

Monitor **Deloitte.**



**Canada Mining Innovation Council  
Value Proposition:  
Towards Zero Waste Mining**

**August 4, 2015**

## Document context

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### Background

- The mining industry generally agrees that it is behind the innovation curve and that a focused effort is required to create a profitable and responsible long term industry
- The Canada Mining Innovation Council (CMIC) is focusing its efforts through the Towards Zero Waste Mining strategy which will eliminate mine waste by facilitating collaboration across partners within the business ecosystem to collectively transform the industry

### Document Purpose

- Define and further refine CMIC's Towards Zero Waste Mining strategy to the mining industry
  - Emphasize the importance of this project and the necessity for step change through CMIC via its open innovation approach
  - Crystallize the definition of Towards Zero Waste Mining and identify the key focus areas
  - Define how CMIC will collaborate and partner across stakeholders, reconcile potential Intellectual Property (IP) issues, finance long term initiatives, and govern / report activities and outcomes
- Serve as an internal guiding document / strategy to align key stakeholders and potentially serve as material for the Business Case to attract partners in the mining ecosystem (e.g., industry players, academia and government)

### Source Data

- This document contains information from a number of different sources (CMIC representatives, external service providers, mining companies, government repositories, and analyst insights). This value proposition attempts to consolidate all of these within an internal strategy for CMIC
- The partnership between CMIC and Monitor Deloitte is defined in accordance with the terms of an agreement between the parties

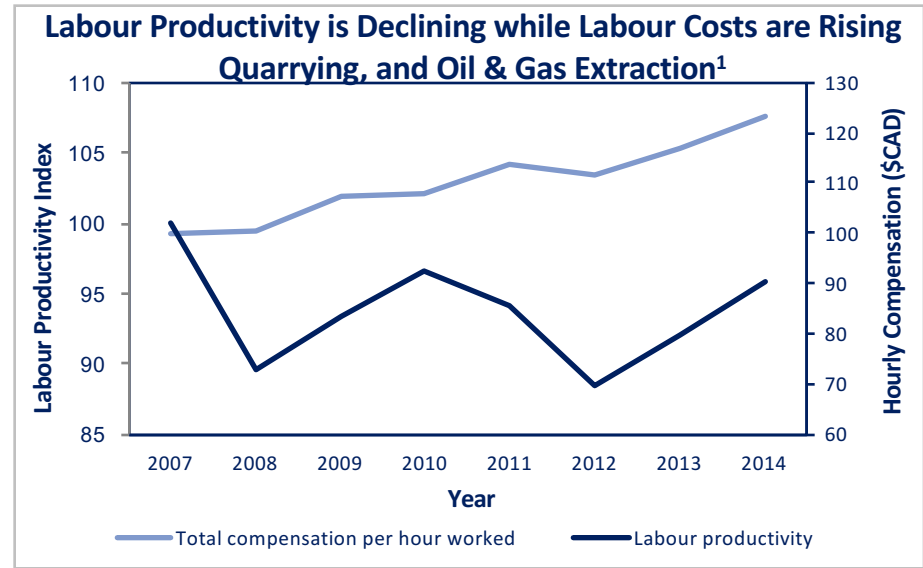
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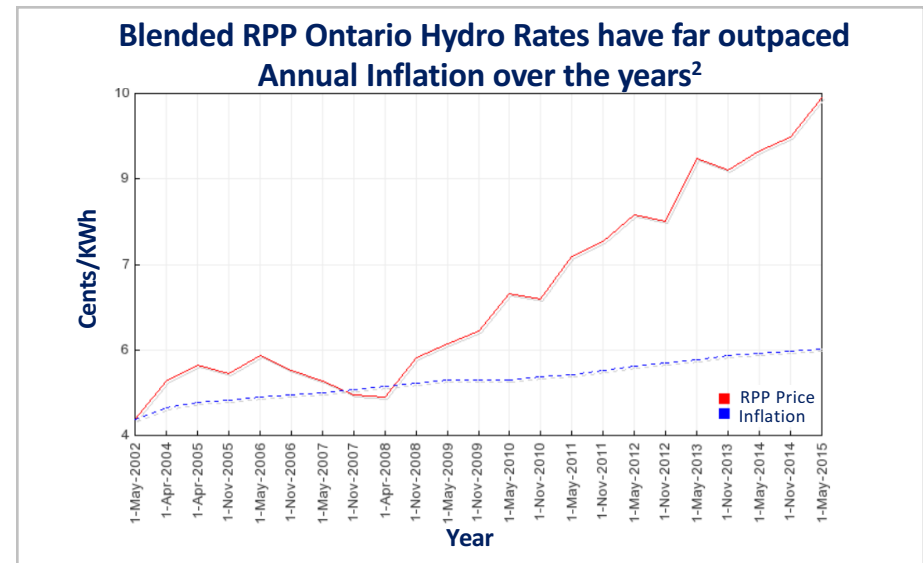
# Increased global complexity requires sector adaptation to new realities...



**Structured labour market forces, declining resource quality, and a legacy of inefficient capital allocation** have led to declining productivity



**High energy consumption, elevated operating costs (e.g., energy, infrastructure, labour, royalties, permitting fees, and compliance), have resulted in decreasing margins for existing operations and diminishing economic feasibility of new mine developments**



Source: (1) Statistics Canada, CANSIM table 383-0012, 2007 to 2014; (2) Ontario Hydro – Ontario’s Historical RPP Rates

## ... especially complexities associated with the license to operate and the decline of commodity prices

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### Increasingly Complex License to Operate

Concerns from multiple stakeholders including conservation and the potential environmental impacts of mineral development and mine closure have resulted in **increasing government regulation** and **demand for heightened corporate social responsibility** and **stakeholder engagement**

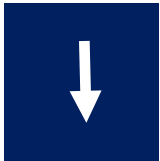


### Operating with Uncertainty

**Volatile commodity prices** have resulted in **unpredictable margins**, forcing companies to plan for the unforeseeable, and decreasing financing capital availability

*In order to make a significant shift towards improvement, the industry must collectively challenge existing ways of thinking by revisiting long-standing practices and processes*

## Current commodity markets are not conducive to industry sustainability...



### Resource quality is decreasing

*Between 2001 and 2012, the weighted average resource grade of nickel, copper, and gold reduced by roughly 40%, 30%, and 10% respectively<sup>1</sup>*



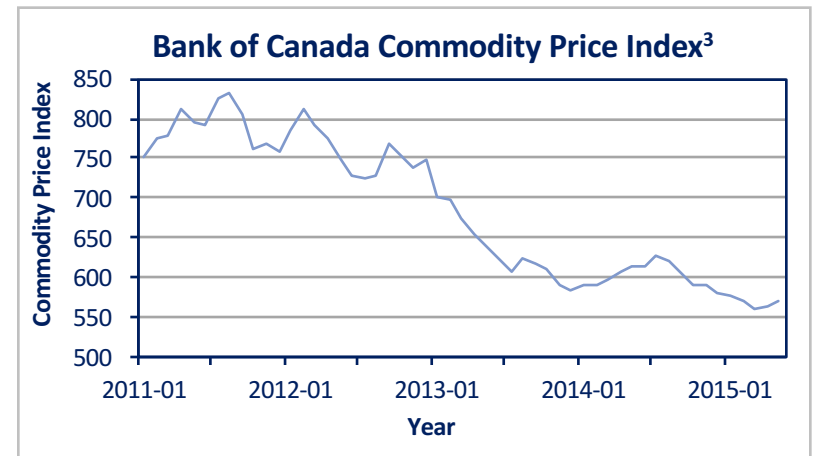
### Energy prices are increasing

*Energy costs continue to rise in Canada and are projected to be 20% higher in 2035 compared with 2013<sup>2</sup>*



### Commodity prices are volatile

*The price of gold dropped by roughly 33% between 2011 and 2015<sup>3</sup>*

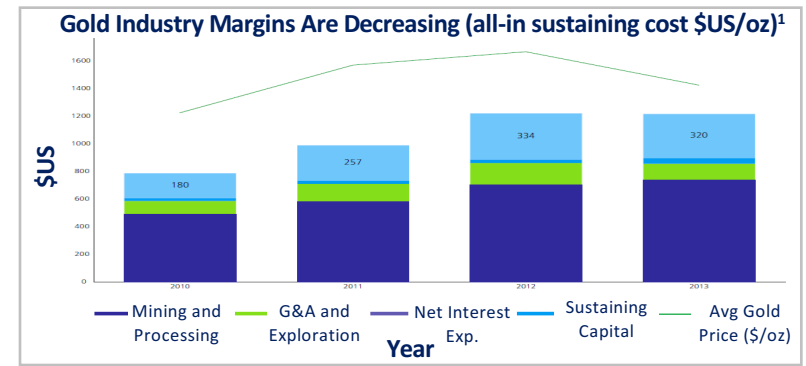


Source: (1) "Deloitte Mining Spotlight on: Sliding Productivity and Spiraling Costs", 2014; (2) National Energy Board, "Canada's Energy Future 2013 - Energy Supply and Demand Projections to 2035", 2013; (3) Bank of Canada, Commodity Price Index - Monthly

## ... and is decreasing the viability of mining in Canada as an economic force

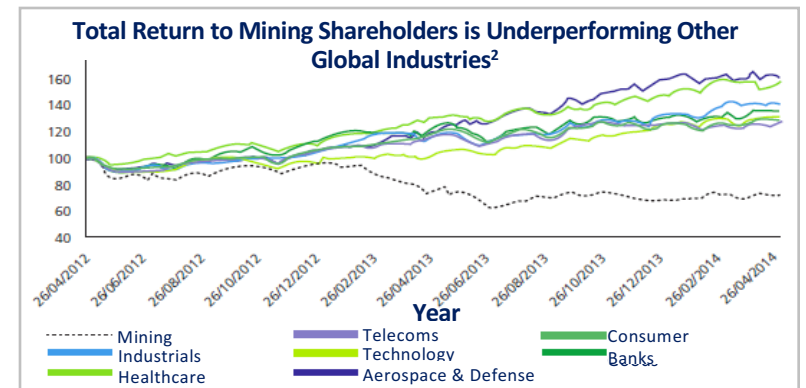
### Declining Profitability

Based on current trends and future projections, **costs** will likely continue to **increase over time**. Historical cost cutting exercises (e.g., layoffs) are not sustainable and without a significant shift, **margins may decrease** to a point where mining **operations are no longer profitable**



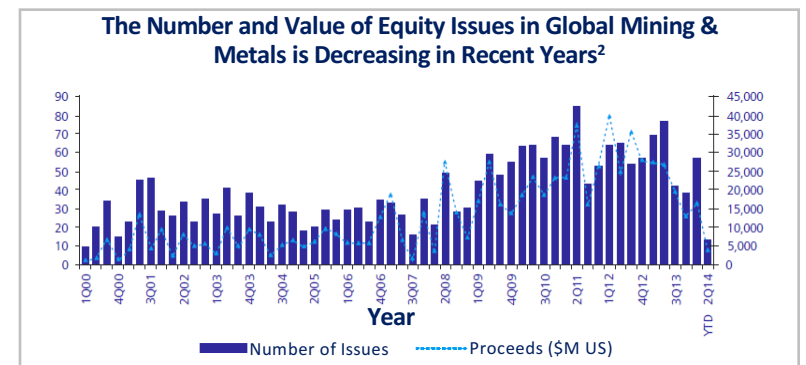
### Underperforming Shareholder Return

With mining's total return to shareholders underperforming other sectors, companies are under mounting **pressure to boost short-term profits**, often at the expense of long-term planning. **Passing on long-term, possible high return investments**, results in further **decreasing long term returns**



### Future of Mining Projects Increasingly Under Risk

**Significant price risk exposure** due to volatile commodity prices has resulted in **declining equity financing** and scaled back exploration activity by juniors and majors. As a result, the **long-term future supply pipeline looks increasing under risk<sup>2</sup>**



Source: (1) Société Générale, 2013; (2) "Deloitte tracking the trends 2015 – the top 10 issues mining companies will face this year"

# Stagnant investment in Canadian mining innovation has resulted in decreased global market share

## Mining Industry Investment Gap

Australian mining firms have invested more than four times as much in research and development as Canadian firms<sup>1</sup>.

Canadian mining firms invest more in Australian-led innovation than in Canada due to strong cooperative government-industry strategic planning and financing

## Canadian Government Support

- The mining industry is undervalued and receives little direct strategic financial support towards innovation from the Canadian government despite the industry's importance in implementing government Economic and Northern priorities.

## Examples of Canadian Government Support for Industry-led Research, Development & Innovation

1

Manufacturing: \$200M via. Advanced Manufacturing Fund (AMF)<sup>3</sup>

2

Forestry : \$100 via. Forest Investment in Forest Industry Transformation (IFIT)<sup>3</sup>

3

Automotive: \$750M via. Automotive Investment Fund (AIF)<sup>3</sup>

4

Aerospace: \$1.15B via. Strategic Aerospace and Defence Initiative (SADI)<sup>3</sup>

While the **Canadian government has showed initial signs of commitment** to the mining industry through NRCan's Geoscience for Energy and Minerals, Targeted Geoscience and Critical Metals initiatives, these only support a subset of mining challenges. **There is still need to develop a broader strategic partnership building a more sustainable mining value chain with a much smaller environmental footprint through CMIC's Towards Zero Waste in Mining™ roadmap**



## CMIC facilitates and focuses the mining innovation ecosystem to collaboratively address pressing mining business challenges

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### About CMIC

- **Why CMIC was created:** formed to provide innovation leadership to the Canadian mining industry
- **What CMIC does:** facilitates an industry-academic-government innovation ecosystem to focus joint efforts on addressing Canadian mining continued license to operate profitably challenges in support of public policy
- **CMIC's mission:** enhance the competitiveness and sustainability of the Canadian mining industry by ensuring excellence in research, innovation, and commercialization with the objective of Towards Zero Waste in Mining™
- **CMIC's vision:** re-launch Canada as a global leader in increasing a responsible mining industry's social license to operate, thereby remaining a strong pillar in the Canadian long term economic landscape

## The CMIC Innovation Ecosystem

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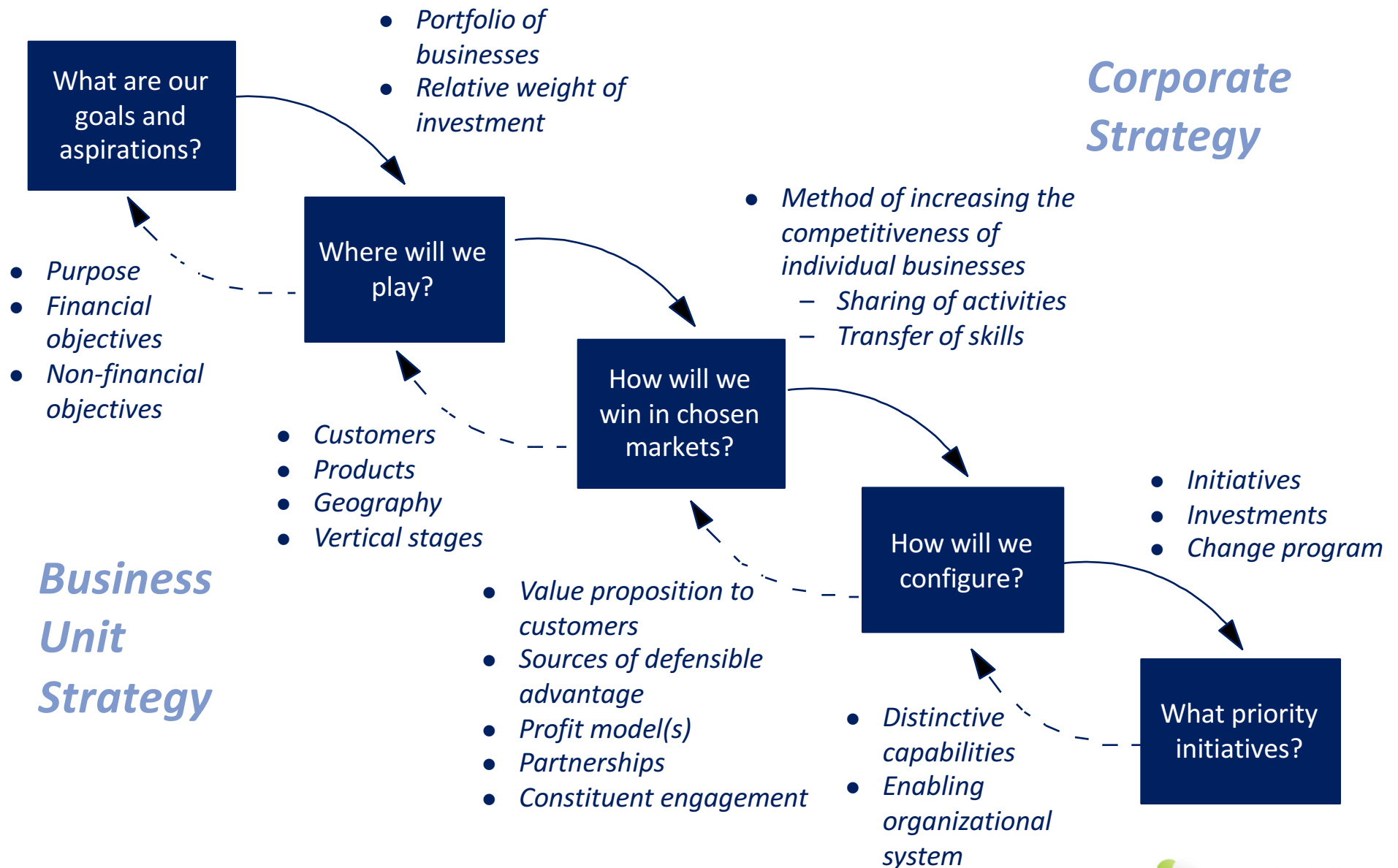
- Nodes represent different parties in the innovation ecosystem who all contribute in different ways to mining innovation. For example:
  - **Exploration and Mining industry:** *share expertise and resources*
  - **Government:** *share ambitions for increased mining productivity and more jobs*
  - **Colleges / universities:** *research and ideate new mining techniques*
  - **Research and development centres:** *research and ideate new mining techniques*
  - **Clean-tech / ICT / space / defense / other sectors:** *share similar challenges and technology*
  - **Associations:** *provide community and shared goals*
  - **Service providers:** *share common goals and interests in mining innovation*
  - **Startups:** *provide a resource for collaboration and are a source of new ideas and technology*
  - **Institutional funders / venture capitalists / foundation funds:** *provide funds and expertise to support innovation development*



## CMIC business ecosystem framework



# CMIC's workflow represents a set of choices along a cascading framework



# Towards Zero Waste Mining will focus on solving common industry issues

Articulated as core pre-competitive challenges identified by senior executives from mining companies across Canada

## Future State Mining Objectives

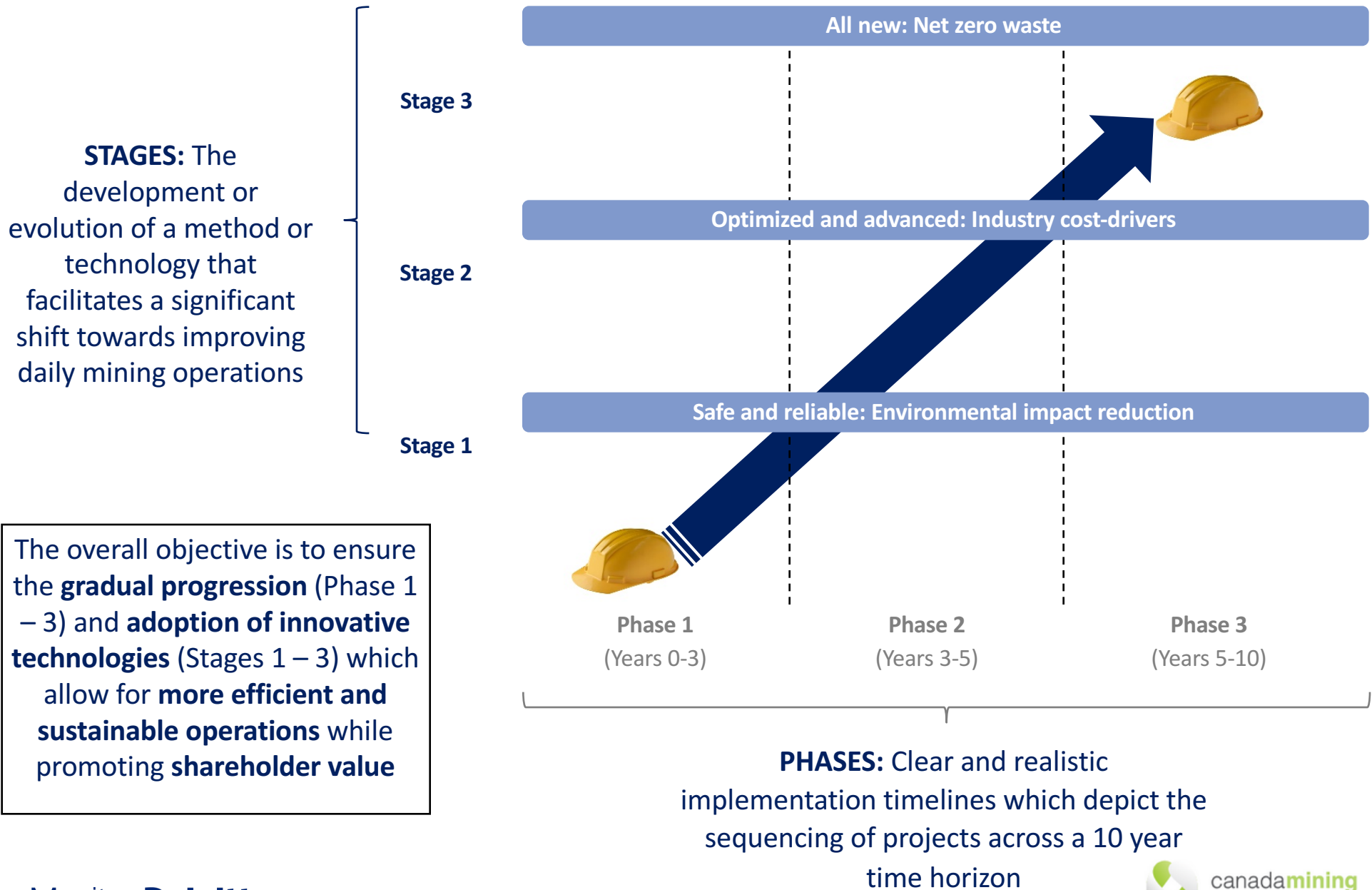
### Zero Waste Mining Issues

Defined as portfolios that address key objectives to accomplish a more efficient future mining state

	Increasing Mining Intensity	Decreasing Energy Intensity	Increasing Labour Productivity	Decreasing Capital Intensity	Safety, CSR & Environmental
Exploration	✓		✓	✓	
Underground Mining	✓	✓	✓	✓	✓
Energy / Processing		✓		✓	
Environmental Management					✓
Better Chemistry	✓		✓	✓	✓
Equipment	✓		✓	✓	
Mine Planning	✓			✓	
Other					

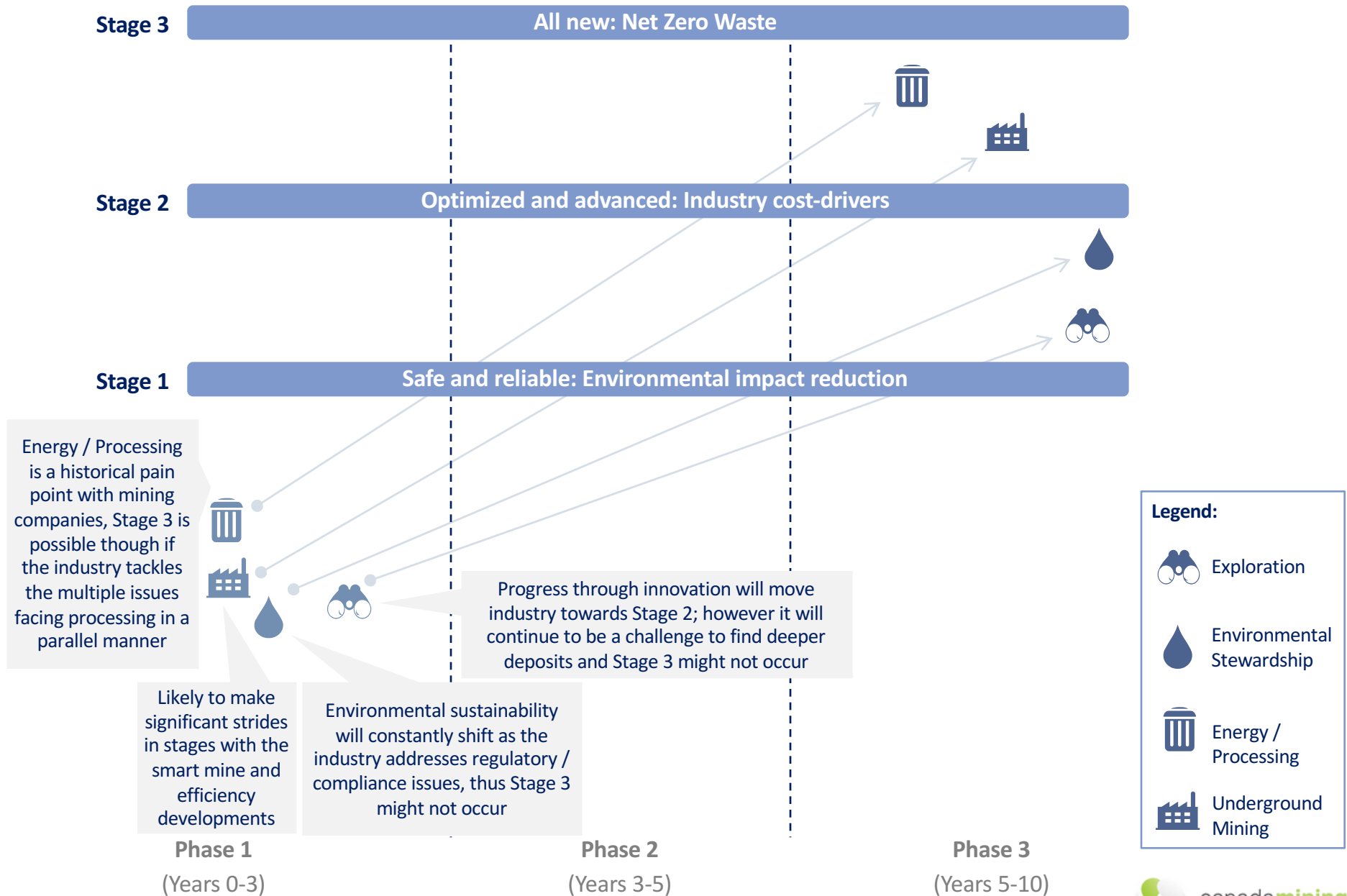
Priority portfolios CMIC will address as part of the TZWM strategy

# Towards Zero Waste Mining portfolios develop technology roadmaps with a phased and staged approach



The overall objective is to ensure the **gradual progression** (Phase 1 – 3) and **adoption of innovative technologies** (Stages 1 – 3) which allow for **more efficient and sustainable operations** while promoting **shareholder value**

# CMIC will closely monitor the trajectory of each portfolio, against the roadmap timelines and stage gates



# Appendix

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- List of Abbreviations



## List of Abbreviations

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- **AIF:** Automotive Investment Fund
- **AMF:** Advanced Manufacturing Fund
- **CMIC:** Canada Mining Innovation Council
- **IBM:** International Business Machines Corporation
- **ICT:** Information, Communication and Technology
- **IFIT:** Investment in Forest Industry Transformation
- **IP:** Intellectual Property
- **KPI:** Key Performance Indicators
- **M:** Million
- **NRCan:** Natural Resources Canada
- **Oz:** Ounce
- **R&D:** Research and Development
- **ROI:** Return on Investment
- **SADI:** Strategic Aerospace and Defence Initiative
- **\$CAD:** Canadian dollars
- **\$US:** American dollars
- **\$US/oz:** American dollars per ounce

## CMIC aims to revive Canada's status as a global mining leader by stimulating innovation, improving technology adoption, and promoting cultural change



- **Revive Canada's status as a global mining leader**
- Drive the Towards Zero Waste Mining strategy - **"Stimulate mining technology innovation in Canada to achieve zero waste in mining and mineral processing within 10-20 years, with a focus on the environment, energy, and productivity"** by:
  - **Foster collaboration** among industry, academia, government, and research facilities, leveraging expertise and funding to arrive at implemented solutions faster and more cost effective
  - **Bridge gap** between industry complexities and capabilities, focusing on challenges that are common to mining companies
- **Decrease barriers to technology adoption** within the mining industry:
  - **Provide shared costs / benefits** to project participants, through sharing of generated data, free licenses for software developed, and non-commercial access to developed IP / patents
  - **Facilitate development of detailed technology roadmaps** and assist industry in understanding the positive financial impact and return on invested capital
- **Promote cultural change** in the mining industry toward longer term decision horizons:
  - **Shift mindset** from annual Key Performance Indicators (KPIs) to 5-10 year timeframes while providing incremental value on an annual basis
- **Foster a mining industry innovation business ecosystem** based on the principles of:
  - Simple, open, fair, and transparent
- Encourage sustainable mining practices to **improve the sector's license to operate**

## CMIC is facilitating an industry led Towards Zero Waste Mining strategy focused on tackling common issues across mining companies



- Coordinate and develop industry led projects focused on shared mining business challenges related to the Towards Zero Waste Mining specifically in the areas of:
  - **Declining productivity:** increase productivity throughout the lifecycle of a mine (e.g., efficiency in mineral extraction)
  - **Increasing costs:** reduce energy consumption and other mining costs
  - **Increasingly complex license to operate:** reduce environmental impact of mineral development and mine closure (e.g., processing waste such as tailings)
  - **Operating with uncertainty:** reduce risk and barriers to adoption associated with long-term investment decisions
- Build the program nationally with the financial and resource support of all current and prospective CMIC members in the Canadian mining ecosystem, with particular involvement from:
  - Initially, **major, mid-tier and junior Canadian metal mining companies and mining suppliers** who have demonstrated strong initial interest and can **derive benefit** for both domestic and international operations
  - Federal government who can benefit from the **jobs created** and **GDP increase** due to project innovations

## CMIC's approach is differentiated because it is a facilitated open innovation and industry led model



### How Will CMIC Win

- Foster collaborative, industry generated innovative Zero Waste mining solutions through a reliable and agile **open innovation model** facilitated by CMIC:
  - Focus on common **high priority challenges** to deliver results **which will have the greatest impact**
  - **Aggregate financial and best in class non-financial resources** (e.g., cross industry experts) and allow industry members to decide on best use allocation
  - **Reduce financial and time risk** through collaboration, permitting continued focus on day-to-day priorities
  - Deliver faster industry **enhancing intellectual property**

### How Will Industry Win

- Realize **financial** (e.g., ROI and payback period) and **non-financial value** (e.g., increased license to operate) from projects administered by CMIC, including:
  - **Shared cost and risk** associated with **new technology adoption / implementation** for participating companies
  - **Increased productivity** and / or **decreased operating costs** resulting in **increased margins** and **feasibility of mine development**
  - **Reduced cyclical nature** of mining research and development through shared costs and government funding to **permit long-term project development**
  - New **sustainable mining practices** resulting in **improved industry license to operate**

**CMIC's success is a function of the financial and non-financial value realized by Industry**

## CMIC has a transparent, industry led governance structure with supporting mechanisms to promote innovation



- Governance:

- Developing a transparent, **industry led platform** that will foster open innovation in the areas of highest priority
- Making linkages to other parties within the mining partner ecosystem to connect ideas and resources
- Establishing a decision making structure that is **driven by industry players** in both a top down (e.g., Board of Directors is comprised of industry executives) and bottom up (e.g., Members are comprised of nominated representatives who actively participate in CMIC to make decisions regarding project planning, prioritization, execution, IP sharing, etc. on behalf of their company) approaches
- Providing support to the **industry led decision making structure** through a streamlined CMIC Project Management Office
- As the Towards Zero Waste Strategy expands expands, **encourage broader participation** of different mining players by offering tiered investment opportunities for companies of different investment capacity and interest (currently there are 2 levels but a third lower level may be considered)

- Supporting mechanisms:

- Defined project end goals and staged **targets** (e.g., ROI)
- **Opportunities for IP / patent ownership for General Partners and Project Partners**
- Repositories of **shared data and full non-commercial access to all IP / Patents developed** for CMIC members

## CMIC will prioritize investigation into key challenges that are common across mining companies



### CMIC Project Portfolio Priority Projects

#### Exploration

- Accelerated targeting undercover
- Near-time data retrieval and analysis

#### Underground Mining

- Real time continuous underground mining

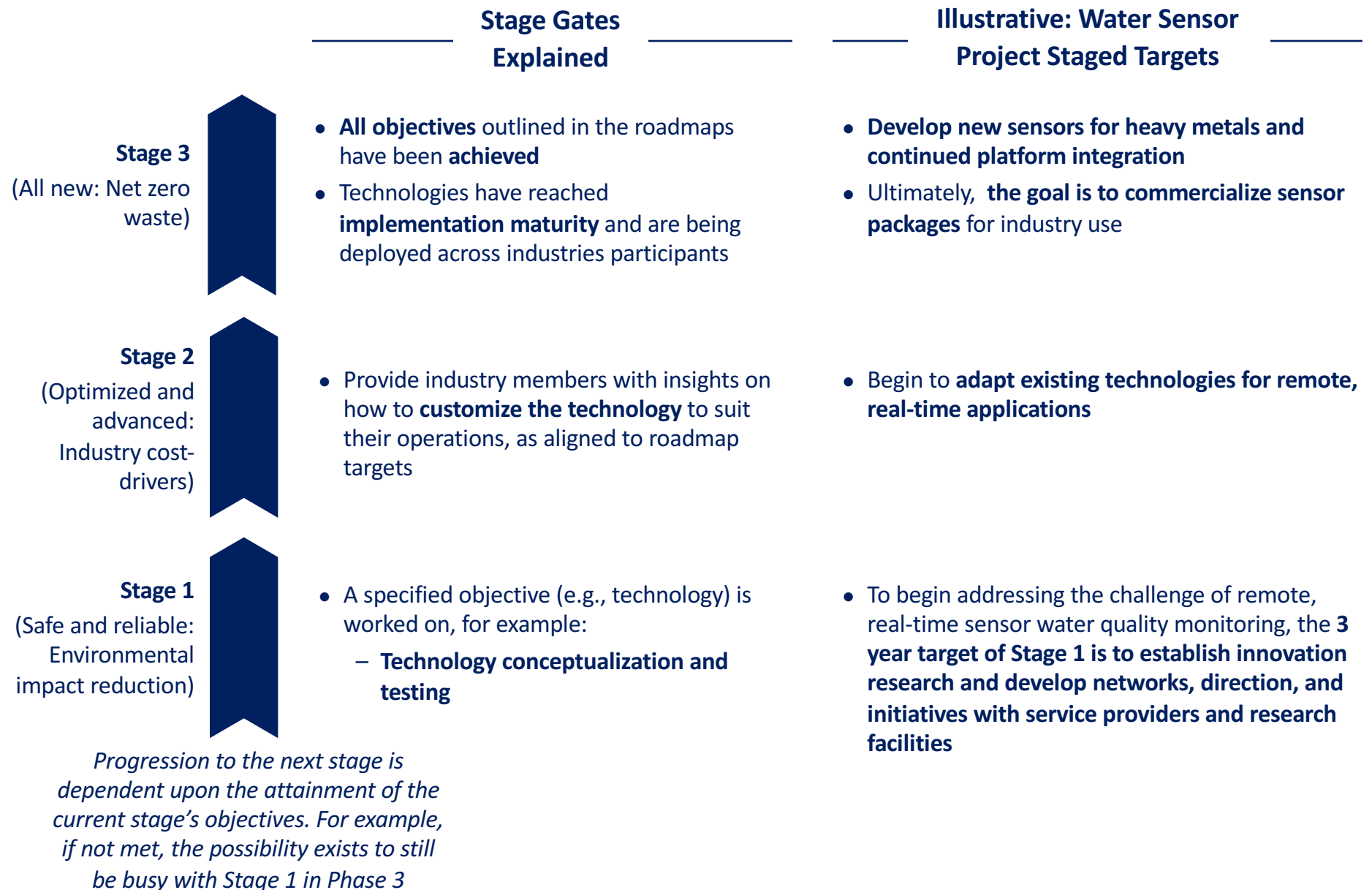
#### Energy / Processing

- Low grade waste energy recovery in comminution
- New comminution technology demonstration

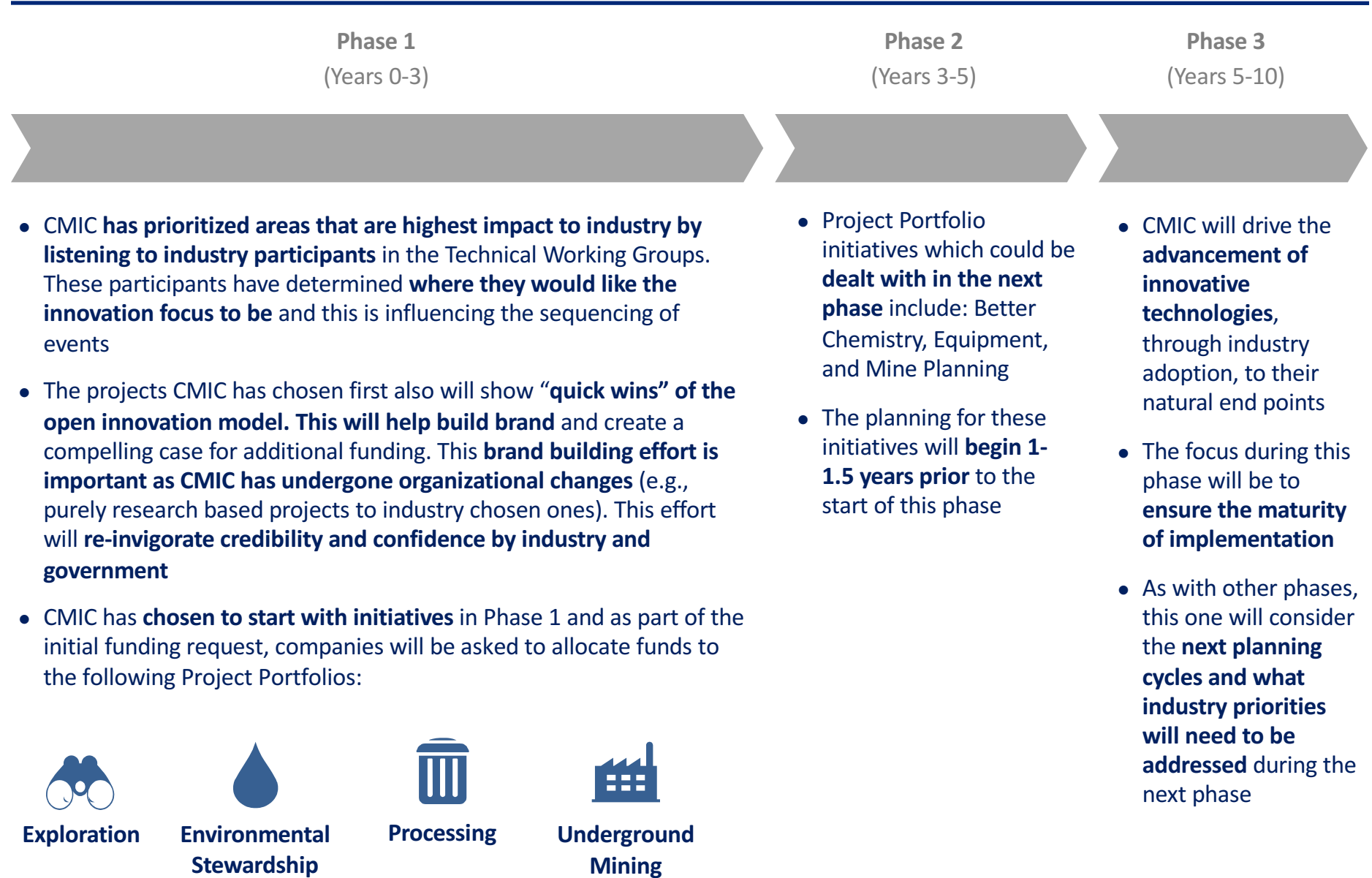
#### Environmental Stewardship

- Mining Industry Knowledge Hub
- Water sensors
- Closure criteria
- Data management

# The staged project objectives allow CMIC to track the maturity of technology adoption while promoting a significant shift in mining industry...



## ... these priorities will be phased along the following timelines, with some reaching their roadmap targets sooner than others





## CMIC incorporates multiple, agile project delivery models...

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1. **CMIC managed research consortia:** Our current exploration project is the largest geoscience consortia in North America, addressing explicit research needs for the industry.
2. **Project integration/coordination:** This clusters existing new mining projects, adds potential new project elements and accounts for multi-million investments being made by companies. This will be one component of our underground mining program.
3. **Technology Demonstration:** This accounts for new technology that is not developed far enough and is typically too costly for a single company to test. In the case of energy efficient processing we are examining 3-5 new technologies in this genre.
4. **CMIC Directed, Partner Delivered:** These projects typically occur on the initial stages of larger, consortia-based project to prove an idea or provide a baseline of data, information and models on which we need to proceed.
5. **CMIC Instigated with “Ecosystem” Participation:** These are either very difficult technical challenges that have broad applicability and interest or where there are significant groups working on elements yet need to be stimulated to move in the right direction. environmental monitoring technologies. Low grade waste energy recovery is one example.
6. **Mini-Consortia:** Evolve around needs of a select group of companies and include two nascent projects in genomic based sensors for environmental monitoring and hybrid air vehicles for alternative transportation.



**Exploration**



**Underground Mining**



**Processing**



**Environmental Stewardship**