind power and to minimise associated total life cycle costs. Permanent magnet generator technology is advantageous for the wind power market, because it offers high reliability and requires less maintenance than conventional methods. PMG-based technology is also able to produce energy more efficiently at lower wind speeds. Therefore, 1.5-7% more energy can be produced per year." By continuously developing the reliability of energy generation equipment, it is possible to enhance cost efficiency.

Crowning off the successful achievements to date, The Switch successfully commissioned its 8+ MW PMG, which is intended to be used offshore. The massive drive train component that features a medium-speed, rear-mounted PMG design

brings together the best of both low- and high-speed technology, offering extremely high availability and reliability, and resulting in increased annual energy production, particularly at partial loads.

This latest PMG is bigger, better – and stronger – than anything built by The Switch so far with a power rating of 8.6 MW. Medium-speed seems to be a winning combination for offshore by lowering the generator weight without compromising on reliability.

Outstanding drive train and system availability has enabled the PMG to gain a superior position in the market. Careful material selection and accurate calculation of the generator design make the product even stronger when it comes to reliability and durability.

In 2013, our first 5 MW offshore high-speed drive trains were installed in the field in China for CSIC (Chongqing) Haizhuang Windpower Equipment Co., Ltd (HZ Windpower), a Chinese wind power equipment manufacturer, and are now successfully operating.

Our new Haizhuang PMG5000 generators and FPC5000 converters have been designed especially for Haizhuang by integrating the latest technology and the real-life wind power field experience of The Switch. During testing phase, the optimised drive trains fulfilled all performance requirements. The Switch PMGs and FPCs have been appropriately adopted to operate reliably in the harsh offshore environment for which they were specifically developed.

In Japan, The Switch and YASKAWA Electric Corporation, a global manufacturer of servomotors, controllers, inverters, and

industrial robots, have entered into a strategic cooperation on high-power motors, generators and converters. By combining forces, the two companies plan to leverage each other's technology expertise, expand their product range and to strengthen their market positions in Europe and Japan. This cooperation will result in a more complete offering in product packages and eventually in bigger and better wind turbines.

In 2014 The Switch, also brought its technology to the shipbuilding market, and received a significant order from WE Tech Solutions Oy of Vaasa, Finland for four permanent magnet (PM) shaft generators. Coupled together with WE Tech's WE Drive, these PM shaft generators represent game-changing technology for merchant ships to allow them to significantly cut back on operating costs when powering their onboard electric networks. The deliveries will start later this year.

Additionally in 2013 we appointed David Zhao in the position of General Manager for China. This hiring of Zhao underpins The Switch's long-term ambitions to establish itself as the preferred partner in permanent magnet generators (PMG) and full-power converters (FPC) in a market in which The Switch has been extremely strong.

PES: Why do you think that OEMs are still slow in adopting PMGs rather than DFIG?

JPM: There are still markets throughout the world where the initial investment decision-making criterion is price. These include emerging markets just getting into wind, for example. Still, we see a clear market for premium turbines that feature a higher upfront cost, but much better total

lifecycle performance. PMG has been proven to provide the lowest levelised cost of energy (LCOE).

In the first phase of wind turbine technology development, for example, local Chinese turbines were mainly built based on licenses from Europe. Therefore, induction generator based turbines were built originally. The first ones were based on a standard asynchronous machine and a soft starter; later on, drive trains advanced to feature a double-fed induction generator (DFIG) and converter. Finally, along with the shift into the new millennium, came a shift in technology towards new solutions represented by permanent magnet generators (PMG) and full-power converters (FPC).

When The Switch entered China in 2004, there were no PMG-based turbines in production. Yet some open-minded companies had that technology on their drawing boards. Over the past ten years, we have witnessed the PMG revolution in China. In fact, all Chinese wind turbine manufacturers that have really been successful during the past ten years, and are still on top today, have selected PMG and FPC based drive trains in their turbines. They have been lucky to be able to leapfrog ahead to the most modern technology, since they were able to select their own turbine designs from scratch once the license phase was over.

As a comparison, just think about the shift in the type of converters used with DFIGs to the modern FPCs now used in industrial motor drives that took place many years ago.

The main reasons for PMG and FPC drive train success are high reliability and availability, combined with the ease of handling existing and future grid connection requirements, such as low voltage/high voltage ride-through. Drive trains with FPC can also handle requirements for feeding reactive power. DFIG machines cannot reach the same level without an external power conditioning device.

It is clear that the old designs will remain. But the majority of new designs in China are based on PMG and FPC. And these are now leading the way – and the world of wind power.

Another reason that OEMs are slow to switch over is that some of the more established wind turbine manufacturers have started with DFIG technology, which represents their mainstream business, and are now stuck supporting their cash cows. They believe that it is difficult to replace, although in reality this is not the case.

And finally, the development of rare earth material prices experienced considerable fluctuation a few years ago. This scared off many companies from moving faster into the use of PMG. For approximately the

“PMG-FPC turbines work more efficiently because of the additional energy yield they provide in the partial power range over the entire lifetime of a wind turbine, which ensures a better Return On Investment”

past two years, the price of rare earth magnets stabilised with the entry of new suppliers in various parts of the world. This has led to a healthier balance of supply and demand.

PES: What innovations can we expect from The Switch in the next year?

JPM: We plan to keep on developing our technology with our customers. By innovating together, we can better match local needs. Our goal is to continue to make bigger and better turbines.

Today, our references demonstrate our solid track record. We've been delivering innovative results for over a decade, making an impact on profitable power generation and energy use – and ultimately, lowering the cost of energy and operations. And we aim to continue to build this track record with ever-more remarkable achievements.



Low-speed permanent magnet generator



Medium-speed permanent magnet generator

Additionally, our agile way of working as a company is quite innovative. We work with each of our customers to help them be ready and responsive to market changes by embracing our flexible business approach. This brings them agile partnerships, scalable growth and well-planned localisation.

PES: Quality must be a priority for your customers. How difficult is it to get the balance between quality and profitability?

JPM: Quality is one main factor that leads to profitability. That's why our advanced drive trains have been designed from the start for high quality and simplicity. We have built our turbines to offer our customers the quality they need to run their business profitably. This includes greater reliability, higher uptime and lower maintenance needs. Even more importantly, our drive trains offer high quality electricity that can be fed into the grid thanks to our fault ride-through capability and low harmonics.

PES: What are the biggest challenges for The Switch?

JPM: In the wind power industry, the debate on which generator and converter option makes for the best modern wind turbine drive trains is still raging. Numerous technology experts and industry commentators promote the use of the double-fed induction generator technology, while expressing doubts about the advantages of the permanent magnet generator (PMG) approach.

The Switch needs to change these misconceptions, and set the record straight. We need to explain why PMG with a full-power converter (FPC) is by far the best technology, regardless of which key decision-making criteria you use.

PES: One of reasons of OEM to choose PMG over DFIG was the better ability of FPCs to comply with ever more stringent grid codes. However, today, both partial and full converters can be designed to satisfy 100% of grid codes. Is this statement true? If not, or explain why?

JPM: The lower grid connection costs of PMG-FPC equipped turbines represent a significant advantage over DFIG models. Efficiency and grid compliance are the top demands when it comes to generator