Partners in Project Green

A Program of Toronto and Region Conservation Authority

Energy Leaders Consortium:
Site Visit with Humber College

October 30, 2024

We respectfully acknowledge that we are situated on the Traditional Territories and Treaty Lands, in particular those of the Mississaugas of the Credit First Nation, as well as the Anishinaabe of the Williams Treaty First Nations, the Huron Wendat, the Haudenosaunee, and the Metis Nation.

As stewards of land and water resources within the Greater Toronto Region, Toronto and Region Conservation Authority appreciates and respects the history and diversity of the land and is grateful to have the opportunity to work and meet on this territory.

A Collaborative Space for All

Proposed Operative Values for ELC meetings:

1. Balance airtime to hear from as many voices as possible
2. Be curious and challenge our own assumptions and biases
3. Be open to building on each other's suggestions or taking the conversation in another direction

Agenda

Time	Activity
8:30am – 9:00am	**Arrival/ networking**
9:00am – 9:15am	**PPG welcoming remarks**
9:15am – 9:45am	**Humber College Presentation: the SWITCH project**
9:50am – 10:20am	**Kaaj Energy Presentation: Thermal Energy Storage**
10:20am – 10:50am	**Q&A/ Discussion**
11:00am – 12:00pm	**Facility Tour: SWITCH project**
12:00 to 12:30pm	**Closing/ networking/ departure**

Introduction

Upcoming ELC Sessions & PPG Events

Date	Topic
November 6th 8:30am – 1:45pm	**Futureproof Your Fleet: Medium-duty vehicles** Join us in-person in Ontario Tech University, Durham
November 13th 2:00-3:00pm	**Fostering Collaborative Leadership for Sustainability:** Part 1 Online workshop
November 27th 10:00am-1:30pm	**Fostering Collaborative Leadership for Sustainability:** Part 2 In-person workshop
November 28th 1:00-2:30pm	**Navigating Business Insurance in the Age of Climate Change** Webinar with Insurance Bureau of Canada
December 4th 1:00pm-2:30pm	**ELC Member Roundtable with BASF** Additional details to be shared

Please contact Matt Brunette if you are interested in hosting an ELC Site Visit or presenting at a Member Roundtable.

Futureproof Your Fleet Workshop

Register Now: Futureproof Your Fleet Workshop for Medium Duty Vehicles, Durham Region - Partners in Project Green

- Learn about 4 different low/zero carbon vehicle technologies at this free workshop
- Network with peers, industry experts and service providers across transportation and sustainability sectors
- Special facility tour and demo of a hydrogen-powered Transportation Refrigeration Unit by HydroCool
- Several low/zero carbon vehicles on display

When: November 6th, 8:30am to 1:45pm
Where: Ontario Tech University, Oshawa

Futureproof Your Fleet Webinar: Case studies from Industry Leaders

Making the case for decarbonising your fleet with the Emterra Group and Park'N Fly

Industry leaders will share their knowledge and expertise on the different low and zero emissions vehicle technology like electrification and Compressed Natural Gas. Participants will have the opportunity to:

- Learn about fleet and facility decarbonization
- Deep dive into two technology options
- Build an understanding on how to plan for transitioning their fleet

Register Now: Webinar Registration - Zoom

When: November 20th
Time: 1:00- 2:00pm
Where: Zoom Webinar

Fostering Collaborative Leadership for Circularity

Join us for a two-part workshop aimed at engaging organizational leadership into wide-spread sustainability initiatives!

- Led by seasoned sustainability innovator, Nadine Gudz
- We will meet on November 13th and 27th, 2024 for an introductory webinar followed by a half-day, in-person practice workshop
- *Learning Objectives:*
  - Identify and develop collaborative leadership competencies, practices and strategies
  - Explore the concept of “communityship” as an alternative to leadership
  - Practice storytelling as a pathway to engagement across functions
  - Apply the Three Horizons framework to facilitating dialogue with diverse stakeholder groups

Nadine Gudz, PhD

November 13th, 2024
November 27th, 2024

Please contact Ritika Jain for more details

Moving Towards Circular Construction, Renovation, and Demolition: Where to Begin?

In the face of rapid development in the GTA, a new way of thinking is required to reduce our built environment carbon footprint. Hear about:

- Circular construction strategies
- Reclamation Audits
- Material Reuse/Recovery Options

When: November 19th 1:00- 2:00pm

Where: Zoom Webinar

Scan & Register Now

Today's Speakers

Aman Hehar
Associate Director, Energy and Climate change, Humber College

Reza Lotfalian, Ph.D.
Co-founder and Chief Technology Officer, Kaaj Energy

Ali Shojaei, Ph.D., Eng.
Co-founder and Director, Power System, Kaaj Energy

Humber College Presentation

ENERGY MASTERPLAN

EMPOWERING SUSTAINABILITY

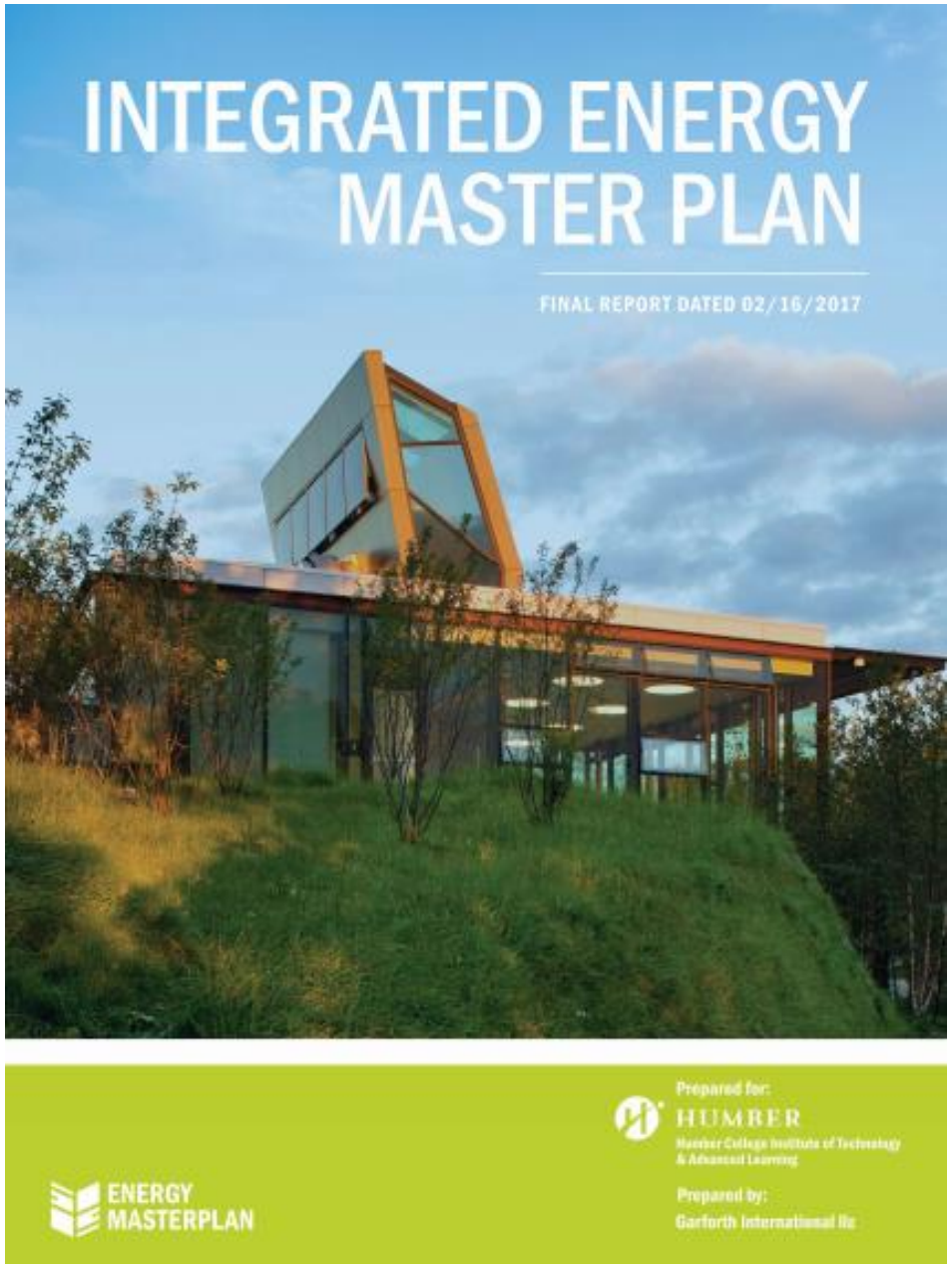
Humber's Integrated Energy Masterplan & Project SWITCH

30th October 2024

HUMBER

Humber Polytechnic

- One of Canada's largest colleges
- Established in 1967
- ~35,000 full-time students
- Two campuses, 50+ buildings
- Total floor area: 3M ft^2



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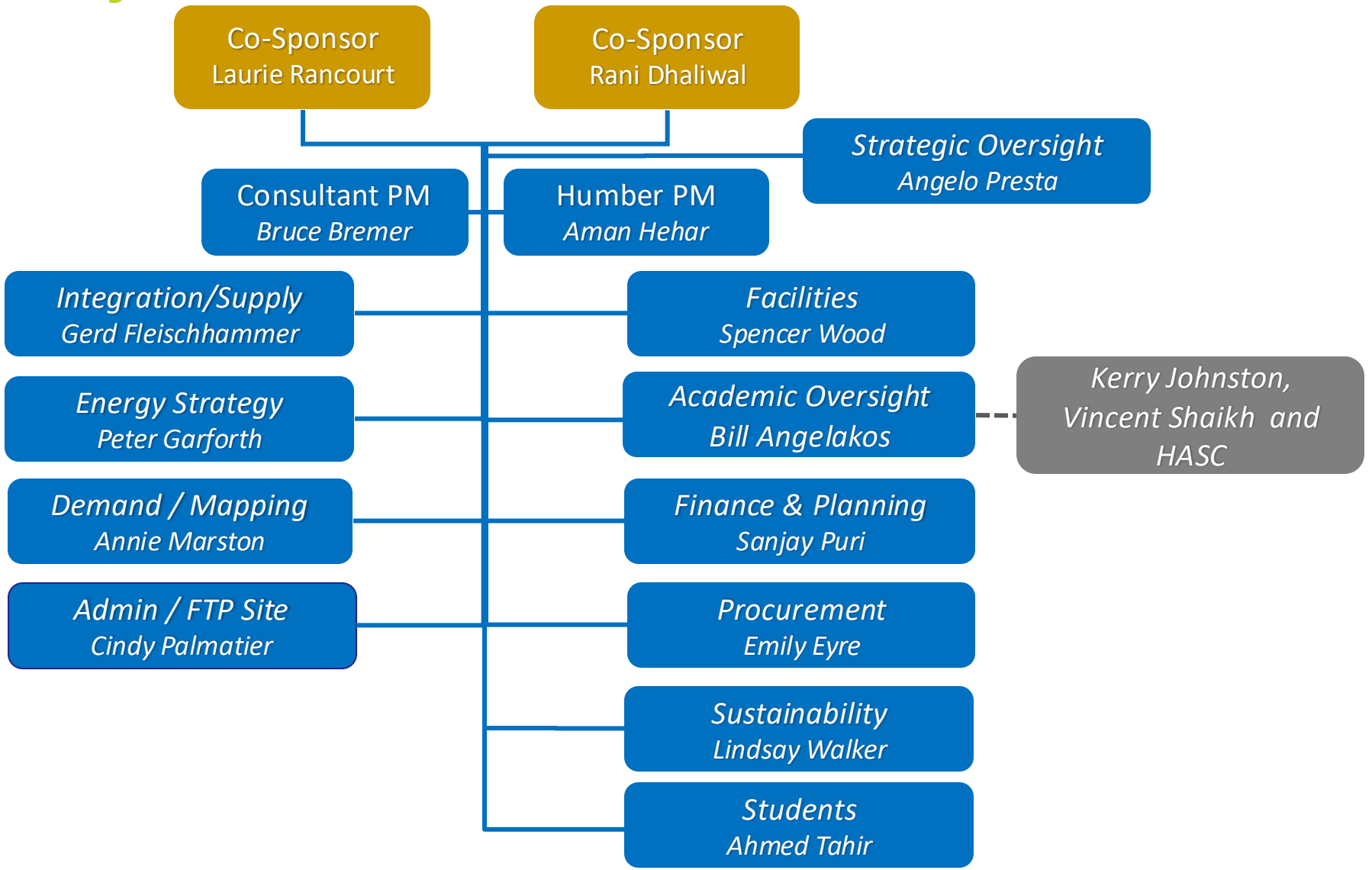
ENERGY MASTERPLAN

IEMP Project Work Team in 2015



High Engagement & Probability of Success

HUMBER

ENERGY MASTERPLAN

Framing Goals

Performance by 2034 , Baseline 2014

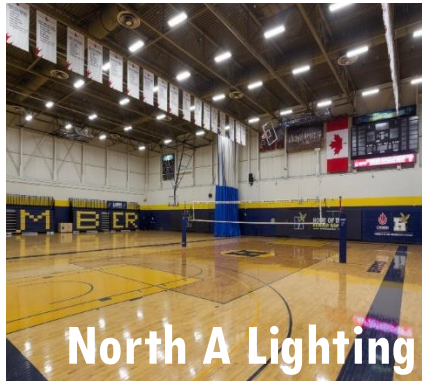
- Energy Efficiency
  - **At least 50% reduction per ft^2**
- Water Efficiency
  - **Further 50% reduction per student**
- Carbon Footprint
  - **30% reduction in greenhouse gas emissions**
- Return on Investment
  - **IRR of at least 7%**
- Academic
  - Offer **world-class** academic courses addressing integrated energy, water and climate solutions

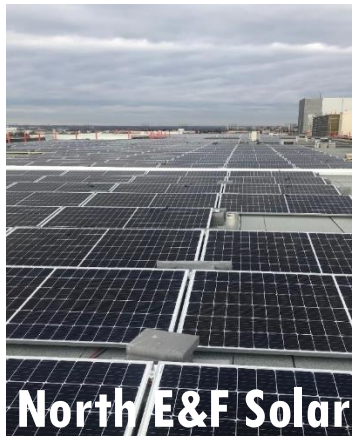
Aligning with Global Best Practice Efficiency

IEMP Progress to Date

IEMP Projects

- Since 2016, over 30 major projects delivered
  - Building Envelope Retrofits
  - Solar Photovoltaic Panels
  - Lighting Retrofits
  - HVAC Upgrades
  - Metering & Controls
  - Water Efficiency


North A Lighting


North E&F Solar

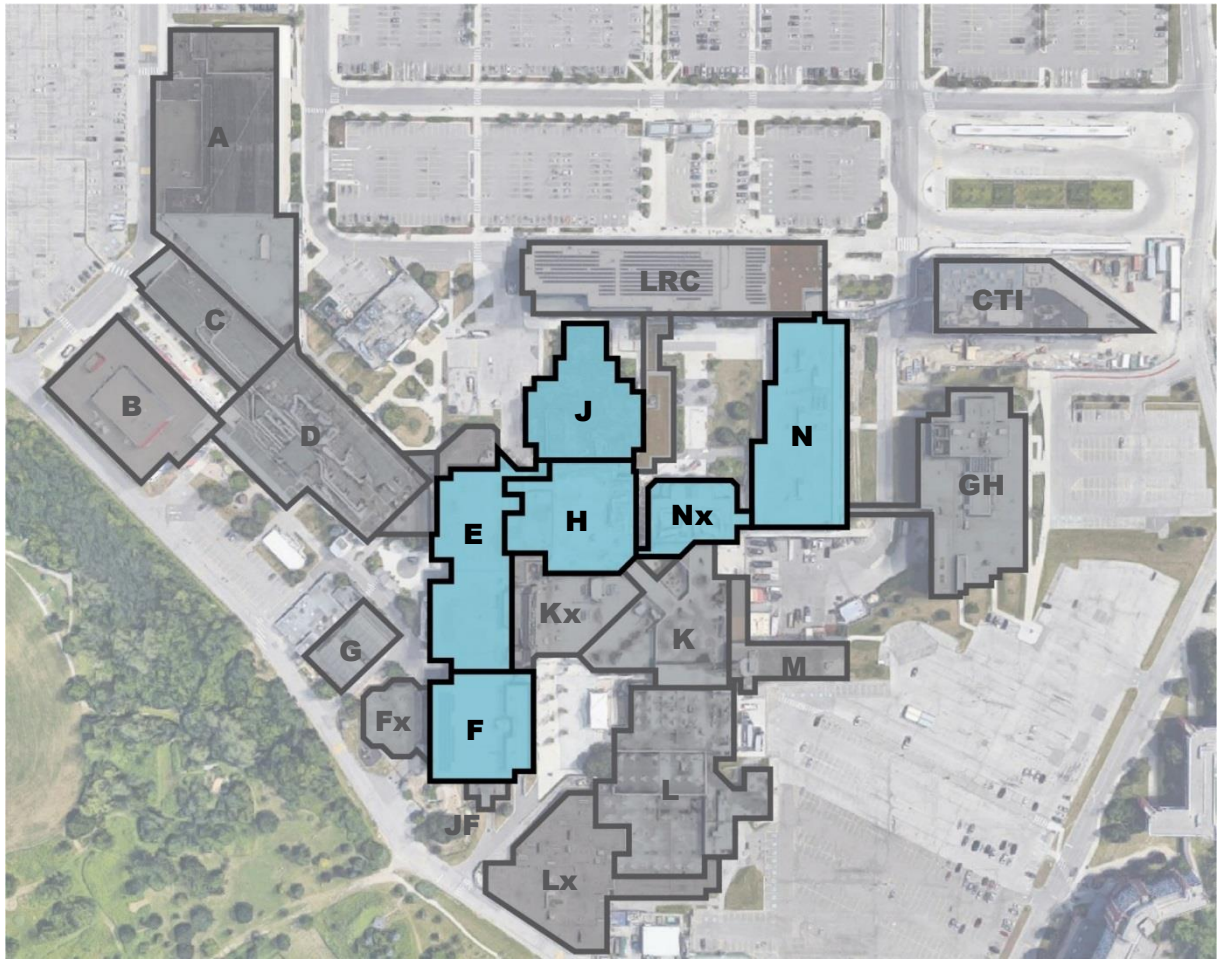

North E Envelope


North Nx Retrofit

IEMP Project Examples – Building Envelope

IEMP Project Examples – Building Envelope

- North Campus



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ENERGY MASTERPLAN

IEMP Project Examples - Lighting

- ~1,000,000ft^2 retrofitted to LED
- 80% reduction in lighting energy
- Reduced maintenance costs
- Advanced Lighting Control System Installed

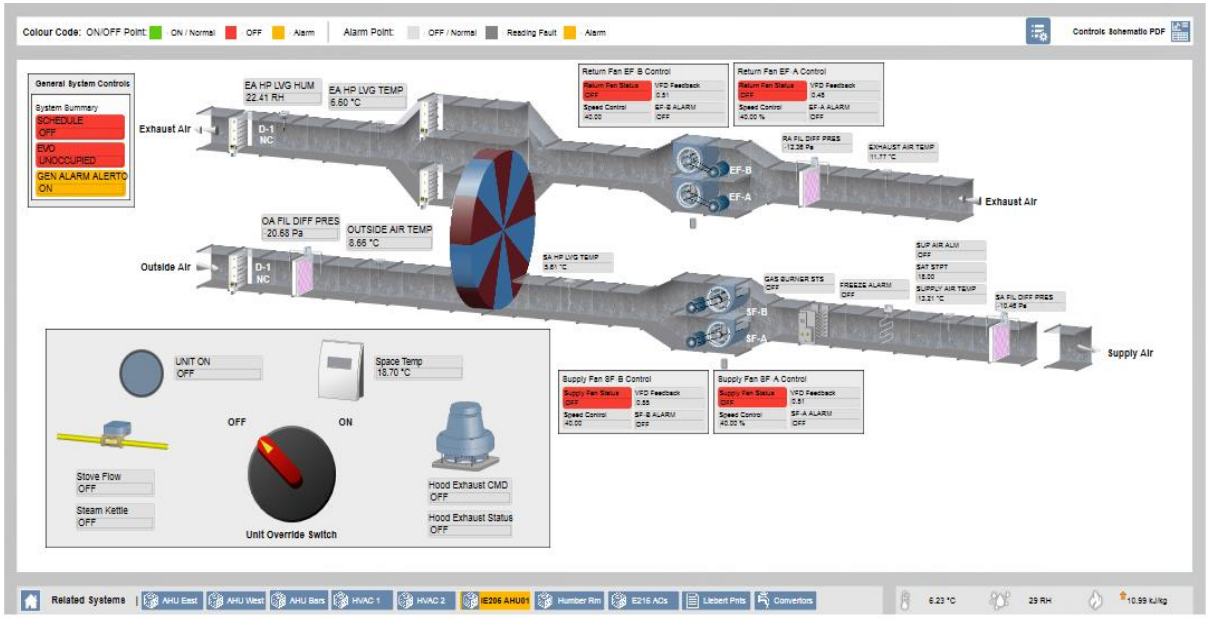

North A Building

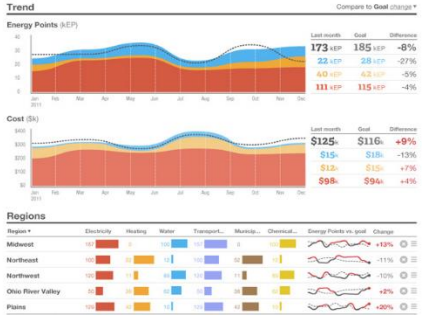
Lakeshore F Building


North E Building

IEMP Project Examples – Metering & Controls

- Implemented college-wide metering system
- Upgraded legacy HVAC control systems





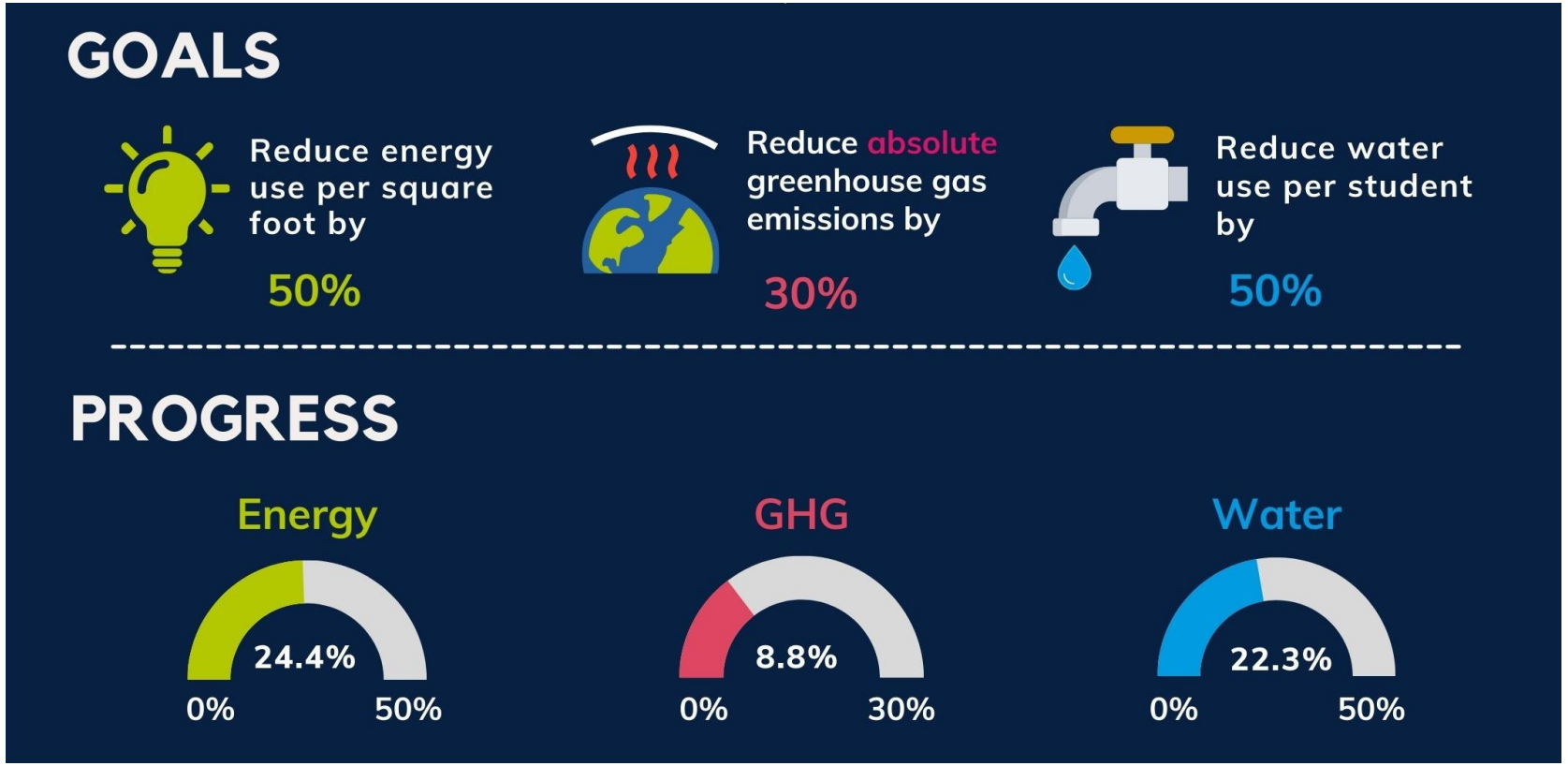
IEMP Project Examples - New Construction

- New buildings to target “global best practice” in energy efficiency
- Barrett CTI
  - 70% less energy use than average Humber Building
  - 2nd Largest Net Zero Energy Building in Canada

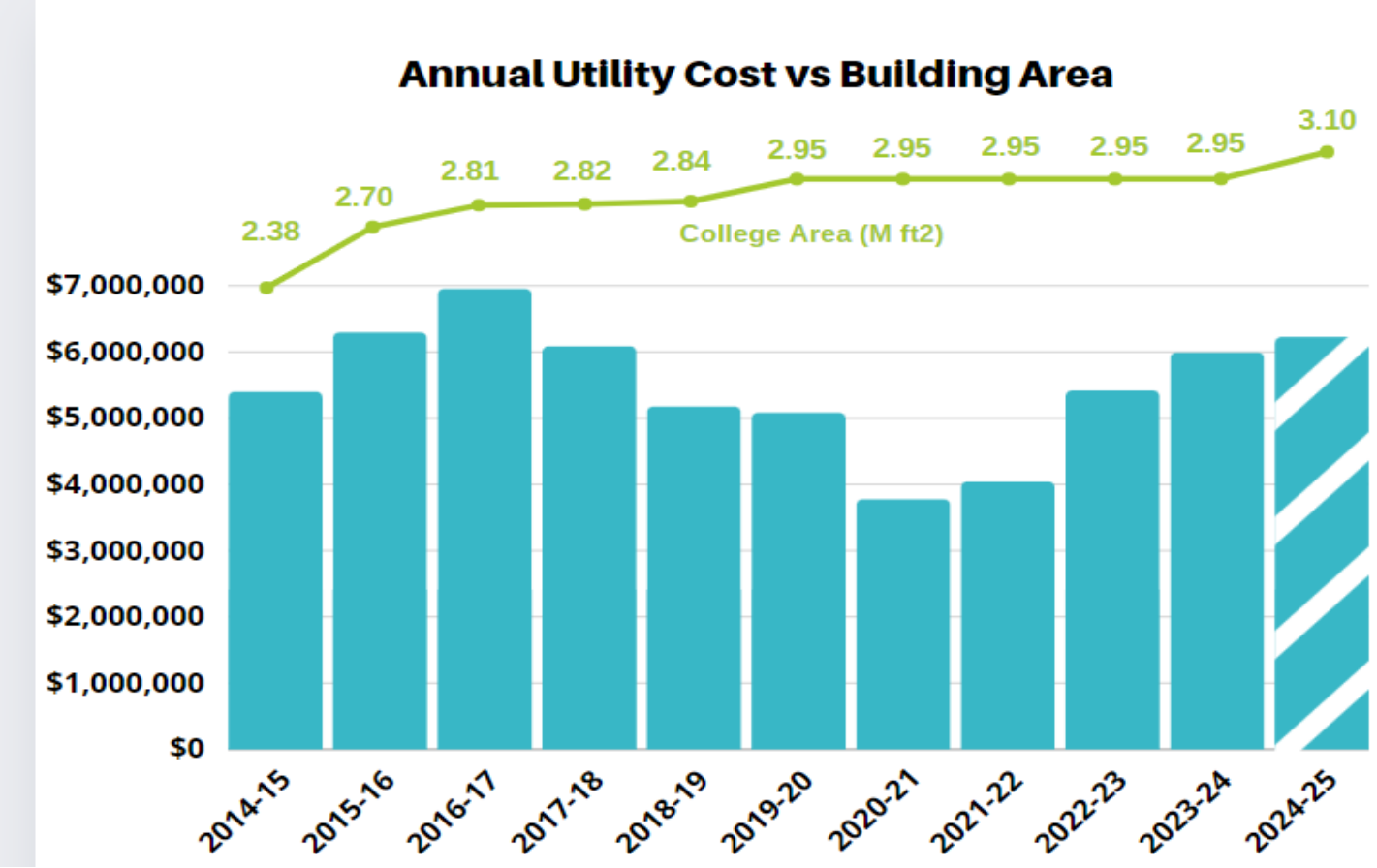
IEMP Project Examples – Solar PV

- 1.3MW installed capacity at North Campus

IEMP Results (as of March 31, 2023)



IEMP Results – Utilities Budget



Key Takeaways:

- $2.38M saved last year and $8.6M since 2015
- 30% growth in area since 2014, but utilities budget remains virtually unchanged
- Federal Carbon Tax was introduced April 1, 2019, now costs Humber ~$500,000
- Humber is a college sector leader in energy and utility cost efficiency

HUMBER POLYTECHNIC ACCELERATES PLAN TO ACHIEVE NET ZERO IN 2029

Humber has an ambitious plan to decarbonize the institution more than two decades earlier than its original goal of 2050

By **Chris Clay** on October 21, 2024
Reading time: 3 min read

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ENERGY MASTERPLAN

SWITCH

SWITCH Project

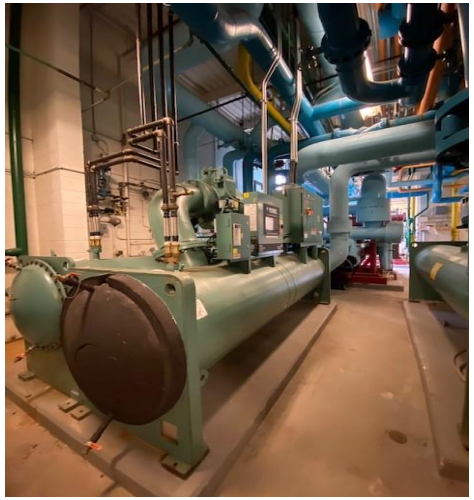
- Project to modernize north campus heating infrastructure, while significantly reducing energy & emissions

- Design-Build Partner is Ecosytem Energy Services

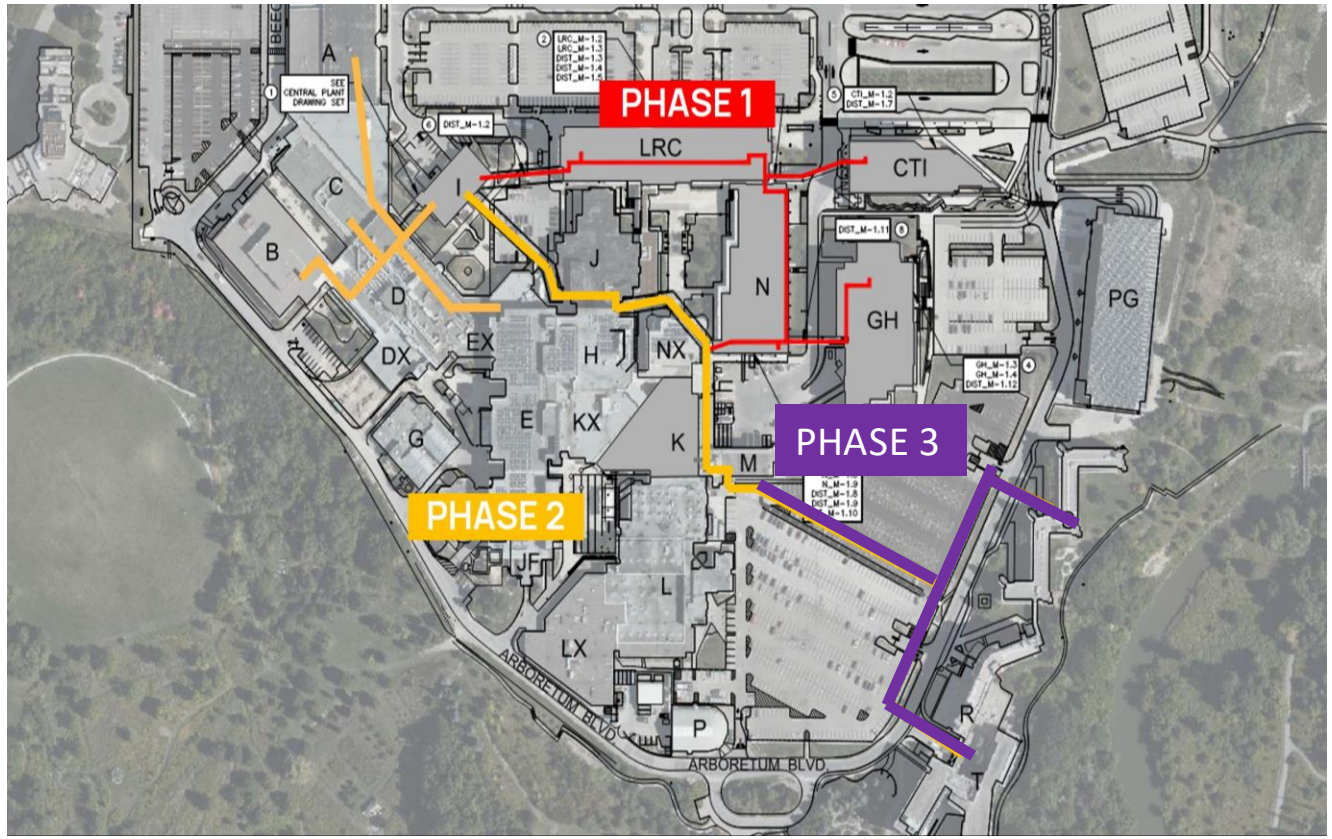
- Construction Timeline:
  - March 2023 - Construction started
  - Fall 2024 – Phase 2 Construction recently completed
  - Late Fall 2025 – Construction Completion

SWITCH Project

- Legacy Steam System
  - Built in 1972
  - Located in Central Plant (l Building)
  - E, D, H & J first buildings connected
  - Steam Heating System operates at:
    - *Up to 170°C*
    - *~65% Efficiency*



SWITCH Project – New Heat Network



- Replace steam pipes with hot water pipes:
  - *Operate at lower temperatures (54-75°C)*
  - *Improve efficiency (>100%)*
  - *Enable low carbon heat sources*
- Connect all buildings to system via 4.5km of new distribution piping
- Future flexibility

4.5km of new distribution piping

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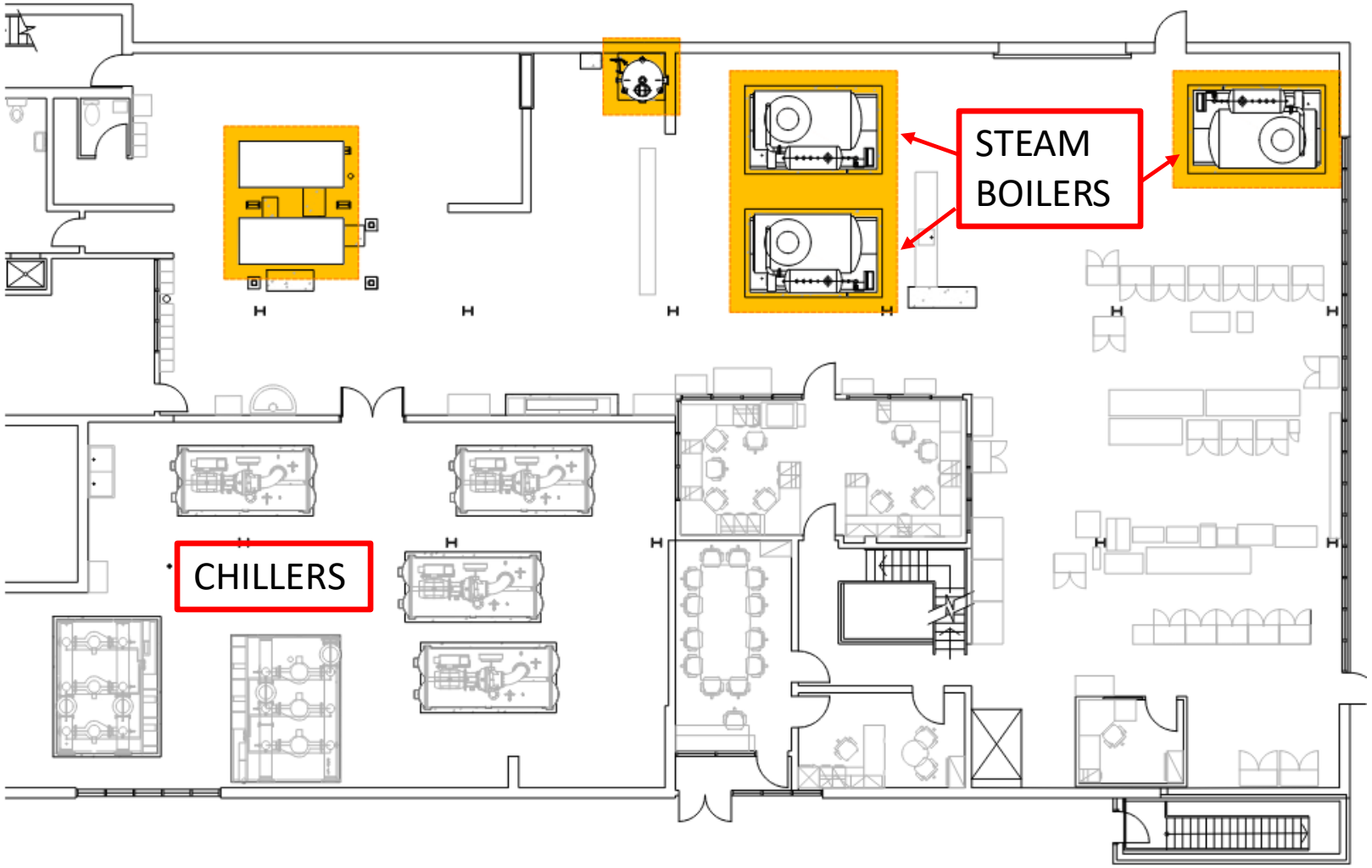
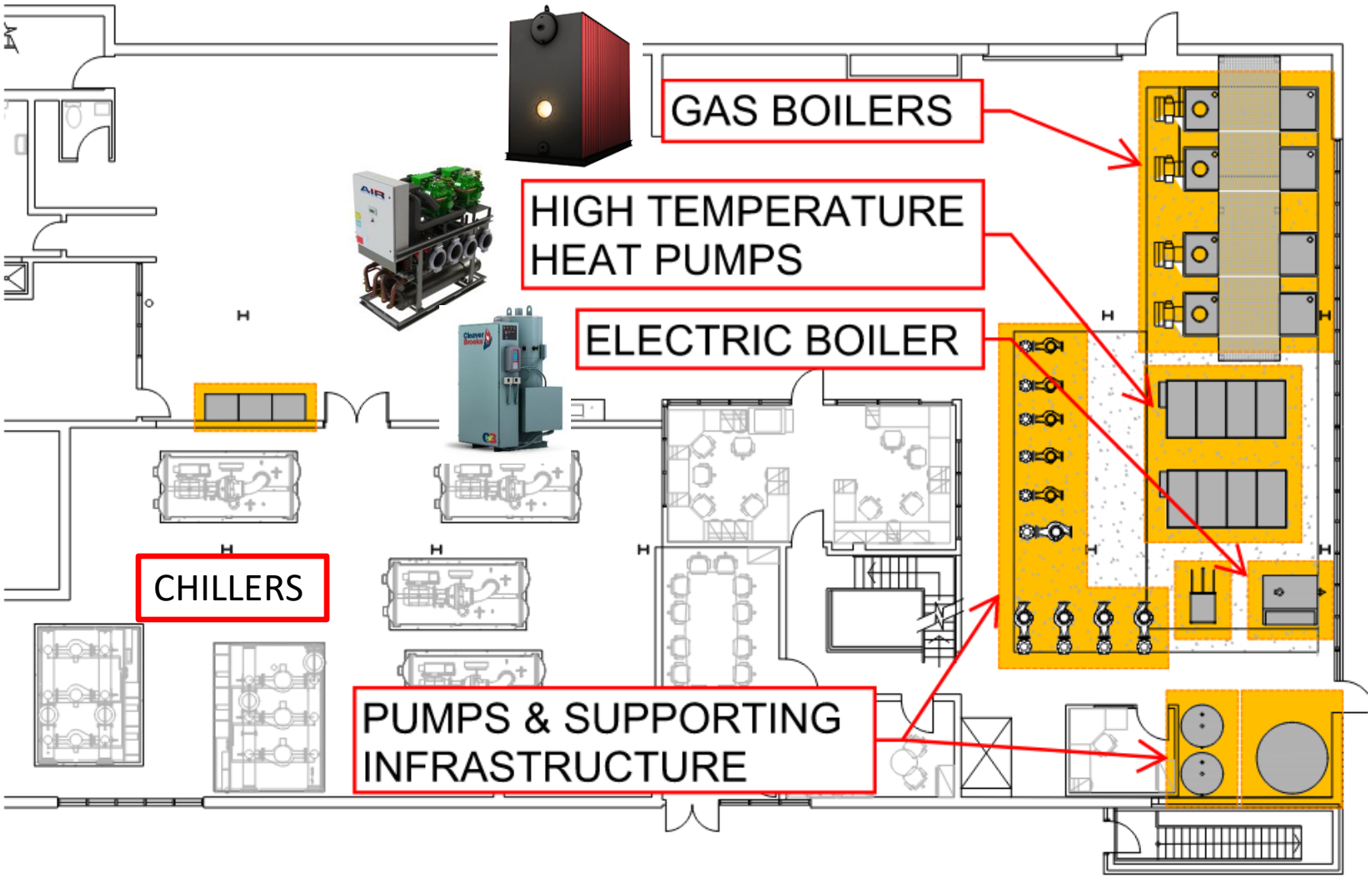
ENERGY MASTERPLAN

SWITCH – Existing Central Plant Layout



SWITCH – New Central Plant Layout



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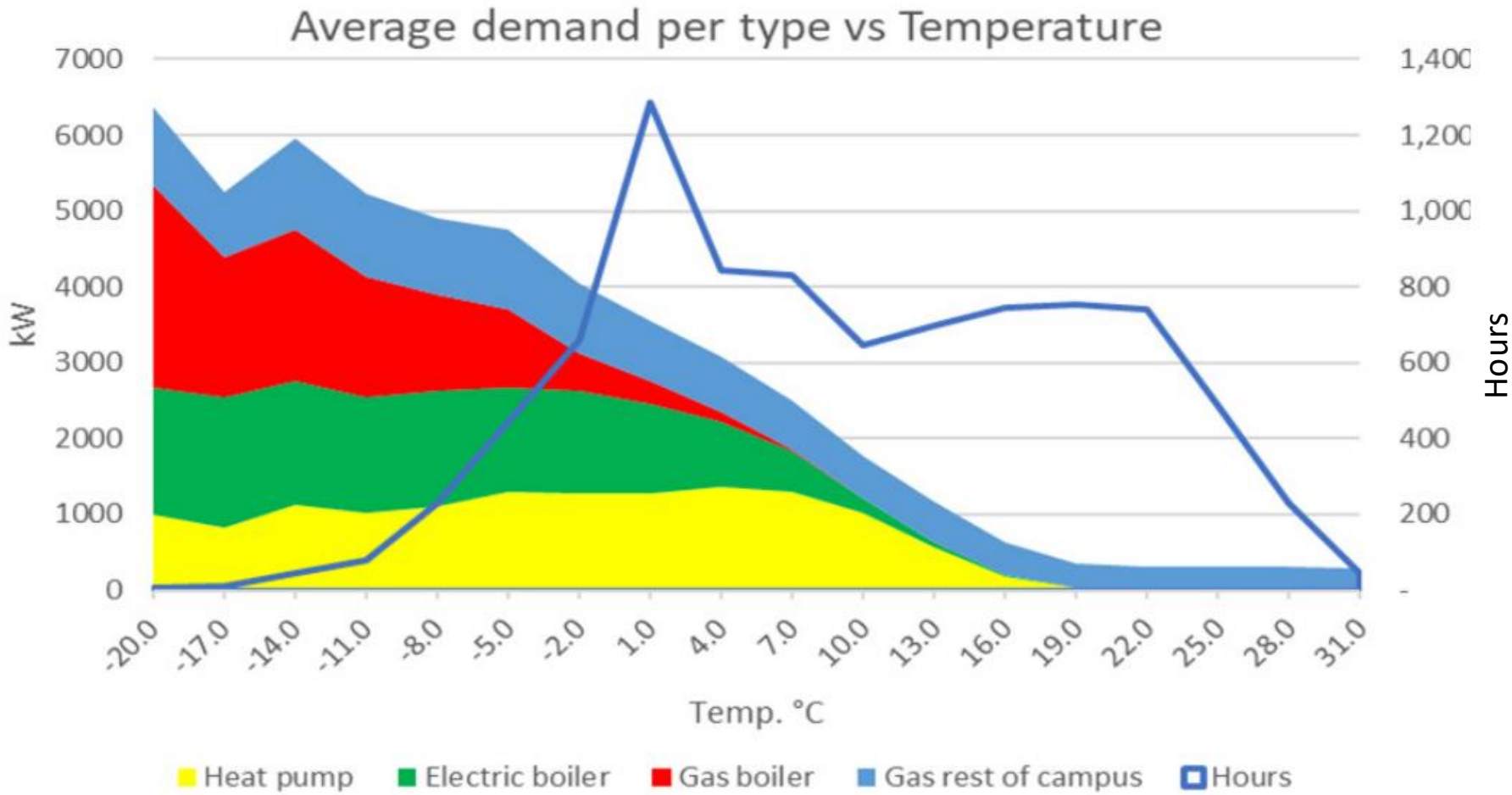
ENERGY MASTERPLAN

SWITCH – Plant Loads by Heating Source



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ENERGY MASTERPLAN

North Campus DE Project – Battery Storage

- 4 MWh Modularized Battery Energy Storage System
- Charged overnight, discharged during day
- Reducing daytime peaks, significantly reduces electricity rates

SWITCH - Key Outcomes

- Help the North Campus reach net zero by 2050 through:
  - 70% less natural gas use on-site
  - 40% fewer GHG Emissions
  - 22% less energy use
- Project achieves IEMP GHG emissions reduction goal
- Financial Return:
  - $50M total OPEX Savings to 2050
  - $1.5M/year, going up to $3M+ financial return/year by 2050
  - 7% IRR over 30 years
- Modernizes aging steam heating infrastructure
- Centralizes operations and maintenance
- Provides redundancy to heating piping network

Spencer Wood
Director, Facilities Management

Aman Hehar
Associate Director, Energy & Climate Change

Kaaj Energy Presentation

KAAJ ENERGY

Decarbonized energy on demand

Company info

Founded in **2020**, based in Ottawa

5 team members including **2 PhDs in thermal energy storage (TES) and power systems**

TRL 7 with project partnerships in Spain and Morocco

1 US process patent issued

Supported by NRC, Invest Ottawa and Foresight Canada

Accelerating the global transition to renewables through sustainable, efficient and cost-effective thermal energy storage (TES)

The problem

I&C[1] energy consumers are **highly exposed** to rising energy costs and increasingly stringent emission standards, putting commercial operations **at risk**

45%

of energy-related GHG emissions are from heat[2]

170%

Historical HH natural gas price volatility[3]

>$400/kWh

Installed cost for existing I&C TES storage technology[4]

1. Industrial & commercial
2. 'Net zero heat. Long duration energy storage to accelerate energy system decarbonization'. LDES, McKinsey
3. For 2019 to 2024, based on daily Henry Hub pricing (EIA) with 252 trading days per year
4. Thermal oil and molten salt. CAD

The solution

Efficient, cost-effective and reliable **TES** to reduce energy costs and cut down GHG emissions

80%+

reduction in natural gas consumption[1]

80%+

reduction in tCO_2e for natural gas displaced by electricity[2]

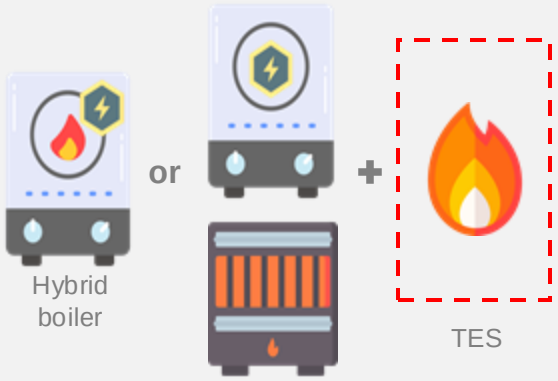
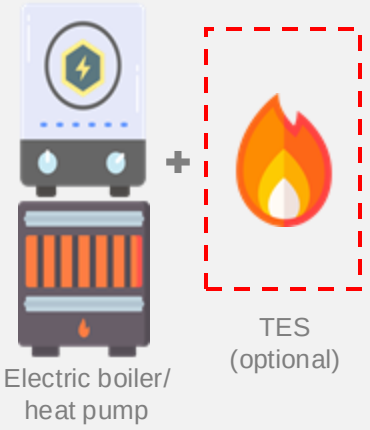
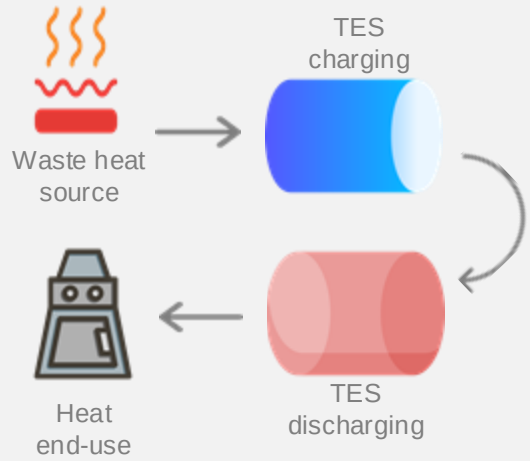
$55/kWh

average installed TES unit cost[3]

1. Example for a beverage producing plant. 500 kW heat with 4.2 MWh TES and 380 kW backup generator
2. 2022 Ontario electricity grid GHG intensity versus end use I&C natural gas consumption
3. Heat applications. CAD

The concept: TES

TES configuration is determined by underlying **energy price differentials**, **electricity pricing policies** in place (ex. Time-of-use (TOU)) and the **availability of waste heat**[1]

Gas is always cheaper than electricity	Electricity is sometimes cheaper than gas	Electricity is always cheaper than gas	Waste heat available[1]
 Gas boiler	 Hybrid boiler or Electric boiler/ heat pump + TES	 Electric boiler/ heat pump + TES (optional)	 Waste heat source; TES charging; TES discharging; Heat end-use

1. Sufficient temperature and handling quality

The who, how and why

The who

Commercial & industrial energy consumers

Have a use for **heat** at **150-800°C** temp

Time of Use eligible

Consumers seeking to **decarbonise operations** either voluntarily or due to compliance

The how

Heating as a service (Haas) model or **project developer** model

Collaborative design process with **equipment outside facility** with no operational impact

6-12 month design and build timeline post contract execution

The why

30-80% in avoided energy and emissions costs depending on application

Emissions reductions between 30-80%, supporting voluntary commitments and/or compliance obligations

Reduces exposure to energy price volatility

The KAAJ ENERGY solution

- Avg. installed cost **~$55/kWh[1], compared to >$400/kWh[1]** for existing battery TES systems
- Works with many **low cost & readily available storage mediums** (ex. Steel slag, iron ore, sand)
- **Modular** system design that uses **off-the-shelf** materials and components
- Displaces natural gas, **reducing GHG footprint and opex**
- Reliable **20+ year lifespan, compared to 10-15 years** for existing battery LDES systems

1. CAD

Supply chain

Engineering Procurement Construction Commissioning

CIC energiGUNE
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

HATCH

Off-the-shelf technology and low complexity system design mean **EPCC partners can be based on location and project fit**

Storage medium

Simple, inexpensive[1] and readily available TES mediums can be utilised to suit project partner(s), optimise for logistics and reduce GHG footprint

1. Several TES mediums can be waste material, such as steel slag where the producer will pay a tipping fee to remove the material (ex. $70 USD/tonne)

Case study – beverage production plant

Site: beverage production plant based in the Greater Toronto Area

Gas: 191,000 m^3 annual consumption

Carbon: emitting ~370 tCO_2e annually, reaching a cost of $170 CAD/$tCO_2e$ by 2030[1]

Solution: 500 kW electric heater, 4.2 MWh TES, 380 kW backup generator. **Total capex: $770k CAD**

No upfront cost

82% reduction in nat. gas consumption

16% reduction in energy costs[2]

1. Ontario's Emissions Performance Standards (EPS) program
2. Includes electricity, natural gas and carbon

Case study – gear manufacturing plant

Site: gear manufacturing plant in Southwestern Ontario

Gas: 4.7mln m^3 annual consumption

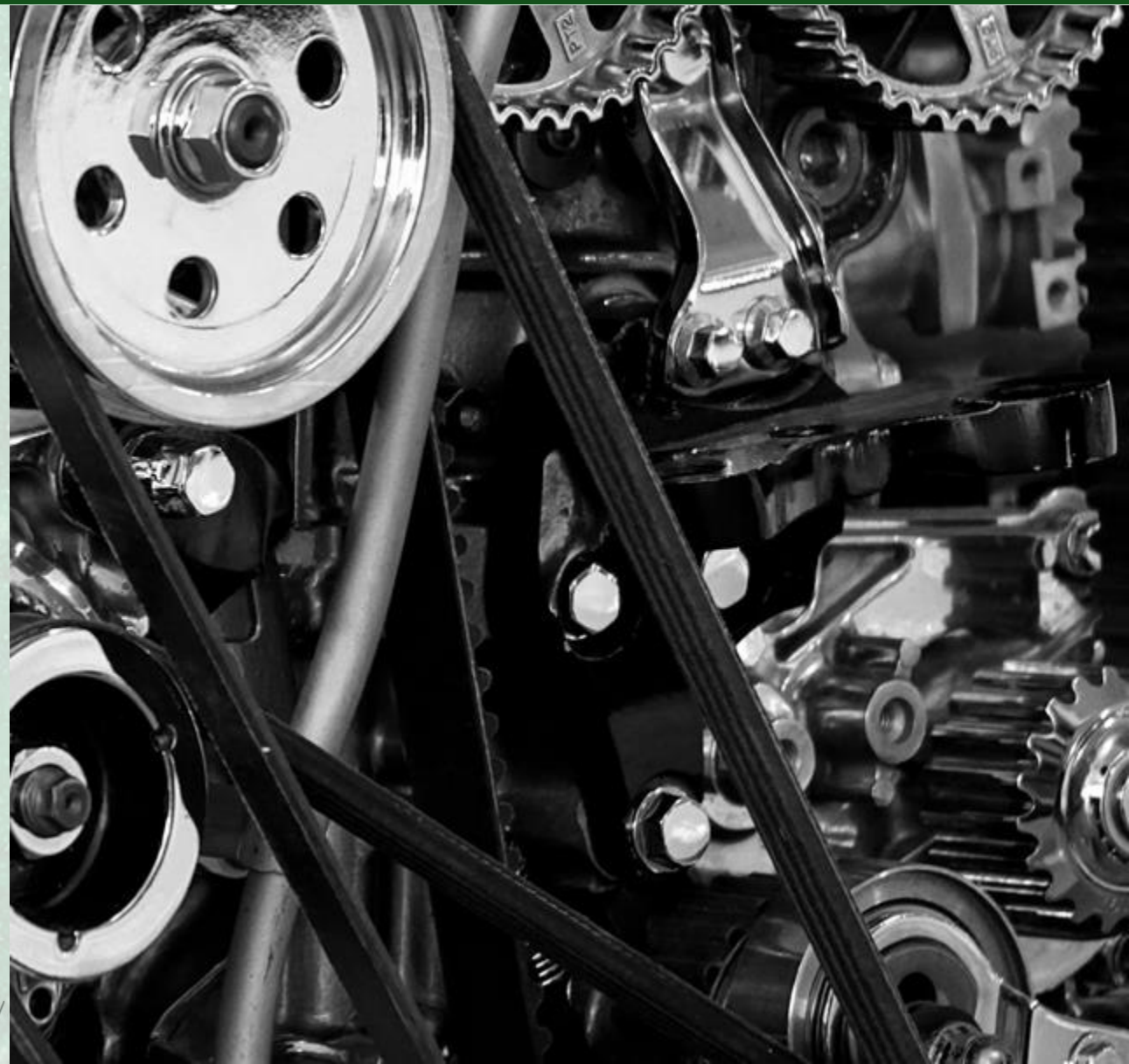
Carbon: emitting ~9k tCO_2e annually, reaching a cost of $170 CAD/$tCO_2e$ by 2030[1]

Solution: 6 MW electric heater and 36 MWh TES.
Total capex: $2.9M CAD

No upfront cost

31%
reduction in nat. gas consumption

17%
reduction in energy costs[2]



1. Ontario's Emissions Performance Standards (EPS) program
2. Includes natural gas and carbon

Case study – aluminium recycling plant

Site: aluminium recycling plant in NY

Gas: 7.4mln m^3 annual consumption

Carbon: emitting ~14k tCO_2e annually

Solution: 3.3 MW waste heat recovery. Lowering emissions by ~5k tCO_2e. **Total capex: $1.8M CAD**

No upfront cost

35%
reduction in nat. gas consumption

14%
reduction in energy costs[1]

1. Includes natural gas, no carbon tax considered

Team

Michael Avedesian

PhD, P.Eng, FCAE, FCIC

Chairman of the Board

35 yrs experience in ops, tech & management / CEO founder of 3 start-ups, one went IPO / Former Board of TM4 / McGill Senior Associate, Advisor and Lecturer

Reza Lotfalian

PhD

Founder, President & CEO

11 years of experience in energy storage and manufacturing / Led development of $20+M energy storage projects

Ali Shojaei

PhD, P.Eng

Co-founder & Director of Power Systems

Schneider Electric engineering manager / Expertise in product development, manufacturing, BD, power systems design, operation & control

Chris Stern

Strategic Advisor

Climatech entrepreneur: cement free carbon negative concrete (Carbicrete @ series B) and residential solar developer (Pure Energies, exited 2014)

KAAJ ENERGY

Decarbonized energy on demand

Q&A Session

Facility Tour

Closing Remarks


Partners in
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A Program of Toronto and Region Conservation Authority

Thank You!