MICROGRIDS
RENEWABLES
THE FUTURE OF ENERGY IS HERE
REGULATION
SMART GRIDS
ELECTRIC VEHICLES
CLIMATE CHANGE
CONSERVATION

Ryerson University

Centre for Urban Energy

2017 Annual Report

CHANGING THE ENERGY PARADIGM

The Centre for Urban Energy (CUE) at Ryerson University is uniquely positioned to make carbon-free power a reality. As the premier energy research centre in Canada, we generate ideas that shift the energy paradigm. From innovative industry partnerships to commercialized technologies, we are transforming urban energy.

CONTENTS

MESSAGE FROM OUR ACADEMIC DIRECTOR

Since the Centre for Urban Energy (CUE) at Ryerson University opened seven years ago, the pressures on the energy industry have continued to grow. Current approaches to energy generation, transport, storage and use are not sustainable. They cannot achieve the ambitious local, provincial and national targets for greenhouse gas emission reductions. Nor can they cope with urbanization or ensure affordable and available energy for future generations.

A carbon-free energy sector is difficult to imagine. It's also a challenge for any of us to grasp the magnitude of shift required to get there. What we do know is that we need a new paradigm, new thinking and new technologies, which is what the partners, researchers and innovators at CUE strive to generate.

CUE is thriving because we focus on delivering tangible solutions to real-world problems. This approach has fuelled productive collaborations, long-term partnerships and impact here at home and in diverse locales such as India, Brazil and Chile, where local technologies are having a global impact.

Looking ahead, our move to the state-of-the-art Centre for Urban Innovation late in 2018 will enable us to reconfigure our existing facilities while adding lab and office space. This move will also immerse us in a multidisciplinary hub of researchers exploring a range of urban issues.

On behalf of the staff, faculty members, researchers, students and industry partners who make CUE such a success, I invite you to join us in 2018.

Bala Venkatesh

Academic Director,
Centre for Urban Energy

Professor, Electrical
and Computer Engineering
Ryerson University

FUTURE FOCUSED

WORK WITH US

We are industry driven and research led. Our industry partners define the problem and we delve into it, maintaining the independence required to push boundaries, invent novel applications and generate impact.

Our partners' challenges

- Immediate priorities interfering with a long-term focus
- Lack of time to step back and think about the big picture
- Limited resources or expertise for research and innovation
- Pressure on individuals and groups to specialize

Our expertise

- World-class researchers and technologies with urban energy expertise
- Multidisciplinary collaborations: engineering, science, environment, business, social sciences, public policy, law and infrastructure management
- Integration of research, innovation and commercialization
- Research and testing with direct real-world impact
- Nonpartisan, objective, academically driven innovation
- An evidence-based approach to big picture issues

Services we offer

- Research projects, reports and papers
- Testing and facilities
- Consultation services
- Incubation and entrepreneurship
- Professional development

How you can partner with CUE

- Commission a research project to generate new thinking about a pressing problem
- Test and develop grid-scale prototypes and products in the one-of-a-kind Schneider Electric Smart Grid Laboratory, which can recreate any electricity grid in the world
- Train highly skilled personnel to use new technologies and existing assets
- Develop your workforce by hosting a customized executive energy education course
- Sponsor a white paper or student awards program
- Guest lecture at one of our professional development programs
- Mentor an energy entrepreneur in our Clean Energy Zone
- Participate in our conferences, roundtables and events

TRANSFORMING THE ENERGY SYSTEM

The grid of the future

Thriving, healthy communities require affordable and accessible energy, especially in countries like Canada where energy consumption influences quality of life. A sustainable energy system is also critical for addressing climate change by eliminating greenhouse gas emissions.

On the move

In 2018, CUE will move to the new Centre for Urban Innovation (CUI) at Ryerson University. The move will give us access to a new building, new lab spaces and the capacity to interact with other research institutes such as Ryerson Urban Water.

WHERE ARE WE NOW?

- Centralized grid
- Climate crisis
- Aging infrastructure and rising costs
- Air pollution in major urban areas

HOW CUE WILL GET US THERE

Research is the starting point for innovation. CUE is producing new thinking about how we generate, deliver, store and consume energy. We mobilize ideas. Working with our partners, we implement and commercialize innovations to generate immediate and lasting impact.

- Research and testing
- Consultation
- Education
- Policies
- Innovation and incubation
- Implementation of new technologies

WHERE ARE WE GOING?

- Distributed energy
- Thriving cities
- $\downarrow CO_2$ Low or zero carbon sources such as wind and solar
- Affordable and accessible energy for all

"The Centre for Urban Energy is a world-renowned research centre. There is no better team to work with as we look to test and integrate the edge-of-the-grid technologies that will help us deliver clean, safe, affordable and reliable electricity to our customers."

— PRAVEER SINHA, CEO AND MANAGING DIRECTOR, TATA POWER DELHI DISTRIBUTION LIMITED

OUTCOMES AND IMPACT

PARTNERS AND PROJECTS

From its inception, CUE has been a multidisciplinary industry-academic collaboration. Our founding partners, Hydro One, the Independent Electricity System Operator (IESO) and Toronto Hydro, understood the central role of research in designing a carbon-free energy system. Since then, dozens of partners have joined the cause, working with CUE researchers on a wide range of research projects. These partnerships are ongoing, continually evolving and focused on pressing energy issues. They also share a common quality: each project has a tangible outcome.

Five examples of how CUE projects create real-world impact:

A fast-charging station powering an electric vehicle (EV) battery to 80% capacity in 30 minutes

A high-efficiency power converter saving power loss in microgrids

A new model that makes wind power integration faster and more accurate

A hybrid storage system that makes it easier to integrate renewable energy sources into Ontario's electricity system

A controller to help flywheels last longer and save energy implemented on Ontario's electricity grid

Read about all of our ongoing and completed projects at **ryerson.ca/cue/research/projects**.

ENERGY STORAGE REACHES NEW HEIGHTS

A small box on a hydro pole offers a boost to the grid

15.9 kWh
Energy capacity

34x36x42 in.
Prototype dimensions

2,100
Approximate equivalent number of smart phone batteries

Increasing urbanization and densification will require innovative solutions to meet the needs of residents, improve grid reliability and meet carbon-emission targets.

Problem

The amount of energy used by customers varies significantly throughout the day. Highly urbanized areas have limited space for building large electrical facilities.

Solution

The world's first utility pole-mounted energy storage system. Developed at Ryerson with a smart controller, designed at eCAMION and tested on Toronto Hydro's grid, this modular storage solution stores and discharges electricity during peak hours. The project was funded in part by Ontario's Smart Grid Fund.

Impact

This system will reduce strain on distribution transformers by smoothing the daily electricity peaking cycle. Reliability for customers will be increased by the battery's ability to respond to real-time data, including any indication of an outage.

CUE's role

The CUE research team of Bala Venkatesh, Mohamed Awadallah and Manuel Baun partnered with eCAMION and Toronto Hydro. They developed the concept and the smart controller, tested the unit in the Smart Grid Lab at CUE, and field tested the unit on the Toronto Hydro network.

"With support from the Ontario government's Smart Grid Fund, and in collaboration with Ryerson and eCAMION, the world's first-ever pole-mounted energy storage devices are being tested on Toronto Hydro's grid. This made-in-Ontario, game-changing technology stores and discharges electricity when the grid needs it most, which helps create a more efficient, more flexible grid."

— GLENN THIBEAULT, ONTARIO MINISTER OF ENERGY

ENVISIONING THE FUTURE OF ENERGY

IESO Research Fellows research and develop urban energy solutions

3
Research streams

18
White papers produced

2014-2017
Timeline

The Independent Electricity System Operator (IESO) provided CUE with funding for three full-time IESO Research Fellows to conduct original research on the challenges facing Ontario's electricity sector.

Problem

There is a pressing need to plan for the province's future energy needs. The IESO identified three priority areas: conservation, community energy planning and energy storage.

Solution

Ontario needs a new conservation and demand model (CDM) that better achieves CDM goals; practical how-to recommendations to include electricity planning at the land-use planning stage; and the introduction of a Capacity Market (CM) to provide price stability and supply reliability.

Impact

Valuable evidence-based analysis of future CDM programs; research on integrating urban and energy planning to guide and inform policy setters, regulators, municipalities, energy suppliers, utilities and academia; and a CM model that promotes economic efficiency, reduces investment risk and increases transparency of capacity procurement.

CUE's role

IESO Fellows Bob Singh, Jessie Ma and Bhanu Opathella and their student teams provided the research case studies that offered new tools, new models and practical suggestions to improve energy conservation, planning and storage capacity.

"The IESO is proud to support the CUE as a collaborative intersection between utilities, technology vendors and the academic research community. The IESO strives to create an environment where innovation can thrive, and this partnership with CUE helps us do that."

— PETER GREGG, PRESIDENT AND CEO, IESO

CANADA'S ENERGY STORAGE NETWORK

Five-year NSERC Energy Storage Technology Network aims to create a strong domestic energy storage industry

90
Trained highly qualified personnel

15
Universities

25
Industry and government partners and collaborators

Modern grid-scale energy storage – such as large battery systems – is set to transform the electricity system in Canada, offering immense benefits to industries, utilities, governments and consumers.

Problem

Canadian transmission and distribution assets are aging and require significant investment, conservatively estimated at $350 billion by 2030. Energy storage can help reduce or eliminate these costs while providing a solution to renewable energy intermittency and improving grid resilience.

Solution

This five-year, $5 million pan-Canada network, funded by NSERC, brings together the brightest minds in academia, industry, utility and government to explore four research themes aimed at developing and marketing the next generation of energy storage technologies.

Impact

NSERC Energy Storage Technology Network (NESTNet) is poised to become the global leader in energy storage, placing Canada at the forefront of this growing market. The network will also train highly qualified personnel who will build and operate the next generation of electricity systems with energy storage.

CUE's role

CUE plays a central role in NESTNet, leading its creation and managing the network. CUE researchers are also heading several projects within the four interrelated research themes and providing Ryerson students with hands-on experience.

"I would like to applaud all of the research teams at universities across Canada for their outstanding work this year. You are all contributing immeasurably to the success of the network and therefore playing an integral role in meeting today's energy and climate challenges head on."

— NEETIKA SATHE, VICE-PRESIDENT, ADVANCED PLANNING, ALECTRA INC. AND NESTNET BOARD CHAIR

A NEW ENERGY ROAD MAP FOR TATA POWER-DDL

Partnership builds ties between India and Canada

1.6M
Tata Power-DDL customers

1,852 MW
Tata Power-DDL's peak load

2030
Indian government target to have all vehicles on its roads powered by electricity

Facilitated by Smart Grid Canada, Ryerson University struck a research partnership with Tata Power Delhi Distribution Limited and the Ontario Ministry of Energy to explore the integration of renewable energy, electric vehicles and energy storage and energy storage technologies that will advance energy innovation in Delhi, India's second-largest city.

Problem

Tata Power-DLL is seeking a road map for its adoption of microgrids and energy storage technologies associated with renewable energy, for improving grid stability while integrating renewable energy, and for the implementation of electric cars.

Solution

Analyze and develop novel solutions while creating a road map for technology adoption using microgrids, energy storage and smart grid technologies to enhance the performance of Tata Power-DLL's system.

Impact

Over the course of the project, solutions and products from several of Ontario's innovative energy companies will be examined for inclusion on the road map. Additionally, an export opportunity for Ontario companies to Tata Power-DLL arising from this project can be duplicated across the Indian landscape.

CUE's role

CUE is leading this project. It will assimilate data received from Tata Power-DLL, develop various solutions for power quality improvement, and evolve road maps as required while connecting new products such as solar photovoltaic (PV), energy storage and electric cars.

"Global partnerships like that between CUE and Tata Power-DDL create outstanding opportunities for our researchers and our students while supporting our commitment to environmental, social and economic sustainability."

— MOHAMED LACHEMI, PRESIDENT AND VICE-CHANCELLOR, RYERSON UNIVERSITY

EMPOWERING ENERGY ENTREPRENEURS

CLEAN ENERGY zone

Housed in Ryerson University's CUE, the Clean Energy Zone is an incubator focused on clean, sustainable energy solutions. The zone brings researchers, students and industry partners together to commercialize sustainable solutions that address societal needs and provide real environmental, social and economic impact.

Members of the Clean Energy Zone develop their ideas while learning new skills to improve their business acumen and technical expertise. Through its relationship with CUE, the zone also offers access to state-of-the-art research labs, co-working spaces and curated mentorship from industry partners and academic researchers and faculty.

Incubation process

The Clean Energy Zone supports the startup journey between ideation and market growth.

Ideation
Focus on solving a problem or exploring an opportunity

Development
Look for validation of a defined idea

Startup
Seek industry connections and funding for a prototype or concept

$5.2M+
Funding raised by startups

12
Current startups

66+
Jobs created in new startups since 2012

19
Graduated companies

Zone Learning

Zone Learning is a distinct model of experiential learning pioneered at Ryerson, developed to prepare students for the workplace of the 21st century by working on real projects, causes, companies and startups at one of Ryerson's 10 zones.

A BOOST FOR EV CHARGING

Startup wins prestigious award for fighting climate change

5
Full-time employees

35+
Proposed EV charging sites

$75K
Funding since joining the Clean Energy Zone

Ontario is looking to boost electric vehicle sales to five per cent of total vehicle sales by 2020. The province is in the midst of installing about 500 publicly available fast chargers to help increase sales of green cars.

Problem

EV owners who live in apartment buildings or condos or who park on the street have difficulty accessing charging. Limited access to privately owned charging, both residential and commercial, is blocking the expansion of EV ownership.

Solution

SWTCH has developed a web-based platform that allows homeowners with EV chargers to rent plug-in time to EV owners. SWTCH also collaborates with multi-unit residential, workplace and public destination charging stations to aggregate information and relay it to EV owners for ease of use.

Impact

By increasing accessibility for EV drivers, offering both residential and commercial platforms, SWTCH's objective is to become a key enabler in achieving greenhouse gas emission reduction targets for Ontario's Climate Change Action Plan.

The zone's role

Co-founders Carter Li and Laura Bryson, winners of the 2017 Joseph and Antoinette Sorbara Entrepreneurial Award and the 2017 Lieutenant Governor's Visionaries Prize, created SWTCH at the Clean Energy Zone.

"We took advantage of everything the Clean Energy Zone and the entire zone ecosystem had to offer: workshops, networking, collaborations. Ryerson gave us a home to develop our startup and opened all kinds of doors for us."

– CARTER LI, CO-FOUNDER AND CEO OF SWTCH

SMARTER ENERGY STORAGE

Intelligent software reduces grid loads and energy costs

3
Key strategic partners: BGIS, Black & McDonald and Osmington

10
Number of employees

3
Office locations: Toronto, New York and Boston

Utilities have to size their infrastructure to accommodate energy use in periods of peak demand. Energy bills are structured to recoup costs incurred by utilities and ISOs to maintain sufficient supply and grid infrastructure for the hottest and coldest days of the year.

Problem

In urban areas, the growth of peak demand is rising three to five times faster than the growth of electricity consumption. Off-peak energy storage can reduce metered loads during peak times but timing and regulating the charging cycle is highly complex.

Solution

Peak Power has developed energy software with intelligent, predictive controls that optimizes the operation of storage systems, providing benefits for both utilities and building owners.

Impact

The Peak SYNERGY controls platform allows building owners to achieve long-term savings from rising electricity bills, reach sustainability goals and increase onsite resiliency, all while aiding utilities in addressing aging infrastructure and peak demand requirements.

The zone's role

CEO Derek Lim Soo and COO Matthew Sachs developed Peak Power in the Clean Energy Zone, receiving technical support as well as the mentorship the zone offers. They were also provided access to important grants, such as those from the Ontario Centres of Excellence and Sustainable Development Technology Canada.

"The support and guidance we received from the Clean Energy Zone was outstanding. It helped us access government grants and showcase our company by broadcasting our successes. We couldn't have had a better partner."

– DEREK LIM SOO, FOUNDER AND CEO OF PEAK POWER

CENTRE FOR URBAN ENERGY OUTCOMES AND IMPACT

FILLING THE VOID

Education and professional development

The energy sector is facing a looming shortage of skilled personnel: half of its workers are preparing to leave the industry within five years, yet an estimated $350 billion of investment by 2030 will create roughly 150,000 jobs in Canada. CUE offers a suite of educational programs, professional development and student awards to attract and develop top talent in the energy industry.

Professional Master's Diploma in Energy and Innovation (PMDip)
The PMDip addresses the pressing need for qualified personnel in the energy sector by immersing participants in the relevant knowledge and skills required to excel as corporate officers, administrators, technicians and in other leadership roles.

Electrical Engineering 101
This seminar series introduces the fundamental concepts of electrical engineering to non-engineers looking to advance their career in the energy sector.

Postgraduate Certificate in Energy Management and Innovation
In cooperation with The G. Raymond Chang School of Continuing Education at Ryerson University, this certificate program enables adult learners to contribute effectively to energy management, conservation, sustainability, entrepreneurship and public policy.

Customized executive education seminars
CUE provides tailored workshops, such as the Power in India series with Tata Power CEO and MIT scholar Praveer Sinha, a three-day workshop focused on public-private partnerships, the use of social innovation as a business tool, and developing the utility of the future.

Visit **ryerson.ca/cue/professional-development** to learn more.

Student awards

Visit **ryerson.ca/cue/research/student-awards** to learn about all award opportunities – made possible by our generous sponsors.

IESO
Students receive an assistantship award of up to $5,000 per term and report to one of the IESO research fellows across three streams: conservation, community energy planning and energy storage.

Toronto Hydro
Toronto Hydro provides $10,000 per year to enable new, innovative ideas for products, inventions and technologies relevant to urban energy challenges. Winners also gain access to the Clean Energy Zone.

Enwave Energy Corporation
Enwave provides $20,000 in funding per year to support new, innovative ideas for urban energy products, inventions and technologies. Individual winners gain access to the suite of programs at the Clean Energy Zone.

2017 IN REVIEW

Opposite page:
Navdeep Bains, Minister of Innovation, Science and Economic Development, test drives an EV at CUE in May 2017 along with Steven Del Duca, then Ontario's Minister of Transportation.

IN THE NEWS

"We need new low-carbon technologies that cost less and perform better than the status quo."

– JESSIE MA

Deal reached on climate change (CTV)

"The value of energy storage is rising, and Canada is definitely in a good position."

– DEREK LIM SOO

Canadian energy-storage startups get global traction (Globe and Mail)

"The idea is that we can expand the public charging infrastructure by leveraging private EV chargers and the shared economy."

– CARTER LI

Toronto startup seeks to boost electric-vehicle charging options (Globe and Mail)

"The biggest benefit is that you can charge these units during off-peak hours."

– BALA VENKATESH

Toronto Hydro, Ryerson launch pilot project to store energy in pole-mounted compact box (Toronto Star)

"The planet is something that we value, and there's a cost for things that we value."

– JESSIE MA

Assessing cap and pay in Ontario (Global)

A YEAR IN OUR LIFE

Highlights from an eventful 2017 at CUE

MARCH

The impact of climate change

Dianne Saxe, Environmental Commissioner of Ontario and longtime environmental lawyer, delivered a lecture illustrating the impact of climate change on the province and the world, underscoring the urgent need for significant action

APRIL

CUE opens its doors

During the 2017 Open House and Student Research Awards event, visitors met researchers, graduate students and industry representatives, toured the facility, explored the Schneider Electric Smart Grid Laboratory, and test drove the latest electric vehicles. The event also celebrated student research achievements at an awards ceremony.

MAY

A major zero-emissions vehicles announcement

The Hon. Navdeep Bains, Minister of Innovation, Science and Economic Development, chose CUE as the venue to announce the Government of Canada's intention to work with provincial and territorial partners, industry and stakeholders to develop a national strategy for increasing the number of zero-emission vehicles (ZEVs) on Canadian roads.

JUNE

Researchers from across Canada descend on Ryerson

The second annual NestNet Week event series, which included the Leading the Charge Conference, explored the future of energy storage. The event attracted more than 100 students, researchers, partners, government agencies and members of the public from across Canada and around the world.

JULY

School for startups

The summer featured Zone Learning @ CUE, a five-week series of interactive sessions designed to provide MBA students and energy entrepreneurs from varying backgrounds, particularly engineering, with the tools, knowledge and connections they need to turn ideas into energy startups.

OCTOBER

A global dialogue on clean energy

Bala Venkatesh moderated a panel at the Toronto Global Forum, a prestigious business summit fostering dialogue on national and global issues that attracts more than 2,500 international delegates from many sectors, including heads of state, central bank governors, ministers and global economic decision makers.

Below:
Dianne Saxe, Environmental Commissioner of Ontario speaks at CUE in March 2017

BY THE NUMBERS

FUNDING:

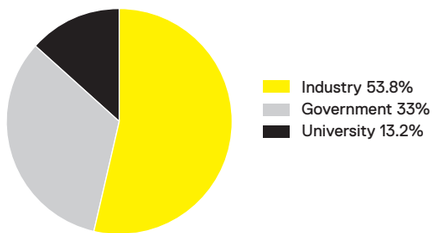
$28.3M

Total funding

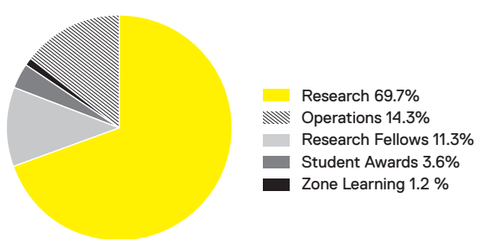
$1.5M

In 2017

FUNDING BREAKDOWN:



FUNDING DISTRIBUTION:

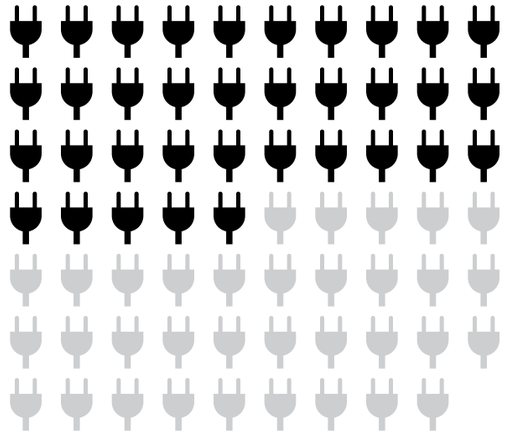


PROJECTS:

69 Total

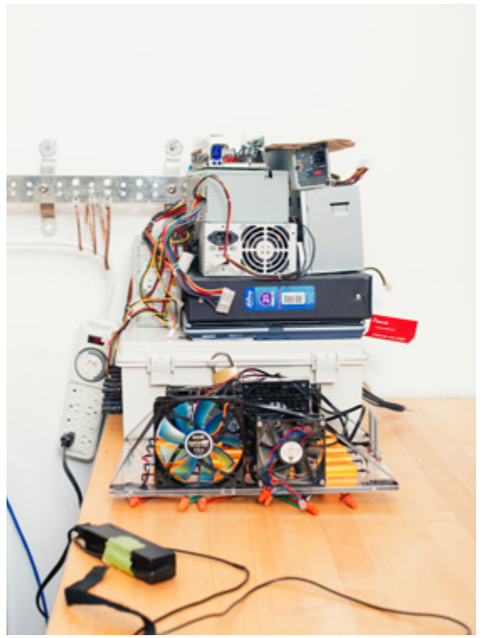
35 Completed

34 In progress



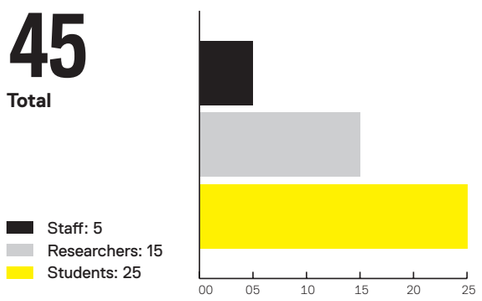
SPONSORS AND COLLABORATORS:

Alectra Utilities
CH2M Hill
eCAMION
Enwave
IESO
Mitacs
NSERC
Ontario Ministry of Energy
Opus One
Schneider Electric
Tata Power-DDL
Toronto Hydro



PEOPLE:

45
Total



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Alectra Inc.

Hari Subramaniam
President,
Carousel Development Inc.

Bala Venkatesh
Academic Director,
Centre for Urban Energy,
Ryerson University

EVENTS AND OUTREACH:

35
Events hosted

32
Tours

37
Speaking engagements and events participated in

DEMAND MANAGEMENT

ENERGY STORAGE

EFFICIENCY

G

NET-ZERO BUILDINGS

This cover lists the 13 focus areas that the Centre for Urban Energy has identified as critical to a sustainable future.

POLICY &

TRANSMISSION &

V

DISTRIBUTION

ELECTRICITY

PLANNING

For more information on our efforts and an online version of this report, visit **ryerson.ca/cue**

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