alphaDIRECT ADVISORS

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IN FOCUS: BALLARD POWER SYSTEMS IS PROPELLING UNMANNED VEHICLES WITH HIGH VALUE FUEL CELL SOLUTIONS

This report focuses on Ballard Power Systems Inc. (BLDP) and its work in the area of unmanned vehicles, including UAVs or drones.

Ballard FCair® -600 fuel cell system for powering UAVs or drones. *Source: www.ballard.com*

THE ALPHADIRECT INSIGHT

Ballard's advanced hydrogen fuel cell technology enables UAVs to fly approximately three times longer than with the leading battery systems. By decreasing the cost for users by as much as 90%, together with a growing commercial market, in our view Ballard is creating a clear competitive advantage within the commercial unmanned vehicle market.

BLDP Business Snapshot

Founded: 1979
Headquarters: Burnaby, Canada
Ticker: BLDP (NASDAQ/TSX)
Stock Price: USD$4.07*
Market Cap: USD$720M*
Website: www.ballard.com
**As of October 5, 2018*

BALLARD®

About *alpha*DIRECT EnergyTech Investor

alphaDIRECT Advisors (ADA), a division of EnergyTech Investor, LLC (ETI), is a Publishing and Investor Intelligence firm that creates and implements digital content and programs to help investors better understand a company's key drivers including industry dynamics, technology, strategy, outlook and risks as well as the impact they could have on the stock price. ADA's expertise encompasses a variety of sectors including Clean Transportation, Emerging EnergyTech, Energy Services, Smart Buildings, Solar, Water Value Chain and Industrial. ADA was founded by Wall Street veteran and research analyst, Shawn Severson, after seeing a significant shift in the investment industry that resulted in less fundamental research conducted on small cap companies and a significant decline in information available to all investors. ADA's mission is to bridge that information gap and engage companies and investors in a way that opens information flow and analytical insights.

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www.alphadirectadvisors.com
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Participants

Phil Robinson
Vice President – Unmanned Systems
Phil is Vice President – Unmanned Systems with responsibility for UAV power systems. He joined Protonex in 2005 to head the company's engineering department (Protonex was subsequently acquired by Ballard in 2015). Phil was involved in the earliest UAV power systems, developed for U.S. Air Force and U.S. Navy hand-launched UAV programs.

Phil is also active in UAV standards efforts, serving as Technical Lead for the ASTM F38.01 workgroup WK60937, Fuel Cells for Use in Unmanned Aircraft Systems (UAS), and as a charter member of the SAE E-39 Unmanned Aircraft Propulsion Committee – where he is involved in activities regarding fuel cell and hybrid battery propulsion systems. Phil has spoken at numerous conferences and events, on topics ranging from the technical aspects of hybrid systems to U.S. Government policies on innovation and acquisitions.

Mr. Shawn Severson
Founding Partner
***alpha*DIRECT Advisors**
Mr. Severson is the Founding Partner of *alpha*DIRECT Advisors (ADA), a division of EnergyTech Investor, LLC (ETI). He has over 20 years of experience as a senior research analyst covering the technology and cleantech industries. Prior to founding *alpha*DIRECT Advisors, he led the Energy, Environmental and Industrial Technologies practice at the Blueshirt Group. Mr. Severson was frequently ranked as a top research analyst including one of the Wall Street Journal's "Best on the Street" stock pickers and multiple awards as Starmine's top three stock pickers.

ABOUT BALLARD POWER SYSTEMS, INC.

Ballard is a Canadian public company headquartered in Burnaby, British Columbia, and is listed on both NASDAQ and the Toronto Stock Exchange under the ticker BLDP.

On October 1, 2015, Ballard acquired Protonex, which was a U.S. corporation headquartered in Southborough, Massachusetts.

Following the divestiture of non-core Protonex assets in 2018, Ballard maintains a focus on the unmanned vehicle sector.

For further information please visit www.ballard.com.

Phil Robinson, Vice President – Unmanned Systems
Source: www.ballard.com

Shawn Severson: First, I'd like to thank you, Phil, for taking the time to speak with us today. The last time we spoke with Ballard Power Systems, we discussed the Heavy-Duty Motive market with Ballard VP and COO Rob Campbell. Today our focus will be on Ballard's activities in the unmanned vehicle space, including UAVs or drones. Before we get started, could you give us a brief introduction of yourself and what brought you into the unmanned vehicle business?

Phil Robinson: Absolutely, and thanks, Shawn. I have a deep background within the startup community, mostly in the area of broadband communication systems in extreme environments. About 12 years ago Protonex called and asked me to help out with hydrogen fuel cells. I was confused as to why they called me since I didn't really know what a hydrogen fuel cell was at the time. Protonex explained that it was that exact reaction they were looking for, since the entire marketplace needed to adopt a different perspective. The fuel cell business was really good at doing academic work, but what I am really good at is creating markets and putting new products into those markets, so I ended up joining to head up the engineering and manufacturing operations, making small fuel cells. I've been at it ever since.

Shawn Severson: How did Ballard get into this space originally?

Phil Robinson: First, I should note that in the course of this discussion, you'll hear three terms used largely interchangeably: UAVs or so called unmanned aerial vehicles; UAS or unmanned aerial systems; and drones. Depending on who you're talking to, people might use one or more of these different terms. Consumers use the term drones, whereas commercial operators use the term UAVs. Defense operators tend to use the term UAS. We started working on UAS power systems more than a decade ago with both the U.S. Navy and the U.S. Air Force, putting these small fuels cells into many different applications, and onto quite a few "platforms", which is what they call different aircraft.

I think it's important to remember that the attributes of fuel cells, including light weight, high power density, no noise, low thermal signature, no vibration, and no emissions, are well suited for UAV applications.

The Naval Research Labs pushed several of these fuel cell powered platforms into the field over the past decade, and we had an opportunity to iterate and improve our systems dramatically over that period. At the same time, we were selected by Insitu, a subsidiary of Boeing, to provide a fuel cell power system for the ScanEagle platform. Insitu has been a great partner, and our work together has helped us further mature our fuel cell technology to operate reliably and at high performance. We have also worked with Lockheed Martin on its Desert Hawk UAV platform. Then about three years ago, Ballard acquired Protonex and its unmanned vehicle business and we were able to take our small fuel cell technology and leverage a lot of additional expertise from Ballard. Of course, for the most part, Ballard makes larger fuel cell systems, but the underlying technology, the MEA, is very much the same. This collaboration has resulted in further performance and reliability gains, which are really appreciated by our customers and partners.

About a year and a half ago, we saw commercial market applicability of this small fuel cell technology and so we decided to

create a new commercial group and product portfolio. We developed versions of the products for commercial use, which we call the FCair®-600 and FCair®-1200 and almost immediately started getting

Launch of Boeing Insitu ScanEagle UAV. Source: www.ballard.com

Initial commercial interest. These products generate 600 and 1200 watts of power, respectively. We received our first commercial order about a year ago and we now have a handful of commercial customers that are running our systems and integrating them into various prototype commercial UAVs.

Shawn Severson: Great. Thank you, Phil. Can you explain why you would even use hydrogen fuel cells in a drone or UAV, and can you specifically discuss the flight duration and reliability of the technology and the systems?

Phil Robinson: Absolutely. Our customers are typically commercial drone users or equipment providers that are frustrated by one or more of three different problems. The first problem is flight duration and range - since batteries simply don't support long flights. The second problem is limited propulsion system reliability associated with small internal combustion engines, which have a very short runtime between overhauls, and have a history of premature failures. And then the third problem is noise, again usually associated with small engines. As you probably know, most small drones today are powered by lithium-ion or lithium polymer batteries, and pretty much everyone has the same problem: the drone not being able to stay up in the air long enough.

This is particularly a problem for commercial operators. For a hobbyist, if the drone won't stay up for more than ten or 15 minutes, she brings it down and replaces the battery – and while it may be a pain, it's part of the hobby. However, for a commercial operator that has a thousand-acre field that she needs to scan, for example, if she must constantly bring the drone back for recharging, it is not only frustrating, this constant battery swapping is also very expensive. Commercial operators are losing an enormous amount of productivity in the time lost returning to "base", swapping batteries, and then flying back to the area of interest. So, one of the big frustrations is this limited flight duration and the range that results from that. The biggest benefit of the hydrogen fuel cell system is that we typically fly about three times further or longer than the best battery systems on the market today.

In the case of the ScanEagle, Insitu's platform, flight time wasn't the problem at all, since the aircraft has traditionally run on a small internal combustion engine. But, the little engines that are used in UAVs are small and light, really powerful, and they effectively eat themselves up and so it's necessary to overhaul these engines every couple of hundred hours. Well, that overhaul is very expensive, so it affects your operating cost. Additionally, while the average overhaul happens every couple of hundred hours, it's common for an engine to fail sooner than that. And then you have an

aircraft going down. Well, I can tell you that when a UAV crashes then nobody is having a good day.

Shawn Severson: Can you expand a little bit more on your target markets and industries for UAV applications?

Phil Robinson: Certainly, Shawn. Commercial UAVs are making tremendous advances. They are robots that fly. In the U.S., there are 1.6 million miles of oil and gas pipeline under DOT jurisdiction, every inch of which must be inspected every two weeks. We've got UAV partners that can increase inspection fidelity and decrease costs by as much as 90 percent compared to inspection by a manned helicopter, which is a pretty significant value proposition. In another example, some of our partners are scanning thousand-acre fields and identifying plant health of every single plant in the field. By doing this, water, fertilizer and pesticide usage can be reduced dramatically and crop yields increased at the same time. The UAV permits identification of problems early, and a small problem can be fixed before it turns into a big problem.

As another example power lines, wind turbines, bridges and radio towers, all need regular inspection and all of them present hazards to the inspectors. By letting commercial operators get the runtime they need to effectively perform the job using UAVs, they save money, but more importantly they save lives by allowing inspectors to stay out of dangerous situations. So, there's an enormous value proposition for these guys. The list goes on and on and there's lots of different industries that are being disrupted by UAVs today, but they in general have a common theme. They need more power than batteries can deliver, and they need more reliability than engines can deliver. And so, they're coming to us for substitutes.

Shawn Severson: Can we continue on that same line and talk a little bit about your market growth. We've seen an increasing numbers of drones in the consumer space, but also in the commercial UAV market. Do you see an increased demand within these markets over the coming years or in any other particular market?

Phil Robinson: According to several market studies I've seen, while the number of consumer drones shipped in 2017 far outweighed those shipped to the commercial market, the commercial market in terms of dollars actually exceeded the value of consumer drones for the first time. So, there's a smaller number of commercial UAVs, but they're far more expensive. The defense UAS markets are very large and are growing, but the growth is dominated by airplane sized drones. Traditional airplane engine technology works fine for platforms of this size, so they are really not part of the market we address. The hand launched and small defense UAS market is growing, but our focus is on the commercial space because we believe that's where the majority of the growth for the small systems that we're producing is going to occur over the next 3-plus years.

Shawn Severson: So, based on your answers, investors will ask about hydrogen infrastructure. Does the infrastructure availability limit the market at all or are there any other thoughts on that particular subject?

Phil Robinson: Early on, we recognized that we couldn't depend on infrastructure or somebody else to build it and we figured out that if we're going to provide a solution, we

had to provide the complete solution, including hydrogen infrastructure. Of course, there's a lot of those components that we don't make, but we've partnered with companies that make hydrogen storage tanks and lightweight regulators for example. And we also recently established a new partnership with a hydrogen gas distributor. This means that we can get a cylinder of hydrogen delivered to any commercial address in the continental U.S. within 14 days, which is obviously very beneficial.

When we're talking about hydrogen infrastructure, one of the big advantages we have over the automotive industry is that a regular hydrogen cylinder, which looks much like a welding cylinder, will power a drone for many flights but might not be enough hydrogen to fill up a car.

The result of one recent partnership that is pretty exciting and that we showed at the InterDrone Conference in Las Vegas last month, is a small portable electrolyzer – a machine that converts water to hydrogen – for customers that need to use these systems in areas where they can't get hydrogen delivered. So for example, we have customers that want to use our systems overseas or in very remote areas and with an electrolyzer, you can generate the hydrogen you need onsite and refuel your aircraft. Thus you get the duration advantages from fuel cell systems without actually carrying hydrogen to the flight location. It is our intent and strategy to provide the entire infrastructure solution together with the fuel cell system in the UAV, so early adopters don't need to become hydrogen experts

Shawn Severson: Is there an ROI argument for these commercial users when you talked about supplying a complete system relative to the existing technology?

Phil Robinson: The ROI is compelling. If you look at a traditional alternative that a commercial drone is replacing, the manned aircraft, for example, the ROI is positive on the eighth flight, which is during the first month of operation. There is an amazing cost savings aspect with these applications. When we start looking at the hydrogen system, the ROI is similarly going to be very quick because the hydrogen propulsion system makes such a significant impact on the commercial operator's costs.

When commercial drone users are going out now they're testing how they will operate, and they are discovering that yes, they have this really positive ROI if they can keep their aircraft in the air. Even when adding the infrastructure into the ROI calculations, it still typically takes less than a year to generate a positive ROI. For the vast majority of operators we're talking to, it's a no-brainer. This is something that pays for itself so quickly that it is easy for operators to make an investment decision.

Shawn Severson: Thank you. That was very helpful. We've heard about new FAA rules and experimentation leading to Beyond Visual Line of Sight or BVLOS commercial drone usage. Do you think the FAA is on track and do you have any other comments on that subject?

Phil Robinson: Absolutely. As you suggest the FAA rules are going to be absolutely critical for the commercial UAV market. In late 2016, the FAA legalized commercial UAV operations without a waiver, now known as Part 107 rules. Since then, over 100,000 Part 107 pilots have been licensed and the FAA has been incredibly proactive in developing

the new rules and standards we need to safely integrate commercial UAVs into our nation's airspace.

I met with Earl Lawrence, the FAA's director of Unmanned Aircraft Systems Integration Office in Washington D.C. recently. He is basically the head drone authority at the FAA. Earl and his team are committed to pushing forward rules that enable UAVs to go beyond the pilot's visual line of sight (BVLOS) as well as night operations and operations over populated areas. A major thing that they want to see from the industry is that we have the technology and the processes to execute these kinds of missions safely.

Key questions include: how do the systems interoperate; who has jurisdiction over what; and who is responsible when things go wrong? These are really important questions, and the answers will be critical to ensuring safe integration of commercial UAVs into the national airspace.

There's progress being made, but realistically we're probably two years away from seeing rules that will enable these types of missions without a waiver.

Shawn Severson: What do you think the main issues are that could slow down adoption and growth in the sector?

Phil Robinson: I think one of the most challenging areas will be standards. One of the things that enables an industry to grow is standards that multiple suppliers and users can depend upon. These standards ensure seamless interworking between vendors' equipment and confidence that the systems are safe to use. The good news is that we're seeing increasing efforts by the ASTM, SAE, and others to engage industry and generate these standards – I'm very encouraged.

Shawn Severson: One last question and kind of in a summary fashion, can you help us understand the main competitive advantages within unmanned vehicles and maybe compare to help investors understand why this is a growth industry and what the advantages are of this particular system and technology?

Phil Robinson: Really the competitive advantage of hydrogen fuel cell powered systems and Ballard hydrogen fuel cell systems in particular, compared to batteries is simple – the runtime. We get three times the range, which enables commercial service providers' business models to work. Similarly, we have a five-times reliability improvement over internal combustion engine UAVs. Ballard has the experience and expertise to bring these value propositions to commercial UAV operators, and we hear from customers that they are game changers for them and their business models.

Shawn Severson: Thank you very much for your time today.

SHAWN SEVERSON
FOUNDING PARTNER

Mr. Severson founded *alpha*DIRECT Advisors (ADA), a division of EnergyTech Investor, LLC in 2016 after seeing a significant communication and information gap developing between small and micro-cap companies and the financial community. Mr. Severson has over 20 years of experience as a senior research analyst covering the technology and cleantech industries. Previously, he was Managing Director at the Blueshirt Group where he was the head of the Energy, Environmental and Industrial Technologies practice. Prior to the Blueshirt Group, Mr. Severson was at JMP Securities where he was a Senior Equity Research Analyst and Managing Director of the firm's Energy, Environmental & Industrial Technologies research team. Before joining JMP, he held senior positions at ThinkEquity, Robert W. Baird (London) and Raymond James. He began his career as an Equity Research Associate at Kemper Securities. He was frequently ranked as a top research analyst including one of the Wall Street Journal's "Best on the Street" stock pickers and multiple awards as Starmine's top three stock pickers.

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