Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy

November 7, 2018
University of Waterloo
Federation Hall

Technology & Innovation Policy Forum 2018 Report

November 2018

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in partnership with

LAND ACKNOWLEDGEMENT

The University of Waterloo (including the Waterloo, Kitchener, and Cambridge campuses) is situated on the Haldimand Tract, land promised to the Haudenosaunee of the Six Nations of the Grand River, and is the traditional territory of the Neutral, Anishinaabeg, and Haudenosaunee peoples.

ABOUT THE AUTHORS

Nigel Moore
Nigel Moore is the Manager of Global Programs and Initiatives at the Waterloo Institute for Sustainable Energy, where he manages the 'Affordable Energy for Humanity' Initiative (AE4H). He is the author of numerous publications on topics including energy innovation, energy poverty, climate change, and climate engineering. Much of Nigel's work has been spent as a manager and co-ordinator of international research partnerships and knowledge sharing platforms on energy and climate related topics, including most recently as designer of a platform for collaboration within the AE4H network that brings together a diverse consortium of global energy sector leaders to address inequalities in access to clean energy.

Prior to joining WISE, Nigel spent time as a researcher and program manager at the Institute for Advanced Sustainability Studies (Germany), the University of Oxford (UK), and the Centre for International Governance Innovation (Canada).

Dr. Jatin Nathwani
Professor Nathwani is the founding Executive Director, Waterloo Institute for Sustainable Energy (WISE) and holds the prestigious Ontario Research Chair in Public Policy for Sustainable Energy. Professor Nathwani is also the Co-Director, with Professor Joachim Knebel (Karlsruhe Institute of Technology, Germany), of the consortium 'Affordable Energy for Humanity (AE4H): A Global Change Initiative' comprising 110+ leading energy access researchers and practitioners from 30 institutions and 12 countries.

Prior to his appointment to the University of Waterloo in 2007, Professor Nathwani worked in a leadership capacity in the Canadian energy sector over a 30-year period. Professor Nathwani has over 100 publications related to energy and risk management, including seven books and is a Registered Professional Engineer (PEO) in the Province of Ontario, Canada.

FOREWARD

This report provides a summary of the highlights of the Technology Innovation & Policy Forum 2018 organized by the Council for Clean & Reliable Energy and the Waterloo Institute for Sustainable Energy entitled: "Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy".

We would like to acknowledge the contribution of the expert speakers and panelists, the academic and industry innovators participating in the Innovation Showcase, and the advanced educators that provided tours of the Centre for Advanced Photovoltaic Devices and Systems Lab, the Giga-to-Nanoelectronics Centre, and the Non-Destructive Testing Centre.

Thank you to the University of Waterloo for hosting this third annual Forum on their campus in Waterloo, Ontario, Canada.

INTRODUCTION

The 2018 Annual Technology and Innovation Policy Forum was held at the University of Waterloo on November 7, 2018. Representatives from public, private and institutional organizations attended the third annual Technology Innovation & Policy Forum at the University of Waterloo.

This year's theme, Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy, brought together one keynote presentation, two panels and a set of presentations by technology developers. The Keynote presentation by Yung Wu, the CEO of MaRS Discovery District focused on how Canada can become an innovation powerhouse.

The first panel focused on the Promise and Perils of Energy Disruption including the possible emergence of decentralized energy systems and their potential to create enormous new economic value for the customer. The technology disruption also threatens the existing structure of energy production and delivery. The panel discussed whether the threat is real and the implications for the future evolution of the industry.

The second panel focused on Financing Business Models: The Good, The Bad, and The Ugly. Financing innovation is almost always an issue. The highly experienced panel discussed alternative approaches to financing and the advantages and pitfalls which need to be considered. The panel also considered successes and failures with alternative business models and the role of government in fostering innovation.

Presentations from the Innovation Showcase Featurewas presented by The Land Art Generator. This was followed by current or notable project highlights from technology developer leaders representing the Natural Gas Innovation Fund, Microsoft Canada, Siemens Canada, and CISCO Canada.

This report brings together the commentaries provided during each segment of the day's presentations and panels as well as highlights the main findings of the third annual Technology Innovation & Policy Forum 2018.

Overall, the Forum aimed to achieve several goals and objectives:

- The goal of the Forum was to explore the effect of emerging technologies on the distribution sector business models.
- The Forum was comprised of panel presentations by leading industry, government, and academia, with extensive opportunities for networking.
- The objective of the Forum was to address the alignment of energy policy and the need to foster innovation to achieve a low carbon economy.

INTRODUCTORY MESSAGE FROM THE CCRE & FORUM CO-CHAIRS

On behalf of the Council for Clean & Reliable Energy and the Waterloo Institute for Sustainable Energy, thank you for taking the time to read this report from the third Technology Innovation and Policy Forum.

This report summarizes the outcomes from the Technology Innovation and Policy Forum 2018. This Forum was intended to bring together policy makers, technology innovators, leading researchers, entrepreneurs and industry thought leaders to help shape next generation smart energy solutions. The goal of the 2018 Forum was to explore the effect of emerging technologies on the distribution sector business models. Throughout the day, leading industry, government, and academia, will provide expert presentations on addressing the alignment of energy policy and the need to foster innovation to achieve a low carbon economy. Through dialogue and extensive opportunities for networking, collaboration and discussion, the Forum will focus on establishing a common basis for accommodating divergent interests.

We are pleased that you have decided to join the discussion by reading this report, and we look forward to your future participation.

Glenn Wright
Chairman
Council for Clean & Reliable Energy

Jatin Nathwani
Forum Co-Chair
Executive Director, Waterloo Institute for Sustainable Energy
University of Waterloo

David McFadden
Forum Co-Chair
Counsel
Gowling WLG (Canada) LLP

KEYNOTE PRESENTATION SYNOPSIS:

HOW CANADA CAN BECOME A GLOBAL INNOVATION POWERHOUSE?

Yung Wu, CEO of MaRS Discovery District

The question on everyone's mind today is whether the world will return to a pluralistic, collaborative place with shared ideals. Current political divisions are reflected in debates about environmental and economic policy, which are often portrayed as 'either/or' positions. However, we must come to acknowledge the promise of solutions that have both environmental and economic benefits. The promising route forward seeks 'and' solutions, not 'either/or'. This is the only way that we can move toward a truly sustainable future, for the environment and our economy.

As innovators, researchers, policy-makers, and entrepreneurs we are here because we are looking for solutions to a complex set of increasingly urgent problems. The perils of climate change should be front-of-mind. On top of this we face a leadership vacuum and shifting geopolitical and economic power centers.

Canada can capitalize on this vacuum by taking up a leadership position through innovation, in particular on the climate change file. Greenhouse gas emissions are on the rise, weather is becoming more unpredictable, and in the next 20-30 years we will see environmental upheavals unless we take urgent action to reduce GHGs. These events will take place within our lifetimes, so the time for action is now.

Despite the difficulty of our position, we should be buoyed by the fact that we are living in an age of unprecedented technological progress and innovation. We have the ability to transform not only our own economy, but the world's. Canada's entrepreneurs will be our leaders. This includes not only business entrepreneurs but those from other sectors who are developing new solutions to environmental and economic challenges simultaneously. These include strategies to reduce CO2 emissions while building economically sound business models and advanced technological tools.

Canadians are wired to thrive in this moment. We are a people that always looks to 'and' rather than 'or' solutions. We must leverage our affinity for difference and our capacity for innovation to meet global challenges and provide a model for the world.

One of the most important things that we have going for us is talent. Talent is the fuel for innovation, and it is flowing in our direction. Toronto is North America's fastest growing corridor for technology job growth, with more new positions added in the past year than Seattle, New York City, Washington DC and the Bay Area combined. Across Canada the cleantech industry already employs over 55,000 people. On top of this, there are a growing number of pioneering Canadian firms that illustrate our capacity to build innovative, economically sound, and environmentally responsible businesses.

There are 13 Canadian companies on the Global Cleantech 100 List, illustrating our outsized influence on the sector already. Part of the reason for this is a confluence and convergence of multiple streams of innovation that are coming together, including artificial intelligence, green energy, and others. This creates a domino effect that keeps talent at home and attracts new innovators to join our blossoming centres of technology research, innovation, and entrepreneurship.

The MaRS ecosystem raised close to $1.3Billion last year and generated $1.4Billion in revenues. We are starting to see some major returns from our innovation sector and clusters. Canada's entrepreneurs are shaping the future and

are being joined by others who want to be a part of this movement. But we must improve in our ability to win in big foreign markets. We need to overcome our size handicap by encouraging larger more established Canadian companies and investors to see climate change as a different type of risk management issue than they are at present – the primary risk being inaction. Large institution investors including our pension plans are revered globally for their prudence, but they have yet to fully engage in our economic transformation. They need to inoculate their own assets from the impacts of climate disruption by investing in solutions that will reduce climate risk and deliver new economic opportunities. Finally, we must attract international talent from around the world.

We must seize this moment and press our advantage to grow the Canadian cleantech sector. This means embracing our view of diversity as strength and investing in entrepreneurs who are bringing 'and solutions to the global marketplace of ideas.

EXPERT PRESENTATIONS: THE PROMISE AND PERILS OF TECHNOLOGY DISRUPTION

Moderator Dr. Jatin Nathwani

Ingrid Ott

The transformation of our energy systems effects all citizens and entire economies. Technology innovation is a critical part of this transformation, but along with it there is a need for institutional innovation to ensure an efficient and equitable shift in how we generate, distribute and consume energy.

What can economists contribute to this transformation? While we could not forecast the recession in 2008, we are good at understanding incentives. For example, Nobel prizes in economics were awarded to Nordhaus and Romer in 2018 for contributing to our understanding of climate change and technology and how they can be represented in economic analyses.

Until recently, policy-makers were not able to use economics to conceptualize what actions to take to accelerate innovation or address climate change. The work of these economists can now be used by various institutions to develop innovation and sustainability strategies. An important part of these strategies must be in designing systems that make the external costs of greenhouse gas emissions more transparent to everyday citizens. This requires institutions, not just technology. We also need to look to social innovation for solutions that are holistic and generate positive economic and environmental outcomes over the long term while engaging citizens proactively.

Raymond Tracey

Local Distribution Companies (LDCs) are in many cases the organizations that must bring innovations to the market. LDCs are consumer-facing and thus look for innovations that bring value to end users of electricity. Much has changed in the past ten years and LDCs have been on the leading edge of change and innovation in the electricity system in Ontario. We now have smart meters in every home which are enabling virtual metering and peer-to-peer energy trading, and we have a more complex electricity market in general. LDCs have also championed more innovative asset management techniques that optimize utilization of energy assets, as well as web-based tools and applications that allow customers to more readily understand their bill and consumption patterns and use this information to make smarter energy decisions.

LDCs will continue to bring innovation to the sector in the future through self-healing grids that leverage artificial intelligence to automatically restore power in the event of an outage, as well as through enabling storage and net metering to help communities reach 100% renewable electricity. LDCs can also shift to becoming 'digital utilities' who

leverage big data and the connectedness of the entire grid to manage its complexity. The scaling of digital utilities is limitless – no longer constrained by geography. What's more, LDCs have a track record of bringing these innovations to consumers while keeping rate increases below inflation.

Without this innovation, LDCs will lose customers who choose to defect from the grid – so being a leader and championing new technologies is critical to the financial sustainability of LDCs. Many of the new technologies that we are deploying are made in Ontario and are now being deployed all over the world.

Catherine Rosenberg

Technology disruption is about disrupting someone, often an incumbent. Incumbents are not necessarily taken by surprise when it comes to technology disruption, rather, they decide to ignore change because they do not see its immediate impact on their revenue. Incumbents also tend to put a focus on return on investment and their largest customers, whereas start-ups and other 'disruptors' focus on smaller customers and wider social impacts of the technologies that they are bringing to market.

The disruptors of our energy system have arrived. We are in an age of data collection, sensing, control, renewables and storage. Costa Rica, Portugal, and Iceland have all run their entire countries on renewables for months at a time. Large companies like Google, too, are powered entirely by renewable electricity. The future is already here. There are many inflection points including first, the falling cost of energy storage, second, the use of 'Internet of Things' (IoT) infrastructure for pervasive measurement and control of electricity systems, and third data analytics and the intelligent use and interpretation of data. All of these can be seen as threats or opportunities, depending on whether you choose to embrace them. Utilities, policy-makers, and customers are the stakeholders for whom this matters and who can either be impacted positively or negatively by these disruptions.

Theft detection and state estimation are opportunities for the utility to use new technologies. Photovoltaic (PV) storage is an opportunity for customer, depending on the jurisdiction that they are in. Personalized comfort systems for heating, ventilation and air conditioning (HVAC) are also an opportunity for the customer. IoT for control is a great opportunity for utilities but it must not create new more reliability and security problems. IoT for data collection is a great opportunity but utilities do not want to share data because it has value.

Technologies create opportunities, but incumbents are often too slow to take advantage of them. New business models are needed, and regulations should not get in the way. Great lessons can be learned from German experience - the threat is for players that cannot adapt.

Joshua Wong

Much of the innovation that we see today is about copying or integration. In the electricity sector, innovation will be driven by the need for utilities to become flexible platforms that manage the interaction of the system's various nodes. Beyond the electricity sector, the largest market cap companies are all platforms.

The question facing us is how to turn brick and mortar utilities into platforms for energy use, sharing, management, and control. Distributed renewables have driven some of the change that we are already seeing. There is a need to connect all the new technologies that are now being developed with business models that enable utilities to support the flow of energy and value and the emergence of the prosumer, as well as to maintain the sustainability of the grid.

Underlying all of this are 5 Ds: decentralization, decarbonization, digitization, deregulation and democratization. This is all part of an inevitable shift toward a service-based electricity platform. Grid 1.0 was composed of poles and wires, grid 2.0 was the smart grid, and grid 3.0 will be a transactive platform with value being exchanged by participants. Ultimately, a lot of innovation is about combining innovation and objectives. The new utility platform's objective is to bring together stakeholders to enable value to flow between them.

ENERGY INNOVATION SHOWCASE

Moderator Ron Clark

Elizabeth Monoian & Robert Ferry

The Land Art Generator Initiative (LAGI) takes an interdisciplinary approach to the issue of sustainability.

When they were first constructed, power plants were located within cities and designed by architects to fit in with urban environments. Then we moved them out of the cities because we were able to increase voltage and transmit electricity over longer distances without as much loss and reduce the impact of their emissions in urban centres – these new power plants were entirely utilitarian in design. The old power plants in cities were then repurposed for new uses such as museums or art galleries. With most of our electricity infrastructure now beyond our line of sight many people have no idea where their electricity comes from. At LAGI, we see an opportunity to reconnect with our electricity infrastructure, which is increasingly renewable and can have positive aesthetic qualities. It can be attractive and beautiful, and because it does not result in pollution, can re-enter our cities.

LAGI brings together architects, designers, engineers, landscape architects and others to generate beautiful design ideas for renewable electricity infrastructure that can also serve as public art. We have generated over 1000 ideas to date. We have explored several landscapes all over the world that could be made more beautiful with energy technology as public art. Energy Duck, a large duck-shaped installation covered in solar panels that can be raised and lowered in the water as a form of energy storage is one such idea that engages people to get them excited about energy technology. PV panels can be different colours and tints, and thin films and dye-sensitized solar cells can be semi-transparent and integrated into a variety of structures. Concentrated solar power plants can replicate the land art of the American southwest. We can imagine a world where you can take your family for a picnic at a power plant.

The ideas that we are generating can power significant numbers of urban homes and can serve as public parks that raise awareness of sustainability issues. These are 'and' solutions. They give us something to run towards rather than run away from. The economic benefit of public art is huge and well-recognized. By adding renewable generation to our public art, we can improve the economic return on public art investments even more.

John Adams

The Natural Gas Innovation Fund (NGIF) is a pooled investment fund wherein natural gas utilities and companies invest directly in small companies that are developing new natural gas technologies that can reduce emissions. The Canadian Gas Association has a keen desire to provide solutions that are emissions free. The NGIF is underpinning the sector with some amazing small, innovative companies that will be future suppliers of emissions-free gas.

NGIF is a cross-Canada organization where the investor is the end user, or purchaser of the product that the Fund's companies will provide. These investors are selecting opportunities that they feel are important to the industry. There are open funding calls right now, with stage-gated projects. Every one of these companies is working on reducing emissions from natural gas systems. The investors are not taking intellectual property (IP) only contributing to a pot of money that goes to innovators and new companies. 41 projects have been funded to date. $8.1M has been approved,

$70M has been raised. Strategic investments are in production of gas, transmission, and distribution which includes capture of emissions and energy efficiency. This includes technologies related to methane venting, fugitive emissions, heat and power generation, renewable gas, CO2 capture and liquified natural gas (LNG).

The stage-gate process includes intake, evaluation, and management. The evaluation is being done by the investors/end users at the natural gas utilities. Investors are incentivized to use a very hands-on approach to support the entrepreneurs that they are funding because they are themselves the beneficiaries.

Julie Morin

Companies of all types are going through digital transformations. Power is a critical piece of this, and all large companies care about their power and its reliability and affordability. This is true of large technology companies like Microsoft, where we are aiming for 100% renewable power usage. We are presently at about 50%.

Smart cities, smart factories and smart hospitals are examples of the digitally transformed infrastructure that is in demand today. They all rely on the grid, which must also be smart to make their own transformation possible. Microsoft has created a product called Azure digital twins that helps manage assets to make smarter their use of energy and resources. This optimization can mean that you don't need as much supply to meet demand. Intelligent software can also allow for maintenance of grids, through self-healing techniques.

Azure also allows buildings to be intelligently managed. A learning from the deployment of this capability is that the data generated can be used in a variety of ways, not only to reduce energy use but also to utilize other assets more efficiently. These can all lead to cost savings.

Alif Gilani

How can digitalization create value in the energy sector? This is the key question that we see emerging. Digitalization is a game-changer. The grid is evolving to become a decentralized bi-directional grid with more integrated parts, an ever-changing generation mix with significant capacity additions taking place, distances from source to load decreasing, a changing landscape of distributors, grid defection, refurbishment and upgrades across the system. Amidst this rapid and all-consuming trend of change in electricity systems, digitization provides the key to effective management.

The two macro-trends we see are distributed energy and digitalization. Grid instability, cyber security, extreme weather, and dispatching of conventional plants are threats to various stakeholders. Utilities are also seeing marketplaces change and are having to change their business models. Customers are becoming prosumers. In this environment, digitalization turns challenges into opportunities.

The previous focus of the sector on assets needs to change. Substations are becoming smart. Seal-healing networks are now possible through cloud-based solutions. There are many ways in which utilities can provide value through digitalization rather than new assets.

Siemens has developed systems for managing remotely distributed energy systems, micro-grids, and larger grids. Our tools enable real-time monitoring and control. Situational awareness is increasingly important, industry participation is on the rise, and artificial intelligence and analytics continue to gain momentum.

Ian Gallagher

Understanding new forms of value that is making digital disrupters successful is critical, as we have seen in the presentations that we have already heard today. Platforms are tools for abstraction that allow multiple services to be built on top of them without an end user needing to care about what is holding the platform up. It is about making systems work together and allowing multiple services to be accessed through a simple interface. CISCO works on integration of systems for this reason.

An exciting example of what is coming down the pipe comes from an innovative company called Sense. They have developed a technology that can be installed within a home's electrical box and listens to the electrical signals passing through the mains. It creates a plethora of data about energy use based on this ability, which essentially can turn a home with standard appliances into a smart home that can be monitored on an app interface. It is essentially a 'behind the meter' smart meter. The data captured by devices like this are going to be useful to utilities as well. One of the benefits of small innovators is that they can target immediate opportunities to provide value as consumers.

At CISCO we provide a platform for innovators like Sense to work within the same system/platform to bring their innovations to the market. It is insufficient for a company to deliver value in only one area – they must deliver value across the sector. We categorize the primary types of value as cost, experience, and platform value. Platform value is the key – it provides an ability for a product or service or system to never stop delivering cost and experience value.

PANEL DISCUSSION: FINANCING ENERGY BUSINESSES – THE GOOD, THE BAD, AND THE UGLY

Moderator David McFadden

Tom Corr

Overview:
Ontario Centre of Excellence (OCE) is a non-profit organization with its roots in a number of Ontario Centres of Excellence that were merged into one 13 years ago. OCE aims to create jobs by supporting the development and commercialization of new technologies. OCE funds research with industry partners always at the table to provide matching funds – OCE therefore helps to bridge the gap between industry and academia. OCE also provides funding to entrepreneurship incubators around the province, in particular those that are located at universities and colleges. 40 business development staff support OCE, which has invested $258M, resulting in an estimated 9772 new jobs created in Ontario in 2017-2018. 44% of the funding awarded last year went to the bio-economy and cleantech sectors. Also, in the energy sector, OCE was involved in elimination of coal in Ontario through supporting the conversion of the Atikokan coal plant to biomass. OCE now oversees a $74M program of cleantech investments.

The Good:
Pond Technologies converts smokestack emissions into bio products using algae. They have been successful because they are honest, transparent and have consistent constructive communications with investors. They have also showed resilience and sacrifice in hard times and have outlasted many of their contemporaries, being one of the only survivors of the algae companies that boomed in the early 2000s. Pond has been able to retain great talent and investors as a result. They have strong IP portfolio that have allowed them to sustain their growth. This matters to investors. They also have a clear path to market and scale-up because of their ability to create a product (algae) with many different high value uses.

The Bad and the Ugly:
Unfortunately, a lot of IP has been left on the shelf in this province because researchers don't know how to commercialize their innovations, and business people often don't understand what IP is worth (or not worth). The important thing is to move IP out the door as quickly as possible. There is clear tension between researchers who want to refine and improve their innovations, and businesspeople who want to find a fast route to market. Many researchers underappreciate the degree of effort that is necessary to commercialize after IP is developed. When they try to commercialize a product they are often not well-suited to run a business and refuse to hand over the reins soon enough, or to appreciate the importance of raising capital. A lot of promising companies die this way.

Jeffrey Steiner

Overview:
Angel Investors Ontario's mission is to grow the angel investor ecosystem in Ontario to build prosperity, create jobs and strengthen communities. We help entrepreneurs link up with the main angel groups across the province, of which there are 13. An angel group is a group of accredited angel investors who work together to mitigate the risks of their investments, save time and attract better investments. They meet regularly to hear pitches and share insights. Angel groups also share the burdens of due diligence. AIO helps co-ordinate all of the 13 angel groups. Approximately 60% of the recent AIO angel investments in Ontario have been in information and communications technology (ICT) sector. There are 1508 angel investors in Ontario who are formerly members of the Ontario ecosystem. They made $56M total investment last year and have cumulatively invested $365M in the last 10 years, resulting in approximately 11,700 jobs. AIO also provides tools for entrepreneurs to refine their business plans and pitches. Northern Ontario Angels is the largest group and is interested in green technology as well as companies that are located in southern Ontario. AIO hosts virtual joint screenings, allowing virtual pitches to be shared with all angel groups. These are sometimes themed to focus on female entrepreneurs, clean technology, businesses run by Syrian refugees, and other topics of broad social interest.

The Good:
Char Technologies is a shining example from our perspective because they were able to go public only two years after an initial angel investment, but this is not the norm. Char developed a technology to filter sulphur from natural gas, and as is the case with many successful businesses, this niche blossomed into a platform for many other similar markets.

The Bad and the Ugly:
While researchers and innovators-turned entrepreneurs take a lot of the blame for failed businesses, problems can arise later too, even when professional managers are running a company with mature IP. Often there is too much focus on continuous research and development rather than sales. Companies get obsessed with having the best product and aiming for perfection, whereas they should be obsessing on revenue. Angels want revenue above all else. We are constantly dealing with inventors who think their IP is worth a huge amount of money, even with no sales to back this up. This is the 'insane valuation' problem. What we have seen from our own deals is clear that any company that has good IP, but no sales can only achieve a valuation of $2-3M, no matter how big their prospective market and how great the IP may seem.

Steve Muzzo

Overview:
I have started three energy companies. The first was Trilliant Networks, created 18 years ago as a smart meter company that eventually became an IoT business. It is a multi-technology platform that allows utilities, governments, and end-users (with half a billion users in 17 countries currently under the platform) to manage their energy systems. Trilliant won the Hydro One smart meter contract and turned that into a global business. Cricket Energy was started 4 years ago as a retail energy business that rents water heaters and does suite metering (sub-metering of utilities in an apartment building for example). It also has an engineering division that does consulting and engineering. Ozz Electric is a diverse energy company that makes acquisitions across North America. It has multi-faceted capabilities and expertise and can do a huge array of projects. Ozz has over 1000 employees.

The Good:
Strategic investors have been critical to our businesses - these are people who have a stake in the success of the business and the connections and expertise to help it grow. Often, they can become a customer or partner, so the relationship is symbiotic in several ways. Advice for companies: be prepared for acquisition at any time. Always act like a public company.

The Bad and the Ugly:
Strategic investors can also be a problem. They can over-promise and under-deliver and become a negative influence on a business. If I could do it all over again I would build in some kind of off-ramp to protect my companies against strategic investors that don't deliver.

Council for Clean & Reliable Energy
transforming the way we think about power

Appendix 1
Conference Program and Presenters

Technology & Innovation
Policy Forum 2018 Report
November 2018

Technology Innovation & Policy Forum 2018

Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy

Council for Clean & Reliable Energy — transforming the way we think about power

WISE — Waterloo Institute for Sustainable Energy

University of Waterloo

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Conference Program

8:00 am **Registration & Continental Breakfast**

9:00 am **Welcome**
Glen Wright, Chairman, Council for Clean & Reliable Energy (CCRE)
Karen Taylor, Vice Chair, Council for Clean & Reliable Energy (CCRE)

9:15 am **Keynote Speaker**
Yung Wu, CEO, MaRS Discovery District

How Canada Can Become a Global Innovation Powerhouse

9:45 am **Panel 1: Promise and Perils of Technology Disruption**

Emergence of decentralized energy systems has the potential to create enormous new economic value for the customer. The technology disruption also threatens the existing structure of energy production and delivery. The panel will discuss whether the threat is real and implications for the future evolution of the industry.

Moderator: **Jatin Nathwani**, Professor and Executive Director, Waterloo Institute for Sustainable Energy (WISE); Member, CCRE
Panelists: **Dr. Ingrid Ott,** Expert Member, Merkel Commission on Research and Innovation, Professor and Chair, Economic Policy at Karlsruhe Institute of Technology (Germany)
Raymond Tracey, CEO, Essex Power
Dr. Catherine Rosenberg, Tier 1 Canada Research Chair in the Future Internet and CISCO Research Chair in 5G Systems, Professor, Electrical and Computer Engineering, University of Waterloo
Joshua Wong, CEO, Opus One Solutions

Q&A Session: 45 minutes

11:15 am **Break**

11:30 am **Innovation Showcase Feature and Technology Developers Presentations**

Moderator: **Ron Clark**, Partner, Aird & Berlis LLP
Presenters: **Elizabeth Monoian** and **Robert Ferry**, Founding Co-Directors, The Land Art Generator
John Adams, Managing Director, Natural Gas Innovation Fund, Canadian Gas Association
Julie Morin, Intelligent Cloud Business, IOT Global Black Belt SSP, Microsoft Canada
Alif Gilani, Head of Engineering, Energy Management Division, Siemens Canada
Ian Gallagher, General Manager, Collaboration, CISCO Canada

12:30 am **Lunch, Innovation Showcase, Networking & Industry-Academic Collaboration**

1:15 pm **Optional Lab Tours** (for Pre-registered Guests)
Laboratory 1: Centre for Advanced Photovoltaic Devices and Systems (CAPDS)
Laboratory 2: Giga-to-Nanoelectronics Centre
Laboratory 3: Non-Destructive Testing Centre

2:30 pm **Panel 2: Financing Business Models: The Good, the Bad and the Ugly**

Financing innovation is almost always an issue. This highly experienced panel will discuss alternative approaches to financing and the advantages and pitfalls which need to be considered. The panel will also consider successes and failures with alternative business models and the role of government in fostering innovation.

Moderator: **David McFadden**, Counsel, Gowling WLG (Canada) LLP; Member, CCRE
Panelists: **Dr. Tom Corr**, President and CEO, Ontario Centres of Excellence
Jeffrey Steiner, President & Executive Director, Angels Investor Ontario
Steve Muzzo, President and CEO, OZZ Electric and Cricket Energy

Q&A Session: 45 minutes

4:00 pm **Closing Remarks**
Karen Taylor, Vice Chair, CCRE

Reception, Innovation Showcase, Networking & Industry-Academic Collaboration

Thank you to our event sponsors

ENBRIDGE · NGIF Natural Gas Innovation Fund · AIRD BERLIS · Waterloo North Hydro Inc. · CGA Canadian Gas Association · Power Workers Union

CONFERENCE PRESENTERS

KEYNOTE SPEAKER

Yung Wu

Chief Executive Officer, MaRS Discovery District

Yung Wu is a pioneering entrepreneur and serial investor. Under Wu's leadership, MaRS will continue to advance prosperity through entrepreneurial achievement. Previously, Wu was chair of NFQ Ventures, an early-stage investment firm based in Toronto. He has a track record of founding, scaling and actively backing several groundbreaking startups, including: Castek Software, an insurance software vendor that was sold to a division of Oracle in 2007; Fuse Powered, a mobile analytics and big data firm that was purchased by Upsight in 2016; and Antibe Therapeutics, a biotech company developing medicines to treat pain and inflammation. Wu has been recognized as one of Canada's "Top 40 under 40" leaders and for leading one of the country's "50 Best Managed Private Companies."

John Q. Adams

In his role as Managing Director of the Natural Gas Innovation Fund, John is responsible for raising capital from industry investors, manages the fund's investment process, governance and accountability, and implementing the fund's investment strategy for natural gas priorities to raise capital from its industry investors; manages the fund's portfolio activities including technology scouting and deal review, technical and business evaluation, due diligence and evaluation, project management, corporate performance and entrepreneurial support; and ultimately responsible for all day-to-day management decisions including human resources, risk management, accounting and auditing, investment and fund management and performance.

John brings 25 years of experience in the cleantech energy sector with his current position at NGIF and previous positions at Sustainable Development Technology Canada (SDTC) - with a range of increasingly senior positions including Director, Applications/ Funding Advisory, Director, Stakeholder Relations, Vice President Industry, and Executive Director raising $40M in partnership agreements, leading national funding competitions, created a national Virtual Incubator, and reviewed over 1000 cleantech ideas and proposals; and at Mitsui & Co. (Canada) Ltd. With positions in infrastructure business and international trade.

John has a Bachelor of Science (B.Sc.) Environmental Science and Environmental Management from University of Toronto.

Ron W. Clark

Ron is a Partner at the law firm Aird & Berlis LLP. He loves the challenge of operating a practice at the intersection of corporate/commercial, energy and municipal law. Having advised numerous clients through the historical and institutional development of the energy market in Ontario, Ron brings extensive experience and perspective to guiding his energy clients through both the immediate and anticipated steps of a transaction. In addition, with a deep interest in the intersection of law and public policy, Ron enjoys meeting the unique challenges of his clients with respect to the constant evolution of the energy market.

Ron's corporate/commercial practice includes advising corporations, financial institutions, municipalities and individuals on commercial agreements, asset and share purchase transactions, mergers and acquisitions, private placements and secured lending transactions. The energy side of his practice involves counselling stakeholder groups, retailers, distributors and generators on legislative and policy matters relating to electricity markets.

Ron has been retained in connection with power procurement arrangements, development of generation and cogeneration facilities and the Ontario government's clean energy supply and renewable energy supply RFPs and contracts. He has also been involved in electricity restructuring in Iraq, Saudi Arabia, Ghana, Albania, Macedonia and the Regional Southeast European market. Additionally, Ron chaired the Ontario Energy Association's Task Force on Ontario's proposed electricity legislation.

Ron has a background in public international law and previously served as a diplomat with the Canadian Department of Foreign Affairs and International Trade, with postings in Ottawa and Brussels.

Dr. Tom Corr

As President and CEO of Ontario Centres of Excellence, Dr. Tom Corr brings more than 30 years of entrepreneurial experience in the IT and venture capital sectors. As a technology business owner with a distinguished academic background, Dr. Corr is a leader in bridging the worlds of entrepreneurship and academia.

Prior to joining OCE in 2010, Dr. Corr was the CEO of the Accelerator Centre (AC) at the Waterloo Research and Technology Park and Associate Vice-President of Commercialization at the University of Waterloo (UW) and Director of Commercialization - IT & Communications at the University of Toronto. Dr. Corr's career also includes leadership roles in the IT sector including positions as Managing Partner at Catalyst Partnership; founder and CEO of Momentum Systems; founder and CEO of Applied Development Corp., and President of Canadian Data Processing Corp.

He holds a Doctor of Business Administration degree from Henley Management College/Brunel University in England, an MBA from the University of Toronto, and the ICD.D designation by the Institute of Corporate Directors. Dr. Corr serves on the boards of C-FER Technologies (Chair), the Southern Ontario Smart Computing Innovation Platform, and Ontario Genomics.

Ontario Centres of Excellence is a non-profit organization that drives the commercialization of cutting-edge Ontario-based research across key markets sector to build the province's innovation economy and secure its global competitiveness. OCE currently manages more than 930 research, commercialization and talent projects that will bring innovation to the marketplace and foster the training and development of future innovators, entrepreneurs and business leaders.

Robert Ferry and Elizabeth Monoian

Robert and Elizabeth are the Founding Co-Directors of the Land Art Generator (LAGI). They conceptualized LAGI in the Fall of 2008 and the project was strongly founded by theSspring of 2009.

In addition to developing and managing the LAGI design competitions, Ferry and Monoian have developed an array of unique STEAM materials that are widely used globally, including the Field Guide to Renewable Energy Technologies, Art+Energy Camps, Art+Energy Flash Cards, a 13-step STEAM Toolkit, information graphics, publications, and more. LAGI is the recipient of multiple National Endowment for the Arts grants and has been awarded the J.M.K. Innovation Prize, a program of the J.M. Kaplan Fund.

Through LAGI Elizabeth and Robert have published, exhibited, and presented globally on the aesthetics of renewable energy and the role of art in providing solutions to climate change.

Ian Gallagher

Ian Gallagher is the general manager, collaboration for Cisco Canada. He leads a national team of collaboration product specialists responsible for working with Cisco partners and customers to create and execute business impacting collaboration strategy and architecture.

Since joining Cisco as a systems engineer in 2000, Gallagher has held a number of roles in both sales and engineering. Most recently, he served as a systems engineering manager for collaboration. Before becoming a consulting systems engineer for collaboration in 2006, Gallagher worked as a global systems engineer for the Toronto Dominion Bank and was involved in the early deployments of IP telephony at TD Bank, Royal Bank of Canada and several other key Canadian collaboration customers.

Prior to joining Cisco, Gallagher worked as a senior network architect for Symcor Services where he helped consolidate the cheque processing and print operations of three large Canadian banks. Gallagher holds a bachelor's degree in computer science from York University.

Alif Gilani

Alif Gilani is the Head of Engineering of Siemens Canada's Energy Management Division and the Head of Operations & Project Management for the Digital Grid Systems Segment.

Mr. Gilani is responsible for all engineering, innovation and development of Energy Management activities in Canada. He reports directly to the head of the Energy Management Division and works with various business unit heads as well as heads of key support functions of sales, strategy, business excellence and communication within the division.

Prior to his current roles, Mr. Gilani was the Technical Lead Manager for the Energy Automation Division in the Lower Gulf Region Arab Emirates, Bahrain, Qatar, Oman & Yemen. Mr. Gilani has over 12+ years of experience in the areas of protection, control and substation automation and has executed a multitude of projects with varying complexity in a number of countries leading multinational and multicultural teams. In addition to this, Mr. Gilani leads the research and development team within Siemens Canada's Digital Grid Systems segment on the prototyping of a low cost microgrid controller system. He heads all Microgrid projects within Siemens Canada from a project management, base design development, configuration and testing perspective.

He is a professional engineer and holds a P.Eng from PEO and APEGS and serves as a member and contributes to IEEE, CIGRE and the National Electricity Roundtable (NER).

Mr. Gilani received a Bachelor of Science (B.Sc) Degree in Electrical Engineering from Queens University in Kingston, Ontario, Canada in 2001 and a Masters of Engineering (M.Eng) Degree in Engineering Management from the University of Ottawa in Ottawa, Ontario, Canada in 2003.

David J. McFadden, Q.C.

David McFadden is Counsel at Gowling WLG having served previously on the firm's Executive Committee and Board of Trustees. He has acted for corporations, municipalities and utilities involved in the generation, distribution, transmission, marketing and financing of energy.

David is the Chair of the Board of Director of Toronto Hydro Corporation, 407 International Inc., and PCI Geomatics Inc. He serves as a member of the Board of Directors of Cricket Energy Holdings Inc.

David is a past Chair of the Board of Directors of the Ontario Energy Association (OEA) and continues to serve on the OEA's Board. He serves as Vice Chair of the Energy Transformation Network of the IESO and is a member of the Advisory Board of the MaRS Advanced Energy Centre and the Council for Clean and Reliable Energy.

David is the Chair of the board of Governors of the Mackenzie Institute and is on the Board of Governors of York University where he chairs the Board's Governance and Human Resources Committee. He previously served as Chair of the Toronto Board of Trade and continues to serve as a member of the Board's Audit Committee.

David was the Chair of the Board of the Ontario Centres of Excellence Inc. (2004-2010) and in that position led the creation of the Centre of Excellence for Energy which has supported energy innovation across Ontario. David has also served as Chair of the Stakeholder's Alliance for Electricity Competition and Customer Choice, was a member of the Canada-US Electric System Working Group which investigated the massive blackout in August 2003, co-led an investigation team into the 2006 nationwide blackout in Jamaica, was a Member of the Ontario Ministry of Energy's Electricity Conservation and supply Task Force (2003-2004), and served on the Ontario Distribution Sector review Panel (2012).

David was named the Leader of the Year by the Ontario Energy Association in 2013.

Julie Morin

Julie Morin is part of the Microsoft Internet of Things Global Black Belt Team tasked with helping public and private sector customers accelerate their digital business transformation through the Internet of Things.

She brings experience in driving technology initiatives with Canadian organizations by finding innovative solutions to address high value digital transformation projects. Julie is in line with the industry's fast changing requirements for enterprises looking for guidance with the Internet of Things, predictive analytics, machine learning and data strategy while ensuring compliance, and security as a forefront.

Steve Muzzo

Mr. Muzzo is the Founder and Chief Executive Officer of Ozz Electric, OZZ Clean Energy's largest shareholder, and a strategically active board member. Established in 1991, OZZ Electric is a full service Electrical and Data Com company with over 900 electricians servicing the ICI and Multi-Residential markets in Ontario, Alberta and Newfoundland. He also co-founded OZZ Comfort Solutions and Trilliant Inc. Trilliant provides intelligent network solutions and software to utilities around the world for advanced metering, demand response, and smart grid management.

Jatin Nathwani

Professor Nathwani is the founding Executive Director, Waterloo Institute for Sustainable Energy (WISE) and holds the prestigious Ontario Research Chair in Public Policy for Sustainable Energy at the University of Waterloo.

WISE brings together the expertise of 100+ faculty members to develop and implement large-scale multi-disciplinary research projects in collaboration with business, industry, governments and civil society groups. The vision of the Institute is simple: clean energy, accessible and affordable for all.

His current focus is on implementing a global change initiative: he is the Co-Director, with Professor Joachim Knebel (Karlsruhe Institute of Technology, Germany), of the consortium 'Affordable Energy for Humanity (AE4H): A Global Change Initiative' that comprises 130+ leading energy access researchers and practitioners from 30 institutions and 16 countries.

Prior to his appointment at the University in 2007, Professor Nathwani worked in a leadership capacity in the Canadian energy sector over a 30-year period. He brings a unique combination of academic perspectives with extensive experience in the business sector that includes corporate planning and strategy, energy sector policy developments, power system planning, environmental and regulatory affairs and research program management.

Professor Nathwani serves on several Boards at the provincial and national levels and has appeared frequently in the media (print, TV, radio) and has over 100 publications related to energy and risk management, including seven books.

Professor Nathwani holds a PhD in Engineering from the University of Toronto and is a Registered Professional Engineer in the Province of Ontario.

Dr. Ingrid Ott

Ingrid Ott heads the institute of Economic Policy at Karlsruhe Institute of Technology where she administers education and training in various disciplines including endogenous growth theory, spatial economics, economic policy, innovation theory & policy, methods in economic dynamics, and quantitative methods in economics. She is a full professor at KIT with strong research expertise in innovation and growth theory, cutting-edge technologies and regional development. Under her supervision, her research team has developed formal theoretical models and applied these models by means of simulations and empirical analyses to concrete economic problems successfully deriving policy recommendations.

Prof. Ott was a member of the Expert Commission for Research and Innovation that advises the federal government (Germany) on research, technology and innovation policy issues, and identifies progress and options for action each year. She is also a member of the founding committee of the Institute of Technology Futures (ITZ) and member of the board of directors of the Centre for European Economic Research (ZEW) in Mannheim. She has also served as the head of research division New Technologies and Regional Innovation Systems at the Hamburg Institute of International Economics (HWWI).

Dr. Catherine Rosenberg

Catherine Rosenberg is a Professor in Electrical and Computer Engineering at the University of Waterloo since 2004. Since June 2010, she holds the Canada Research Chair in the Future Internet. She was elected an IEEE Fellow for contributions to resource management in wireless and satellite networks on 2011 and was elected a Fellow of the Canadian Academy of Engineering in 2013. In April 2018, she became the Cisco Research Chair in 5G Systems.

Additionally, Professor Rosenberg was on the Scientific Advisory Board of the Orange Group (France-Telecom) from 2007 to mid-2015. She became its president from January 2013 to mid-2015. She also became the president of the Scientific Advisory Board of the French IRT (Research and Technology Institute) BCOM on multimedia and networking in 2014.

Her research expertise lies in wireless networks, multimedia, traffic engineering and energy systems. Her work in wireless networks includes 5G, IoT, and generally resource management. Professor Rosenberg's multimedia research encompasses CDN, peer-to-peer, and real-time streaming. Her research in traffic engineering focuses on quality of service, network optimization and game theory and pricing. Prof. Rosenberg's research in energy systems includes smart grid design, storage modeling, renewable integration, and data analysis.

Jeffrey Steiner

Jeffrey Steiner is a Toronto lawyer and business leader involved in the media, real estate, and mining sectors. He founded New Franchise Media Inc., which develops film & TV projects based upon the bestselling novels of Jeffrey Archer.

In his role from 2002-2009 as President & CEO of the Toronto Economic Development Corporation (TEDCO), he developed the new Toronto headquarters for Corus Entertainment Inc. - a 500,000 square foot LEED-Gold green building on Toronto's waterfront.

Mr. Steiner is a member of the Board of Directors of Canada's official export-import bank Export Development Canada (EDC). He previously served on the Board of Directors of the Ontario Centres of

CONFERENCE PRESENTERS CONTINUED

Excellence (OCE Inc.), which oversees government investment in the commercialization of university R&D through industry collaboration and venture capital.

His previous experience includes serving in the federal government as Chief of Staff to the Minister of Indian Affairs & Northern Development, and at the Department of National Defence.

Karen Taylor

Karen Taylor has over 25 years of related financial and energy experience. She was a top ranked equity analyst for 16 years covering the pipeline, energy utility, and power generation sectors in Canada and the United States. She also served as Executive Advisor to the Chair of the Ontario Energy Board and was a Member of the Ontario Energy Board, giving her a deep understanding of rate regulation. Karen has a Bachelor of Commerce with a major in finance with distinction from the University of Alberta, an MBA with honours from the Richard Ivey School of Business, is a CFA Charter Holder, and has the ICD.D designation from the Institute of Corporate Directors.

Raymond Tracey

Ray is responsible for the development and integration of Essex Power Corporation and its three subsidiaries into successful businesses: Essex Powerlines, Essex Power Services and Essex Energy. Ray plays a key role in ensuring that corporate systems and business processes comply with the deregulated processes such as wholesale and retail settlements, electronic business transactions and unbundled billing.

Ray serves as the Chair on the board of directors of the Electricity Distributors Association (EDA) for the 2015-2016 terms. Ray holds a Bachelor of Applied Science in Electrical Engineering from the University of Windsor, and registered with the Association of Professional Engineers of Ontario in 1988. Ray has 30 years of proven experience in engineering, planning, market settlement, business integration and innovation.

Joshua Wong

Joshua Wong is President and CEO of Opus One Solutions, a software engineering and solutions company empowering the decentralized energy economy in improving grid reliability, utilization and efficiency, as well as unlocking grid potential for 100 percent clean energy.

Prior to Opus One, Joshua was the Director of Engineering at eCAMION Inc., a leading provider of battery storage system solutions. In this role, he leads the development of integrated solutions for on-grid, off-grid, and mobile applications. Prior to eCAMION, Joshua was the smart grid and grid solutions lead at Toronto Hydro Electric System Limited, the electric utility for the city of Toronto, where he led the policy, strategy, business and engineering development of Toronto's smart grid infrastructure, including a 25-year smart grid roadmap. Furthermore, he spearheaded the Smart Community initiative, effectively introducing and delivering a portfolio of smart grid demonstrations including distribution automation, smart metering, advanced sensing, electric vehicle charging and energy storage initiatives.

Joshua specializes in driving practical innovations and navigating complex whitespaces in the smart energy sector, applying integrative and systemic thinking to deliver immediate results. He is a licensed Professional Engineer in the province of Ontario. He received his Bachelor of Applied Science in electrical engineering from the University of Toronto, Masters of Electric Power Engineering from the University of Waterloo and completed executive programs from Harvard Business School, MIT Sloan and IMD Business School.

Glen Wright

Glen Wright is the Chairman of the Council for Clean and Reliable Energy, a federally incorporated non-profit volunteer organization that provides a platform for open dialogue and solutions-oriented approach to the challenges of the energy sector. He is the former Chairman of Hydro One Inc. and Waterloo North Hydro.

Mr. Wright is currently the Chairman of LeanCor LLC and LeanCor Canada Inc., a global supply chain company that offers a unique combination of training and education, hands-on consulting and outsourced logistics services.

Mr. Wright has served as the Chair of the Ontario's Workplace Safety and Insurance Board, and was a Member of the Commission for Environmental Cooperation, part of the North American Free Trade Agreement, where he served as the Chair of the of the Joint Public Advisory Committee.

Glen's private sector career has focused primarily on the insurance and actuary fields. He has served on the Board of a wide range of corporations in the insurance, environmental, technology and manufacturing sectors and participated in a variety of charitable and not-for-profit Boards including the Canadian Broadcasting Corporation and Wilfrid Laurier University. Early on in his career he served as a Member of Waterloo City Council and Waterloo Regional Council and has acted as a senior advisor to several federal and provincial leaders.

Lab Tours: 1:15 – 2:15 pm

LAB 1: Centre for Advanced Photovoltaic Devices and Systems (CAPDS)

Promotes cutting-edge research and development that spans the spectrum of photovoltaic (PV) technology. The 14,000 square-foot facility includes infrastructure for synthesizing semiconductor base materials; developing nanotechnologies for PV; designing and fabricating advanced PV devises and systems modules; and, testing and characterizing PV materials, devices and systems.

LAB 2: Giga-to-Nanoelectronics (G2N) Centre

G2N is a unique facility at the University of Waterloo and Canada, offering a wide range of capabilities for processing electronic materials and devices. Established in 2005, the Centre is a hands-on facility providing users training and access to run their own research. This facility consists of groups within the University of Waterloo and external partners that make up the interdisciplinary research that spans nano-materials to large-area electronics. In addition to facilitating academic research programs, G2N also provides the capability to develop and prototype novel and emerging technologies for commercial applications.

LAB 3: Non-Destructive Testing Centre

Around the world, cities are facing a major challenge: What to do about aging infrastructure such as bridges, water mains, roads, and electrical transmission lines. How can engineers know if they have years of life left in them or are on the verge of collapse? University of Waterloo research teams are developing innovative techniques to help distinguish the good from the bad in materials ranging from concrete to wood - without manually taking the system apart.

Thank you to our event sponsors

Council for Clean & Reliable Energy
transforming the way we think about power

Appendix 2
Innovation Showcase

Technology & Innovation Policy Forum 2018 Report

November 2018

Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy

Council for Clean & Reliable Energy
transforming the way we think about power

WISE
WATERLOO INSTITUTE FOR SUSTAINABLE ENERGY

UNIVERSITY OF WATERLOO

November 7, 2018
Federation Hall
University of Waterloo

Innovation Showcase

The Technology Innovation and Policy Forum is pleased to present the Innovation Showcase featuring displays and projects, state-of-the-art products and information from institutional, corporate, government agencies and funding sources. Academia, entrepreneurs, innovators and industry representatives will be pleased to connect with you during the networking session times from: 8:00 to 9:00am, 12:30 to 2:30pm and 4:00 to 5:30pm.

The Waterloo Institute for Sustainable Energy (WISE) was established at the University of Waterloo in 2008. The Institute comprises more than 150 faculty members with graduate students and postdoctoral fellows working as multi-disciplinary research teams across Engineering, Science, Mathematics, Arts and Environment. The Institute is the focal point at the University of Waterloo (UW) for research in energy studies. In collaboration with utilities, private sector partners, government agencies and civil society groups, the Institute's goal is to foster the development of innovative technologies and alternatives to existing energy production and delivery systems, and to promote energy efficiency and environmental sustainability. At WISE, we have 31 state-of-the-art labs that can be used for applied research, technological development, and equipment testing.

The Department of Electrical and Computer Engineering (ECE) is Waterloo's largest academic department, with over 2,500 students, 86 full-time faculty members, and more than 50 supportive staff. Our research activities cover a wide range of fields, from high-voltage engineering and sustainable energy to breakthroughs in wireless technology that will enhance communications across our global society.

The High Voltage Engineering, Electricity Market Simulation and Optimization, Smart Distribution Research, Power Electronics, Advanced Battery Technologies, Center for Advanced Photovoltaic Devices and Systems, Solar Thermal Research, Fuel Cell and Green Energy R&D, Wind Energy, Green and Intelligent Automotive, and Maglev Microrobotics research lab facilities have been actively pursuing R&D and commercialization initiatives in the discipline of smart grid electrical systems at the national and international level.

In partnership with the Canadian Council for Clean and Reliable Energy we are pleased to offer this exciting opportunity to network with the innovators that are leading the way to a 'low cost-low carbon' economy.

Thank you to our event sponsors

ENBRIDGE · NGIF · AIRD BERLIS · Waterloo North Hydro Inc. · CGA · POWER WORKERS UNION

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

UNIVERSITY OF WATERLOO

Application of Power to Gas Concept at an Automotive Manufacturing Plant

Azadeh Maroufmashat, Postdoctoral Fellow,
University of Waterloo

A promising Power-to-Gas energy hub concept is proposed for an automotive manufacturing plant in southern Ontario. This energy hub converts electricity from the power grid and solar panels to hydrogen gas to be used in multiple pathways. These applications include energy for fuel cell vehicles (FCVs), and injection in hydrogen enriched natural gas (HENG) pipelines which supplies for facility heating, and manufacturing processes. Ontario's surplus of electricity, combined with solar energy and natural gas, are all converted to supply electricity to the electrolyzer and output hydrogen gas. Some of the hydrogen that is produced is also blended into the natural gas pipelines and sent through a combined heat and power (CHP) unit to supply additional energy for the facility heating and manufacturing processes. Excess energy produced by the CHP can also be supplied back to the electrolyzer to create a continuous loop of renewable energy. Canada has one of the largest pipeline networks in the world, but there are limitations of introducing hydrogen at 5 vol% based on studies in Europe and Canada. Based on these findings there is restriction for the blending system to handle a concentration of 5 vol% hydrogen gas. The demand profile for the refuelling stations shows that the system is capable of supplying for 100 forklifts and 40 FCVs operating around the municipal region with a total capacity of 222 kg per day. The foundation of the Power-to-Gas system is based on a formulation of a mixed integer-linear-programming-model which optimizes the operation of all energy pathways and determines the installation capacity of the electrolyzer and compressors.

Our primary objective is to minimize capital costs, operational costs, as well as produce revenues selling hydrogen, and providing the demand response for ancillary services to the power grid. Power-to-Gas also creates a net-emission reduction which could be used to sell emission allowances in the provincial Cap & Trade program in Ontario.

Next, the available area for the energy hub is 2400 m2 which will account for the electrolyzer facility, hydrogen storage, and compressor units. This site is in close proximity to the refueling stations, CHP unit, controls center, and electrical substation, so the existing logistical pathways for energy transfer can be taken advantage of. Additionally, unshaded roof space of 160,000 m2 is available throughout the plant for solar arrays to generate a daily energy output between 117 to 150 MWh. Hydrogenics will provide their PEM electrolyzer for the system which can produce 99.999% pure hydrogen gas to supply for the dispensing stations. A Greenfield reciprocating compressor will compress the hydrogen gas to 172 bar to store in the ASME storage tank with a capacity of 89 kg. Finally, the post-storage compressors will compress to 825 bar and 250 bar for refueling the FCV and forklifts, respectively. The blended hydrogen will be injected into the natural gas pipelines at 5%vol and led to two CHP units (Centaur 50 CHP) with a nominal output power of 9200 KWe in total. The HENG will supply for facility heating demands which include the paint booths and plastics department. All of these processes have considered applicable safety instrumentation and are in accordance with all relevant codes and standards.

The installation of the Power-to-Gas system will require a total capital investment of $2,620,448. The electrolyzer and 1500 solar panels will account for 41% and 17% of the capital costs, respectively, as they are major processes used to supply electricity and hydrogen gas. The compressors will account for most of the operating costs which total $237,653. The energy hub, 76,073 kgH2 per year will be produced for all the end-use applications. Based on a sensitivity analysis, the annual revenue for selling hydrogen at $1.5 to $12 per kgH2 can sum to $54,741 to $437,928. In the Cap & Trade program, CO2 allowances can be sold at $18 to $30 per tonneCO2 and the model predicts a CO2 offset of 2359.7 tonnes. The optimal streams of revenue include selling hydrogen at $12 per kgH2 and selling CO2 allowances at $30 per tonneCO2. The ancillary services incentives are kept constant at $15 per MWh. With a combination of these optimal revenue streams the automotive manufacturer can expect a payback period of 2.8 years.

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Random Field Modelling of Wall Thinning due to Flow Accelerated Corrosion

Sreehari Ramachandra Prabhu, PhD Candidate,
University of Waterloo

Flow accelerated corrosion (FAC) is a degradation mechanism which causes wall thinning of carbon steel piping in power plants. The uncertainties involved in the factors leading to FAC mechanism introduces varying thinning rates in the feeder pipe population, which leads to various pipe wall thicknesses. The local thinning at the vicinity of welds introduces additional uncertainties. Probabilistic approaches have been used for reducing the uncertainty by considering the minimum thickness point as a random variable. However, the concept of a single random variable cannot capture the real nature of this problem since the wall thinning is a spatially distributed mechanism. This paper describes a random field modeling approach to effectively account for the spatial variation in wall thickness and to simulate samples of wall thickness patters using the spectral representation method. The simulated samples can be used in Stochastic Finite Element Analysis for a probabilistic study on pipe structural integrity.

Smart Operation of Four-Quadrant Electric Vehicle Chargers in Distribution Grids

Mauricio Restrepo, Post Doctoral Fellow,
University of Waterloo

An average model of a single-phase, four-quadrant EV charger is developed. The steady-state and step responses of the proposed model for different P-Q requests are used to validate its performance against a four-quadrant EV charger prototype. Also, a three-stage algorithm to coordinate the operation of four-quadrant EV chargers with other volt/var control devices in distribution feeders is proposed. The first stage of the algorithm is operated on a day-ahead basis, and defines the LTC and capacitor schedules while minimizing the peak load associated with EVs.

The second and third stages update their operation every five minutes, to fairly allocate the aggregated and individual EV loads in the MV and LV feeders, while minimizing active power losses and voltage deviations.

Impact of Battery Energy Storage of Transmission Systems

Fabian Mauricio Calero, PhD Candidate,
University of Waterloo

A Battery Energy Storage System (BESS) dynamic model is presented, which considers average models of both voltage source converter (VSC) and bidirectional buck-boost converter (dc-to-dc), for charging and discharging modes of operation. The dynamic BESS model comprises a simplified representation of the battery cells, which allows to simulate the effects of battery degradation, dc-to-dc converter, VSC, and the dynamics associated with the filter and transformer connecting the BESS to the grid. Decoupled dq-current control is used for the VSC, allowing the operation of the BESS in several modes: constant active and reactive power, constant power factor, voltage regulation, frequency regulation, oscillation damping, and a combination of these. The importance of modeling the current control and dynamics of the dc-to-dc is demonstrated when the battery cells are degraded due to, for instance, ageing. The proposed model is implemented in DSATools and tested for different contingencies, connected to a benchmark system and compared with one of the most common existing BESS models.

Modelling of Compressed Air Energy Storage for Power System Studies

Ivan Calero, PhD Candidate,
University of Waterloo

A detailed mathematical model of a diabatic Compressed Air Energy Storage (CAES) system and a simplified version are presented, considering independent generators/motors as interfaces with the grid. The model includes the compressor, synchronous motor, cavern, turbine, synchronous generator, and associated controls. The configuration and parameters of the proposed model are based on the existing bulk CAES facilities of Huntorf, Germany. The performance of the CAES system model are the first evaluated with step responses, and then examined when providing frequency regulation in a test power system with high penetration of wind generation, comparing them with existing models of CAES systems.

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Steady-State Analysis and Optimal Power Routing of Standalone Hybrid AC/DC Microgrids

Mahmoud A. Allam Alsanbawy, Postdoctoral Fellow, University of Waterloo

Conventional power flow analysis approaches cannot be applied to standalone hybrid ac/dc microgrids due to their distinctive features, such as droop characteristics, lack of a slack bus, and coupling between the ac and dc variables. To overcome these hurdles, a generic steady-state analysis approach that accommodates the system characteristics has been developed. First, mathematical models of various ac and dc distributed generator (DG) types and interlinking converters (ICs) have been developed, based on their different structures and control topologies. Second, a power flow algorithm integrating these models has been proposed to solve for the hybrid microgrid's variables. Furthermore, the developed power flow algorithm has been used to identify some operational challenges of these microgrids, such as their restricted loadability due to the unbalanced ac subgrid's operation. Accordingly, a novel optimal power routing scheme has been proposed to resolve the identified operational issue. The results show the effectiveness of the developed tools in analyzing the system and alleviating the loadability restriction.

Innovative Energy Research at the Waterloo Institute for Nanotechnology (WIN)

Oleg Stukalov, Business Development Manager, WIN, University of Waterloo

Next Generation Energy Systems is a key thematic area in nanotechnology research with WIN members focussing efforts on meeting global energy needs for sustainable energy production. Nanotechnology seeks to address these challenges by investigating novel materials for improved battery design and storage systems, efficient solar cells, waste energy harvesting, thermoelectric conversion and new low-carbon innovations that will lead to greener and cleaner power for today and tomorrow. Under WIN's banner, students will present research results on efficient hydrogen generation for fuel cells, recent advances in battery and supercapacitors research for energy storage, and micro-power generators.

Strategic Support for Circular Economy in the Construction Industry through Product Recovery Management

Ben Sanchez,[1] Chris Rausch,[1] & Carl Haas,[2]

1 PhD Candidate, Civil & Environmental Engineering;
2 Professor, Civil & Environmental Engineering, University of Waterloo

Buildings contribute significantly to the global environmental load caused by human activities. From a life cycle perspective, the building industry is responsible for about 30 per cent of global annual Greenhouse Gas (GHG) emissions, 40 per cent of energy consumption, 32 per cent of earth's resource depletion, 12 per cent of water consumption, and 40 per cent of waste to landfill. As such, there has been growing interest to improve a building's performance over its life cycle stages (production, construction, operation, and End-of-Life [EoL]) to increase sustainability within the construction industry. Our research team is developing novel strategies to address these ongoing sustainability challenges by promoting product recovery management and a circular economy (CE) for existing building infrastructure. Our strategies merge cutting-edge technologies with the most updated and realistic building databases to improve the monetization of environmental impacts. The first aspect of our research examines adaptive reuse for buildings which involves restoring and, in some cases, changing the existing use of buildings that are obsolete or are nearing their disuse stage. By analyzing data provided by our industry partners, we are demonstrating how to utilize Life Cycle Assessment (LCA) in decision making to quantify and monetize the environmental savings of adaptive reuse. We have developed an optimization tool using computational algorithms to assist in maximizing the environmental benefits in the process of adaptive reuse by recovering as much of the economic and ecological value of an existing building as possible. On a future stage, our research will be extended across the entire building stock to determine the potential environmental benefits in a typical city which include factors such as initial embodied energy, initial embodied GHG emissions, initial embodied water, and material stock. By quantifying and mapping the potential environmental benefits embedded in the building stock, governments and city councils will have data to better understand, plan, and transform existing infrastructure systems towards sustainable development, resilient configurations, and CE by using the existing redundancy of the built environment. Our research represents an advance to the forefront of regulations for energy and natural resource value chain in the construction industry.

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Transformer Insulation Diagnostics and Condition Monitoring of Line Insulators

Satish Kumar Polisetty, Graduate Student -MASc, University of Waterloo;
Anurag Anand Devadiga, PhD Candidate, University of Waterloo

The significant global growth in renewable energy production has led to increasing concerns about the problems associated with electrical equipment in power plants connected with this type of energy. The crucial electrical components of renewable energy generation are step-up transformers, with respect to which, gassing problems and premature insulation failures have been extensively reported in recent years. One of the factors related to the reported problems is the presence of high-frequency high-dV/dt voltages that are created by switching operations in wind energy plants. The present work deals with diagnosis of wind turbine step-up (WTSU) transformers by using various techniques like dissolved gas analysis, frequency response analysis, partial discharge measurements, and dielectric frequency response. The work mainly involves detailed understanding of the influence of repetitive transient over-voltages on WTSU transformers and developing possible mitigation techniques.

On another note, on-line condition monitoring of critical assets is one of the ways the electrical insulation industry can contribute to safeguard the grids by avoiding system outages due to insulator failure. As such, the electric utilities are now focusing online monitoring in the field of condition monitoring of power system components. Here in high voltage engineering laboratory at the University of Waterloo, attempts have been made to study the condition of line insulators using radio frequency and acoustic emission techniques. Artificial intelligence tools are employed in the analysis and decision making in an effort to detect the defected insulators effectively.

PEV Charging Infrastructure Siting Based on Spatial-Temporal Traffic Flow Distribution

Ahmed Abdalrahman, PhD Candidate, University of Waterloo

Plug-in electric vehicles (PEVs) offer a solution to reduce greenhouse gas emissions and decrease fossil fuel consumption. PEV charging infrastructure siting must ensure not only a satisfactory charging service for PEV users, but also a high utilization and profitability for the chosen facility locations. Thus, the various types of charging facilities should be located based on an accurate location estimation of the potential PEV charging demand. In this research, we propose a spatial-temporal flow capturing location model. This model determines the locations of various types of charging facilities based on the spatial-temporal distribution of traffic flows. We utilize the dynamic traffic assignment model to estimate the time-varying traffic flows on the road transportation network. Then, we cluster the traffic flow dataset into distinct categories using the Gaussian mixture model and site each type of charging facilities to capture a specific traffic pattern. We formulate our siting model as a mixed integer linear programming (MILP) optimization problem. The model is evaluated based on two benchmark transportation networks, and the simulation results demonstrate effectiveness of the proposed model.

The Accelerator Center

Tabatha Laverty, Manager, Marketing & Communications;
Cam Wind, Manager, Programs & Client Experience, The Accelerator Center

The Accelerator Centre (AC) helps entrepreneurs grow and scale their companies quickly and efficiently. The award winning program, which was ranked one of the top accelerator programs in the world by UBI Global, provides education, one-to-one mentorship and funding opportunities to startups across Southwestern Ontario. This year, the AC has launched a specialised program and facility for clean tech entrepreneurs known as the TD Sustainable Future Lab. Stop by and learn about the program and discover some of the incredible innovations being developed through the program.

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Enhanced Active and Reactive Power Sharing in Islanded Microgrids

Mehdi Parvizimosaed, PhD Candidate,
University of Waterloo

Due to the urgent need to develop a more efficient, more reliable, and cleaner electric power grid, the energy sector is currently moving towards the introduction of smart grid. Within the smart grid, a microgrid is a low-voltage distribution network which consists of a variety of distributed generators (DGs), energy storages, and both controllable and uncontrollable loads. The microgrid operates in two modes: 1) interconnected mode linked to the main grid through a distribution substation called power common coupling (PCC), and 2) islanded (autonomous) mode when the microgrid is isolated from the main power grid during a fault or disturbance. In the islanded mode, the microgrid control system for frequency and voltage is more challenging than that in grid-connected operation mode, especially when there are more than one energy source. we present a new distributed transient droop control (DTDC) for frequency and voltage regulation in an islanded microgrid based on active and reactive power data communicated among nearest-neighbour distributed generators. The controller requires no knowledge of microgrid topology, line impedances, and types of loads, and rapidly regulates the frequency and voltage of islanded microgrid to their nominal values while accurate active and reactive power sharing is maintained among distributed generators. Our proposed controller provides simplicity, flexibility, and redundancy of control scheme while keeping the frequency and voltage stability margins. Small signal state space model of the islanded microgrid is developed for frequency and voltage stability analysis under the DTDC. Analytical time-domain simulation results demonstrate the effectiveness of proposed DTDC in frequency and voltage control under communication disruption and fully cooperated control model.

PEV Charging Infrastructure Siting Based on Spatial-Temporal Traffic Flow Distribution

Yasaman Masoudi , PhD Candidate, Autonomous Vehicle Team, University of Waterloo

Research at the Smart Hybrid and Electric Vehicle Systems (SHEVS) Laboratory is focused on connected and automated vehicles where we specialize in developing novel control systems for ecological, safe, and smooth vehicle operations in complex and multi-vehicle driving situations, primarily on connected and automated hybrid and electric vehicles which represent next-generation sustainable transportation systems.

Prof. Nasser L. Azad directs the Smart Hybrid and Electric Vehicle Systems (SHEVS) laboratory, a centre of excellence in vehicle control systems design and optimization. In addition he has investigated the application of computational intelligence and evolutionary optimization techniques to the solution of a variety of engineering problems.

Differential Power Processing in Offshore Wind Farms

Marten Pape, PhD Candidate,
University of Waterloo

Large-scale offshore wind farms contain many wind turbines in a locally confined space. As such, the wind conditions experienced by individual turbines at a given time contain certain similarities. These similarities represent an opportunity to reduce the electrical conversion equipment required to be deployed offshore and indicate potentials for conversion efficiency improvements. In this research, wind turbines featuring a DC-voltage collection system, as well as converter arrangements only processing output power differences among wind turbines are investigated. Modeling has confirmed the expected benefits, compared to today's technology, as well as similar

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Development of Polymer Composites for Power Industry

Khadija Kanwal Khanum, Postdoctoral Fellow, University of Waterloo

As the World's energy demand seems to be all time high and increasing, the focus of research is now more on renewable and sustainable energy. The power industry needless to mention acts as a bridge between all types of energy generation and the consumers. In this study, the importance of nanocomposites materials and its processing with respect to power industry are discussed. Nanocomposites are remarkable class of materials, consisting of various types of nano-fillers which acts as reinforcement in the matrix and thus enhance the desired properties. These nanomaterials have to be dispersed homogeneously in the matrix to gain optimized effects and therefore require special processing tools. Therefore in this research, processing of various polymer nanocomposites of silicone filled with silica and alumina fillers are highlighted. Various processing techniques such as high shear mixing and electrostatic dispensing are evaluated and the effect of processing methods on the electrical insulation properties of nanocomposites are studied. Also along with the results, other ongoing research and facilities of high voltage laboratory would be presented.

Apart from reactor design and catalyst selection, it is key that the methanation system be designed and optimized to study the feasibility of this technology. The process design for the methanation system utilizes design software ASPEN HYSYS and aims to address the challenges mentioned above. To evaluate the feasibility of this technology, techno economic assessments of the system have been done to analyze the project costs, profit margins and overall economics. Sensitivities have been conducted to test the effects of various parameters on the project costs. Various configurations of plant design have been considered and assessed to allow optimization. With the results obtained thus far, the project seems feasible and its economics highly depend on both the selling price of renewable natural gas and the price of electricity.

Stress Grading System of Medium Voltage Motor Fed by Adjustable Speed Drives

Alireza Naeini, PhD Candidate, University of Waterloo

Meeting today's energy demand is one of the most important issues in the world, so it is essential to enhance the efficiency of power consumption. An induction motor with an adjustable speed drive (ASD) results in a high efficiency system and flexible control of processes and machinery, and can cover a wide range of applications. Therefore, the application of this combination has increased rapidly. Over the past ten years, the demand for ASDs has been growing, especially at medium voltage and in many applications. This trend creates a challenge for the insulation structures of motors because of the presence of repetitive pulses in the output voltage of ASDs. The immediate output of inverters is a pulsed voltage or current, and the objective of the controller is to control the fundamental component of the output voltage or current. Stress grading systems are among the most important part of insulation system of medium voltage (MV) motor winding. They are used to prevent partial discharge (PD) in the air gaps between the surface of coils, and also in the end winding region. In these regions, the electric field is increased more than the critical electric field, so PD is produced. PD can deteriorate the insulation system and eventually cause motors to fail. In addition, they produce ozone, which is harmful for insulation and also for the metal parts of motors. A stress grading system consists of two main parts: conductive armour tape (CAT) and stress grading tape (SGT).

INSTITUTIONAL SHOWCASE
STUDENT RESEARCH

Techno-Economic Assessment of Power-to-Gas for Synthetic Natural Gas Production from Biogas

Sogol Mottaghi-Tabar, MASc Candidate,
University of Waterloo

Energy demands are forecasted to grow with increasing global populations and further industrialization. As a result, an increase in greenhouse gas (GHG) emissions is expected in the years to come. Although research is underway for carbon dioxide capture technologies, a viable option for dealing with these GHGs is to utilize them for synthesis of chemicals or fuels. Photochemical and electrochemical reduction of carbon dioxide are currently being evaluated as a means to produce various hydrocarbons without the use of petroleum products. Although these approaches display potential, they are inherently limited by carbon dioxide solubility in water and show severe diffusion limitations. Alternatively, thermo-catalytic conversion of carbon dioxide shows promise with its ability to pair high temperatures with heterogeneous catalysis. One particular reaction to consider is the methanation of carbon dioxide; where carbon dioxide molecules are reacted with hydrogen to produce methane and water. This technology can be implemented for biogas, landfill gas or flue gas treatment and presents a viable route for obtaining synthetic natural gas (SNG). This power to gas system can allow for generated SNG to be stored in the existing natural gas infrastructure for long periods of time and dispatched when required for use by both natural gas end users and combined cycle generators to meet power grid demand peaks.

This project presents many challenges which must be addressed. The methanation reactor's highly exothermic nature requires an adequate heat removal system for both safety and operational optimization. The process requires considerable amounts of hydrogen to be produced. It is important that the hydrogen be obtained feasibly and with low emissions as synthetic natural gas will be renewable only if the hydrogen required for the reaction is generated using renewable energy sources. Inert gases and any other undesirable gases must be removed from the SNG prior to compression and pipeline injection to meet pre-existing pipeline specifications. Additionally, sour biogas must be sweetened as H_2S is poisonous to the methanation catalyst.

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CORPORATE SHOWCASE
FUNDING AGENCIES & ASSOCIATIONS

Waterloo Region Electric Vehicle Association (WREVA)

Mark Coughlan, Founder, Waterloo Region Elecrtic Vehicle Association (WREVA)

Waterloo Region Electric Vehicle Association
WREVAG@gmail.com @WREVAGroup

The Waterloo Region Electric Vehicle Association (WREVA) is a group of EV Owners and Enthusiasts in the region dedicated to Electric Vehicle promotion and education. We host and participate in many EV Events and Meetings throughout the year, in order to educate the public on the benefits of EV Ownership. Interested in receiving our emailed monthly newsletter? Contact us via email WREVAG@gmail.com or via Twitter @WREVAGroup

Mictacs Inc.

Ashley Hannon, Business Development Specialist, Waterloo, Mictacs

Mictacs

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The Affordable Energy for Humanity Global Change Initiative (AE4H)

Nigel Moore, Manager, Global Programs & Initiatives, Waterloo Instituite for Sustainable Energy

AE4H
Global Change Initiative

The Affordable Energy for Humanity Global Change Initiative is an emerging international collaboration between the world's leading scientists, technology developers and practitioners on the topic of universal energy access. Our Vision is to deliver the next generation technologies, innovations and practical solutions that will drive the costs of energy services to a level low enough for a revolution in energy access without the need for tax incentives and subsidies.

Participants in this initiative are guided by a common purpose to apply their skills, expertise and knowledge to the urgent cause of improving the affordability of clean energy in contexts where it matters most. Harnessing the resources and enthusiasm of researchers in order to change the energy access equation is the primary inspiration behind the initiative.

Keysight Technologies

Peter Schweiger, University of Waterloo Account Manager; **Nizar Messaoudi**, University of Waterloo Application Engineer, Keysight Technologies

KEYSIGHT TECHNOLOGIES

Keysight, formerly Agilent Technologies Electronic test and Measurement group, is a leader in enabling test engineers to bring their technologies to market faster and at lower cost. Our automotive & energy industry and solution group focuses on measurement and development solutions for on Connected Car, Automotive Radar, electric vehicle, battery, power semiconductor, Smart Grid, & renewable energy technologies.

CORPORATE SHOWCASE
FUNDING AGENCIES & ASSOCIATIONS

Ontario Centres of Excellence (OCE)

Dan Ruby, Business Development Manager
Ontario Centres of Excellence

Ontario Centres of Excellence (OCE) drives job creation, economic development and the province's global competitiveness on behalf of the Government of Ontario. OCE co-invests with industry to accelerate the commercialization of innovation originating in the province's publicly-funded colleges, universities and research hospitals, resulting in new, made-in-Ontario products, services, technologies and solutions.

Lime

Meghna Kedia, City Launcher, Lime

Lime is revolutionizing micro mobility and empowering a new urban lifestyle. The mobile app lets riders easily find and unlock our fleet of shared smart bikes and scooters, providing them with a fun, efficient and sustainable way to move around the city. By partnering with local communities, Lime is working to not only improve transportation, but cultivate a culture centered around active, healthy and sustainable urban living. Since launching in June 2017, the company has logged over 13 million rides across the US, Europe and Oceania. Lime is based in San Francisco, CA, and is funded by leading VC firms including Google Ventures, Fifth Wall and Andreessen Horowitz.

Pond Technologies

Punyama Jayasinghe, Chemical Process Engineer;
Philipp Garber, Manager, Marketing, Pond Technologies

Pond (TSX.V:POND) is a Canadian technology company with applications in pollution abatement, nutrition and cannabis. Pond designs and operates scalable bioreactors that use society's most abundant product – industrial greenhouse gas emissions – and Pond's specialized growing systems to cultivate algae and other valuable biomass. Pond's systems effectively close the carbon loop and create wealth from waste.

With support from Ontario Centres of Excellence, the National Research Council, and other partners, Pond has been refining its technology at St. Marys Cement since 2011 and is currently building its first two Ontario commercial plants, at Stelco Steelworks in Nanticoke and at Markham District Energy in Markham. Both plants are expected to produce valuable algae by the end of 2019 and sell into several sectors: the burgeoning natural food colouring, health supplements and bio-ink markets, as well as the vast volume markets of fishmeal and bioplastics.

CORPORATE SHOWCASE
FUNDING AGENCIES & ASSOCIATIONS

iGEN Technologies

Alan Clarke, Director of Business Development, iGen Technologies

iGEN Technologies Inc. is an Ontario based company specializing in the manufacturing and turn-key installation of innovative power generation systems. The two principal owners of the company are Michael Chatzigrigoriou and Patrick Lai, both with engineering and business experience in the energy management industry.

The iGEN system simultaneously provides both space heat and power to satisfy basic societal needs across well-established market sectors. The mission of iGEN is to reduce fuel costs for communities through the deployment of an innovative packaged heat-and-power generation system that functions by either burning a common fuel source or recovering waste heat to generate supplemental power.

The iGEN system is built up from components, all sourced and installed from carefully chosen technology partners. The payback is aggressive, the technology clean, and operation is seamless. iGEN is confident the triple bottom line (economics, environment, end result) expectations of prospective clients will be met with this solution.

Canadian Gas Association Fund

John Adams, Managing Director, Natural Gas Innovation Fund, Canadian Gas Association

CANADIAN GAS ASSOCIATION
ASSOCIATION CANADIENNE DU GAZ

Founded in 1907, the Canadian Gas Association (CGA) is the voice of Canada's natural gas distribution industry. Our members are natural gas distribution companies, transmission companies, equipment manufacturers and other service providers. Canadian natural gas distribution companies deliver natural gas to approximately 7 million homes, schools, hospitals, places of worship, to meet their energy needs. Combined this represents almost one-third of all the energy needs in Canada, coast to coast to coast. By our estimate that is well over 20 million Canadians who currently have the opportunity to benefit from the safe, clean, reliable, abundant, and affordable energy service that natural gas utilities provide.

We also develop educational information and organize and sponsor training schools, workshops, seminars and conferences to foster dialogue on energy policy and achieve a better understanding of natural gas.

Technology Innovation & Policy Forum 2018

Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy

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Thank you to our partners and innovators

Council for Clean & Reliable Energy
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Ontario Centres of Excellence
Where Next Happens

AE4H
Global Change Initiative

Waterloo Region Electric Vehicle Association
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KEYSIGHT TECHNOLOGIES

pondtech

Lime

iGEN TECHNOLOGIES

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