

MARS

A Quarterly Publication

Future of Energy
& Environment

REMOTE CONTROL FARMING
IS COMING TO A PRAIRIE NEAR YOU

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MaRS is a journal conceived to reflect the creative spirit of our urban innovation hub, as well as the cultural and economic diversity of Toronto, the singular city in which MaRS is based. The mission of the magazine is to examine both new ways of thinking and new ways of doing things, from scientific research to technological advancements, always with a view to improving the human condition. MaRS maps innovation and highlights how it touches our lives.

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REMOTE CONTROL FARMING IS COMING TO A PRAIRIE NEAR YOU

BY CHRIS TURNER

Saskatchewan farmer Trevor Scherman with Farmers Edge weather station

If you haven't visited a farm on the Canadian prairie lately, the scale of 21st-century agriculture can seem staggering. Take Trevor Scherman's spread: 4,400 acres south of Battleford in central Saskatchewan. That's more than four times the area of Vancouver's Stanley Park, so if he needs to stop his tractor and wait for a hired hand to bring him more seed, it can take a while.

Managing a farm of such size is all about efficiency. On Scherman's smartphone is a single app created by a company called Farmers Edge, which gives him access to a range of data and management tools unimaginable even 10 years ago.

Farmers Edge gathers data from three weather stations right on Scherman's property and five others on neighbouring farms, and crunches the numbers to let him know if there's a wind headed his way that might disrupt pesticide spraying. The app contains a gridded map

of his farm, combining precise information drawn from satellite imagery with soil samples taken from each square on the grid.

All this information is fed into a predictive model built on data gathered from the 50 million acres worked by Farmers Edge clients across western Canada. It then tells Scherman's self-steering tractor how much seed and fertilizer is needed, grid square by grid square. The app also schedules his hired hands and tracks his finances.

Farmers Edge has replaced multiple weather apps on Scherman's phone and any number of websites, spreadsheets and downloaded files on his computer back at the farmhouse. In the seven years Scherman has been the company's client, he has watched inputs drop and yields climb. He now spends the same amount of money to produce more — and saves time and many headaches along the way.

"I've been able to wake up in the morning," he says, "and, with the weather stations Farmers Edge has installed on my land, I know if I'm going spraying at four in the morning or if I'm going to my son's ball game that day.

"Before, you used to wake up and drive all around the country and check rain gauges to see how much rain we got, so you could make your decisions. Well, it was noon before you figured out what you were doing."

“ WITH THE
**WEATHER
STATIONS**

FARMERS EDGE HAS INSTALLED
ON MY LAND, I KNOW IF I'M
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MY SON'S BALL GAME THAT DAY. ”



BIG DATA TAKING ROOT ON THE FARM

This is what Big Data looks like down on the farm — and it's spreading fast across the entire cultivated world. Farmers Edge, founded by a pair of Manitoba agronomists in 2005 and based in Winnipeg, is growing at Silicon Valley speed — and with some of its money.

The legendary Silicon Valley venture-capital firm Kleiner Perkins Caufield Byers was an early investor back in 2014, later joined by a Japanese commodity trading firm in a \$58-million financing round. They were bought out late last year by Canadian investment giant Fairfax Financial (a major investor in BlackBerry), signalling a pivot from startup to going concern. Two years ago, the company's app and data-crunching tools were in use on 600,000 acres of farmland. Today, the number is six million, with substantial

market penetration in western Canada — nearly one-tenth of all land in cultivation on the prairie is now managed by Farmers Edge clients — and new growth in Australia, Brazil and eastern Europe.

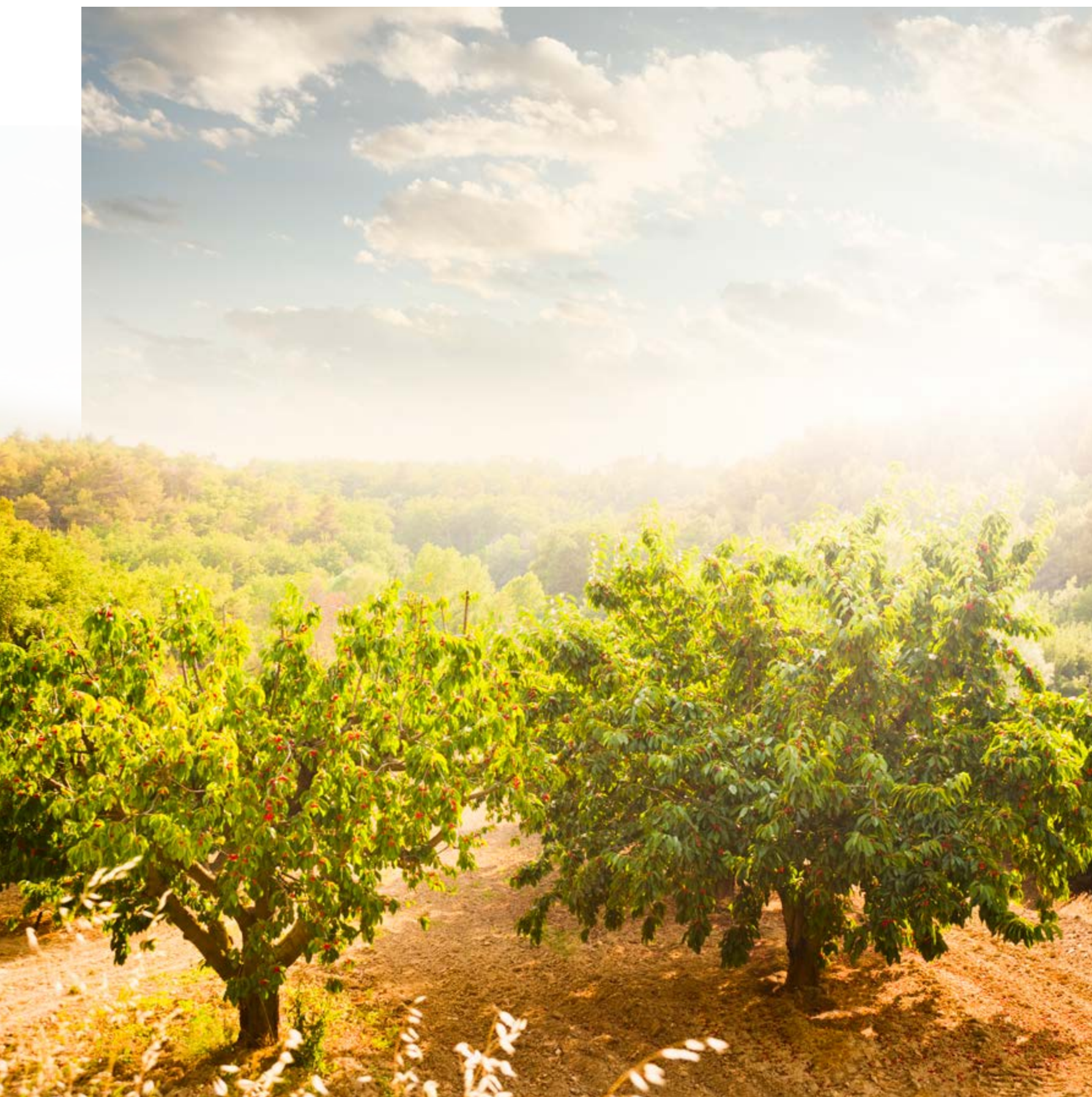
“We're collecting the right data to help make better decisions on the farm,” says Bruce Ringrose, the company's head of sustainability. “The result for the farmer is economic benefit while also reducing the environmental impact.”

“**FARMERS IN GENERAL
REALLY HOLD SCIENTISTS AT
HIGH VALUE... THEY BELIEVE**

SCIENCE

CAN SOLVE A LOT OF THEIR RISKS.”





FARMERS: THE EARLY ADOPTERS OF THE PRAIRIES

Farmers Edge joins a fresh crop of ambitious high-tech companies taking root in the agricultural sector. Whereas it has developed tools for managing a whole farm, other companies are using Big Data and digital communications to solve much more specific problems.

Contrary to stereotype, farmers are open to change when they encounter the right kind of technology — after all, their GPS-guided tractors made them very early customers for autonomous transport.

“Farmers in general really hold scientists at high value...,” says Michael Gilbert, founder and chief executive officer of Semios, a Vancouver-based company that provides pest control to the lucrative global orchard market. “They believe science can solve a lot of their risks.”

In commercial orchards, highly lucrative tree crops such as cherries and almonds have long relied on regular physical inspection to alert growers to insects, disease and other threats. A class of bio-pesticides called “pheromones” has long been known to be very effective, but needs to be applied repeatedly each day to be effective.

What’s more, wireless communications can’t be used to trigger the application devices because the high volume of water in fruit trees’ leaves soaks up the signals. To solve this problem, Semios developed its own sensors and wireless network, which it then paired with its pheromone-delivery system. Knowing its customers don’t want a pile of new electronic gear to maintain, the company packages it all as a subscription service.

“We own the hardware and we own the network and we manage it all for the customer,” Gilbert explains. “And all we sell them is the science.”

THE FUTURE OF FARMING: LESS WASTE, FEWER CHEMICALS

Next-generation science is even changing the future of farming at the molecular level.

Frontier Agri-Science, a startup that emerged from the University of Toronto, is developing new strains of drought-tolerant grain based on a protein identified by company founder Julian Northey that determines a plant's ability to handle stress.

Frontier hopes to boost tolerance to drought, pests and other stresses by selectively breeding plants to be high in the protein, but without genetically modifying them. Its first field trial — a variety of durum wheat the company hopes could increase yields by up to 20 per cent in drought conditions — began in the United States this spring. If it's successful, the new wheat could be planted commercially in western Canada within five years.

Frontier also intends to use a “pay as you grow” model — a sort of royalty based on annual yields. This approach is a rebuke to the global agribusiness model often employed by conglomerates such as Monsanto. They sell seeds that don't reproduce, meaning farmers can't save some of their harvest for the next planting. “I don't know if I ethically agree with that,” Northey says.

“MACHINE LEARNING

LOOKS LIKE THE DAWN OF A BRIGHT FUTURE, WHERE LESS MONEY AND SEED ARE WASTED, FEWER CHEMICALS ARE NEEDED, AND HIGH-PRICED EXPERTISE CAN BE APPLIED WHERE IT'S MOST VALUABLE. ”

The future of commercial-scale farming can seem daunting — larger and larger farms run by fewer and fewer people, a world in which reams

of data feed autonomous machines that gather yet more data to figure out solutions as they operate.

It also raises the previously inconceivable possibility of farm production being halted by cyberattack. There have been few incidents to date, but security agencies, including the FBI, worry the risk is growing as farmers rely increasingly on connected technologies.

“Farmers now need to consider carefully who they're partnering with to protect and back up their data — their business depends on it,” says Tanya Rosemarin, a vice president at Chubb Insurance, a global leader in technology insurance.

But to the industry's pioneers, this “machine learning” looks like the dawn of a bright future, where less money and seed are wasted, fewer chemicals are needed, and high-priced expertise can be applied where it's most valuable.

FARMS ARE FERTILE GROUND FOR REMOTE CONTROL

Consider how Farmers Edge has begun to use its staff agronomists — those old-school experts who gather and analyze soil samples and figure out what farmers need to do to boost their yields. The data collected to feed the company's soil-nutrient modelling has reduced the need for gathering soil samples from every field each year. This allows the company to focus its human expertise on new clients and new markets where it has less data on hand.

Back in the fields, where is all this automation and data crunching going to lead? “I think remote-control farming is coming,” says Bruce Ringrose of Farmers Edge.

Strange as it may seem, there are now few places better prepared for remote control than the farm.

HIGH TECH TAKING ROOT ON THE FARM

TO PROTECT VULNERABLE FRUIT TREES

farmers use automated pheromone dispensers and pest traps, soil moisture and leaf-wetness metres



SCIENTISTS ARE BREEDING NEW STRAINS OF PLANTS

resistant to stresses like drought and pests without genetically modifying them

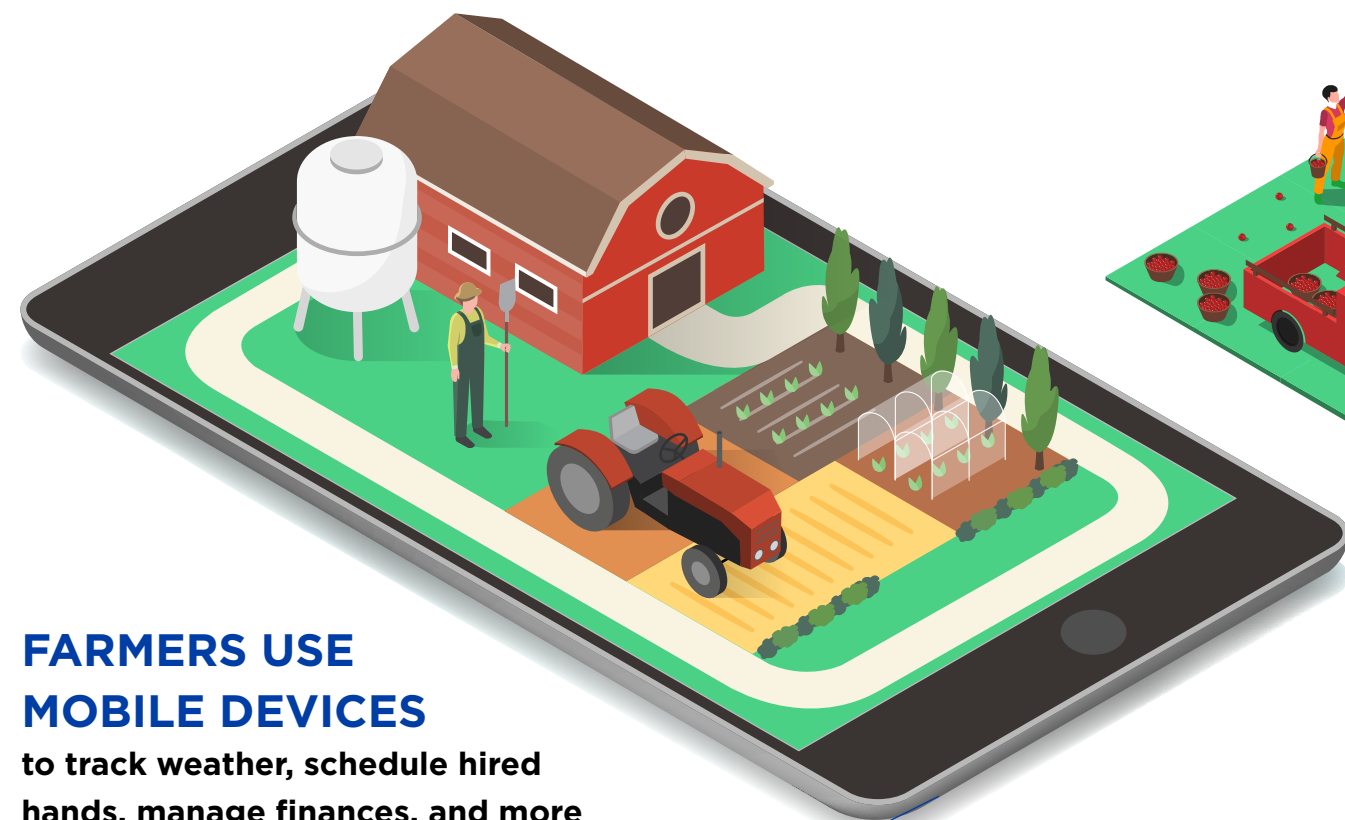
WEATHER STATIONS

throughout the farm provide current conditions, 10-day forecasts, historical weather data and more



FARMERS USE MOBILE DEVICES

to track weather, schedule hired hands, manage finances, and more



SELF-STEERING TRACTORS

can be programmed remotely to precisely sow seed and fertilize at the optimum time



GREENING THE FLEET:

Driving efficiency
in the heavy
transportation sector

BY JOHN BARBER

Jack MacDonnell, CEO of EnerMotion



Heavy trucks rule the roads of the industrial suburbs north of Toronto's Pearson airport — jamming traffic, fouling the air and shattering whatever peace may once have existed here in the engine room of the Canadian economy. This is not a place for the eco-conscious. But it serves as a useful dose of modern reality, a reminder of facts that many people — including government regulators — have long preferred to ignore.

Greenhouse-gas emissions from Canada's transportation sector rival those of the Alberta oil sands — the country's single greatest source. Between 1990 and 2015, emissions from the freight truck fleet tripled. In fact, diesel-powered trucks now cause more pollution than coal-fired power generation, and yet the federal government still has not announced the tighter regulations promised.

“ **DIESEL-POWERED TRUCKS NOW CAUSE MORE POLLUTION THAN COAL-FIRED POWER GENERATION** ”

But not everybody is waiting for Ottawa to act. Here in the midst of the din, one bold startup is perfecting technology that promises major gains in the efficiency of long-haul trucks. Using heat energy from the exhaust of diesel engines that otherwise goes to waste, EnerMotion Inc.'s “Hyper” unit is able to supply emission-free cooling and heating to the trucks' cabs. Hyper improves fuel efficiency and eliminates the need for constant engine idling during rest stops.

Had he known it would take nine years to bring the product to market, “I probably wouldn't have done it,” admits Jack MacDonnell, EnerMotion's chief executive officer. But the first factory-made Hyper

boxes are now rolling off an assembly line at auto-parts giant Linamar in Guelph, Ont., and undergoing final testing in some of the largest trucking fleets in North America.

EnerMotion's biggest challenge in attracting investors was its ambition to build “a box, a physical product,” rather than software, according to MacDonnell. In a world where new apps from Silicon Valley can make instant millionaires, manufacturing in Ontario is not the sexiest proposition for investors. But with an advanced industrial infrastructure and abundant technical support available for the project — and despite the boss working without pay for five years — Toronto served the unorthodox startup well. “Because of our focus on clean energy, this has been the right location to be in,” MacDonnell says.



“ **IN A WORLD WHERE NEW APPS FROM SILICON VALLEY CAN MAKE INSTANT MILLIONAIRES, MANUFACTURING IN ONTARIO IS NOT THE SEXIEST PROPOSITION FOR INVESTORS.** ”

TORONTO IS DRIVING INNOVATION IN HEAVY TRANSPORTATION

EnerMotion is not alone. The Toronto area has become a hotbed of innovation in the often-overlooked but critical effort to bring clean technology to heavy transportation:

- In Mississauga, Hydrogenics Corp. has become a world leader in the development of propulsion and storage systems for hydrogen fuel cells.
- In Don Mills, startup manufacturer inMotive is developing an automatic transmission that promises to make electric vehicles significantly more efficient than they already are.
- Downtown at innovation hub MaRS Discovery District, startup TransPod is planning a Canadian entry into the race begun by pioneering entrepreneur Elon Musk to develop a high-speed vacuum-tube train — the so-called Hyperloop.

- And at an airfield near Brantford, just over an hour outside of Toronto, Solar Ship Inc. is testing a hybrid aircraft — part blimp, part plane — designed to lower the cost of delivering heavy cargo, such as emergency supplies, to the world's most isolated regions.

All located in Toronto and the surrounding area, these companies are also united when it comes to global reach. To test its new transmission, inMotive has teamed up with a major South Asian automaker. TransPod received its first round of funding — \$15 million — from Italian high-tech holding company Angelo Investments. Hydrogenics fuel cells are powering a new zero-emissions train that is built by Alstom in France and operating in Germany. And Solar Ship is working with a freight hauler in central Africa to provide that region with disaster relief.

FINDING SUCCESS BY REFINING EXISTING PRODUCTS OR DISRUPTING OTHERS

With international connections built into their DNA, the companies are finding new ways to make the perilous journey from inspiration to commercial success, a road Canadian entrepreneurs have often found blocked in the past. The projects are as diverse as they are far-reaching, ranging from targeted refinements of existing technologies to plans for revolutionary disruption.

“**THE TORONTO AREA HAS BECOME A HOTBED OF INNOVATION IN THE OFTEN-OVERLOOKED BUT CRITICAL EFFORT TO BRING CLEAN TECHNOLOGY TO HEAVY TRANSPORTATION.**”

EnerMotion has chosen the former: “There’s always emerging technology,” Jack MacDonnell says, “but you can’t replace infrastructure overnight.” Cleantech visionaries describe a future of electric-powered trucks that drive themselves. “But what do you do during the transition period of 20 to 30 years?” he asks. “You have to do something now, and this technology does something right now. That’s what’s important.”

At the other extreme, replacing infrastructure overnight — to “disrupt and redefine” commercial transportation in general — is exactly what Sebastien Gendron, the young founder and chief executive officer of TransPod, plans to do.

“The bigger it is, the better chance we have to bring it to fruition,” he says. “The stars are aligned at the moment, especially in Canada. So we are pushing forward.”

HIGH-SPEED, LEVITATING TRAINS BY 2025

With 30 employees in Canada and Europe, the company expects to have its first line — a magnetically levitated and propelled tube train that can travel between Montreal and Toronto in 30 minutes — built and running as early as 2025.

“Many people are telling me that Canadians are risk-averse,” Gendron says. “I disagree with that. I still think there is room for innovation — more than we think here.”

What’s missing in Canada, he adds, are investors willing to finance home-grown innovations. “I think we can change that.”

Paul Bottero, co-founder and CEO of inMotive, is not so sure. Innovation, he says, is plentiful. But his firm is a “textbook example” of Canada’s failure to commercialize its own inventions. “We can’t say enough about how well the Canadian ecosystem supports innovators,”

Bottero says. “In our sector, there’s a lot of technical knowledge here, a lot of support in terms of fabrication, testing and so on. But the commercialization piece happens elsewhere.”

In his case, Bottero adds, the reason is simple: “There are no car companies headquartered in Canada,” he explains, “and the major decisions around something as important as a powertrain typically happen where the centres of power are.” For inMotive, that means India, where its transmission is now being tested in electric vehicles made by one of Asia’s largest auto manufacturers.

ROADBLOCKS ON THE WAY TO LAUNCHING THE “FLYING TESLA”

Solar Ship founder Jay Godsall has run into more complicated roadblocks on his decades-long quest to build what he calls a “flying Tesla” — a helium-filled

blimp that can manoeuvre like an airplane. Being powered by hydrogen fuel cells and the sun allows it to be fully autonomous, operating far from roads or runways.

“The biggest hurdle is not so much money as doubt,” he says. “Your greatest drag coefficient on your business is being around a bunch of people who don’t believe you can do it, even if you show them all the things you can do.”

Canada is “a great place to come up with ideas,” he adds. “The universities are stacked full of fabulous people and, once you’re up and running, this is a fantastic place to own and operate a business. But it’s a really terrible place for support of its own innovations.”

While Godsall says local investment remains sparse, he adds, “global money likes Canada, so I think the clear message for innovators today is, ‘Do not stick to home.’”

And the message for local investors is that perhaps it’s time to recognize what the rest of the world already seems to know: You have to start somewhere, and the Toronto region’s growing expertise, established industrial base and advanced skills in new technology have made it one of the world’s best places to do just that.



Rendering of TransPod train



WE ARE DROWNING IN PLASTIC WASTE. CAN TECHNOLOGY SAVE US?

BY DAVID PATERSON

In the three decades since Canada pioneered blue box recycling, similar systems have become familiar sights in cities throughout the developed world. But the rise of recycling disguises an awkward truth: only 10 per cent of the plastic produced globally is put back into use. Even in a rich nation like Canada, where all but the most isolated communities can recycle, plastics are recovered at a much lower rate than materials like paper and metal.

Now technology is rising to meet the challenge posed by the enormous heap of plastic discarded into the environment every year, as well as materials that are collected but end up in landfill because they can't be recycled economically.

FISH SWIMMING THROUGH OCEANS OF PLASTIC

How big a predicament is plastic? Scientists estimate that up to

12 million metric tons of plastic is swept into oceans every year, a problem highlighted by the recent discovery of two vast garbage patches in the once-pristine Arctic Ocean to go along with those already polluting the Pacific.

The recycling of plastic is improving so slowly in part “because there isn't an easy rule for people to follow,” says Ashley Wallis, a program manager with Environmental Defence, a Canadian non-profit agency.

One problem is that so many varieties of plastic are in use; another is the fact that municipalities have different rules. For example, Toronto residents can recycle white plastic forks but not black ones, while in neighbouring Mississauga, both types go in the trash because they're too small for that city's sorting machinery.

RECYCLING CAN BE LIKE A SPIRAL OF DECLINING VALUE

Recycling programs are picky because not all plastics can be treated the same. While some, such as water bottles made of polyethylene terephthalate, or PET, are relatively easy to recycle, others, such as ketchup bottles, contain multiple layers of plastic that are much more difficult to process.

In many cases, instead of material fit for new products, recyclers end up with a gloop containing contaminants that affect its colour, clarity and other physical properties. Cleanliness can also be an issue. For example, very few Ziploc bags are recycled. Those that are — just 0.2 per cent — are collected via grocery-store drop-off boxes because those found in curbside bins are generally too dirty to make a valuable product.

So, for many plastics, recycling is more like a spiral of declining value. The complexity, combined with high costs for collecting, transporting and sorting, would seem to create little incentive for investment.

“THE RISE OF RECYCLING

DISGUISES AN AWKWARD TRUTH: ONLY 10 PER CENT OF THE PLASTIC PRODUCED GLOBALLY IS PUT BACK INTO USE. ”

THE KEY TO RECYCLING MORE PLASTIC? UPCYCLING

Yet new technology may soon fill the gap by launching a wave of “upcycling” that takes plastics now considered hard to recycle economically and turns them into something much more valuable.

GreenMantra Technologies, based in Brantford, Ont., is perfecting a process that breaks down waste plastics — including hard-to-recycle grocery bags and plastic film — into small molecules. Instead of being reassembled as they were, the components become entirely new products, such as waxes and lubricants, that are up to five times more valuable.

GreenMantra already produces about 5,000 tonnes a year of ingredients used in coatings, roofing shingles and adhesives for packaging. It has also worked with the City of Vancouver to create

an asphalt surface for roads that incorporates its waxes.

But the company has even bigger plans, says chief executive officer Kousay Said. “Now that we have successfully commercialized the wax platform, we are moving into polystyrene,” which he says is not currently recycled “at any significant rate.”

RECYCLING MORE PLASTICS ON-SITE

Whereas GreenMantra buys waste plastic that has already been sorted and turned into pellets, another Canadian company is working to recycle mixed plastics wherever they are.

Pyrowave has created a portable system that can be installed anywhere there is a lot of plastic waste — from auto-assembly plants to grocery stores and plastic sorting facilities. The device works like a reverse vending machine, using microwave technology to break

down plastics placed in it, and then creating waxes, oils and monomers, which are small molecules that can be turned into new products.

Then, once it has collected and sold the output to manufacturers, Pyrowave shares the proceeds with the clients that rent its machines, creating an added incentive to recycle.

Jocelyn Doucet, chief executive of the company, which has offices in Montreal and Oakville, says the market is hungry for solutions that derive value from waste, especially if they are convenient: “Our tech is very robust, it can take very contaminated plastic material, mixed plastic material, it doesn’t matter — you’ll get the output.”

BUT UPCYCLING ISN’T THE ANSWER TO ALL PLASTIC WOES

Upcycling shows great promise, says Joe Hruska, vice-president of sustainability with the Canadian

Plastics Industry Association (and one of those responsible for creating the blue box program in Ontario), but it’s no magic bullet.

He feels the best results come from an approach that emphasizes responsible consumption and the reuse of plastic, as well as recovering it from the waste stream.

Still, with some skeptics suggesting there will be more plastic in the oceans than fish within 30 years, alchemists who can turn it into something worthwhile are bound to give recycling a healthy boost.

“ **SOME SKEPTICS SUGGEST THERE WILL BE MORE PLASTIC IN THE OCEAN THAN FISH WITHIN 30 YEARS** ”

THE RECYCLER'S DILEMMA

EVEN SOMETHING AS HUMBLE AS A DISPOSABLE COFFEE CUP CAN COMPLICATE LIFE FOR THE CONSCIENTIOUS CONSUMER.

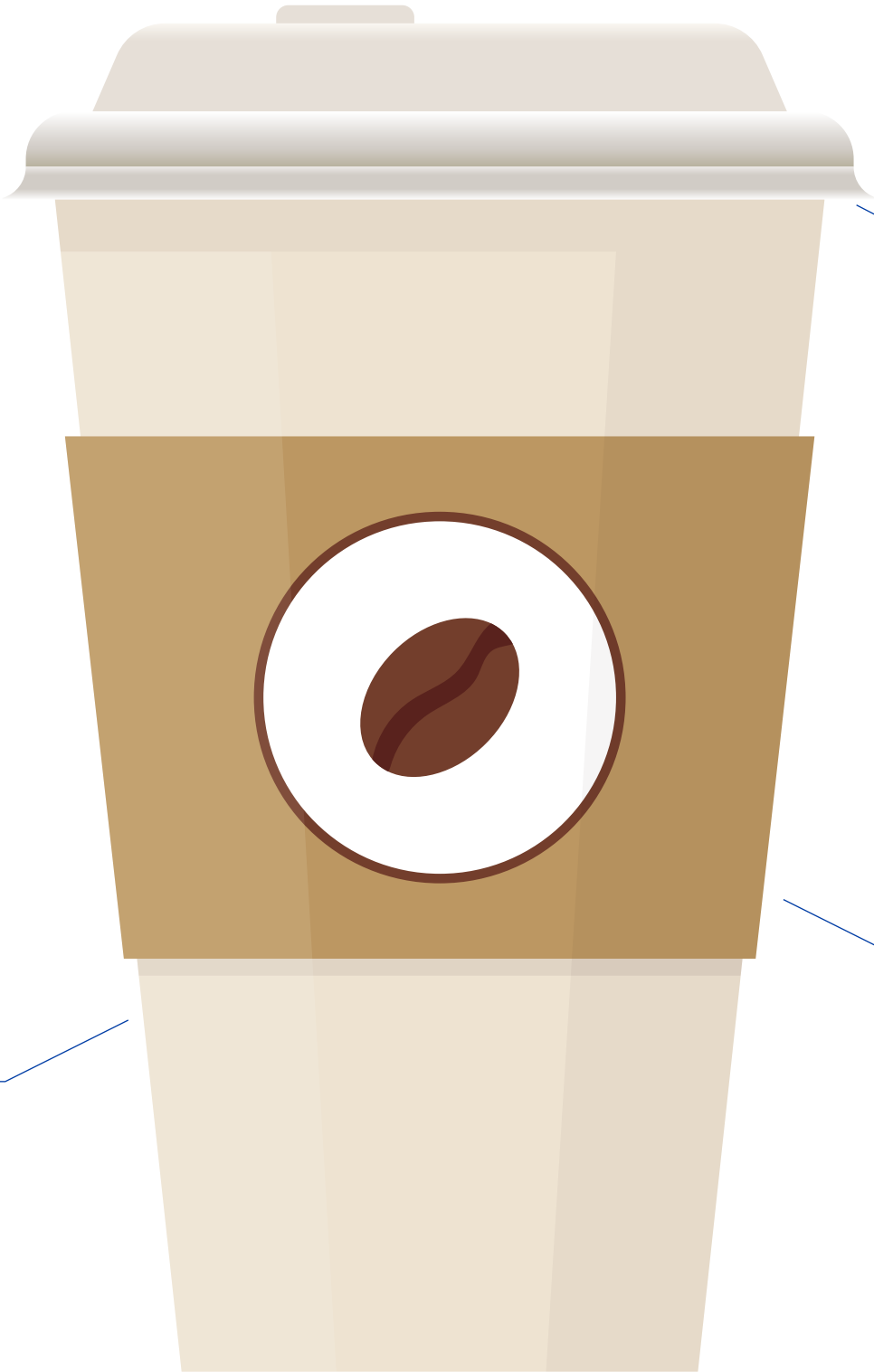


STIR STICK

If wood, it either goes in the compost or garbage, depending on your community's guidelines; if plastic, it probably goes in the garbage.

PAPER CUP

Special equipment is required to remove the plastic wax coating, so cups may or may not be recycled, depending on whether your community has it.



PLASTIC LID

If white, it can be recycled; if black, probably not.

CARDBOARD SLEEVE

Can almost always be recycled.

FEEDING THE IMAGINATION WITH WASTE PLASTIC

Startup ReDeTec keeps 3D printers humming with recycled plastic

3D printing is revolutionizing the way some professionals work, enabling designers and architects to create prototypes and working models much more rapidly than in the past. The downside: It can be incredibly wasteful. Not only do 3D printers use an excess of plastic during production, even the final product often ends up in the trash.

The plastic filament used in 3D printing costs more than \$30 a roll, so Toronto-based startup ReDeTec sees a substantial upside in the recycling market. It has created a compact desktop

device called the ProtoCycler, which grinds up waste plastic, and melts it, before extruding it as a filament ready for reuse.

So far, the ProtoCycler can handle only PLA and ABS, the two most common types of printer plastic. But new printers coming on the market can use PET, the plastic commonly used in water containers, so ReDeTec is now researching ways to adapt its technology.

This raises the possibility that soon even your old water bottle could be converted into futuristic prototypes that could change the world.

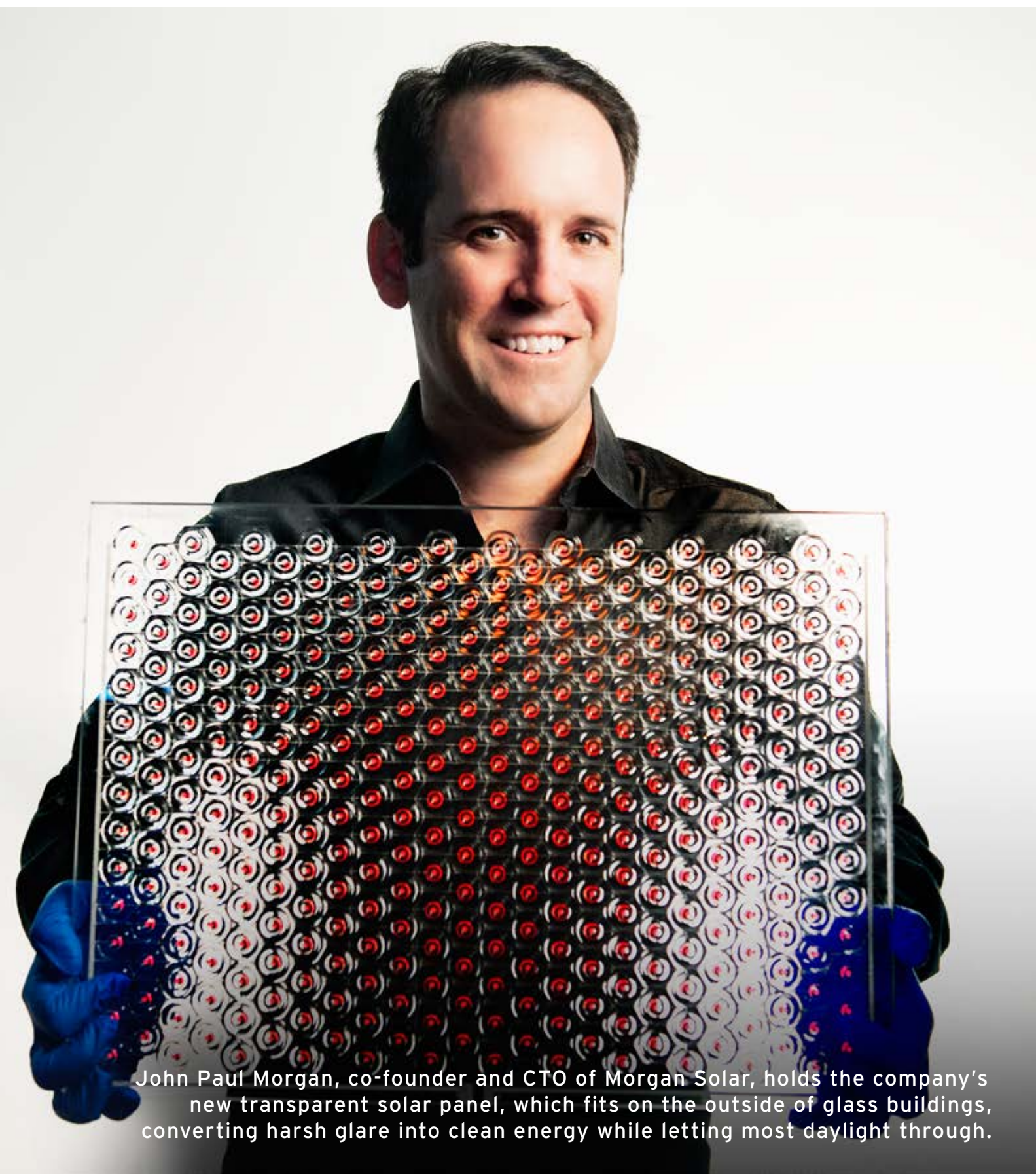


Dennon Oosterman, co-founder and CEO, ReDeTec

CLEANTECH'S BACK-TO-THE- FUTURE MOMENT

Canada's golden age of
telecom pays dividends to
entrepreneurs decades later

BY TYLER HAMILTON



John Paul Morgan, co-founder and CTO of Morgan Solar, holds the company's new transparent solar panel, which fits on the outside of glass buildings, converting harsh glare into clean energy while letting most daylight through.

John Paul Morgan shines a green penlight on a prototype that he created — a solar optic that converts light into electricity. As he does, the beam strikes the device's acrylic surface, then bends abruptly at a right angle toward the centre, where it elegantly converges on a thumbnail-sized solar cell that produces the power.

It has been nearly a decade since he developed this device, and his technology has improved dramatically since then. Now significantly more affordable, it is also lighter, better designed, and arguably one of the more efficient ways to produce solar electricity on the planet.

Looking back on the source of inspiration for his unique design, Morgan, co-founder and chief technology officer of Toronto-based Morgan Solar, points to the early 2000s when he worked in Ottawa for JDS Uniphase, the optical-

networking pioneer that at the time was a giant of Canada's world-leading telecom scene.

It was there, in the JDS lab, that he got to tinker with optical components and equipment, solve problems and learn the language of light. "That experience prepared me for Morgan Solar," recalls Morgan, one of JDS's more prolific young inventors. "I certainly could not have done what I'm doing now without it. JDS basically taught me to be fearless when it came to optics."

TELECOM TECH BOOSTS CLEANTECH

Although Morgan's mission now is to make solar energy cheaper and more widely available, his story illustrates a common but little-noticed theme in Canadian cleantech: Years of expertise and experience from Canada's golden age of telecom are today being reapplied to solve major challenges around energy and the environment.

The result is a new generation of companies building on the intellectual property of an earlier era, when companies such as JDS, Newbridge Networks and especially Nortel Networks were hotbeds of optical networking innovation. Ventures such as Morgan Solar are now leveraging this know-how to generate cleaner electricity, eliminate waste from industrial processes, put energy-hungry data centres on diets, and enable the 21st-century smart grid. "When you look at my notebook during the initial invention phase for Morgan Solar, you see 20 years of patent history standing on the shoulders of these giants," Morgan says.

“JDS BASICALLY TAUGHT ME TO BE
FEARLESS
WHEN IT CAME TO OPTICS”

“YEARS OF EXPERTISE AND EXPERIENCE FROM CANADA'S GOLDEN AGE OF TELECOM ARE TODAY BEING REAPPLIED TO SOLVE MAJOR CHALLENGES AROUND ENERGY AND THE ENVIRONMENT.”



OTTAWA'S SILICON VALLEY NORTH BUILT THE BACKBONE OF THE INTERNET

Before Google became a household name and Netflix began serving up online videos, and well before social-media fixtures such as Facebook and Twitter captured our collective attention spans, Ottawa's high-tech scene — the original Silicon Valley North — was building the backbone of the Internet these popular services depend on.

The cutting-edge lasers, optical components and fibre-optic gear it developed now carry, analyze and guide much of the data generated today — from online transactions and machine-to-machine communications to the seemingly limitless number of cat videos that spread virally through YouTube.

At their peak, Canada's giants of networking were valued at more

than half a trillion dollars — greater than the combined value of Canada's Big Five banks. Then, between 2000 and 2002, it all came crashing down. The telecom market collapsed, orders dried up and massive job cuts followed. Nortel later declared bankruptcy and its various parts were sold off. JDS, a shadow of itself, relocated its headquarters to California and eventually broke up into two smaller companies, Viavi Solutions and Lumentum Holdings Inc., in 2015.

Yet the roots of their innovation remain intact, and new shoots are sprouting — many of them green. Toronto-based FIBOS, an optical-sensor developer, says its business has been heavily influenced by work done by Nortel and JDS during the 1990s involving “fiber Bragg gratings.” FBGs alter the core of an optical fibre using ultraviolet lasers, enabling the fibre to transmit some wavelengths and block others. When first demonstrated by federal scientist Kenneth

Hill in 1978, the concept was a significant advancement for optical communications because it created the ability to distribute telecom channels in a new way.

“This was a big Canadian invention, and the list of people who could make FBGs in the 1990s was very short,” says Nicholas Burgwin, co-founder and chief executive officer of FIBOS. “Nortel and JDS invested heavily into it, and this gave them a competitive edge.”

Some of that investment made its way to Toronto when Ryerson University took advantage of the JDS downsizing to purchase some of its equipment in a fire sale. It was at Ryerson, with this equipment, that Burgwin first developed his FBG-based sensor technology to monitor strain and temperature in rugged industrial settings.

It turns out, optical sensors have a huge advantage over traditional electronic sensors. They can be used

reliably in a volatile environment, such as an oil refinery, where temperatures often rise above 1,000 degrees celsius. Because they transmit light — not electrons — there's no risk that a spark will cause an explosion.

As a result, optical sensors make it possible to improve the efficiency of industrial processes in a range of new settings, from chemical plants to sawmills.

Burgwin, much like John Paul Morgan, is well aware of what his firm's future owes to the past.

“We've made slight changes, but what we're doing is essentially what the telecom industry has been pushing out for years now in high volume,” he says. “They've given us the confidence and ability to do what we do.”

PUTTING THE INTERNET ON AN ENERGY DIET

**RANOVUS manages today's
data tsunami using less power**

BY TYLER HAMILTON



There are two indisputable facts about the Internet — it never stops growing and it needs increasing amounts of energy to survive.

Netflix subscribers alone streamed 42.5 billion hours of video in 2015, and by one estimate consumed enough energy to power more than 2 million households. Depending on how that energy is generated — coal versus renewables, for instance — the impact on our climate can't be ignored.

INTERNET TRAFFIC EXPECTED TO TRIPLE BY 2020

But hold on to your hats, we're just getting started. Global Internet traffic is expected to grow threefold from 2015 to 2020, two-thirds of it related to video. By then, there will be an estimated 26 billion devices exchanging data across this global network of networks, according to market forecasts from Cisco.

“Arguably we're only at the tip of the iceberg,” says Chris Boivin, until recently vice-president of investments at Sustainable Development Technology Canada (SDTC), which supports cleantech demonstration projects across the country.

According to Boivin, the carbon footprint of data centres, those 24/7 workhorses of the Internet, is already on par with that of the global airline industry, so reducing their energy intensity has become a priority for government and entrepreneurs alike.



“ **THE CARBON FOOTPRINT OF
DATA CENTRES,
THOSE 24/7 WORKHORSES OF THE INTERNET,
IS ALREADY ON PAR WITH THAT OF THE GLOBAL
AIRLINE INDUSTRY** ”

PUTTING DATA ON A STRICT ENERGY DIET

“The power consumption of these things has become enormous,” says Hamid Arabzadeh, co-founder and chief executive officer of Ottawa-based RANOVUS, which has come up with a way to accommodate this rapidly expanding appetite for data while putting it on a strict energy diet.

The core of the company’s innovation is quantum-dot laser technology that can transmit more data at lower cost, using significantly less power. First conceived at Bell-Northern Research (predecessor to Nortel Networks), quantum-dot lasers are designed using self-assembling nanomaterials that, because they are so small, exhibit unique behaviours referred to as “quantum effects.”

“Usually, lasers can generate only one wavelength,” Arabzadeh explains. Quantum-dot lasers, on the other hand, are made

up of millions of nanoparticles of different sizes, with like-sized dots emitting their own wavelength of laser light. “What you end up with is many wavelengths coming from a single laser source,” he adds.

The upshot: A single laser can do the job of many.

But Nortel didn’t have the chance to fully develop and commercialize the laser technology. Sadly, it became another orphan of the telecom giant’s stunning collapse during the early 2000s.

The federal government, to its credit, had enough foresight to find it a stable home in Canada, negotiating a deal that would see the intellectual property — and the world-class lab built to develop it — transferred to the National Research Council (NRC). Good news, yes, but it also meant the technology became little more than a cool science project for federal researchers.

FROM COOL SCIENCE PROJECT TO MARKET-READY PRODUCT

Arabzadeh, who had spent seven years at Nortel running parts of its optical networking business and another seven years as CEO of Nortel technology competitor CoreOptics (acquired by Cisco in 2010), grew increasingly aware of the cutting-edge laser research and saw tremendous potential.

Looking for a new project, he negotiated an agreement with the NRC to commercialize the technology. This resulted in the creation in 2012 of RANOVUS, which has spent the past five years — and \$40 million in investment — turning a lab experiment into a market-ready product.

A big part of this work, in collaboration with researchers at McMaster University in Hamilton and partners in Germany, has been developing the high-speed

electronics and silicon-photonics components required to make the laser operate reliably in a data-centre environment.

“It’s gone through its next phase of evolution with RANOVUS,” Arabzadeh says. “The laser would not work if deployed today on its own. What we have had to include is all the other things around it to make it work.”



MANAGING MOUNTAINS OF DATA ONE LASER AT A TIME

The result of this tremendous effort is a laser product that could potentially replace up to 100 conventional lasers in a data-centre setting, at one-quarter the cost and using one-fifth the power. As Arabzadeh explains, “To be able to do what we’re doing overcomes many challenges in physics, engineering and manufacturing.”

Such an innovation couldn’t come at a better time, given the data tsunami we face as a society.

“TO BE ABLE TO DO WHAT WE’RE DOING

OVERCOMES MANY CHALLENGES

IN PHYSICS, ENGINEERING AND MANUFACTURING.”

Trends related to cloud computing, artificial intelligence and the Internet of Things are expected to drive traffic significantly higher, and more traffic means more energy to power the data centres that process, store and carry it.

This is why SDTC has so far provided \$7.9 million to help RANOVUS develop and demonstrate its technology, which is capturing the attention of some big Internet players, among them Facebook, Amazon and Microsoft.

“They basically said this is Star Trek-like stuff,” Arabzadeh says. “It’s going to change the optical networking world.”



THEY BASICALLY SAID THIS IS

“STAR TREK-LIKE STUFF,”

ARABZADEH SAYS. “IT’S GOING TO CHANGE THE OPTICAL NETWORKING WORLD.”

WHY THERE AREN'T MORE WOMEN IN CLEANTECH

BY DAVID PATERSON



Women are more likely than men to consider climate change a serious threat, they recycle more diligently and are more likely to make eco-friendly consumer choices. Yet only about five per cent of clean technology companies in the MaRS portfolio have female founders. Why is cleantech still a man's world? And what will change that? **Jane Kearns, senior advisor at MaRS Cleantech,** offers her insight.

Q: DOES CLEANTECH HAVE A PROBLEM WITH WOMEN?

A: Having worked in cleantech for over 20 years, I don't think so. It's actually a very welcoming industry for the women who work in it. Despite being relatively small, the sector is growing mightily and there is a real sense of banding together to build exceptional companies that will change the world. I've experienced virtually none of the deep-seated misogyny that has spawned Silicon Valley's toxic bro culture, made public in the wake of recent scandals at

tech giants like Uber, large VC firms and incubators alike.

Q: SO, WHY AREN'T THERE MORE WOMEN?

A: Most cleantech startups are based on deep science — physics, chemistry, engineering. Very often they spring from university research departments or are built by technical people who have spent years at industrial, mining or utility companies, and have seen a business opportunity. Engineering is still heavily male-dominated, and industrial conglomerates also skew heavily male. So, the pipeline of women who want to found cleantech companies and have the technical skills and experience to succeed is quite narrow. Add to that the well-documented fact that women entrepreneurs face an uphill battle when securing funding, and you have some significant hurdles to creating successful female-led cleantech startups.



**Q: ANY SIGNS OF CHANGE?**

A: We have seen some really smart young women starting cleantech companies lately, and some of our serial female entrepreneurs are also getting great traction with their new ventures. I work with one young founder, Daniela Roeper, who started Borealis Wind, a company dedicated to keeping wind turbines ice-free in winter, straight out of university, and says anxiety over climate change is sparking more interest in cleantech among women her age. Another female entrepreneur, Emily Hicks, is the co-founder and president of FREDsense, which makes a portable platform that senses water-borne contaminants in virtually any industrial application. She and her company keep winning technical and business competitions, and she was recently named to Canada's Top 30 Under 30 in Sustainability. So, while the percentage of female founders in cleantech seems low, young women

like these give me great hope that the tide is turning and we will see more women solving deep technical challenges that benefit both our environment and our economy.

Q: WHAT MORE NEEDS TO BE DONE?

A: We need to grow the pool of potential female entrepreneurs. Women make up fewer than 40 per cent of graduates in science and technology subjects — in engineering, a class is considered gender diverse if one student in four is female. Research shows that, if a girl is put off science and math by Grade 4, she simply thinks she can't do it and gives up forever. We need to make a concerted effort to create science and math programs that are interesting and accessible to girls, and expose them to female role models. For example, groups like Women in Renewable Energy are helping to raise the visibility of women in the sector.

The StandUp Ventures Fund, founded last year by the Business Development Bank of Canada and MaRS Investment Accelerator Fund to support women entrepreneurs, is also an encouraging step. It will help to address the unfair funding landscape that women face, and demonstrate clearly what research has already shown: that female-led startups perform just as well, if not better, than those founded by men.

NEW TECHNOLOGIES LEAD EDISON-ERA ELECTRICITY GRID INTO THE FUTURE

BY JOHN BARBER



It's not as though Calgary entrepreneur Brent Harris set out to take on Elon Musk and beat the legendary innovator at his own game. "That's not our mission," Harris says of Eguana Technologies, the company he founded 15 years ago to bring green energy systems to remote, off-grid locations. "But," he adds, sounding more surprised than proud, "it certainly is the situation at this time."

Musk's Tesla Inc. first announced its Powerwall home battery system in 2015 amid heady expectations. Energy storage promised to take home solar systems mainstream, to save householders money, if not make them independent of the conventional grid altogether. According to the hype, what the Tesla electric car did to the automotive industry, the Tesla Powerwall would do to the electrical system.

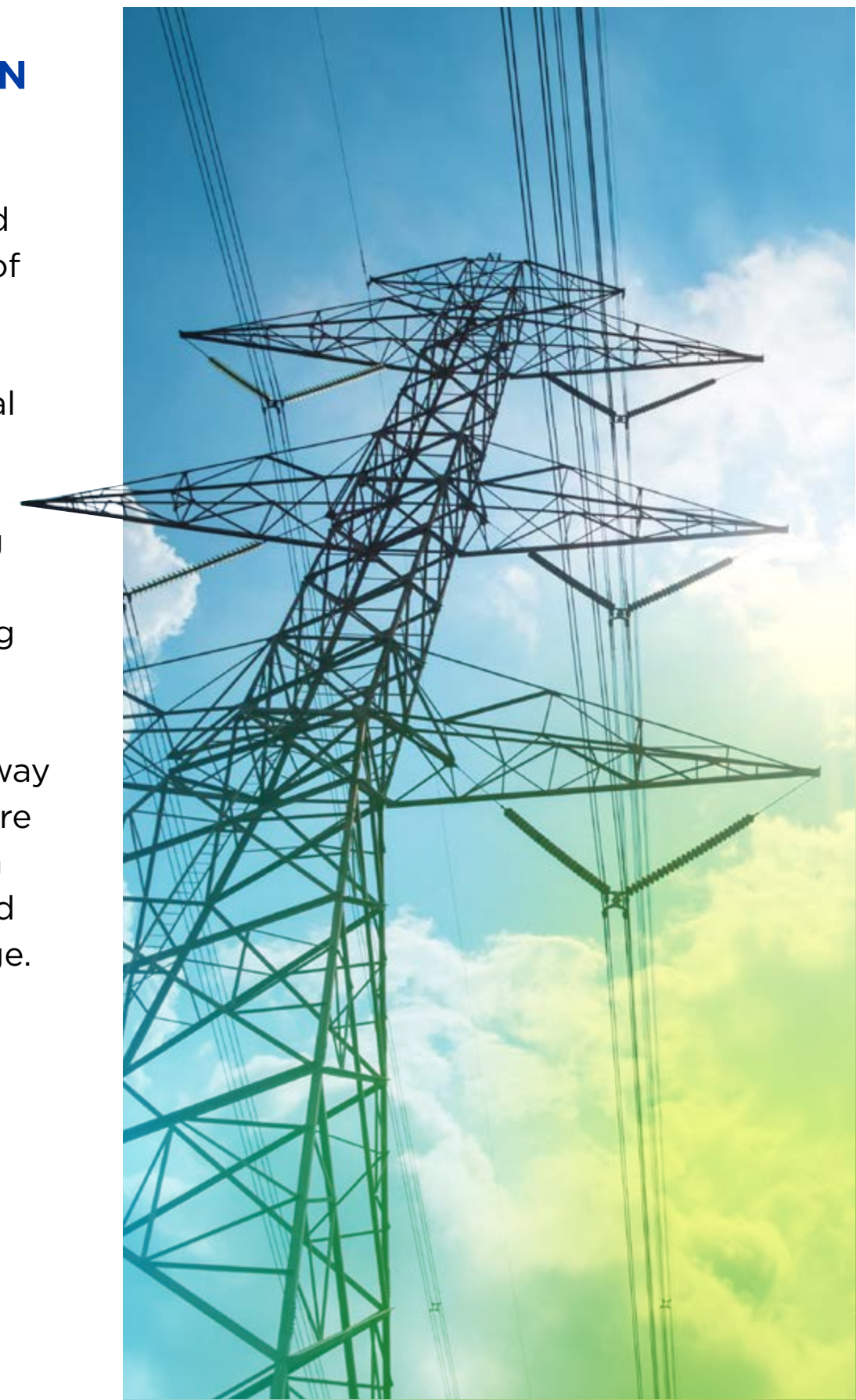
But full production of the unit still awaits the completion of a Tesla "Gigafactory" in California, so in the meantime, thousands of consumers in Europe and the United States have snapped up competing battery systems controlled by Eguana Technologies.

The company's biggest customer base is Germany, where the high cost of power has inspired a world-leading shift to rooftop solar generation — and where being able to store that power for when you need it most can cut reliance on the grid by 80 per cent. Eguana is also focusing on another solar hotspot, Hawaii, where it has partnered with the state's largest solar installer to supply the batteries all new systems now require.

“ A VIRTUAL MOB OF NEW TECHNOLOGIES IS STORMING THE RIGID ARCHITECTURE OF THE EDISON-ERA ELECTRIC GRID, PROMISING RADICAL IMPROVEMENTS IN ITS EFFICIENCY AND USEFULNESS. ”

THE PROMISE: AN AFFORDABLE SYSTEM RUN ON RENEWABLE ENERGY

Even without Tesla leading it, the revolution the company promised is well under way. A virtual mob of new technologies is storming the rigid architecture of the Edison-era electric grid, promising radical improvements in its efficiency and usefulness. For consumers struggling with the steadily rising cost of power, the revolution promises greater control, allowing them to determine when, where and what kind of power to use. It will also turn utilities from one-way pipelines into complex webs where energy is produced and traded in multiple directions with the speed and efficiency of a stock exchange. And for society at large, it holds the tantalizing promise of an affordable system fully run on renewable energy.



Eguana, which takes its name from the sun-loving reptile, initially developed its “smart inverter” technology to deliver power from fuel cells in remote locations. But battery-backed solar energy held such promise that it quickly became the company’s main business.

“We basically make the battery do interesting things on the grid,” Harris explains. “It will let you store your solar energy during the day for use at night. Or, if you’re in a place that has time-of-use rates, it will charge the battery at a low-cost time to offset buying power at a high-cost time.”

But self-generation is only the beginning. The bigger changes occur as buildings are networked. “When you’re talking about a half-dozen batteries, it’s not really a big deal,” Harris says. “But when you start to get hundreds of thousands of these things, and you can call on them all at once, now you have megawatts of power at your disposal.”

SMART TECHNOLOGIES REPLACING DUMB TRANSFORMERS

For utilities, this offers a compelling alternative to installing more and more of what Harris calls “dumb transformers.” The old way amounts to “building a 16-lane freeway that’s going to be busy for an hour a day,” he explains.

The vision is fast becoming real in Hawaii, where rooftops on the populated island of Oahu already produce 500 megawatts of solar energy, and the state has mandated that the grid be powered entirely from renewable sources by 2045. There is now so much “uncontrolled solar” that Hawaii has made storage batteries compulsory for all new installations because the state can’t handle all the power being generated.

Solving such a problem is the business of Toronto startup Opus One Solutions, whose software platform, GridOS, provides the computing power needed to make the smart grid

smart. “It’s a huge challenge,” says Opus One chief commercial officer Keyvan Cohanin.

More than 60 per cent of the North American grid “runs blind,” he says, and the first job of GridOS is to map where the power is flowing in real time. Only then, he says, can a utility manage its resources properly —

and place a value on power from renewable sources and storage batteries. This will eventually lead to a market, Cohanin says. “So that, in the future, market mechanisms can determine who’s selling power onto the grid versus who’s using it, and it becomes a self-balancing operational model — just like the stock market.”

“ **IN THE FUTURE, MARKET MECHANISMS CAN DETERMINE WHO’S SELLING POWER ONTO THE GRID VERSUS WHO’S USING IT, AND IT BECOMES A**

SELF-BALANCING OPERATIONAL MODEL

JUST LIKE THE STOCK MARKET ”

THE SMART GRID WILL SPARK CHANGE FOR CONSUMERS AND PRODUCERS ALIKE

The self-balancing smart grid will allow those who are sufficiently motivated unprecedented control, whether as energy consumers or producers. Others will be content to relax with a good book while their electrical panels automatically “play the market” to their best advantage.

Opus is currently putting GridOS to the test in New York State, joining utility National Grid in a project to manage the energy profile of the 120-acre Buffalo Niagara Medical Campus.

Spurred by widespread grid failure following Hurricane Sandy in 2012, New York is among the handful of jurisdictions leading the march to develop all manner of “non-wire alternatives” to the status quo, both to optimize existing infrastructure and to make the system more

resilient. In the process, Cohanin says, “the role of the utility evolves” from being a reliable supplier of power to “also helping customers be more independent.”

And that could be the toughest change of all, according to Ron Dizy, managing director of the Advanced Energy Centre at MaRS Discovery District in Toronto. It’s not the lack of new technology that impedes innovation, he says: “We think it’s much more an adoption problem than an invention problem.”

Established in the Edison era, the traditional ways of generating and distributing electricity suffer from tremendous inertia. “But it’s not that the government is slow, and utilities are dumb, and the regulator doesn’t get it,” Dizy adds. “The incentive system is set up in such a way that we get the results we get. People are acting completely rationally, in ways counter to what we all agree should be done in the long run.”

The challenge is to devise incentives that encourage the adoption of new technology that meets everyone’s needs. Because the problems are universal, the solution itself may become an exportable opportunity.

Take the experiment in Ontario when the government at the time agreed to pay for solar energy through its original Feed-In Tariff (FIT) program. The initiative, says Dizy, was overly generous and served to stifle innovation: “We deployed lots of solar, but we certainly did it at a higher cost than we needed to.” As a result, the companies created in the province were unable to compete internationally because their costs were too high, he adds.

One positive example of regulatory reform was the deal struck between Hydro Ottawa and the Windmill Development Group to create a self-sufficient micro-grid for what Windmill calls “the world’s most sustainable community.” The 15-hectare development, which

is being built on former industrial lands bordering the Ottawa River, will see its energy use managed by a subsidiary (jointly owned by Hydro Ottawa and the developer) that operates outside the normal regulatory framework, allowing the public/private group to innovate in ways that wouldn’t be possible otherwise.



UTILITIES THAT FAIL TO INNOVATE RISK BEING DISINTERMEDIATED

“Back [in the early 1980s], if the lights were on everyone was happy, and the rates didn’t matter,” says utility veteran Glenn Magill, who began his career with Hydro Ottawa in 1982. Today, Magill is general manager of infrastructure development for Energy Ottawa, a non-regulated subsidiary set up by the utility to market innovative technologies, beginning with a new method to test the performance of buried cables. “It’s a much more challenging industry from an operator perspective,” he says. “But there’s lots opportunity for innovation.”

However, opportunity doesn’t always translate into sales. While Eguana is helping to lead the solar revolution around the world, it has only a handful of customers in its own country.

According to Brent Harris, the promise of energy storage is hobbled in Canada by the widespread use of “net metering” policies, so called because a customer’s meter turns in one direction when it is consuming grid-produced electricity, and then backwards when the household is producing more renewable energy than it can consume. Thus, utilities pay solar producers the same retail price that they charge for power. In effect, the producers “get to use

the grid as a giant free battery,” Harris says, which kills any incentive to store the energy themselves, given that his battery installations cost between \$12,000 and \$20,000 (U.S.).

In Germany, he says, utilities buy solar power at realistic wholesale prices, about one-third what they charge, so it pays to generate and store your own supply. As a result, Eguana has sold 5,000 battery systems for rooftop solar installations there.

Harris sees hope in Ontario’s latest industrial conservation initiative, which rewards medium-sized commercial customers who shift

a certain portion of their consumption to off-peak times. “That’s creating opportunity,” he says, and his company now has a product able to store up to 15 kilowatts when the cost is low for use when the cost is high.

Canada needs a lot more such tactics, according to Dizey. “I think our head’s in the right place, I just think our policies could drive things better and faster,” he says. “But we are a place that gets it.”

And every small step forward makes the ultimate goal — a sustainable, carbon-free energy system — that much more attainable.



CANADIAN CLEANTECH'S TRUMP DIVIDEND

BY MARJO JOHNE



Donald Trump makes no secret of the fact that he's anything but an environmentalist. Where his regressive policies will lead is the subject of constant debate, but it stands to reason that they may cloud the future for Canada's clean-technology sector.

Yet the situation is far from black and white. Close examination shows that not all the fallout from the "Trump factor" is bad. In fact, the controversial U.S. President's greatest impact on cleantech may not even come from all the eco-backtracking he has done.

That backtracking is hard to ignore. During the G20's Hamburg summit in July, he made good on his threat to withdraw from the Paris climate accord. That leaves the United States as one of just three nations not taking part in the UN-led agreement to combat global warming by reducing greenhouse-gas emissions. (The other two? War-torn Syria and Nicaragua, which generates

all of 0.03 per cent of the world's emissions.)

Since moving into the Oval Office, the President has also issued an executive order to roll back the climate-change policies of his predecessor, Barack Obama, put a climate change denier in charge of the Environmental Protection Agency (and cut its funding considerably), loosened restrictions on coal-fired power generation, and introduced a budget that would defund a popular, renewable-energy program.

TRUMP'S ECO-BACKTRACKING A BOON FOR CANADIAN CLEANTECH COMPANIES

"What Trump is doing is bad for the environment — there's no question about that," says Tom Rand, managing director of Toronto-based ArcTern Ventures, which invests in climate-focused startups. "How much impact will this have

on global efforts to fight climate change? That remains to be seen."

However, he adds, despite Trump's insistence that oil and "clean coal" remain vital to America's economic growth, his policy reversals do create opportunities for Canadian cleantech companies. Why? Because Ottawa is doing what Washington is not.

"This is a nascent industry that's just beginning to grow and, for any industry to grow, it needs government support," Rand says. So, with Prime Minister Justin Trudeau focusing on a sector that Trump is ignoring, "we'll have a much healthier cleantech ecosystem in Canada. We will take market share."

Without public programs such as low-cost debt for early commercial deployments, American cleantech is likely to weaken, if not shrink. Private investors could fill the void, Rand admits, but few seem interested these days. "Investor interest in cleantech has waned over the years,"

he says, adding that at one time, as many as 300 venture funds were in the sector. "Today there are five."

According to the Brookings Institution, a Washington-based public-policy research agency, venture-capital investment in U.S. cleantech last year was 25 per cent below that of 2011, falling from \$7 billion U.S. to \$5.24 billion. Cleantech's share of the overall venture-capital pie dropped even more, from almost 17 per cent in 2011 to just below eight per cent in 2016.

"Returns were better in traditional software," explains Marty Reed, chief executive officer of Vancouver-based cleantech fund Evok Innovations. "It's a competitive world and, if VCs can invest elsewhere with a much higher return than they would get from cleantech, why wouldn't they?"



CANADIAN COMPANIES SET TO CLEAN UP IN U.S. MARKET

On a more positive note, says ArcTern's Rand, a diminished U.S. industry will leave a space that Canadian companies can fill, especially with demand for clean technologies growing in Europe and the developing world.

Also, despite the Trump administration's stance, the U.S. likely will remain a solid market. Not only is there state-level green legislation in places such as California, Colorado and New York, Reed says he also expects U.S. corporations to make significant cleantech investments in the near future.

"Walmart, for one, is committed to reducing their greenhouse-gas emissions by a gigaton by 2030," he explains.

One gigaton, or a billion metric tons, is equal to a year's worth of emissions from no fewer than 211 million passenger vehicles. To meet such an ambitious target, Walmart plans to reduce its own carbon output by 18 per cent while, more importantly, asking its major suppliers to make up the rest.

The move is "being driven purely by economics," Reed says. "The average Walmart shopper may not be environmentally focused, but Walmart is dedicated to delivering value goods, and achieving efficiencies with clean technology can help them with this goal."

OTTAWA FILLS THE VOID LEFT BEHIND BY WASHINGTON

The Canadian government is also very focused on the environment, and offers innovative cleantech companies an array of grants, tax credits and other financial aid. The 2017 federal budget has committed \$430 million to research and development for clean energy, transportation and natural-resource innovation, with an additional \$14.5 million set aside for a national cleantech-data strategy.

The budget will also channel close to \$1.4 billion over three years to the Business Development Bank of Canada (BDC) and Export Development Canada (EDC) in a bid to leverage private-sector investment and give cleantech firms more access to equity financing, working capital and project financing.

Both BDC and EDC are still working to finalize the scope of this investment project. EDC spokesperson Phil Taylor notes that the 2017 budget stipulates the money should go to enabling “first-of-its-kind, capital-intensive, early-commercial-scale clean technology deployment.”

As well, the feds have earmarked \$400 million for Sustainable Development Technology Canada, an arm’s-length federal government foundation that funds innovation and cleantech demonstration projects.

HURDLES REMAIN FOR CANADIAN CLEANTECH ENTREPRENEURS

But even with such a supportive ecosystem, there are still obstacles for Canadian cleantech entrepreneurs.

One big challenge, says Evok’s Reed, is the general reluctance of Canadian businesses and

governments to try new technologies. Another challenge is money. Even with the new funding, when compared to the U.S., there aren’t as many funds available here for early-stage companies trying to get commercial projects off the ground.

This can have a dangerous ripple effect, he explains. “What you’ll see with the majority of cleantech companies is their first customer is in the U.S., so they set up their sales and marketing firms over there, then hire a CEO from the U.S. and, the next thing you know, the whole company is there.”

“If we don’t get more aggressive,” Reed argues, “we’ll produce great science and a decent number of small companies — funded largely by Canadian taxpayers — and, when they reach a certain level, U.S. companies will acquire them.”



COULD TRUMP SPARK A BRAIN DRAIN TO THE U.S.?

One of Trump's election promises could accelerate this potential migration despite the fact it has little to do with the environment — and despite reports that his strict, new immigration policies may enrich Canada with global tech talent otherwise bound for Silicon Valley.

This X factor, says Vancouver lawyer Cheryl Slusarchuk, is Trump's vow to lower the tax rate for U.S. corporations.

A specialist in cross-border mergers and acquisitions, Slusarchuk took part, along with Rand and Reed, in a recent Globe Series debate on the Trump factor. She pointed out that, because the corporate tax in Canada

is 28 to 39 per cent, “in the long term, I think we will have leakage to the U.S., where there isn't that kind of tax burden.”

But there is also an upside. Slusarchuk said that even if companies resist the siren's cross-border call, they will still likely cash in on the plan to drop U.S. corporate taxes as low as 16 per cent. For those that have their technology ready, she explained, the tax cut “will free up money for capital expenditures.” Which could mean big sales.

Walmart isn't the only big U.S. firm in the market for tech that's clean and green — no matter what Donald Trump has to say about global warming.

“ IN THE LONG TERM, I THINK WE WILL HAVE
LEAKAGE TO THE U.S.,
WHERE THERE ISN'T THAT KIND OF TAX BURDEN. ”



STARTUPS MAY FACE NEW RISKS AFTER CROSSING THE 'VALLEY OF DEATH'

BY MaRS STAFF

POWERED BY:

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Canada's clean technology sector generates \$13 billion in sales annually and is increasingly seen as a future engine of the economy. These companies invest heavily in assets like high-precision manufacturing equipment and attract skilled workers with well-paid jobs. The federal government has recognized the sector's potential, and significantly stepped up its support, including more funding for research and help for ventures to expand into foreign markets.

More than 80 per cent of Canadian clean-technology companies already think beyond our borders and export their products, primarily to the United States, but increasingly to Europe, China, India and South America. As they win customers, these companies are creating global supply chains and investing in facilities overseas.

This growth will pay dividends for the economy and the environment — but it comes with risks, says Maria

Guercio of Chubb, the world's largest publicly traded property and casualty insurer. As a company grows so too does the range of risks it is exposed to, particularly as it ventures into far-flung markets where labour laws, product standards and intellectual property protections differ. Many early-stage companies focus on surviving the "valley of death" and often push risk management to the back seat, she says.

FROM WATER DAMAGE TO CYBER-ATTACK, STARTUPS FACE A RANGE OF RISKS

"When it comes to insurance, most entrepreneurs think about protecting physical assets, but often overlook the impact that certain kinds of incidents can have on their net income," says Guercio. For example, consider the loss of revenue following incidents like water damage, fire or cyber-attack, whether at the company's own premises or at an overseas supplier, all of which can

disrupt production. The costs from such incidents can radiate beyond repairing expensive equipment and recovering data to include lost customers, forensic investigation fees and even the cancellation of research grants.

Another potential outcome is the disruption of supply chains. A 2015 survey by Chubb and Cleantech Group found that nearly two-thirds of global clean-technology companies had suffered such disruption in the previous three years, in many cases with a material impact on their businesses. Ironically, climate change will likely exacerbate the problem by increasing the frequency of extreme events like floods and wildfires that play havoc with transportation.





Guercio advises companies to work with insurers that have expertise in clean technology and international insurance coverage to protect their businesses.

“Young companies are particularly vulnerable to unexpected setbacks,” she says. “Good risk planning could be the difference between getting back in business and going out of business.” She says that early engagement with an insurance company’s risk engineering services can identify vulnerabilities and provide valuable insights — from protecting the business with adequate fire suppression and separation of hazardous materials to data protection and contractual management.

Clean technology companies are fast paced and continuously evolving. Chubb is committed to staying current with the cleantech industry by continuously learning about new technologies and advanced processes, and developing new

products and services that keep pace. “Companies can work with their broker and insurer to understand the breadth of their insurance policy coverages prior to a claim,” says Guercio. Imagine the loss of market if your company’s R&D work is destroyed and you do not have the means to recover?

In a recent claim, she says, one insured company was supplying power to a utility company that suffered a windstorm loss. “We helped them maintain the same level of net income while they waited for the utility company to get back up and running.”

“GOOD RISK PLANNING COULD BE THE DIFFERENCE BETWEEN GETTING BACK IN BUSINESS AND GOING OUT OF BUSINESS.”

MaRS METRICS

100

THE GLOBAL TARGET (IN MILLIONS)

under the Paris Declaration for the deployment of electric cars by 2030¹

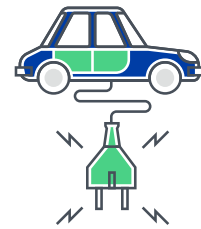
7

TOTAL (IN MILLIONS) OF ALL JOBS IN THE U.S. AUTO SECTOR²

.7

NUMBER OF JOBS (IN MILLIONS)

in the U.S. auto sector devoted to increasing fuel economy or switching to alternate fuels³



2

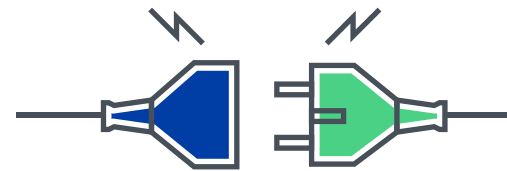
THE NUMBER OF ELECTRIC CARS (IN MILLIONS)

currently in use globally⁴

12

NUMBER OF KILOWATTS PRODUCED

by the world's first wind turbine in 1888 — not enough to power even one modern home⁵



9,500

NUMBER OF KILOWATTS PRODUCED BY TODAY'S LARGEST WIND TURBINE, enough to power 8,300 UK homes⁶

74

GLOBAL NUMBER (IN MILLIONS) OF SMART STREET LIGHTS

which save energy and improve traffic flow by responding automatically to lighting and traffic conditions — forecast to be installed by 2026⁷

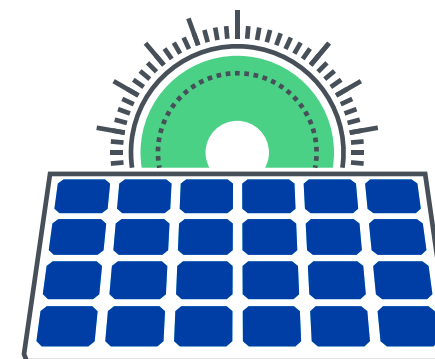
26,000

NUMBER OF U.S. PATENTS related to renewable energy issued since 2009⁸



42

PERCENTAGE OF THOSE PATENTS THAT INVOLVE SOLAR POWER⁹



12

THE TOTAL GENERATION CAPACITY (IN MILLIONS OF KILOWATTS)

of Canada's current wind-energy system¹⁰

5

ESTIMATED NUMBER OF PLASTIC SCRAPS (IN TRILLIONS) afloat in the world's oceans¹¹

¹ https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf ² <https://www.bls.gov/iag/tgs/iagauto.htm#iag31cessaemp.f.p> ³ <https://cleantechnica.com/2017/02/01/us-clean-energy-jobs-surpass-fossil-fuel-jobs-5-1/> ⁴ <https://www.theguardian.com/environment/2017/jun/07/electric-cars-sales-2-million-worldwide-global-sales> ⁵ <http://www.thirdplanetwind.com/energy/history.aspx> ⁶ <http://www.mhivestastoffshore.com/worlds-most-powerful-available-wind-turbine-gets-major-power-boost/> ⁷ <http://navigantresearch.com/t/ViewEmail/r/596F1406A8E672812540EF23F30FEDED/19D6FD34FB1A2FF4948D468F162BC46E> ⁸ <https://www.cbinsights.com/research/agriculture-tech-market-map-company-list/> ⁹ <https://www.cbinsights.com/research/renewable-energy-patents-trends-corporates/> ¹⁰ <http://canwea.ca/wind-energy/installed-capacity/> ¹¹ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4262196/>

1,007

ANNUAL WEIGHT (IN KILOS)

of waste produced by each Albertan, Canada's cast-off leaders ¹²

386

THE COMPARABLE FIGURE FOR NOVA SCOTIANS, the nation's least wasteful souls ¹³



52.8

AMOUNT OF ELECTRICITY (IN GIGAWATTS, OR BILLIONS OF KILOWATT HOURS) the U.S.

solar power grid was capable of producing in 2016 ¹⁴

70

AMOUNT OF ELECTRICITY (IN GIGAWATTS)

the Internet alone consumed in the U.S. in 2015= ¹⁵

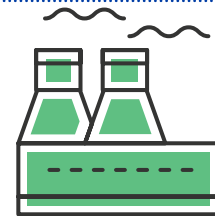
774

THE NUMBER OF CLEANTECH COMPANIES

in Canada today. ¹⁶

#1

WHERE CHINA RANKS



Among greenhouse-gas-emitting countries. It alone produces 25 per cent of all global emissions ¹⁷

#9

WHERE CANADA RANKS ¹⁸

36

PERCENTAGE OF CANADA'S EMISSIONS

that are now attributed to the oil and gas industry ¹⁹



1.3

GLOBAL REVENUE ESTIMATE (BILLIONS OF US DOLLARS)

for the smart home data analytics sector in 2017 (includes data from smart home devices such as connected thermostats) ²⁰

11

ESTIMATED REVENUE (BILLIONS OF DOLLARS) BY 2026



when more people will know how to use such data, and issues involving privacy and personal security have been addressed ²¹

3

THE NUMBER OF PEOPLE (IN BILLIONS) THE WORLD HAD TO FEED IN 1960 ²²

6

THE NUMBER (IN BILLIONS) IN 1999 ²³

9.6

HOW MANY BILLIONS WILL HAVE TO BE FED IN 2050 ²⁴

70

HOW MUCH (PER CENT) MORE FOOD THE WORLD WILL HAVE TO PRODUCE

in 2050 than it did in 2009, according to the UN's Food and Agriculture Organization ²⁵

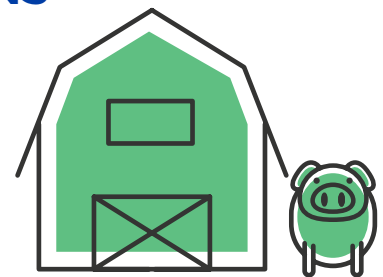
55,600

NUMBER OF CANADIANS who worked for Canada's 774 clean technology companies last year ²⁶

289,200

NUMBER OF CANADIANS WHO STILL WORK IN AGRICULTURE ²⁷

which a century ago employed a million people — one in every three Canadian workers ²⁸



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¹² <http://www.conferenceboard.ca/hcp/provincial/environment/waste.aspx> ¹³ <https://www.greentechmedia.com/articles/read/us-solar-market-grows-95-in-2016-smashes-records> ¹⁴ https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01_a

¹⁵ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/clean-technology-innovation-jobs.html> ¹⁶ <http://www.canadianbusiness.com/innovation/canadas-cleantech-industry-is-bigger-than-you-think/> ¹⁷ <https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=54C061B5-1>

¹⁸ Lux: Analyzing Canada's Ecosystem for Carbon Emissions Reduction Technologies ¹⁹ <http://navigantresearch.cmail19.com/t/ViewEmail/r/B5A80DB542361CD82540EF23F30FEDED/19D6FD34FB1A2FF44D402EFBD42943A3> ²⁰ <http://navigantresearch.cmail19.com/t/ViewEmail/r/B5A80DB542361CD82540EF23F30FEDED/19D6FD34FB1A2FF44D402EFBD42943A3>

²¹ <https://www.learner.org/courses/envsci/unit/text.php?unit=5&secNum=4> ²² <https://www.learner.org/courses/envsci/unit/text.php?unit=5&secNum=4> ²³ <http://www.un.org/en/development/desa/news/population/un-report-world-population-projected-to-reach-9-6-billion-by-2050.html> ²⁴ <http://www.economist.com/technology-quarterly/2016-06-09/factory-fresh>

²⁵ <https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/clean-technology-innovation-jobs.html> ²⁶ <http://www.statcan.gc.ca/pub/11-402-x/2011000/chap/ag/ag-eng.htm> ²⁷ <http://www.statcan.gc.ca/tables-tableaux/sum-som/101/cst01/econ40-eng.htm> ²⁸ <http://www.statcan.gc.ca/pub/11-402-x/2011000/chap/ag/ag-eng.htm>

In late fall 2017, the next issue will examine the gender gap in the innovation economy. What if we left it all up to men? Is Canada actually better at encouraging gender diversity? We'll feature some of our top female entrepreneurs and offer insights into how we can create a future world of equality for women.

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