



Presents

# The Journey to Net Zero Energy

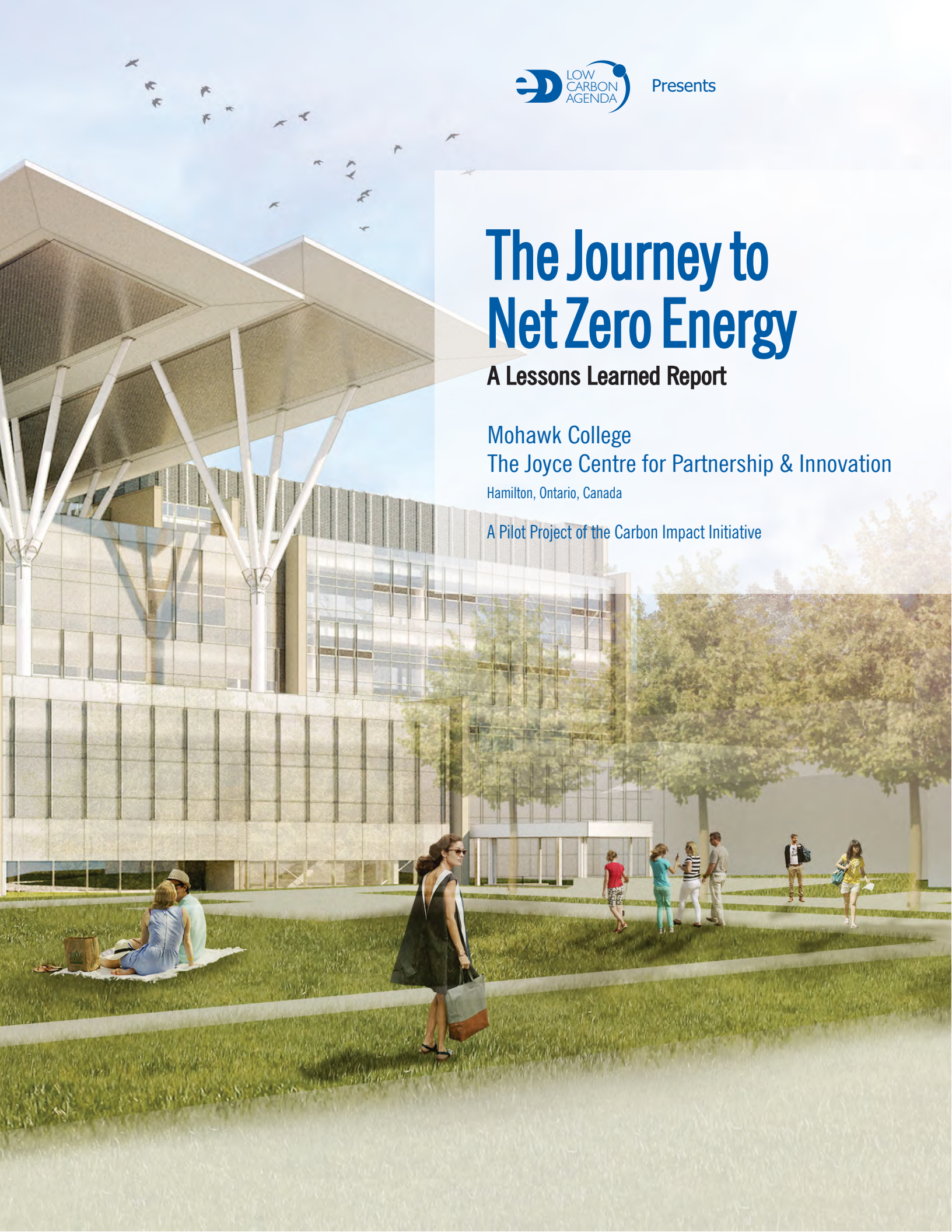
**A Lessons Learned Report**

Mohawk College

The Joyce Centre for Partnership & Innovation

Hamilton, Ontario, Canada

A Pilot Project of the Carbon Impact Initiative



Cover Photo:  
Courtesy of McCallum Sather and B+H Architects

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Mohawk College  
The Joyce Centre for Partnership & Innovation  
Hamilton, Ontario, Canada



# Executive Summary

## The Journey to Net Zero Energy

A Lessons Learned Report: Constructing the Joyce Centre for Partnership & Innovation

Mohawk College's Joyce Centre for Partnership and Innovation was the first pilot project under EllisDon's Carbon Impact Initiative. This project gave the design and construction teams an opportunity to develop the practical onsite experiences needed for future projects committing to high performance targets like Net Zero Energy and Emissions.

**A**t EllisDon, our breadth of knowledge and experience offers exceptional service to clients. We are now focused on becoming even greater than the sum of our parts - one company, one result. We are determined to lead change in the market, rather than merely anticipate it.

The Net Zero Energy Joyce Centre was the perfect project to showcase our commitment to the low carbon economy, while providing the college with a facility they can be proud of for many years to come. Through our efforts with Mohawk College, we learned many lessons. This report discusses the challenges, suggested solutions, and lessons learned while building Canada's first institutional Net Zero Energy building; supported by one-on-one interviews with representatives of the College, the architects, and EllisDon.

Of particular importance was the lesson of collaboration. All project proponents need to be brought to the table very early in the planning stages through an "integrated design" process. The market has been discussing the need to adopt an integrated design model for years, but now we need

to put these interests into practice; this is especially true of buildings targeting aggressive levels of hyper-efficiency.

We also learned that the project budget must account for an assigned Net Zero Energy Coordinator to manage communications from the very beginning of the construction process. We learned that a dedicated energy budget focused on systems integration is key to performance success, and that designing for demand occupancy is important to ensure that tenants will enjoy a comfortable immersive experience without impacting operations.

This report provides context for future Net Zero Energy projects and how success can lead innovative market developments, concluding with a "top 10 list" of lessons learned.

You will see that this report is not a technical document; it is designed to illustrate the journey of all teams involved, and how, by working together in a collaborative environment, we can meet a project's Net Zero Energy objectives.



# Joyce Centre

Building & Energy Technology  
Specifications Overview

## Project Intent & Timelines:

An applied research centre with classrooms, technology labs, and lecture theatres.

- Three areas of academic focus: health, energy, technology.

The Centre will be open to students and faculty for the Fall semester, 2018.

## Building Specifications:

- Five Stories; 96,000sqft
- Capacity for 4,500 students

## Energy Specifications:

**Photovoltaics** - 5,015m<sup>2</sup> array producing 500kWp AC; 1980 individual 330watt panels [Canadian Solar].

**Geothermal Field** - 28 vertical bore holes, 183m deep; 4 slinky loop circuits, each circuit contains a 305m pipe installed in a 92m trench [GeoSource Energy].

## Energy Management Strategy:

The needs and behaviour of the building's occupants were assessed to determine the energy requirements. Parameters included:

- Building enclosure performance to reduce heating & cooling losses;
- Mechanical system performance to optimize ventilation, heating, and cooling distribution;
- Electrical system performance to optimize lighting requirements.

# A "Top 10" List

Recommended priorities to achieving Net Zero Energy as learned through the development of the Mohawk College Joyce Centre for Partnerships & Innovation.

1. Communication is Key
2. Create a "Net Zero Team"
3. Apply Integrated Design
4. Prioritize the Wish List
5. Incorporate Building Automation Systems
6. Manage Procurement
7. Engage Contractors and Trades in the Development Process
8. Focus on the Energy Budget
9. Engage Tenants in Operational Efficiency Targets
10. Knowledge Sharing from Cradle to Grave



# Background

## Launching the Carbon Impact Initiative

In 2016, EllisDon Corporation created a unique sustainability strategy to prepare for the next generation of “hyper-efficient” buildings and infrastructure. As a first step, and together with like-minded corporate leaders, the Carbon Impact Initiative was established as an industry-led response strategy to guide sustainable business development and deliver projects that support Canada’s international commitments on climate change. **Mohawk College’s Joyce Centre for Partnership and Innovation was the first pilot project in the Carbon Impact Initiative.** As a pilot project, it provided us with the practical, onsite experience needed to build future projects committing to performance targets like net zero energy and emissions.

**A**s populations grow and new technologies continue to rapidly transform our markets, we must ensure that the design and development of our urban centres are managed in a resource responsible way so that future generations have access to the expertise they need for long term success; this is the guiding principle of the emerging low-carbon economy.

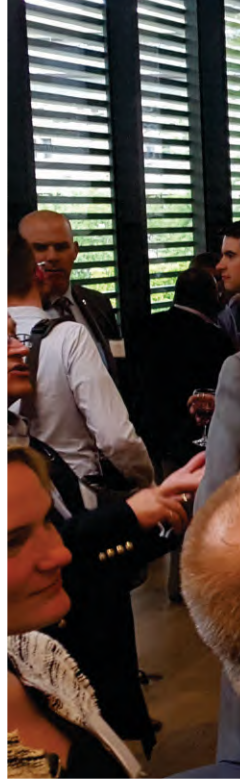
EllisDon has taken a leadership position in low-carbon strategies for Canada by publically launching the “Carbon Impact Initiative,” in partnership with some of the most influential companies and agencies in the country. Our partners include BASF Canada, WSP Group, Enbridge Gas, Mitsubishi Electric, Avison Young, Cricket Energy, Cisco Systems, and the Cement Association of Canada.

Through the Carbon Impact Initiative, we work together on pilot projects targeting net zero energy and emissions,

track the carbon emitted during the life-cycle of projects, and support the introduction of new clean technologies that can meet the hyper-efficiency targets required by clients.

We recognize that nations around the world are already leading a global shift in preparation for the new environmental realities we will be facing over the coming decades. This Initiative represents the first step in our collective efforts to provide the industry leadership required to meet Canada’s international commitments on climate change.

As economies restructure, and climate change continues to impact our environment, we must do our part to ensure cities and communities are prepared to support the needs of future generations. It is our responsibility to ensure the buildings we are constructing are prepared to adapt. This means responding to atmospheric conditions,







but it also refers to cities that will need to function in a world with ever-limiting natural resources and skyrocketing operating costs. We are fortunate in Canada that our easy access to abundant natural resources, like fresh water, will buffer us (to some degree) against climate change, but we must recognize our responsibility to the international community. If Canada can be a leader in low-carbon strategies, such as resilient building design, we can then leverage Canada's established reputation in research & development to lead the transformation of the building construction sector around the world.

World markets continue to struggle with economic stability. As such, we must carefully consider how to foster development in emerging markets, provide alternatives to struggling assets, and capitalize on growth industries. We also need to recognize that advancements in new technologies are changing our industry at a rapid pace. We need to be part of the change by investing in cleantech development, incubating new

ideas and methodologies, and hiring industry innovators. Innovation itself must dictate the way forward and shape our thinking - we must be prepared to do what has never been done before.

### **Our Guiding Principle**

As global markets shift in response to social, environmental, and economic conditions, we will be required to build more with less impact. According to the UN's Intergovernmental Panel on Climate Change, we will need to find a way to reduce 80% of GHG emissions by 2050 from 1990 levels. To do so, we will need to build resilient, adaptable communities that can respond to the latest technologies at a faster pace. This will be no easy task, only big industry leaders who are ready to step up and lead the marketplace can drive this level of change. At EllisDon, our breadth of knowledge and experience offers exceptional service to clients and we are now focused on becoming even greater than the sum of our parts -one company, one result. We are determined to lead change in the market rather than merely anticipate it.

# Defining Net Zero Targets

## A review of recognized industry terms

**I**n response to the emerging low carbon economy, there have been a number of new terms and definitions introduced to the industry in an effort to establish a new level of energy efficiency and sustainable building practices. For clarity, the following definitions have been provided:

### **Net Zero (Site) Energy:**

Refers to a building or infrastructure project that generates 100% of the energy needs on-site through the use of renewable energy sources. In a Net Zero site energy project, for every unit of energy consumed, a unit of energy must be generated. This is an annual target based on operational demands.

### **Net Zero (Source) Energy:**

Refers to a building or infrastructure project without the onsite capacity to generate the required operational energy. To offset annual consumption, energy is delivered to site from a recognized renewable energy provider.

### **Embodied Energy:**

Refers to the total amount of energy consumed during the extraction, refinement, processing, transportation and fabrication of a material, product, or service.

### **Embodied Carbon:**

Refers to the total amount of carbon dioxide (CO<sub>2</sub>) or carbon dioxide equivalent (CO<sub>2</sub>e) generated from all inputs and outputs involved in the extraction, refinement, processing, transportation and fabrication a material, product, or service.

### **Carbon Neutral:**

Refers to achieving a state in which the net amount of carbon dioxide (CO<sub>2</sub>) or carbon dioxide equivalent (CO<sub>2</sub>e) emitted into the atmosphere from the construction and operation of a building or infrastructure project is "Zero," or balanced, by the actions taken to reduce and offset these emissions. This is an annual target based on operating emissions.

### **Operating Emissions:**

Emissions generated during the operational phase of a building's life-cycle, also known as the "in use" phase. This includes emissions as a result of operational systems, including mechanical, electrical, and information and communication technology (ICT), as well as ongoing maintenance and repairs.



# Developing a Market Standard

## Supporting market transformation towards 100% net zero carbon buildings by 2050

An Excerpt from the CaGBC's Zero Carbon Building Initiative - [www.cagbc.org](http://www.cagbc.org)

Mohawk College's Joyce Centre for Partnership & Innovation was selected by the Canada Green Building Council as a national pilot project to demonstrate it's new Net-Zero energy carbon standard and validation process.

In May 2017, Canada Green Building Council (CaGBC) was the first GBC to launch a dedicated Zero Carbon Building Standard, making carbon emissions the key indicator for building performance. [It was] Developed through extensive consultation with representatives from over 50 industry organizations, utilities, governments and companies across Canada. CaGBC is also working with 16 of Canada's most sustainable projects in the Zero Carbon Building Pilot Program, which will inform further development of the Standard and accompanying resources and education.

Within this standard, "A zero carbon building" is defined as one that is highly energy-efficient and produces onsite, or procures carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations."

The requirements for achieving certification under the standard are as follows:

1. Demonstrate Zero Carbon Balance
2. Provide Zero Carbon Transition Plan (Where fuels other than zero emissions biofuels are used onsite)
3. Install Minimum 5% Onsite Renewable Energy
4. Achieve Thermal Energy Demand Intensity Target
5. Report Energy Use Intensity
6. Report Peak Demand
7. Report Embodied Carbon



**ZERO CARBON  
BUILDING INITIATIVE**  
Canada Green Building Council®





**"We're excited to witness one of the first pilot projects using CaGBC's newly developed Zero Carbon Building Standard. Mohawk College incorporates energy harvesting and conservation technologies and is a giant leap in future-proofing new buildings that are fit for purpose, offer climate resilience as well as an enhanced user experience. As the Paris Agreement has set the international challenge to reduce global emissions, green buildings, such as the Mohawk College, demonstrate that innovation and energy efficiency can work together without compromising design. "**

**Terri Wills, CEO, World Green Building Council**





# Mohawk College

## An Excerpt from the Environmental Masterplan 2.0

Mohawk committed to becoming a leader in sustainability when we adopted our first comprehensive Environmental Management Plan four years ago. The plan was the first of its kind for an Ontario college. It was a plan that set bold targets around reductions in energy consumption and waste, and included setting the ambitious goal of achieving a 20% reduction of 2007 baseline carbon emissions by 2020.

The Environmental Management Plan (EMP), first approved in November 2011, has been the blueprint and leading policy document for the College's transformation towards becoming an environmentally, socially and financially resilient institution.

The Pillars, Strategies and Actions outlined in the plan have been vital in making Mohawk's mark as an industry leader in sustainability. As a result, Mohawk has exceeded the original target of a 20% reduction in 2007 baseline emissions by 2020, reaching a 24% reduction in carbon emissions eight years ahead of the EMP schedule.

Mohawk College remains committed to conducting business in ways that positively impact people, the environment and the broader community. Mohawk supports a multi-faceted definition of sustainability, recognizing the interconnection between the economy, society and environment.

To celebrate recent successes and continue on with the task at hand, the Sustainability Office held a series of stakeholder consultations about the future of Sustainability at Mohawk. The result was a revised plan, EMP 2.0. This Plan identifies a new target, calling for a 30% reduction in 2007 baseline carbon emissions by 2020, supported by updated Pillars, Strategies and Actions, which reflect the local, national and global sustainability movement, relative to 2014.

EMP 2.0 focuses on social sustainability, supporting education, participation, further integration with Aboriginal Education and Student Services, "Social Inc." and the demonstration of innovation at all Mohawk College campuses. The goal of the updated Plan is to continue to reduce the College's environmental impact, while developing the sustainability leaders for tomorrow's workplaces and communities.



The regular activities of all Mohawk students and staff have a direct impact on the College's environmental and financial objectives. The continued fostering of a culture of sustainability will have a positive impact on the reduction of carbon emissions, operational costs and an improved quality of life for students, staff and the broader community.

In particular, the focus of the revised plan is on Scope 3 emissions; those related to the day-to-day behaviours, actions and activities of Mohawk College stakeholders. The Plan's emphasis on change management, increased awareness and participation seeks to create opportunities for students and staff to make informed decisions with an environmentally conscious approach to daily life on and off campus.

The introduction and implementation of initiatives, programs and incentives will directly engage stakeholders in fostering

a culture of sustainability. This Plan guides the decision making process at Mohawk and will continue to inform the governance and application of college-wide policies, procedures and overall operations.

The updated Plan is a call for strong leadership in all areas of College activity. Mohawk's commitment to conducting business in ways which positively impact the people and the environment is also a commitment to embedding principles of social, financial and environmental sustainability into all that we do. The enhanced Actions and Targets set out in this Plan will ensure long-term resiliency as a leading post-secondary institution, and will continue to inspire our graduates to practice greater sustainability in the workplaces and communities in which they serve.



Groundbreaking Ceremony, September 30 2016  
Mohawk College, The Joyce Centre for Partnership & Innovation  
Hamilton, Ontario, Canada

# The Joyce Centre for Partnership & Innovation

## Ontario's First Net Zero Energy Institutional Facility

[www.mohawkcollege.ca](http://www.mohawkcollege.ca)

Located at the Mohawk College Fennell campus in Hamilton, Ontario, Canada, the new 96,000 square-foot Joyce Centre for Partnership & Innovation will build on Mohawk's applied research strengths in the three focus areas of health, energy and technology.

**D**oors open on the Joyce Centre for Partnership & Innovation in Fall 2018. It is the cornerstone of a record-setting \$54.25 million renewal of technology labs and classrooms. The five-level centre is also a showcase of environmental sustainability as the region's first Net Zero Energy institutional building. The Government of Canada's \$20 million investment in the centre is the single largest federal infrastructure investment in Mohawk College's 50-year history. Enrolment in technology programs is expected to grow from 3,500 to 4,500 students, and applied research activity will increase by 50%.

The Joyce Centre will leverage new and established partnerships to focus on technologically advanced learning and lab spaces - all under one roof. Guided by the Mohawk faculty and industry partners, students will cultivate their problem solving, critical thinking, and technical skills using cutting edge industry equipment and tools.

The Joyce Centre will include workshop spaces, lecture theatres, industry training centres, and advanced technology demonstrations. Operated as a Net Zero Energy facility, the Centre will showcase Mohawk's vision to be an environmental leader for students, staff and partners have come to expect.

The Joyce Centre will be entirely dedicated to the student experience and expand experiential learning at Mohawk. Students will enjoy greater access to laboratories, and the opportunity to learn through "capstone" projects, industry placements, co-op work terms, applied research & development, and team competitions. This new facility will supply the much-needed graduates to our industry partners and magnify our College's regional economic impact.





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# In Conversation With

## Tony Cupido, Mohawk College



**Tony Cupido, P.Eng**

- Chief Buildings & Facilities Officer -capital construction, day-to-day building operations on the Mohawk campus
- PhD in Civil Engineering: Green Buildings & Policy Development

### **What was the driver of pursuing a building targeting Net Zero Energy?**

Tony's genuine interest in high performance buildings and the opportunities they present for the future, played a key role in bringing the idea of a Net Zero energy building to the table. When given the opportunity to apply to the Federal Post-Secondary Institutions Strategic Investment Fund, he believed that there was no other way to differentiate Mohawk College's application than to set the bar at the highest level by aiming to achieve Net Zero energy. The Joyce Centre for Partnership and Innovation is a flagship project, acting as a catalyst for the adoption of high-performance buildings in Ontario. Not only does it provide an example of the next generation of building performance, it also serves as a living lab, demonstrating the engineering principles required to create and sustain buildings of this type.

### **What approach did you take to ensure all stakeholders were on board with the Project?**

As one can imagine, it can be a challenge to get multiple teams on-board and actively work toward an aligned, and aggressive sustainability target. When asked what approach was taken to achieve unity, Tony stated that "this project was a surprising exception - internal agreement was easily reached and all teams remained ready to embrace the concept of Net Zero." From the beginning, Tony felt that communication was crucial to the project's success; articulating the project's objectives, particularly the Net Zero Energy sustainability target, was important. This ensured that the engineers, architects, and construction management teams all had the right information and understanding going into the project, allowing for cohesive project execution.

### **What significant challenges were faced?**

Tony mentioned that “a significant challenge for the project was the quick schedule tied to the funding requirements.” He expressed how compressed schedules can typically develop challenges due to limited time spent on activities such as due diligence, stakeholder engagement, design reviews, and commissioning. These activities are of particular importance when bringing a Net Zero building to life. Ideally, all such activities should be prioritized early on in the project.

### **What limitations and/or concerns did you have in anticipation of meeting the funding requirements (e.g. milestones, schedule)?**

The compressed schedule happened to fall outside of the typical educational institution schedule as the funding program requirements called for the building to be completed by April 2018, which is also the last month of the winter semester. As the building is to be used primarily by engineering students, they wouldn’t be able to occupy the building until the fall 2018 semester.

What was not anticipated was the market response. As all of the Strategic Investment Funding had been released at once, with several other post-secondary institutions aiming to meet the same program requirements, it created challenges in procurement and competition since the market was flooded with similar bids. Market demand resulted in limited access to labour and materials, leaving little time and opportunity to fulfill necessary requirements.

### **How important was the Federal grant to make this project a reality?**

Despite the schedule and market challenges, the Strategic Investment Fund was critical as it was a major contributor to the overall budget. “Without it,” said Tony, “the project could not have moved forward from conception to construction.” In addition to federal funding, generous donations were received from the Joyce Family Foundation, the Mohawk Student Association, ArcelorMittal, and the Marinucci Family Foundation.

### **What design challenges did you come up against in the early stages of project development?**

The architectural team created a “Basis of Design” document to act as the framework for building development. This document was important in setting spatial requirements and recognizing any limitations for the inclusion of renewable energy systems.

As previously mentioned, the time constraints did not allow for an in-depth analysis of design, which made the energy budget (produced by the energy consulting team) a critical tool in aligning energy consumption with the cost of the other building systems and their applications.

Another challenge was ensuring that the PV system was robust enough to manage operational demand, and that sufficient roof space was available from adjacent campus buildings.

***“Mohawk College aims to be a leader in sustainability and The Joyce Centre for Partnership & Innovation fits perfectly into the colleges Environmental Management Plan.”***

*continued* ➤

**Do you have any recommendations for future projects targeting net zero energy in Ontario re: government, industry, and academic involvement?**

Tony believes that the Governments of Ontario and Canada have implemented excellent legislation as it relates to greenhouse gas emissions, cap and trade, and climate change. As we move forward, he believes there is a need for government to implement additional policy for all ministries and organizations, federal and provincial, to realize the Net Zero initiatives and initiate the Net Zero movement. He believes that all public sector buildings should be targeting Net Zero, as a minimum.

**Tony's Recommendations:**

1. Get all building occupants to become active participants in the buildings they spend time in (this is not limited to academic institutions).
2. Plug loads should be monitored for energy consumption patterns.
3. Incorporate building automation systems (BAS) for the purposes of data collection, knowledge transfer, and diagnostics of energy consumption.



Mohawk College  
The Joyce Centre for Partnership & Innovation  
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# Intelligent Buildings

## Its about Systems Thinking

EllisDon is a market leader in the construction and operation of Intelligent Buildings. Our portfolio now includes projects across Canada, including WaterPark Place, George Brown's Waterfront Campus, Oakville Trafalgar Memorial Hospital and Brookfield Place (Calgary). However, installation of the intelligent infrastructure is only the first step. If you are to make a building and its operation truly intelligent, then you have to leverage both the technology and the information it provides to drive performance.

**E**llisDon believes very strongly that a key contributor to achieving a Net Zero building is through the use of technology. This commitment to technological advancement is embodied by our Energy & Digital Services division who leverage the exponential growth of technology within buildings to ensure our clients achieve their sustainability goals.


It is critical for any building aiming to achieve Net Zero Energy to implement tools that can maintain efficient operations. There is an old adage that states "you can't manage what you can't see;" this is particularly true as it relates to facilities management and achieving a building's Net Zero energy target. EllisDon has pioneered the development of consolidated dashboards for use by both operators and energy managers. The consolidated dashboard delivers a single pane of glass that provides visibility over how the overall building is functioning, while allowing the

user to drill down into each of the building systems. It also provides a foundation for advanced analytics, such as automated fault detection.

The exponential increase of technology within buildings is fundamentally changing how buildings are operated. We are implementing cloud-based applications that provide autonomous control of various building systems. These applications leverage the concepts of big data, machine learning, and advanced computing power, to drive increased building performance. We need to ensure that the operations team embraces the new tools that are now available and subsequently use these tools to drive the building's performance. The adoption of these tools will be critical to the success of the facility.

***"The only constant in life is change, and we must be open to it because when we do, we all benefit."***

*Robert Barnes, EllisDon Corporation*

The background image shows the interior of a modern building with a high, vaulted ceiling made of light-colored wood beams and panels. Large windows on the right side offer a view of greenery outside. In the foreground, there are rows of workstations with blue partitions and people working. A long wooden table runs diagonally across the lower part of the frame. A single white cylindrical pendant light hangs from the ceiling.

**"Significant effort has been expended to achieve Net Zero Energy design at The Joyce Centre for Partnership & Innovation, starting with establishing an energy budget. We've worked diligently to enhance the sustainability features of the building including the selection of natural material, maximizing natural light and views, using finishes strategically, water conservation measures and green roofs."**

**Joanne McCallum, McCullum Sather Architects**







# The Development Process

## Striving for Net Zero Energy

Over the past 15 years, interest in green building design has gone mainstream, in part due to the effectiveness of rating systems like LEED that have educated the market and guided building processes. Industry leading construction companies now have in place the experience and expertise needed to deliver a green building to clients, on time and on budget. The market is about to change as we find our way in the emerging low carbon economy.

**W**e are at a crucial time in the global energy efficiency market where designers, developers, and property owners are being challenged to do more as Canada strives to meet the United Nations goal of reducing GHG emissions by 80% (below 1990 levels) by 2050. Provinces and municipalities are already stepping up to meet the challenge - they are asking the design community for a new level of "hyper-efficiency" in new building projects; they are looking for life-cycle carbon accounting for all buildings and infrastructure; and they are establishing energy retrofit plans for existing buildings. Supported by the leadership of federal government agencies like the Federation of Canadian Municipalities, major urban centres like Toronto and Vancouver are already moving to implement city-wide zero emissions targets.

New buildings and infrastructure projects will need to find ways to meet these targets, but there is no single solution.

Where LEED was a unified driver that began the green building movement in the 90's, today's market is looking for more comprehensive mechanisms that can ensure carbon reductions and energy savings. For LEED developments, the US Green Building Council has now introduced "version 4," incorporating important updates that include the consideration of construction material life-cycle impacts. Most recently, the CaGBC has expanded their portfolio beyond LEED, launching their Zero Carbon Building Standard. Examples of new systems that have recently been introduced to the mainstream market include Passive House, the Well Standard, Living Building Challenge, and others.

We are now moving to design and build projects that can generate as much energy on-site as they consume annually. These "Net Zero Energy" buildings are not meant to be a one-size-fits-all solution for the market, but they do offer a leadership target for the market to aspire to. For example, a tall office tower in downtown





Toronto would find it very difficult to achieve Net Zero Energy (there is just not enough space for on-site energy generation), but the design principles used to achieve Net Zero Energy on projects, like Mohawk College's Joyce Centre, can be used to influence design to meet hyper efficiency targets for tall tower buildings. Rather, a "Net Zero Emissions" target for tall towers (as a continued example) would be better suited. Whatever the hyper-efficiency target (Net Zero Energy or Emissions) established by the client, the design community needs to be prepared to respond.

All project proponents need to be brought to the table very early in the planning stages through an "integrated design" process. This process must include experts in intelligent building systems and facility management to prepare for operations

and plug-load demands. This is especially true of buildings targeting aggressive levels of hyper-efficiency. The market has been discussing the need to adopt an integrated design model for years, but now we need to put these interests into practice.

Through our efforts with Mohawk College, we learned a valuable lesson about the importance of collaboration and about integrating all teams in the development process as early as possible. For the next project, we have learned that integrated design is crucial. Everyone involved in development and operations must be engaged from the very beginning.

Knowing that we were up against some tight timelines, everyone came together to ultimately deliver a building that we can all be very proud of.



Mohawk College  
The Joyce Centre for Partnership & Innovation  
Hamilton, Ontario, Canada

# In Conversation With

## Kevin Stelzer, B+H Architects



### Kevin Stelzer

- Principal with B+H Architects, specializing in laboratory, retrofit-renewal projects and energy efficiency.
- Registered Architect (OAA, NLAA)
- Building Science Specialist of Ontario

**A**lthough B+H has global experience developing hyper-efficient buildings, did you anticipate any challenges in applying these experiences specifically to the Mohawk College project?

**1.** Kevin noted the difficulties in identifying a common evaluation protocol at this early stage of the “Net Zero” market. The Canada Green Building Council’s “Zero Carbon Building Standard” had not yet been released at the beginning of the project so it could not be used for reference. The team decided to use the Net Zero Energy metric from the “Living Building Challenge” as the guideline for the project.

**2.** With a background in building science, Kevin considers an energy budget just as important as cost and scheduling to the design process, but this project posed some interesting time constraints to his usual way of doing things. In his typical design approach, he first looks at building area and location and then designs from the energy perspective. He said that “he

anticipated that a quick design turn-around could make processes such as procurement difficult, but no one anticipated just how difficult.” Kevin quickly learned that the local market needed to be carefully analyzed in order to have an organized bidding and tendering strategy. What ensued was quite erratic at times; acquiring the desired labour and materials proved to be a real challenge to keep pace with the schedule.

**3.** The collaboration on design execution was refreshingly less challenging than anticipated, despite the project's strict schedule. As an example, the design process was able to be flexible enough to consider alternative options when constructing the curtain wall for optimal performance. Kevin understood and appreciated that collaboration on high performance buildings is of great importance. The earlier all teams (from design through construction and operations) can be brought on board together, the better.



**The Mohawk building is the first Net Zero Energy academic building in Ontario – in your experience, what does this type of project mean for the market and the province?**

Kevin stated that “there is definitely an interest in the academic institution market to strive for aggressive efficiency targets.” Observers often questioned him on the build process and how the Mohawk project compared to traditional builds. He also fielded a lot of questions around up-front cost comparisons. He goes on to say that “high performance buildings are desired in the market, but there is still more information needed on what NZE truly means and what really goes into making NZE a reality.” To support NZE projects in the Greater Toronto Region going forward, Kevin believes that regulations like the new Toronto Green Standard Version 3 will increase enclosure effectiveness across the board. This will be a significant help in the way we design future NZE buildings.

**Where do you see the future of low carbon buildings going in Canada?**

Kevin feels that we need to foster stronger collaboration between design and engineering disciplines. He recognizes the importance of the building envelope in operational performance and looks at what measures architects can implement on the mechanical systems of buildings, in what he refers to as “thermal autonomy” (as presented by Loisos + Ubbelohde at the 2013 CaGBC National Conference & Expo). The concept measures “how much of the available ambient energy resources a building can harness rather than how much fuel heating & cooling systems will consume, [linking] occupant comfort to climate, building fabric, and building operation”.

He also feels that the market needs to be prepared for the pricing strategy of constructing high performance buildings and that the construction of buildings needs to be purposeful and thoughtful.

**Can you describe your experience integrating all of the high performance building systems on the project?**


In answering this question, Kevin said “meeting an energy budget with systems integration was actually my favourite design aspect.”

He enjoyed the challenge of designing for demand occupancy and seeing how stable heat sources from the geo-exchange field and the VRF system came into play to create a pleasant social hub that people would want to occupy. Students and faculty should enjoy an immersive experience in the teaching and learning spaces at the Joyce Centre for Partnership and Innovation. He mentions how “Tony Cupido is looking forward to using the building to teach students how to operate high performance buildings.”

**At this point of the project, what is your one key takeaway?**

Kevin feels that the greatest challenge is trying to create an industry-wide culture of high performance buildings, in which protecting the atmosphere is truly valued and where healthy buildings are created to enhance the occupant experience.

*“As we enhance indoor environments we can have a much healthier impact on every aspect of architecture: innovation, uniqueness, cultural goals, and local requirements”.*

A photograph of a construction site, likely the interior of a building under renovation. The image shows a wooden floor, a metal support structure, and a ceiling with exposed pipes and ductwork. A semi-transparent text box is overlaid on the center of the image, containing a quote in white text. The background is slightly blurred, showing construction materials and equipment.

**“Through design and collaboration in key industry initiatives such as the Carbon Impact Initiative with EllisDon and our partners, BASF is continuing to learn and lead the next generation of sustainable, durable and cost effective construction products which will take us into the future of building science. There is no question that net zero projects like Mohawk College are monumental and are leading the construction revolution and we are excited to be a part of it.”**

**Marcelo Lu, President, BASF Canada**





# In Conversation With

## Kathleen Agustin, EllisDon Corporation



### Kathleen Agustin

- Project Coordinator, Sustainable Building Services, EllisDon
- Graduate, Sustainable Energy & Building Technology, Humber College

**M**any of the discipline leaders involved in the project are used to working in silos, focused on their areas of expertise, where they conduct their work effectively in a linear process from design to substantial completion. As the integrated planning coordinator for The Joyce Centre, what were your challenges in getting everyone to the table to collaborate and discuss the bigger objectives for the project?

Kathleen's introduction to this project started with an internal EllisDon meeting where executives from across divisions, including Building Sciences, Sustainability, Construction Management, Mechanical/Electrical Design, Energy and Digital Services, Information Communication & Automation Technology, came together to discuss what steps would need to be taken to ensure the Joyce Centre achieved its Net Zero Energy target.

This team was established after the project had just started construction, in response to an internal interest to ensure everyone was working from the same objective and understood the importance of building Ontario's first institutional NZE building. Everyone invited to join the team had their respective expertise on energy efficient, green building design, but no one had a clear understanding of how all the pieces would fit together to achieve the new level of hyper-efficient building performance required for the project. Over several meetings, questions continued to be left unanswered and it was evident that the communications between the construction team and consulting design team needed to be improved.

To solve this issue, recommendations on building envelope tightness and technology integration were discussed at length and a plan was introduced to facilitate the decision making process. For



example, energy modelling assumptions were understood to be critical in achieving Net Zero Energy so the teams needed to ensure the model reflected what was presented in the design and construction documents. It was also important to identify what expertise EllisDon could provide to the project, beyond just traditional construction management services. The EllisDon team had recommendations; they realized that they had to work closely with the design teams and the client to ensure the project met their targeted Net Zero Energy objective. Everyone needed to collaborate to ensure success.

At the beginning of the construction process, a designated "Net Zero Energy coordinator" had not yet been assigned. This proved challenging for Kathleen, as she took on this role, to catch up to developments in her efforts to facilitate communications. The design team also worked on meeting the requirements for the CaGBC Zero Carbon Building program. Efforts were made to coordinate with the construction team to provide the necessary information required to meet the "embodied carbon" section of the CaGBC report. There are a lot of moving parts to manage in a commercial construction project to begin with; aiming to achieve Net Zero Energy, along with CaGBC commitments, had many assumptions and unknowns to manage.

Throughout Kathleen's involvement in the project, she was "very impressed by everyone's genuine interest," regardless of any set-backs, challenges, or misunderstandings. It takes a large team of very knowledgeable people to bring a project like the Joyce Centre from idea to reality. It was a very humbling experience

for her to be able to speak with so many passionate and intelligent individuals. This is just the first step in the adoption of high-performance buildings in Ontario, and Kathleen cannot wait to see how the market will continue to support buildings that represent the next generation of energy efficiency in Canada.

**For the Joyce Centre, there were a lot of new innovative concepts and technologies to consider that required expertise not usually considered in traditional building design. What was your experience working with the teams to consider intelligent building technologies and facilities services early in the planning process?**

EllisDon's technology experts were engaged in a number of discussions, internally, on what smart building systems were being considered and how the building's performance would be monitored and managed. As the integrated planning coordinator, Kathleen recognised that EllisDon was limited in the ability to introduce new technologies, but had the opportunity to review how the Joyce Centre would meet the planned Net Zero Energy target with the design team and the client.

EllisDon advised the client on the importance of creating a unified monitoring system that Mohawk College could use for operational management, as well as for educational and promotional value. EllisDon has the experience and the expertise in providing this service to other project types, such as data centres, in which real-time information is collected and shared. This is achieved through an interactive "dashboard" to communicate

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energy consumption and distribution, technology performance, occupancy levels, plug-load management, heating and cooling loads, and more. An interactive dashboard would be particularly useful for the Joyce Centre to monitor the geo-exchange field and PV systems to compare and report on performance trends over time.

Kathleen also reviewed how the team discussed the importance of engaging specialists in facility management. For a building like the Joyce Centre, that will rely on renewable energy and integrated communication systems, building operators will have to be trained to work in a highly technical Net Zero Energy environment.

## **Lessons Learned & Recommendations**

### **Kathleen's Recommendation # 1: Understand Net Zero Energy**

It's critical to assemble a cohesive team in which all the members recognize the end-goal. Team members must work together and communicate on how their respective roles can affect project outcomes. Priorities and critical components of a Net Zero Energy building must be established and clearly communicated throughout the course of the project's development. If necessary, time should be taken to give presentations or summary documents to the team in order to confirm that all members understand what Net Zero means from the onset, and outline any requirements that might be different than a similar code compliant building. When everyone understands the goal, how to get there, and how their respective roles can affect outcomes, project execution will be much smoother and cost effective.

### **Kathleen's Recommendation # 2: Assign a Designated Net Zero Coordinator**

Dedicated resources are required to ensure that all disciplines are aligned to meet Net Zero Energy targets. With all the moving parts in the design, construction, and operation of a NZE building, there needs to be a knowledgeable member of the team dedicated to coordinating communications. Since it can be difficult to get all teams together at once, a live online document with comments that can be reviewed in real-time by each member would be useful. Ideally, all disciplines should meet at major project milestones to ensure that design, construction, and planned building operations are aligned and understood.

### **Kathleen's Recommendation # 3: Adopt a Practice of Integrated Design and Delivery**

Design intent, construction processes, and building operations need to be agreed upon and understood at the beginning of the project's development. A predetermined energy budget is also critical for a project of this type. Any changes made to the project over the course of design and construction must be reported to a dedicated energy team so that models can be updated to advise on how these changes can affect future operational performance. Efforts to align all disciplines later during the construction process (in a reactive as opposed to proactive manner) is inefficient and limits a team's ability to address issues without impacting the schedule or budget. It is challenging to make changes once construction is underway, so it's important to have as many risks and assumptions addressed at the beginning.





On-going communications and open collaboration is invaluable to maximizing building performance. As new innovations in building design are introduced to the market (in response to the emerging low carbon economy) it will be a challenge to keep on top of the latest developments. Any change in the construction industry is going to be a challenge, but we need to embrace this as an opportunity if we are going to do our part to adapt to our changing climate. We must all keep our minds open and receptive to new innovative ideas so that projects like the Joyce Centre can influence future resilient city developments.



Site Visits 2018  
Mohawk College, The Joyce Centre for Partnership & Innovation  
Hamilton, Ontario, Canada





**"EllisDon is committed to driving innovation in the construction sector and we must do so by leading change, not just responding to it. Collaborating on projects like Mohawk's NZE Joyce Centre for Partnership & Innovation is a critical step in our on-going process to lead the market towards a low carbon economy."**

**Geoff Smith, CEO, EllisDon Corporation**







# In Conversation With

## Andrew Visconti, EllisDon Corporation



### Andrew Visconti

- Project Manager, Mohawk College Joyce Centre for Partnership & Innovation
- Bachelor of Commerce, Ryerson University
- LEED Accredited Professional

**What were the noticeable differences between managing the construction of a high-performance building like Mohawk's NZE Joyce Centre for Partnership & Innovation compared to a code-compliant building? Any initial thoughts coming into the project?**

As a first step in his efforts as Project Manager, Andrew worked to understand the scope and impact of a project targeting Net Zero Energy. He had some questions: "Did it mean operating off-grid as a self-sufficient building or would it be tied to the grid? How would it be metered? What would be the best approach to take this project from design to construction?"

As the project got underway, Andrew quickly realized he was facing a bit of a "perfect storm" that he had to navigate: a compressed build schedule, a shortage of skilled labour, and difficulty sourcing materials. Andrew identified that there was one good thing going for the project - there was no significant challenges to the overall

construction process as a result of the Net Zero Energy target. He did however have to pay careful attention to the drawing details, as Net Zero Energy required a different mindset. He had to focus on the end goal at all times and watch closely for any potential issues (such as ensuring wall tightness specifications were followed by the trades to prevent air leakage concerns).

Andrew noted that, a lot of emphasis was placed on participation and collaboration from the construction team at EllisDon during the design phase. Efforts between design and construction were much more integrated than he was used to and communications were more focused and involved (as opposed to simply passing information along from the design team). He noticed that a lot of assumptions were made up-front on how the building would operate; occupancy schedules, electrical loads, and seasonal variances for the renewable energy sources had to be considered throughout the design/build process.



**Given the compressed project schedule, what activities seemed to have the biggest impact on the deadline?**

Andrew anticipated that the tight deadline would have an impact compared to typical project milestones, but “the construction schedule couldn’t wait, as there were commitments to federal funding that had to be met. This affected certain deliverables from the design team.”

In one instance, he had to proceed with the building’s structural approvals even before the PV array was fully designed.

The curtain wall was also a challenge to navigate as its development process did not follow a traditional construction schedule. Comprehensive performance testing and detailed design mock-ups needed to be approved before the shop drawings could be distributed to the construction team, then fabrication of all curtain wall components needed to be completed prior to installation on site. On a positive note, the geo-thermal field was separate from the building (not underneath) so its design was done concurrently and did not affect the schedule in any significant way.

In order to meet the thermal performance requirements, the building’s exterior walls required BASF’s Walltite polyurethane spray foam insulation. Spray foam would provide superior wall tightness, but the application process affected the schedule. Areas of the building needed to be cleared of people and loose materials before application could commence. Traditionally, construction activities are coordinated simultaneously, but the spray foam application required activities to be done consecutively resulting in additional steps to the construction sequence.

**What were your experiences engaging contractors and trades regarding the building performance requirements?**

Engagement of contractors and trades onsite was a very collaborative, two-way communication process. This collaboration helped Andrew understand perspectives from the trades in relation to the expectations of the design team. This allowed for inconsistencies to be caught early and addressed quickly. Many times over the construction process, plans had to change in response to unique challenges onsite.

Andrew again referenced the exterior walls as “one of the most important components of high performance building design.” The construction team and design team had to work together to coordinate construction logistics and performance targets. For example, spray foam is not applied in a consistent, uniform thickness to surfaces (the team was concerned about the potential time consuming process of having to shave down over-spray). In order to meet the design specifications, thermal resistance per inch was calculated, paying special attention to the foam’s application. The result was a uniformed, consistent application that provided valuable information for the energy modeling team to work with in their ongoing calculations.

Technical proficiency and proper installation sequencing from the trades onsite were extremely valuable to the construction process, especially when connecting the photovoltaic solar energy system. The system spanned multiple buildings on the campus. It was designed to produce more power than the Joyce Centre building alone required, and tied

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into the greater campus grid to meet the College's overall clean energy strategy. The system had to be connected to multiple electrical rooms - quite the challenge for the trades, but one that was coordinated well thanks to the collaboration of all involved.

**Are there any added resources that you feel could have helped the construction process?**

Andrew believes it would have been beneficial to the mechanical and electrical contractors if measurement and verification (M&V) was introduced earlier in the project. Having already gone ahead with their work, it was challenging to back-track and execute the advice provided by the M&V consultant.

It would also have been helpful to identify and communicate everyone's project responsibilities earlier in the development process. A review of how these roles and responsibilities of the disciplines involved would contribute to a successful Net Zero

Energy building would have been a positive addition to the collaboration efforts as it would have provided team leaders with more information to better anticipate potential issues as the project evolved.

**What is the one thing you will keep in mind when you take on the next Net Zero building?**

Andrew believes it will be very valuable to identify early in the process what is important versus what is a "wish-list" item for the client. In other words, what items are absolutely "necessary" to hit a Net Zero Energy target? It all comes down to determining what critical components are needed to mitigate risk.

All unknowns in the design phase also need to be addressed as early as possible. The teams needed to work together to understand one another's expertise and how it fit into the building's performance requirements to streamline execution.



Mohawk College  
Hamilton, Ontario, Canada



# Facilities Services

## Maintaining Net Zero Energy Operations

Design and construction leadership is integral to delivering a high-performance building to a client, however, this is only the first stage of a full life-cycle journey to Net Zero. The goal of operating a building that produces as much energy as it uses on an annual basis is an ongoing task. To achieve this, the Facilities Services (FS) team must ensure that all facets of the building, supported by occupant behaviour, are aligned with this goal and operating at peak efficiency today, tomorrow, and into the future.

EllisDon Facilities Services' efforts in maintaining Net Zero operations necessarily parallels the objectives of a Net Zero building, specifically leading the energy efficient operation of the building while supporting the assets that will sustainably generate power. As the journey evolves, FS must plan for investments in more complex, non-fossil fuel dependent power typically funded through energy savings generated through low cost/no cost initiatives. When installed, this equipment needs to be managed and maintained in a very different way from traditional fossil fuel energy sources. The FS team must be fluent in all new technology, and depending on the design of the site, be fluent in multiple technologies at the same time. Buildings designed and built as Net Zero can incorporate multiple clean energy technologies, and it is incumbent upon the FS team to understand and maintain all of them.

The Facilities Services team is also responsible for leading the conservation effort, balancing energy use through building controls management as well as occupant/tenant management to ensure the overall consumption does not force energy use from the grid. While most occupants are typically supportive of Net Zero goals (and as tenants, are willing to pay more for it), they are not

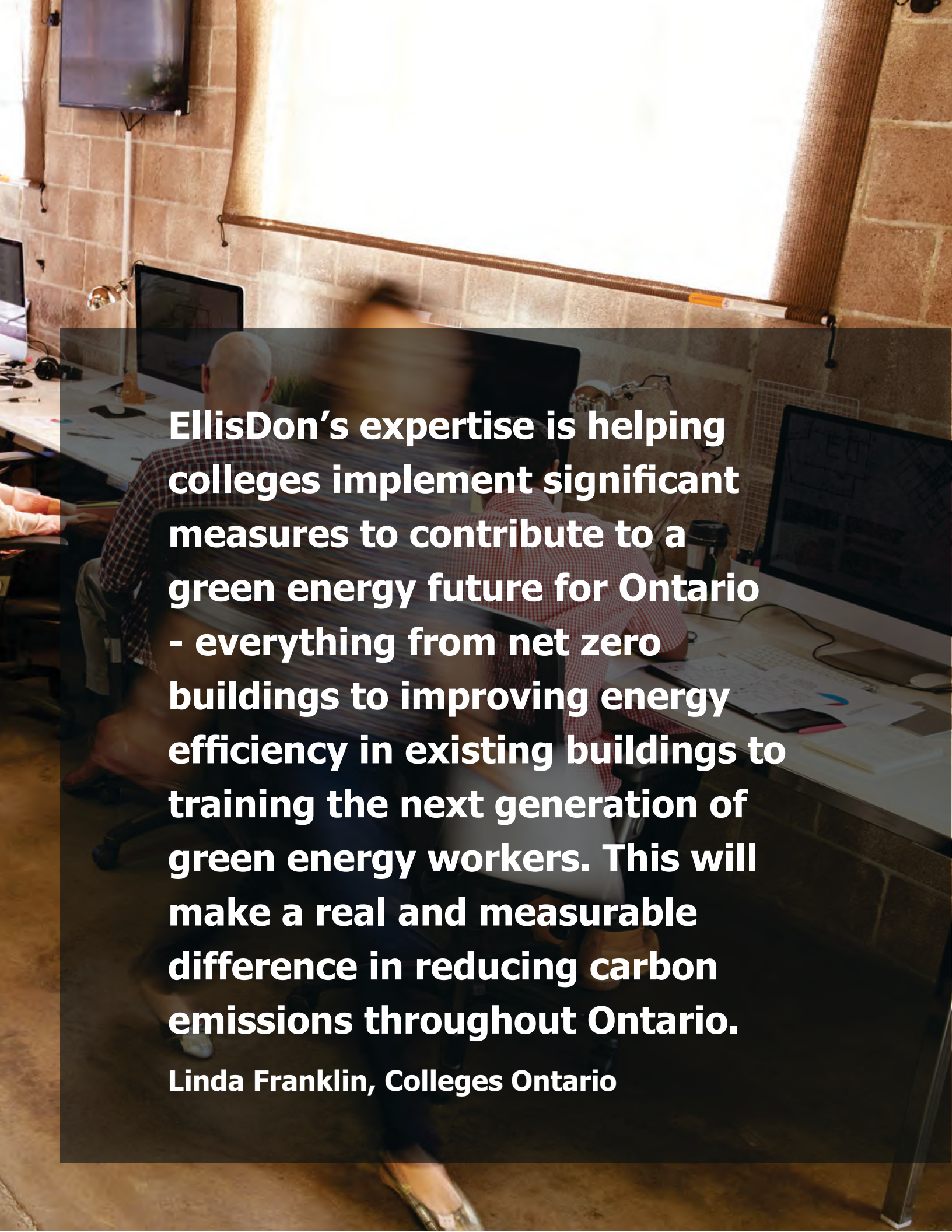
necessarily aware of how their habits impact day to day energy use, nor may they be willing to change them. It is the role of the FS team to ensure ongoing communication of these goals, as well as distributing timely metrics with their client's occupants to apprise them of their success. While the technical aspect of FS is critical, the importance of occupant engagement in this journey cannot be underestimated and needs leadership and communication in order to ensure success.

Maintaining a Net Zero building is not a static accomplishment; Facilities Services must assert ongoing vigilance in order to ensure this annual target is met through balancing demand and supply. This translates into a tireless effort to find efficiencies, consistently auditing the building, and investigating innovation and energy efficient alternatives, as well as implementing low-cost/no cost changes whenever possible. They must also lead the charge on the management and monitoring of energy consumption with an unwavering message of conservation to both their operations and occupant teams. In short, once the building is constructed, the Net Zero journey for Facilities Services has just begun.







The background image is a blurred photograph of an office environment. Several people are seated at desks, working on computers. The desks are cluttered with papers, keyboards, and other office supplies. The office has large windows with blinds, and the walls appear to be made of brick or stone. The overall atmosphere is one of a busy, professional workspace.

**EllisDon's expertise is helping colleges implement significant measures to contribute to a green energy future for Ontario - everything from net zero buildings to improving energy efficiency in existing buildings to training the next generation of green energy workers. This will make a real and measurable difference in reducing carbon emissions throughout Ontario.**

**Linda Franklin, Colleges Ontario**

# Outcomes

## A “Top 10” List of Lessons Learned

The following “top 10” list summarizes the comments, observations, and quotes compiled throughout this report. The intent is to provide the reader with a clear understanding of the priorities identified by the experts engaged in the development of the Mohawk College Joyce Centre for Partnerships & Innovation.

### **1. Communication is Key:**

Ensuring that all stakeholders understand what “Net Zero Energy” means, and how it impacts the project, is critical. In other words, the engineers, architects, and construction management teams need to have the right information upfront to ensure a project is well executed. It is critical to assemble a cohesive team in which all the members recognize the end-goal. Team members must work together and communicate on how their respective roles can affect project outcomes.

Priorities and critical components of a Net Zero Energy building must be established and clearly communicated throughout the course of the project's development. If necessary, time should be taken to give presentations or summary documents to the team in order to confirm that all members understand what Net Zero means from the onset, including outlining any requirements that might be different than a similar code compliant building.

### **2. Create a “Net Zero Team”:**

Since energy generation and demand is a central component in achieving Net Zero Energy, it would be useful to have a dedicated energy team. This team should

be responsible for assessing the energy profile of the building and ensuring that designs reflect energy demands. The project budget also needs to allow for a dedicated Net Zero Project Coordinator. Construction, like many other industries, traditionally works in siloed disciplines. For the purposes of knowledge transfer and collaboration, a dedicated Coordinator should be assigned to improve communications, provide developments of the project, flag any potential challenges, and ensure that the project is on track to meet its performance goals. This is particularly important when working towards a Net Zero Energy target as each discipline will impact the other in the design and execution of the project.

### **3. Apply Integrated Design:**

Collaboration between disciplines is of great importance. All fields of expertise, including Facilities Services and Digital Services, must be integrated at the beginning in order to inform the Net Zero design and build requirements. There is also a need to foster stronger collaboration between design and engineering disciplines so that the traditional “siloed” approach to delivery is addressed and avoided.



#### **4. Prioritize the Wish List:**

It is very valuable to identify early in the planning process what is important versus what is a “wish-list” item for the client. In other words, what items are absolutely necessary to achieving a Net Zero Energy target? It all comes down to determining what critical components are needed in order to mitigate risk and achieve targets.

#### **5. Incorporate Building Automation Systems:**

Intelligent building systems are essential to achieve annual Net Zero Energy targets. Energy generation and consumption must be monitored for the purposes of data collection, knowledge transfer, and diagnostics of energy demands. Incorporating Building Automated Systems (BAS) makes achieving the annual target of Net Zero Energy that much easier, providing transparency and prioritizing operational processes.

#### **6. Manage Procurement:**

The local market needs to be carefully analyzed to ensure the tendering process is well organized. Challenges in procurement and resource competition in a potentially flooded construction market (i.e. limited access to labour, materials, and technology) should be anticipated and managed.

#### **7. Engage Contractors and Trades in the Development Process:**

Collaboration must also extend to the trades. Engagement onsite must be a collaborative, two-way communication process. This collaboration will help construction managers understand perspectives from the trades in relation to the expectations of the design team; this allows for any inconsistencies to be caught early and addressed quickly. Over the construction process, plans will likely have to change in response to unique

challenges noted onsite. Trades that are engaged and educated in the intent of a project are crucial partners in achieving the quality control required for the long term performance targets.

#### **8. Focus on the Energy Budget:**

When planning a Net Zero project, the design process should prioritize the energy budget equal to the construction cost and project scheduling. A predetermined energy budget will influence technology integration, and will impact ongoing operation and maintenance schedules.

#### **9. Engage Tenants in Operational Efficiency Targets:**

A Net Zero Energy building is designed to match annual onsite generation targets equal to annual energy consumption. Once the building is designed and built, operational efficiencies quickly become the point of focus. The facility services team will be crucial to ensuring the project meets its annual energy commitment; just as important will be managing plug-loads and tenant behavior. All building occupants must become educated, active participants in managing building performance.

#### **10. Knowledge Sharing from Cradle to Grave:**

Delivering a high performance building to a client is a sophisticated process that requires experienced experts from across disciplines to work together. The value of this collaborative process in relation to the outcomes need to be recorded and shared so that future projects can adopt the practices that have proven to be successful. Knowledge sharing will also educate the market and prepare clients for the pending mandatory life-cycle energy and emissions reporting requirements by all levels of government.

# Looking Forward

## Preparing for Market Transformation

A number of years ago, the strategic theory of the “triple-bottom-line” was introduced to the marketplace. It defined a new way of conducting business where the economic, social, and environmental priorities of corporate governance would have equal importance in the business planning process. At the time, it was an intriguing idea that presented well at corporate events and in academic circles, but little evidence of practical application could be found.

**W**e were fortunate to have a select few iconic leaders, such as the late Ray Anderson of InterfaceFlor, to demonstrate that the triple-bottom-line theory had merit and could provide a significant return on investment in support of the green economy - but we were nowhere near a transformation of the marketplace. Market transformation has been an elusive goal of leading not-for-profit organizations, such as the US and Canada Green Building Councils, for many years. Yet with all the great work that these leaders and groups have done, we are nowhere near a transformation towards effective management of our finite resources. In today’s market, clean and renewable energy technology provides only 26% of our global energy needs, alternative fuels supply only 10% of our transportation needs, and only 18% of our global building infrastructure can be classified as “green”.<sup>1</sup>

We now need to question whether we are actually capable of making the change required to sustain ourselves. According to the United Nations, global populations are estimated to rise from 6.5 billion to 10 billion by the year 2050. We could run out of proven oil reserves within the next generation, and we will need agricultural land the size of Brazil to feed us - this amount of arable land does not exist on earth. Our planet’s climate systems are in turmoil, and our economies are struggling to stay in control. For the first time in our history, economic, social, and environmental conditions are being strained. We have the tools to support change, yet we keep our “blindness” in place and maintain our “silo”- based strategies of business management.

Dividing our industry sectors into silos worked well for us during the first and second industrial revolutions. These were times when we were first developing big

<sup>1</sup> [www.iea.org](http://www.iea.org)




energy, communications, and manufacturing infrastructures. We were focused on market growth and needed to segregate ourselves into skill sets to manage rapid urban development. Now we need to move from a world of industrial expansion to one of corporate refinement, advanced systems thinking, and collaboration. We also need to realize that the change needed for true market transformation will come from the leaders that can demonstrate the effectiveness of collaboration across government, industry, academia, and NGO organizations. These sectors each serve a purpose and we need to understand that this purpose is to inform, guide, and support opportunities - but none of them can be expected to drive change alone in today's marketplace.

Fortunately, we now have new methods and strategies at our disposal that can prevent potential catastrophe. We know how to create energy without burning carbon based fuels. We know how to build cities that are smart, resilient and culturally diverse. We know how to manage transportation and communication

systems for peak efficiency. And we are beginning to embrace sustainable urban agriculture solutions as a means to address our world food issues. Global efforts are starting to make an impact, pushing the "triple-bottom-line" from academic theory to market reality. Thanks to leadership projects like Mohawk College's Joyce Centre for Partnership and Innovation, we are witnessing the positive impact our collaborative efforts can make on the market.

We can expect to see positive changes in the coming years if academic leaders like Mohawk College continue to push the boundaries of what is possible in the development of the next generation of hyper-efficient buildings. It will then be up to global markets to support these efforts and ensure the return on investments made into these new systems and technologies can sustain long term objectives. We have a long way to go, but we are seeing the evidence of what is possible when we work together towards a low carbon economy.



An aerial, high-angle photograph of a multi-lane highway. Several cars are visible, including a red car, a blue car, and a white car. A large white semi-truck is also on the road. The road has white lane markings and a red and white striped median. The background shows some greenery and a building.

**“We must now agree on a binding review mechanism under international law, so that this century can credibly be called a century of decarbonization”**

**Angela Merkel, Chancellor of Germany**



# Acknowledgements

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## Reader's Notes:

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