High-Tech Buffalo is Open for Business

By Jodi Ackerman Frank

Some time ago, a startup in a suburb of Buffalo, NY, found a simple way to increase energy conservation in laboratories on an unprecedented scale.

Isolation Sciences, founded by Charles Akers in 2010, developed and patented the Continuous Access Port (CAP) for laboratory fume hoods. A tough, clear and pliable plastic film that attaches to the bottom of the door of a hood, the CAP reduces the amount of air exhausted through the hood, conserving energy consumption by over 80 percent. The savings are significant considering that fume hoods nationwide consume more than $4 billion worth of energy every year.

"The product is so simple. Who would have thought that two ports connected to two little pieces of plastic and your basic clothing zipper could be an answer to major energy savings?" said Akers, a biophysicist by trade and an entrepreneur.

Yet, taking the next steps did not seem so simple: manufacturing, commercializing and selling the device to the masses.

So, Directed Energy, a cleantech business incubator funded by the New York State Energy Research and Development Authority (NYSERDA), made Akers an offer. The deal was that the incubator would "purchase" 30 CAPs. The company would have to find a way to manufacture the units and then sell them to actual customers.

"We helped Chuck Akers develop a business plan. A more important part of the process was buying a certain number of the product to get it out into the marketplace and to test whether people wanted it," said Martin Casstevens, who heads the incubator. "Isolation Sciences had been in business for a little while. It had just received a patent on the 'moveable port' technology, which turned out to be a very simple product, and it was on the verge of launching that product. We wanted to help the company excel in this next critical stage of development."

"It was crucial to have this funding to cover operational costs in determining the best way to manufacture these units and to find out the market value," said Akers, who initially made each CAP by hand, using off-the-shelf parts from retail stores. He used Directed Energy assistance in part to complete a manufacturing study, which included researching material costs and how long the whole process would take to produce 30 CAPs, from assembly to shipment.

Today, Isolation Sciences is working with three distribution corporations, including Siemens, the largest Europe-based electronics and engineering company that serves industries in the areas of energy, transportation and healthcare. Siemens, which has

Buffalo, NY

begun a nationwide "green initiative" in the pharmaceutical industry, has more than 3,000 research facilities under service contracts.

"These contracts are prime markets for us since the end users are already working with Siemens to lower energy costs," said Akers, whose company is generating revenue for the first time since it was established.

Cultivating a Cleantech Economy

Directed Energy, which operates through University at Buffalo's (UB) Office of Science, Technology Transfer and Economic Outreach (STOR), was established to cultivate and grow a sustainable-energy business cluster in Western New York. It is one of six business incubators funded by NYSERDA as a way to elevate a cleantech economy across New York State.

STOR also runs the University at Buffalo Technology Incubator (UBTI) at the university-owned Baird Research Park, a site that is composed of a 40,000-square-foot facility designed to help improve the success rate of high-tech startups. The facility's labs and equipment are available to regional entrepreneurs, as well as to faculty and students. In 2012, STOR opened an incubator in Buffalo Niagara Medical Campus to assist early-stage life science companies.

Baird Research Park is also home to Directed Energy, which reaches across 10 counties in the most western part of the State. Within these areas, Directed Energy has established partnerships with other universities, individual investors, business incubators and companies, including Insyte Consulting and Buffalo-Niagara Enterprise, both large business development and marketing consulting organizations.

Directed Assistance, the incubator's flagship program, assists startups with technical, business and financial support in a variety of ways, from prototype development and advanced testing to developing marketing strategies and production planning.

The incubator also has a SBIR Phase 0 program. Managed through Insyte, SBIR Phase 0 assists clean-energy companies in preparing high-quality Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT) proposals issued by the highly coveted federal grant programs.

Through these programs, Directed Energy typically offers grants between $2,000 and $10,000 to early-stage companies that are likely to accomplish notable goals with a small amount of funding. All the programs require cash matches and in-kind contributions. On occasion, a larger award is provided as an investment, which is paid back with royalties on product sales.

Martin Casstevens (l), director of the NYSERDA-funded Directed Energy incubator at the University at Buffalo (UB), meets with Scott Lee (r) and Brian Schultz of Dimien, a Directed Energy client company. The startup is commercializing a metal oxide-based material for smart window applications: the film allows heat to pass inside a building when the weather is cold and reflects the sun's heat when it's hot.

"We offer this money to help these companies further develop their technologies and to strengthen their product vision," Casstevens said. "They may decide to hire an engineer to help kick the tires on an emerging technology and provide an independent third-party evaluation. Or, they might decide to hire a consultant to do some market research so the company understands more about the related industry and customer base."

Or, in the case of OPtoElectronic Nanodevices (OPEN), such funding can help secure a lot more money.

A Little for a Lot

OPEN was founded in 2011 by three UB faculty members. The startup is developing a new nanoengineered solar-cell material that has been shown to enhance the conversion of energy in part by extending the useful range of the solar spectrum (notably the infrared region). The technology has a potential to significantly increase the efficiency of photovoltaic conversion.

The material is based on the company's patented Q-BIC™ technology, developed in cooperation with UB researchers and U.S. Army researchers. Q-BIC, which stands for quantum dot with built-in charge, can harvest a wider spectrum of solar radiation than traditional photovoltaic technologies.

Using Q-BIC as the photovoltaic absorbing material could mean thinner, lighter, and cheaper solar cells that could be affixed to everything from military backpacks and women's purses to vehicles and rooftops.

"The company's mission is to use our Q-BIC technology to develop next-generation solar cells with advanced nanostructures and license them to key manufacturers," said Vladimir Mitin, a distinguished professor in UB's Department of Electrical Engineering who serves as the company's acting CEO.

"In recent years, solar cell prices have fallen, and we have seen a consolidation of manufacturing in China. One strategy for the U.S. to remain a player in this industry is to develop the next generation of innovative products that clearly exceeds current product performance," Casstevens said.

In 2012, Directed Energy offered OPEN $2,000 to cost share the hiring of a consultant to help the company write a SBIR proposal. There are two phases to the SBIR awards. In Phase I, winning applicants are awarded $150,000-$200,000. In Phase II, applicants then have the opportunity to submit a second proposal worth about $2 million.

With an annual $2.4 billion budget, the SBIR is one of largest and most successful federal R&D programs. The program, which offers funding for early-stage breakthrough technology, is administered through 11 federal agencies, including the Department of Defense and the National Science Foundation (NSF).

The company completed a NSF Phase I SBIR project and has applied for a NSF Phase II award. The company is also negotiating a pending SBIR Phase I award from the U.S. Air Force that is directed at another facet of the technology.

> ***"Directed Energy has been a huge help to us," Mitin said. "We are academic researchers and our research has been funded for many years by the NSF and other government research agencies. But we have little experience in pushing our innovations forward as a product."***
>
> - Vladimir Mitin

"This is a way for us to take a small amount of State money and have these companies be more successful in the federal program," Casstevens said. "The agencies that are a part of the federal program fund a lot of energy research. We wanted every applicant in our region to have access to better resources to write winning proposals."

Investing in Buffalo

Directed Energy is part of New York State's focus to revitalize the economy in Buffalo and the surrounding region. In recent years, Buffalo, the second most populous city in the State after New York City, has bounced back as a leading center of advanced technologies and research.

This is due in part to major expansions at UB, the largest public research university in the Northeast, and the Buffalo Niagara Medical Campus, where a consortium of the region's premier health care, life sciences research, and medical education institutions resides.

One statewide initiative that Directed Energy feeds directly into is the Buffalo Billion. In 2012, Governor Andrew M. Cuomo made an unprecedented $1 billion commitment to spur a new-growth trajectory for jobs and investment throughout the Buffalo-Niagara region.

"Directed Energy is helping to drive innovation and to grow the cleantech economy not only in Western New York, but also across New York State. The public-private partnerships found within NYSERDA's incubator program are the cornerstone of Governor Cuomo's efforts to ensure New York's clean-energy economy continues to provide economic opportunities that will create jobs and make local communities more sustainable," said John B. Rhodes, President and CEO, NYSERDA.

To launch the Buffalo Billion initiative, the Governor commissioned the Western New York Regional Economic Development Council, with assistance from consultants at the Brookings Institution and McKinsey & Co., to create a strategic economic development plan to utilize the $1 billion.

The Council's Buffalo Billion Investment Development Plan, released in February 2013, leverages the region's longtime capabilities in advanced manufacturing and the talents of innovators. There is also a strong focus on entrepreneurship.

During UB Partners Day, an annual event in which UB celebrates its partnerships with the community and industry, Bruce Katz, Brookings Institution vice president, spoke about his organization's role in developing the Plan. He also offered initial findings about the state of the region's economy.

"After decades of depopulation, deindustrialization and decentralization, Buffalo faces challenges that are well known and well-studied. Yet, we have found some remarkable assets hidden in plain sight, ranging from advanced research and development at your universities to the disproportionate presence of advanced manufacturing and clean-economy firms." Katz said during the 2012 event. "Bottom line: There is a base to build on here that is special and holds real market potential."

Tapping into Hidden Gems

Robert Anstey, a lawyer and entrepreneur in Williamsville, is well aware of the market and manufacturing potential of Western New York. His company, Graphenix Development (formerly known as Graphene Devices) is tapping into the region's advanced manufacturing facilities and research centers to produce new products.

The company, founded in 2009 using technology licensed out of UB, has developed the Graphenic Intermediate Dispersion System (GRIDS)™. This proprietary method provides an efficient and cost-effective way to disperse graphene-based materials into conductive inks to increase their conductivity to enhance a wide range of technologies.

These technologies include printed electronics, lightweight sensors and advanced ultracapacitors — the latter of which one day might power electric cars. Conductive inks are used in printed circuitry, which is already replacing bulkier components in vehicles and many electronics.

Graphenix Development has executive space at IIMAK, a large ink company in the Buffalo suburb of Amherst that manufactures fluid inks for the printed electronic industry, thermal transfer ribbons, barcode ribbons and direct-thermal films. In partnership with the ink company, Graphenix has incorporated its GRIDS process to double the conductivity of IIMAK's conductive carbon inks. IIMAK's "graphenic ink" was launched in December 2012. More than 20 companies from around the globe have already indicated interest in the product.

Directed Energy played a pivotal role in Graphenix's ability to launch its ink product. By providing a grant to "buy" ink formulations identified in the development plan between Graphenix and IIMAK, Directed Energy allowed the company to meet product development milestones.

"This funding helped guarantee that the product's development would proceed on or ahead of schedule and meet or exceed performance targets," Casstevens said.

Graphenix also has a 2,000-square-foot research and manufacturing facility at Eastman Business Park in Rochester that allows the company to work more closely with Kodak to manufacture a coating for a graphene-based ultracapacitor. The advanced ultracap is expected to be launched within the next 18 months.

"We are working with Kodak to manufacture ultracaps in a similar way that Kodak manufactures film for cameras — layer by layer, roll-to-roll, at high speeds," Anstey said. "It's not just a material process that we've developed, but also a manufacturing technique that uses Kodak's existing infrastructure. We can use the same sort of equipment to control chemistry and the coating."

Energy Efficiency in Industrial Buildings

While Graphenix has turned to Buffalo's existing manufacturing infrastructure to support its product development, another company supported by Directed Energy is helping similar types of facilities to keep the lights on in the most efficient way possible.

S3J Electronics is a company in Lancaster that makes customized and retrofit light-emitting diode (LED) bulbs and fixtures primarily for warehouses and manufacturing facilities. Established in 2009, the company first rented office space at Baird Park before settling in its current location.

Over the last several years, S3J has secured a number of large projects that has already proved smart savings for its clients. The company's first client was Allied Frozen Storage, a third-party warehousing and logistics company, with multiple locations in Western New York.

"All the inherent benefits of LED lighting naturally work out for cold storage — LEDs work better than traditional lighting in cold environments," said company cofounder Jamie Fannin.

"With a little funding, we were able to have a successful startup because we focused on the low hanging fruit – the immediate reachable projects. And cold storage was one of them," added Muk Musleh, a project engineer who has been with the company since the year it was founded.

More recent installations include a project at the Ford Motor Company facility in Hamburg, NY, in which S3J replaced metal halide fixtures (the industry's standard bulb) with LED fixtures. The new fixtures increased light levels by almost double. The end result on the $2.7 million project was a 75 percent energy reduction, with a payback of less than two years.

National Grid, which awarded Ford Motor an energy-reduction grant of $1.35 million for the project completed in 2012, estimates the annual energy savings to be 10.7 million kWh, the equivalent to powering 1,400 homes annually.

S3J also is working with Staroba Plastics in Holland, NY, to upgrade the lighting in its factory. The switch from incandescent high-bay lighting to LEDs is expected to save the company $84,000 annually, with energy use reduced by 75 percent. New York State Electric and Gas (NYSEG) is contributing 50 percent of the overall project cost.

S3J also has a contract with the New York Department of Corrections to supply outdoor LED lighting to each of the State's 69 correctional facilities.

Directed Energy continues to assist S3J's growth as the company proceeds in product innovation and becomes more of a manufacturer and vendor of products that are installed by other companies and contractors.

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>
> - Martin Casstevens

Helping Companies Tell Their Stories

Casstevens has a diverse skillset as a scientist, technologist and serial entrepreneur. His academic background is in biophysical sciences. He has headed three companies, largely in the fields of photonics, materials and biomedical instrumentation.

In addition to his Directed Energy obligations, he serves as the business formation and commercialization manager for STOR and is therefore well versed in the patenting, technology transfer, and government grant proposal processes. STOR, which handles all the intellectual property of the university, reviews about 100 new technology disclosures every year.

Casstevens is also a teacher at heart. It is second nature for him to grab a whiteboard to help explain in layman's terms a sophisticated technology in a step-by-step process.

These professional skills point to Casstevens ability to tell a good story in a way that few highly technical CEOs of new companies know how to do right off the bat. "If you're going to attract investors or partners, you need to tell your story — that is, what your company has to offer and what makes it unique — very clearly," Casstevens said.

Sensordrone, which easily fits on a keychain, is a multisensor device developed by Sensorcon that collects and then transmits environmental data for analysis and display on a smartphone or tablet via Bluetooth. Several apps have already been created that turn the Sensordrone into a carbon monoxide monitor, weather monitor, and propane and other gas detectors — all in one device.

For Mark Wagner, telling a story in a simple way has been especially important, considering his flagship device can accommodate countless sensor applications, ranging from temperature and air-quality gauges to a variety of toxic-gas detectors.

Wagner, founder of Sensorcon, developed the Sensordrone, a patent-pending device with multiple sensors that collects and then transmits data displayed on a smartphone or tablet via Bluetooth.

The Sensordrone unit is about the size of a thumb drive and fits onto a keychain. Its internal sensors monitor temperature, weather, gas concentration and light, and can also connect to water quality and other sensors. The open-source technology allows consumers and commercial software developers to create apps using all the sensors' tractable capabilities. Several apps have already been developed that turn the Sensordrone into a carbon monoxide monitor, breathalyzer, and propane and other gas detectors — all in one device.

"The biggest challenge is getting consumers to understand that Sensordrone does multiple things," Wagner said. "At first we said, 'Look at all the things you can do with this device.' But we realized that we really needed show people simple, single-purpose apps first."

NYSERDA has been interested in the Sensordrone as a way to develop an inexpensive wireless parking garage monitoring system

that measures carbon monoxide levels. During research under a NYSERDA grant, Wagner and his company team realized that the device could be used for energy applications in the smart-building arena, such as controlling heat or air-conditioning output to help maintain buildings more efficiently and provide a more comfortable environment for its occupants.

In 2012, Sensorcon won the grand prize for its device in NASA's Create the Future Design Contest. The device, which can be purchased on Amazon.com, has also caught a notable amount of attention on Kickstarter.com, a crowdfunding website where Sensorcon raised $170,000 for developing the product — far exceeding the company's goal of $25,000.

This rendering shows the GRoW (Garden, Relax or Work) House, a solar-powered home that University at Buffalo students are building as one of the 20 collegiate teams across the country competing in the Solar Decathlon competition, organized by the U.S. Department of Energy.The Solar Decathlon, organized by the U.S. Department of Energy (DOE), is a biennial program that challenges collegiate teams across the country to design, build and operate solar-powered houses that are cost effective, energy efficient, and attractive.

Extending the Pipeline – a Focus on Students

Part of Directed Energy's mission is to develop partnerships throughout the region to support student innovations for a green economy. One way it is doing this is by contributing as a sponsor (along with the Research Foundation for The State University of New York) to support the Solar Decathlon project team, which is headed by Martha Bohm, assistant professor of architecture at UB.

Because of the complex and lengthy application process, Bohm has worked with Directed Energy to divide the national competition into two parts. Phase I, incorporated into a semester-long seminar class, consists of small teams of students that compete with one another in developing concepts and schematic designs. In Phase II, students receive $50,000 to make their architecture design a reality.

In February, the DOE chose the UB student team as one of the 20 finalists to participate in the Decathlon competition. The UB team will build what it has called the GRoW (Garden, Relax, or Work) House, a 1,400-square-foot home that will include a large green-house and kitchen, designed to grow, process and store food. The UB team will build the GRoW House in Western New York, ship it to California for judging, and then bring it back to Buffalo for permanent installation.

OPtoElectronic Nanodevices

Advancing the Photovoltaic Industry

Researchers have long explored ways to incorporate quantum dots in solar cells to increase efficiency in photovoltaic technology. But success has been limited.

OPtoElectronic Nanodevices (OPEN), a client company of the NYSERDA-funded Directed Energy business incubator, believes it has fixed this problem with a new material called Q-BIC™, which stands for quantum dot with built-in charge.

Quantum dots are nanoparticles of semiconducting materials, each just a few billionths of a meter wide. At this size, the crystal particles contain vastly different optical and electrical properties than their corresponding bulk material.

Although adding quantum dots in a variety of materials has shown a substantial increase in energy harvesting, an increase in a quantum physics phenomenon called "recombination" cancels out these energy advancements. Essentially, the quantum dots absorb much of the energy created by the matrix material. This absorption translates into wasted power through heat instead of electricity.

Q-BIC is based on added "impurities" in the semiconductor-based materials that offer an additional negative charge into the quantum dots. This negative charge creates barriers that prevent the electrons from being absorbed by the quantum dot. Instead, the electrons, produced by the energy of sunlight, are repelled from the dots to be collected as electricity in the external circuit. "We discovered that if we charged quantum dots and then we control the charge along with placing these special impurities, we are not only able to produce energy from infrared light, but we can also reduce recombination significantly," said Vladimir Mitin, a professor in the Department of Electrical Engineering at the University at Buffalo who serves as the company's acting CEO.

Using quantum dots with a built-in charge as the absorbing photovoltaic material offers the potential to replace traditional solar-cell materials such as silcon, which is less efficient.

One unique benefit of these quantum dots is that they can be "tuned" across a wide range of energy levels simply by changing their size. This technique reduces the need to add additional layers in multi-junction solar cells.

In multi-junction cells, a variety of materials are used, with each layer (typically three) absorbing different wave lengths, allowing energy to be harvested from different regions of the electromagnetic spectrum. This makes solar panels more efficient (up to 40 percent). But the solar panels are expensive and difficult to manufacture.

OPEN uses gallium arsenide and indium arsenide, which are conventional solar cell materials (along with other materials that serve as "impurities") to create its Q-BIC product. But many other materials could work, according to Mitin.

The team, which has spent $3 million over the last five years to develop its product, is collaborating with the U.S. Army Research Laboratory in Maryland to further improve its material for efficient solar cells.

"An effort of this magnitude typically costs close to $1 million and is a very potent community rallying point," Casstevens said.

The process will be well documented and shared with other campuses and communities. UB engineering students as well as students from the SUNY College of Environmental Science and Forestry in Syracuse also are taking part in this project.

"It's a tremendous experience for our students because they learn how to build a house using some of the most cutting-edge technology and residential construction. So, there's a lot of freedom for exploration not only for sake of technology, but also for design," Bohm said.

"It is this kind of entrepreneurial culture that we need to continue to foster throughout UB and our community at large," Casstevens said. "An overarching goal of Directed Energy is to encourage new thinking to bring us that much closer to a successful cleantech movement throughout Western New York."

Graphenix

Graphene — the Energy Booster for Better Storage

Rob Anstey founded his company Graphenix Development on the premise that graphene-based inks will become the material of choice for next-generation devices that will power everything from wind turbines and solar panel energy storage to electric cars and cell phones.

Graphene is a nanomaterial that consists of a single layer of honeycomb-patterned carbon. The thinnest material known to science, it is lightweight, conducts electricity, and is nontoxic. It is 100 times stronger than steel of the same thickness. In bulk form, the material is known as graphite from which pencils are made.

Since it was first isolated as a separate material in a lab in 2004, graphene has attracted considerable attention because of its remarkable optical, mechanical, thermal and electrical properties in addition to its high surface area, which makes it useful for energy storage.

Graphenix has developed a method called Graphenic Intermediate Dispersion System (GRIDS)™, which provides an efficient and cost-effective way to prepare and disperse graphene into conductive inks to increase conductivity.

"Currently, our company is built around a simple and inexpensive process through which graphene can be dispersed into a black liquid," Anstey said. "That liquid can be used as a superconcentrate for conductive inks. In addition, you can use this black liquid as a coating to give you a high-functional ultracapacitor that can store more energy than standard ultracapacitors."

Incorporating graphene in conductive ink can double its conductivity. But mixing graphene into a liquid-based coating hasn't been easy or cost effective. That's because graphene's neat single layers tend to agglomerate in liquid. The GRIDS method fully mixes the graphene in a solvent-based solution.

Using GRIDS, Graphenix is also working on ways to increase storage capacity in ultracapacitors to replace lead acid batteries altogether, making an ultracap that can store three or four times more energy than the ones produced now. Such advances in ultracaps, which range from the size of a small fingernail to a car battery, could some-day power electric and hybrid cars without the use of a battery. The U.S. Army and Navy have funded the company for research development in graphene-based materials.

"If you could charge an electric car in the same time it took to fill up gas, that could pave the way to a better market for electric vehicles, especially if you could charge your car in about four minutes instead of hooking it up overnight for eight hours. However, in the near term ultracapacitors will work with lithium-ion batteries," Anstey said.

Capacitors are like batteries in that they store and discharge electricity, but they charge and discharge power much faster without reducing their operational life. (Conversely, rapidly charging and discharging in general can significantly diminish the life of batteries.)

Current ultracaps store only a fraction of the electricity that a battery does — and that's where the problem lies. Ultracapacitors are next-generation capacitors that store more energy and outcompete batteries in a number of applications.

When combined with a battery, an ultracapacitor can better manage sudden energy demands that would normally be placed on the battery, lengthening the battery's operation. Ultracaps are already used to support batteries in a wide range of electronics, and companies are beginning to incorporate ultracaps in wind turbines.

Graphenix has focused on using graphene-based materials to improve ultracaps for a number of reasons. First, they can be recharged continuously, usually over the lifetime of an electronic device, unlike batteries that often must be replaced multiple times in the same device. Ultracaps are also more environmentally friendly.

"We think that advanced ultracapacitors could truly change the energy storage market and industry," Anstey said.

NYSERDA Business Development Efforts

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5/14