SUDBURY
INTEGRATED NICKEL
OPERATIONS

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Glencore Sudbury INO

How Onaping Depth nickel project in Sudbury, Ontario, will be one of the first electric mines in the world

Presented by Peter Xavier, Vice President

Energy and Mines Conference, December 11th, 2018

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At a Glance

Glencore in Canada

Our Canadian facilities form a significant part of Glencore's global business. Our sites span seven provinces and we employ 7500 people.

Our assets include nickel, copper, coal and zinc mining operations and projects; agricultural facilities; and a consulting business.

We are one of the world's largest producers of refined nickel with fully integrated operations

One of the world's largest recyclers and processors of nickel and cobalt-bearing materials.

Sudbury Impact in 2017

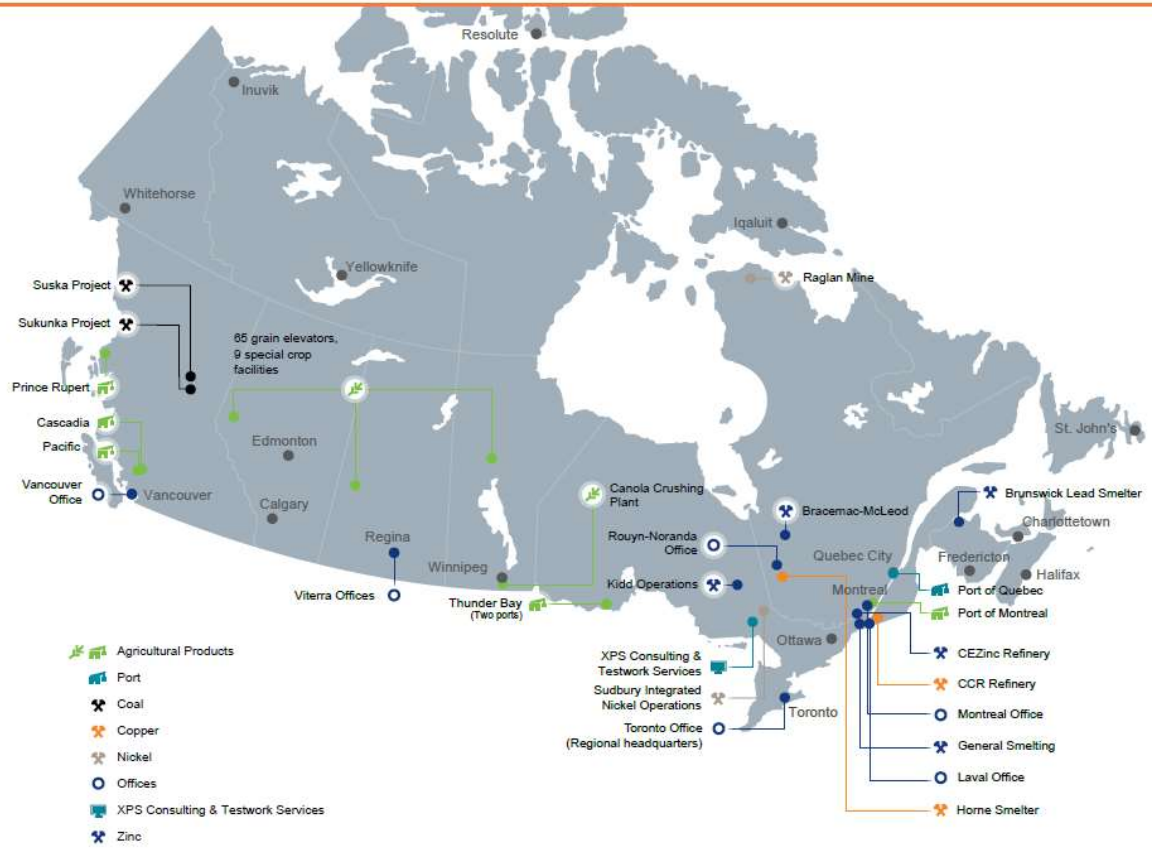
JOBS
1,300
Permanent employees, and more than 500 contractors

CAPITAL INVESTMENT*
$150 M
On sustaining and expansionary investment

INDIRECT JOBS
8,000

TOTAL WAGES & OPERATION SPEND*
$514 m

*in Canadian dollars



Glencore in Canada's contribution to the Canadian economy in 2017.

Our most significant economic contribution comes from our core business activities: employing people, sourcing from local communities, and paying taxes to our host governments.

*in US dollars

JOBS	WAGES	SPEND	TAXES & ROYALTIES	CAPITAL INVESTMENT	COMMUNITIES
7,500	$658 M*	$5.8 B*	$212 M*	$425 M*	$2.4 M*
DIRECT EMPLOYMENT ACROSS CANADA	ANNUAL WAGES AND SALARIES PAYMENTS	ON CANADIAN GOODS AND SUPPLIERS	PAID TO GOVERNMENTS	ON SUSTAINING AND EXPANSIONARY INVESTMENT ACROSS OUR CANADIAN	REGIONAL COMMUNITY INVESTMENT INITIATIVES

Global Nickel Operations

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Sudbury Operations

Overview and Sustainability

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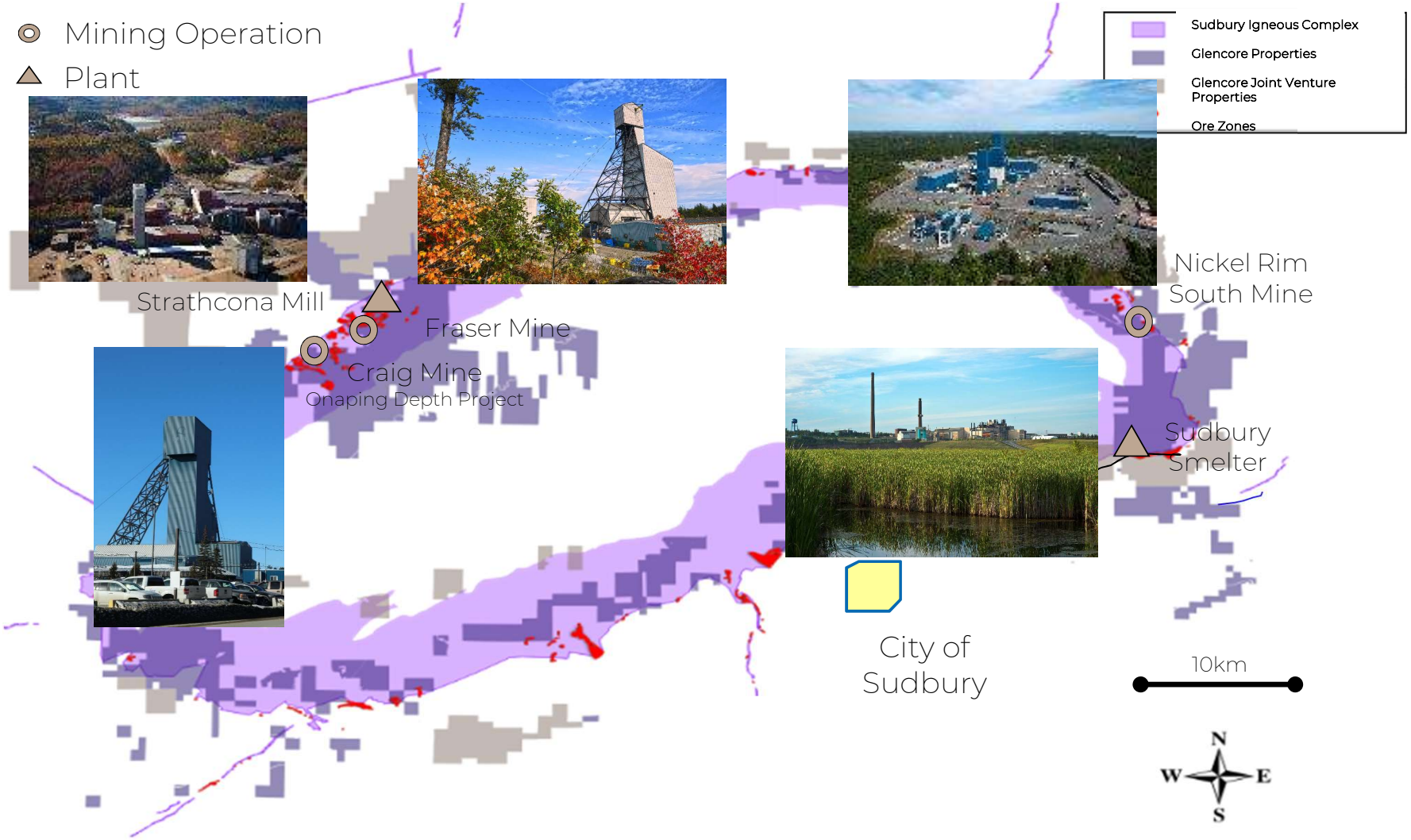
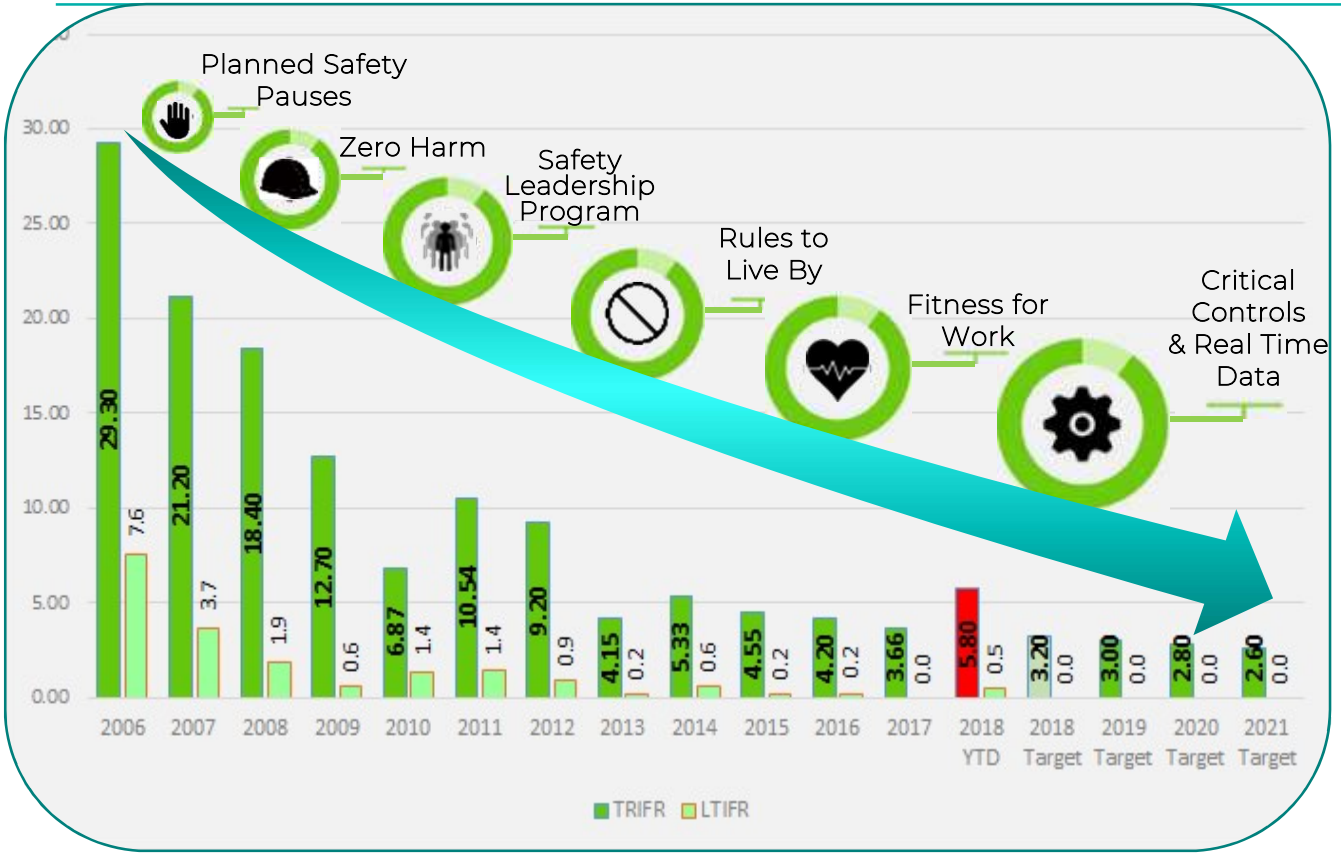
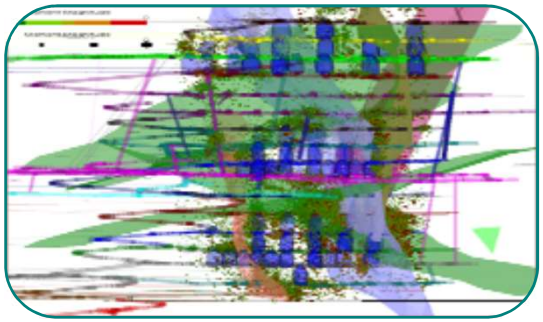
Sudbury Integrated Nickel Operations



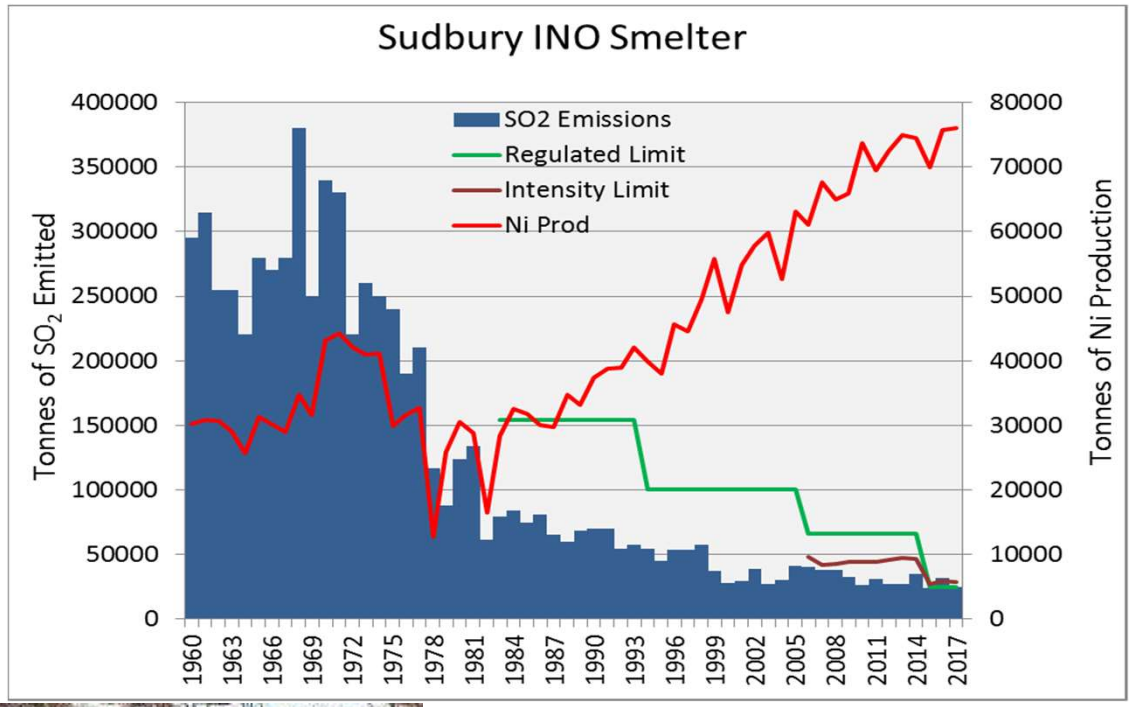
Safety, Environment & Risk

Quality, Coaching & Integrated Systems





- ISO 14001 certified
- Smelter emissions reduction initiatives
- Downward trend in water, energy and GHG targets
- Land reclamation



Community Engagement

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Indigenous Partnerships

Wahnapitae First Nation
(Participation Agreement signed in 2008)
Information Sharing / Consultation
Infrastructure Projects
Human Resources and Environmental Working Groups
Water Sampling and Environmental Monitoring
Cultural Support and Capacity Building

Sagamok
(Memorandum of Understanding signed in 2011)
Information Sharing / Consultation
Community and Infrastructure Project Support

Métis Nation of Ontario
(Memorandum of Understanding signed in 2015)
Information Sharing / Consultation
Community and Infrastructure Project Support

Atikameksheng Anishnawbek
(Memorandum of Understanding signed in 2017)
Information Sharing / Consultation
Support on cultural events, education and training initiatives, environmental and/or infrastructure projects

Open Houses and Career Days


Cultural Awareness and Support


Water Sampling Activity with Wahnapitae First Nation


MoU signed with Atikameksheng Anishnawbek

Open Houses

Community Engagement

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- **Proactive participation in various community initiatives and programs.**
  - Investment of approximately $17 million over past 10 years
  - Active management involvement on several community boards
  - Community surveys

Northern Water Sports Centre

- **Continued partnership in the following five giving areas:**
  - Environment
  - Economic Development/Livelihoods
  - Health
  - Education
  - Locally/regionally relevant projects

Community Open Houses

Technology and Innovation

Our Future Mines

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SUDBURY INO 2022

ADAPTING FOR A DEEP MINING FUTURE WHILE ACHIEVING OPERATIONAL EXCELLENCE

PILLARS OF OUR STRATEGY

OUR LICENSE TO OPERATE

Manage our HSEC objectives & regulatory challenges and continue the journey towards zero harm.

OUR PEOPLE

Focused on our priorities and developing the skills to achieve them.

OUR ABILITY TO ADAPT

We need to innovate and utilize new technologies to secure our future.

EXCELLENCE IN OUR OPERATIONS

Deliver and exceed expectations to achieve the performance required for deep mining.

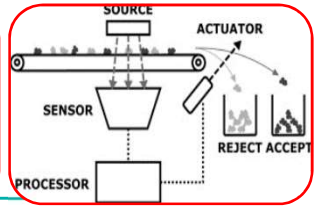
BUILDING OUR FUTURE

Achieve full approval, build two mines and the Process Gas Project on an aggressive timeline and on budget.

Our Future Mines

Sustainably Designing for Depth

Zero Emission	Real Time Information	Maximized Asset Utilization	Safe, Efficient Mining	Industry Collaboration	Minimize Waste Generation
Diesel-less	Real-time Digital Smart	Continuous Automated Operations	Mine Designed for Depth	Agile Ecosystem	Concentrate along the path
Completely Electric Mines	Fully integrated digital operations management	Leveraging Step Change in Mining Technology	Engineering out Deep Mining Challenges	Working with our peers to develop solutions	Reduce our environmental footprint



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Craig Mine – Onaping Depth Project

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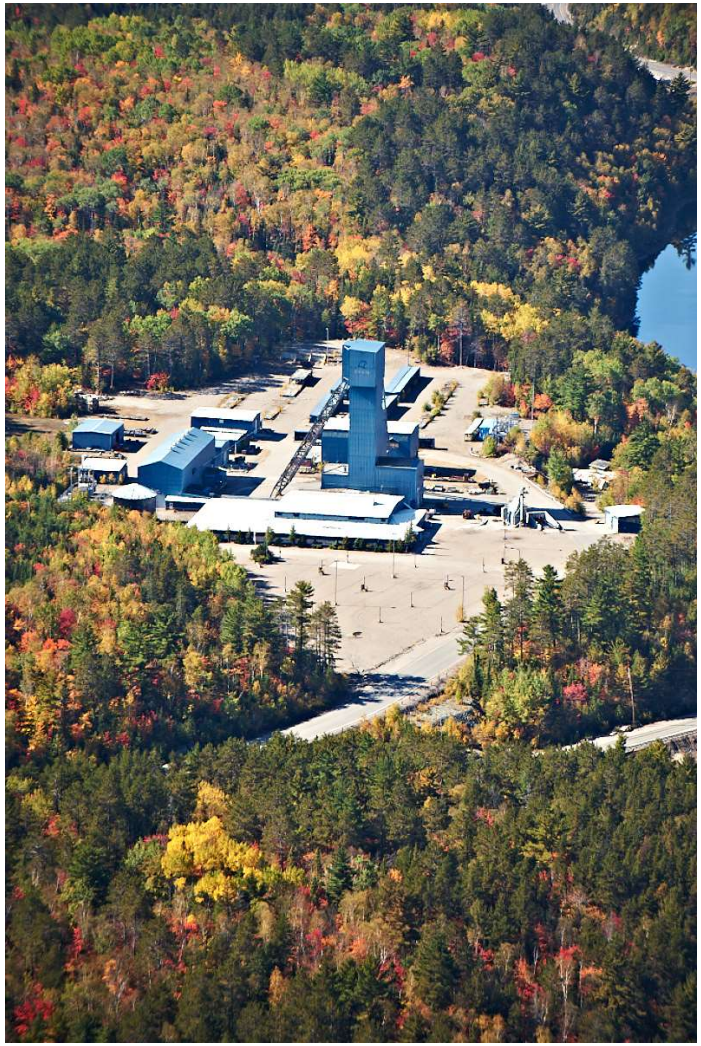
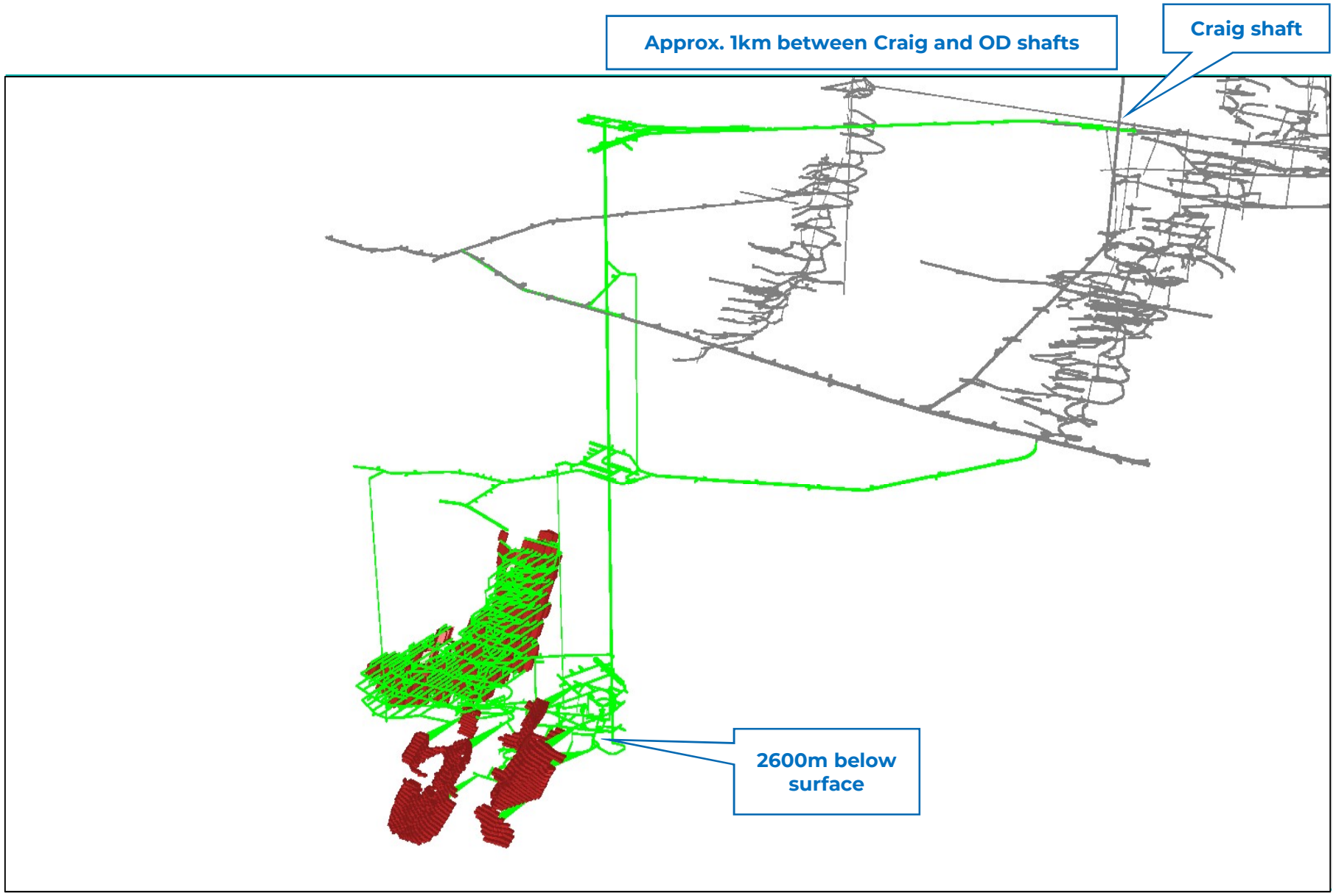
Craig Mine – Onaping Depth Project



- Feasibility Study Completed in end of 2016
- Received project approval of US$700m in Dec 2017
- Bottom up mining approach supported by a single shaft development
- 100% battery electric operated mobile fleet

Craig Mine - Onaping Depth Project



ONAPING DEPTH PROJECT

Battery Electric Vehicle

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100% battery electric operated mobile fleet

- Energy efficiency
- Ventilation savings (lower flow)
- Cooling system savings
- Improved health benefits
- Increased opportunity to improve production profile

Onaping Depth Project
Battery Electric - Benefits

Eliminated:

- Return Air Ventilation Ramp
- Fresh Air Raise
- (3) Ventilation Fans
- (5) Ore Passes (replaced w/ battery electric haul trucks regenerating power down ramp

Annual GHG emissions reductions (metric tonnes CO_2-equivalent/yr)* :

- Diesel: 17,130 tCO_2e/yr
- Reduction: 44%
- Battery: 9,620 tCO_2e/yr

** Energy Design review*

	Diesel		Battery Electric
Ventilation	**300 m³/s**	-40% →	**180 m³/s**
Shaft Diameter	**6.5 m**	-23% →	**5.0 m**
RAR Diameter	**5.0 m**	-24% →	**3.8 m**
Refrigeration	**BAC = 19.2 MWr** **CSC = 25.3 MWr**	-31% →	**BAC = 13.3 MWr** **CSC = 17.5 MWr**
Ventilation Fan Power	**10,900 kWe**	-44% →	**6,100 kWe**
Peak Refrigeration	**3,300 kWe**	-30% →	**2,300 kWe**
Total Power	**14,200 kWe**	-41% →	**8,400 kWe**

Onaping Depth Project
Battery Electric – Equipment Trials and Availability

Availability

- Prime movers are the main concern (we need them Mid 2022)

- 40T trucks available now
- First 14T LHD available Q1/19
- Multiple OEM 14T/18T LHD Operating in 2020
- 40T+ trucks available in 2020

All testing to date showing better than feasibility study metrics (less heat produced, ergonomic, cost to run) and all equipment performing at least as good as theory – CAT, Maclean, FVT, Artisan

Equipment Trials

2016
- UT150 MineCat at Fraser
- UT150 MineCat at NRS

2017
- Papa Bravo personnel carrier at OD
- Maclean Bolter gen 3 at NRS
- Atlas Copco Bolter at NRS
- UDMN project – IFI 250HP Marcotte shotcrete carrier converted to BEV
- CAT 7T LHD BEV Dec 2017 – Field Follow
- Maclean Boom Truck Trial at NRS – Q4 testing and trial only

2018
- T&W Commander is now being tested at Onaping Depth

ONAPING DEPTH PROJECT

Regulations – Ontario 96cfm/hp

Use “air quality” regulations

Uncertainty of Supply, Performance and Cost of BEV Fleet

Supply

Stay in regular contact with OEM’s on their roadmaps

Performance

Buy units and get first hand experience – Our first unit was a personnel carrier(2015) – many other types since
Get OEM’s to perform duty cycle simulations of proposed equipment
Run tests at sites to validate performance
Create a network of Mining Companies and organizations to share experiences

Cost

Have an appropriate premium allowance based on vehicle class/size

Mine Design

One must design the mine around the BEV’s capabilities and needs

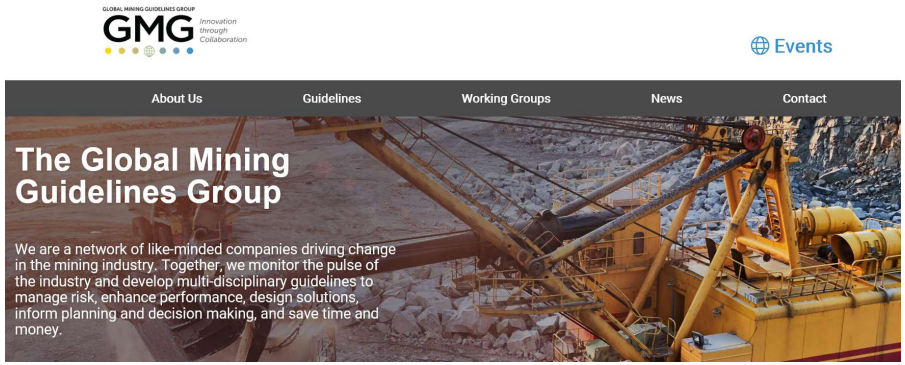
Things to Consider - BEV Mine Design

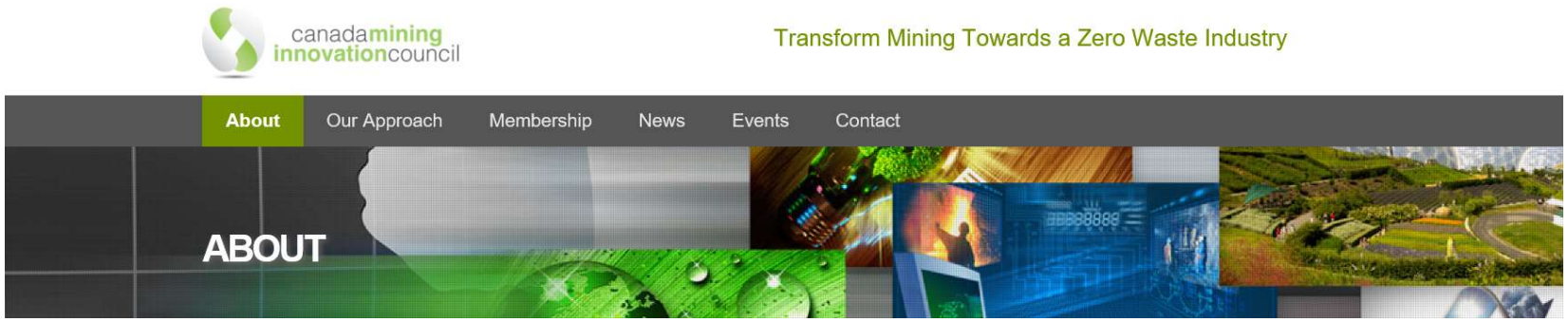
- Take advantage of re-generation
- On board vs off board chargers
- Battery swapping vs batteries stay in vehicle
- Charge rate of batteries – 1/2C to 10C
- Battery chemistries
- *Charging Strategy (fixed vs opportunity)*
- Parking and Charging locations
- Charging Management Systems – individual vehicle and for fleet
- Rent or Buy batteries
- Battery disposal
- Power Quality

Next Steps - BEV Mine Design

- Get involved with GMG (Global Mining Guidelines Group) and CMIC (Canadian Mining Innovation Council)

- Battery Electric Vehicle Underground Working Group





Significant Health and Wellness benefits

Significant reduction in ventilation requirements

- Compounded if refrigeration is required

Lots of effort and incredible interest in BEV's over the past several years

- However, still at its infancy
- Much to learn and many differing views on what success looks like

Our beliefs

- Safer
- Duty can be met, at what cost?
- Operators must design and operate around BEV capabilities
- We must collaborate to accelerate BEV's and BEV Mines

Questions?

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