



# High Pressure Grinding Rolls (HPGR)

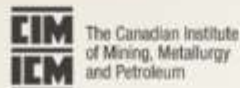
## In Comparison to SAG Milling Technology

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Organized by



In collaboration with



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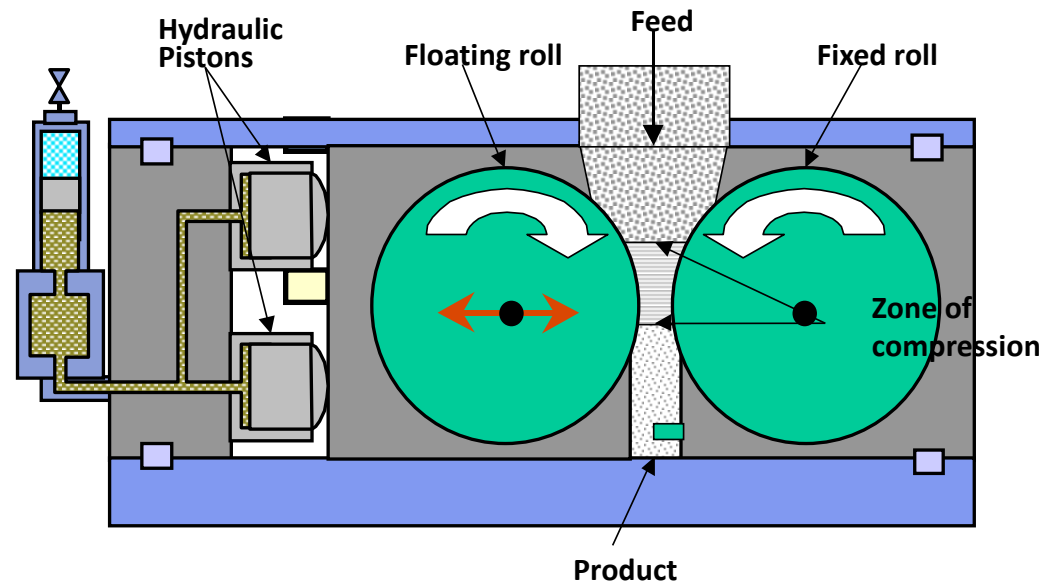
- HPGR Process/Overview
- HPGR vs. SAG
- The Manufacturers
- Mine Operations using HPGR
- Projects by Wardrop/Tetra Tech
- Economic Benefits
- Questions



# The Process

## Major Parts:

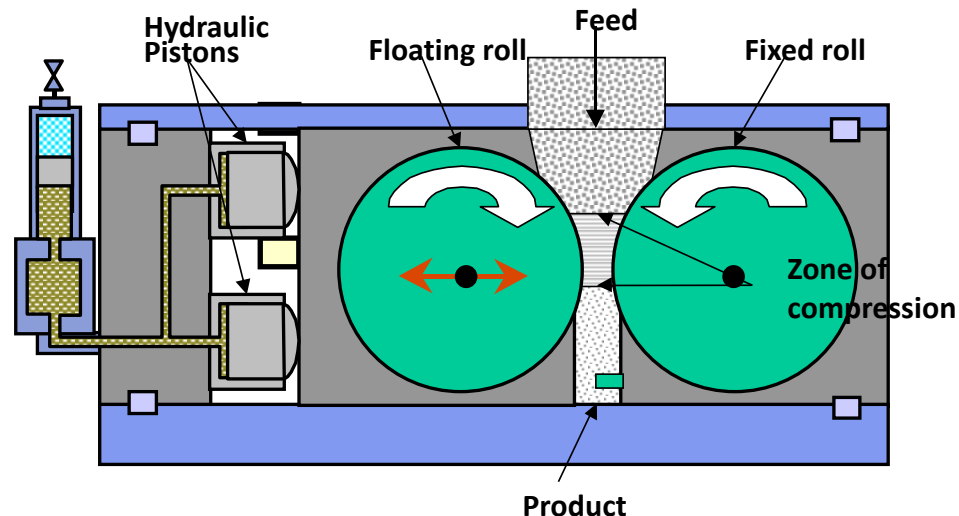
- Counter-rotating Rolls
- One fixed roll, one moving roll



# The Process

## Major Parts:

- Hydraulic pressure applied
- Nitrogen accumulator provides optimum interparticle crushing pressure



# Main Operating Parameters

- Press Force (N/mm<sup>2</sup>)
- Roll Speed (m/s)
- Moisture Content (%)
- Feed Particle Size Distribution

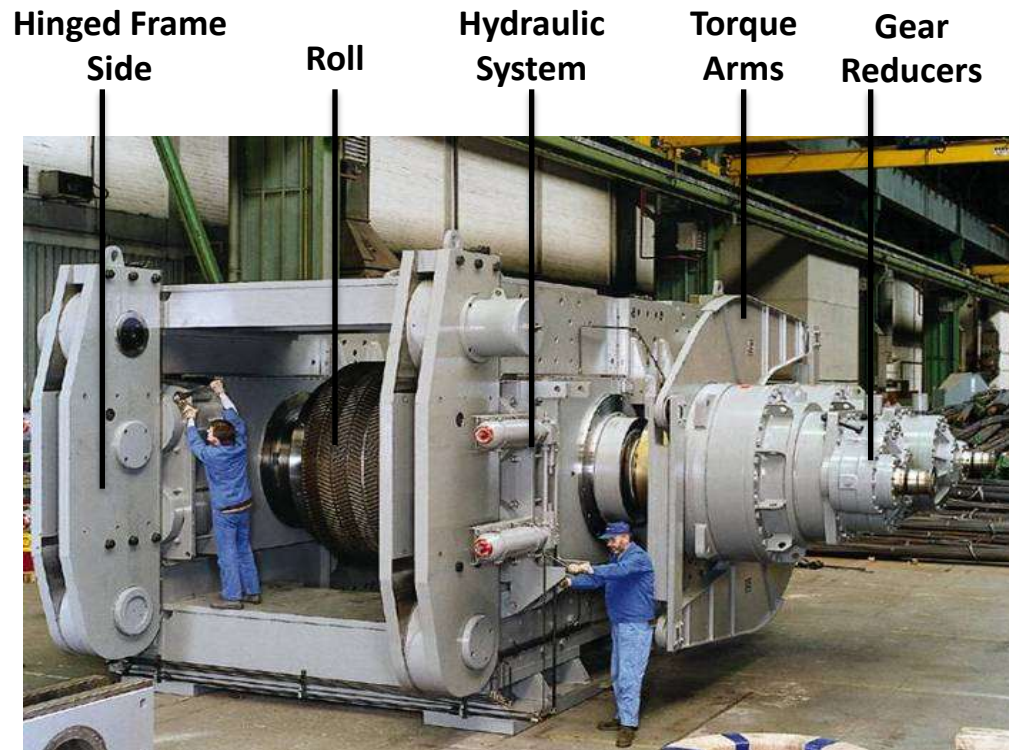
Specific throughput

$$M^* = \text{throughput}/D*L*V \quad (\text{ts/hm}^3)$$

Flake thickness/strength in balance with the compressing force  
(floating roll situation)



# HPGR Assembly from the workshop, view the hydraulic side



# HPGR Installations



# Cerro Verde Maintenance Shop





# The Manufacturers

## **Krupp Polysius (Germany)**

- Favours a high aspect ratio design, i.e. large diameter, small width
- Use of studs for wear protection on rolls surface

## **KHD (Germany)**

- Favours a low aspect ratio, i.e. small diameter, large width
- Use of studs for wear protection on rolls surface

## **Koppers (Germany)**

- Favours a low aspect ratio, i.e. small diameter, large width
- Use of studs and hexadur wear protection linings

## **Others (Metso, FLS, Outotec, CITIC)**



# HPGR vs. SAG

## Advantages

- Significant energy cost savings
- Reduced grinding media consumption
- Reduced overall operating costs
- Reduced footprint
- Higher mechanical availability
- Faster Equipment Delivery
- More Environmentally Friendly

## Disadvantages

- Can increase initial capital costs
- Increased material handling
- Increased dust



# Mine Operations Using HPGR

- Freeport McMoran, Cerro Verde, Peru
  - 2.4 m Dia x 1.7 m wide, 5 MW (2x2.5), processing 2,500 tph
- Freeport McMoran, Grasberg Mine, Irian Jaya, Indonesia
  - 2.0 m Dia x 1.8 m wide, 3.6 MW, processing 1,450 tph
- Nurkazgan Gold, Kazakhstan
  - 1.7 m Dia x 1.4 m wide, 2.3 MW, processing 1,000 tph
- Zapadnoe Gold, Russia
  - 1.0 m Dia x 0.9 m wide, 0.8 MW, processing 320 tph
- Newmont, Boddington Copper/Gold , Australia
  - 2.4 m Dia x 1.7 m wide, 5.6 MW (2x2.65), processing 2,100 tph
- Spinifex Ridge Moly/Copper, Australia
  - Three HPGR units (2x2.65 MW each)

# Mine Operations Using HPGR

- Anglo Platinum, Mogalakwene Platinum Mine, South Africa
  - 2.2 m Dia x 1.6 m wide, 5.6 MW (2x2.8), processing 2,400 tph

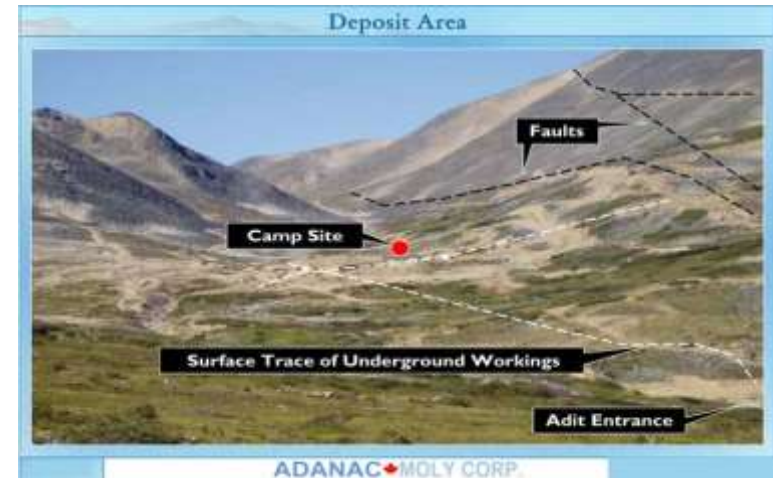


# Projects

## Adanac Moly Corporation

Ruby Creek Project, Feasibility Study

20,000 tpd Moly Ore



## Imperial Metals Inc.

Mount Polley Project, Scoping Study

Expansion from 20,000 to 30,000 tpd

Copper Gold Ore



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# Projects

## International Molybdenum PLC

Malmberg Project, Trade-off Study +  
Feasibility Study

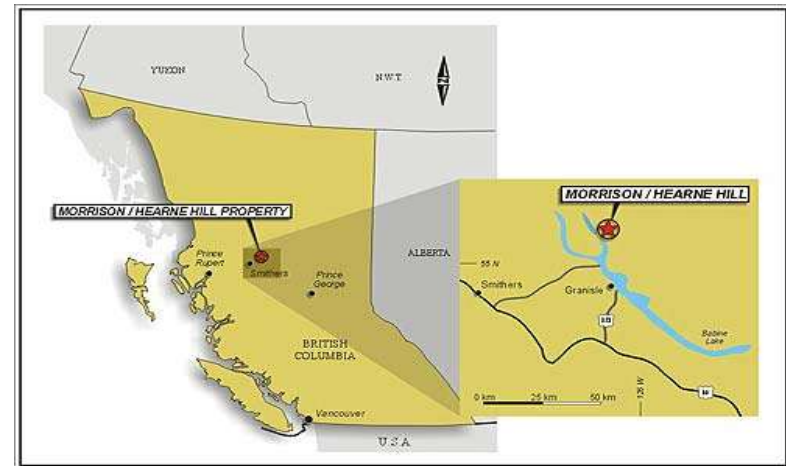
30,000 tpd Moly Ore



## Pacific Booker Minerals Inc.

Morrison Project, Trade-off Study +  
Feasibility Study

30,000 tpd Copper/Gold/ Moly Ore



# Projects

Russian Project, Trade-off Study  
60,000 tpd Copper Gold Ore



**Seabridge Gold Inc.**  
Courageous Lake Project  
Trade-off Study  
25,000 tpd Gold Ore



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# Projects

China Project

HPGR Study

40,000 tpd Copper/Gold Ore



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**Seabridge Gold Inc.**

KSM Project

Trade-off Study + Pre-Feasibility

120,000 tpd Copper/Gold/ Moly Ore





# Projects

**Abacus Mining & Exploration Corp.**

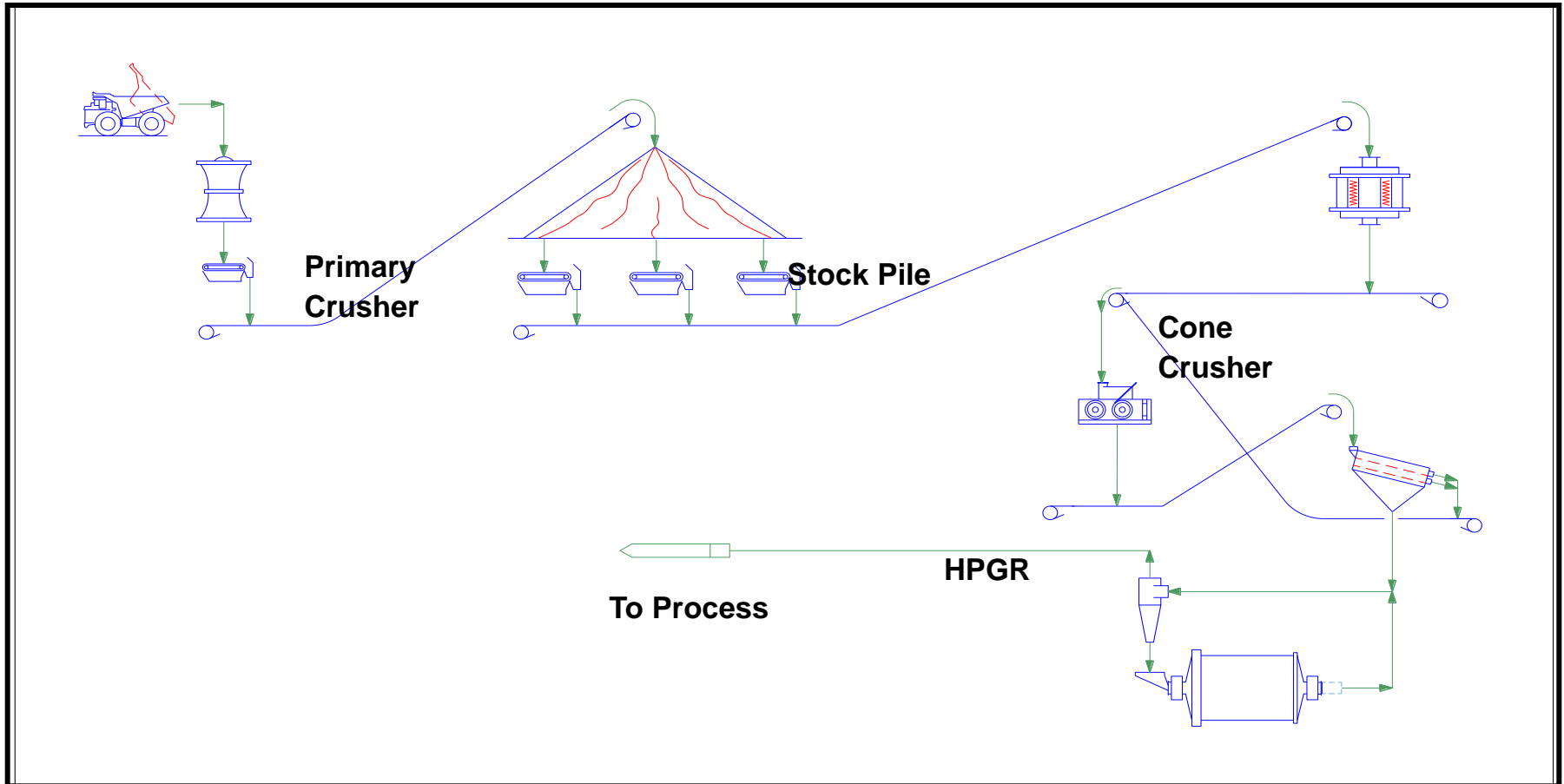
Ajax Project

Trade-off Study + Feasibility Study

60,000 tpd Copper/Gold Ore



# HPGR



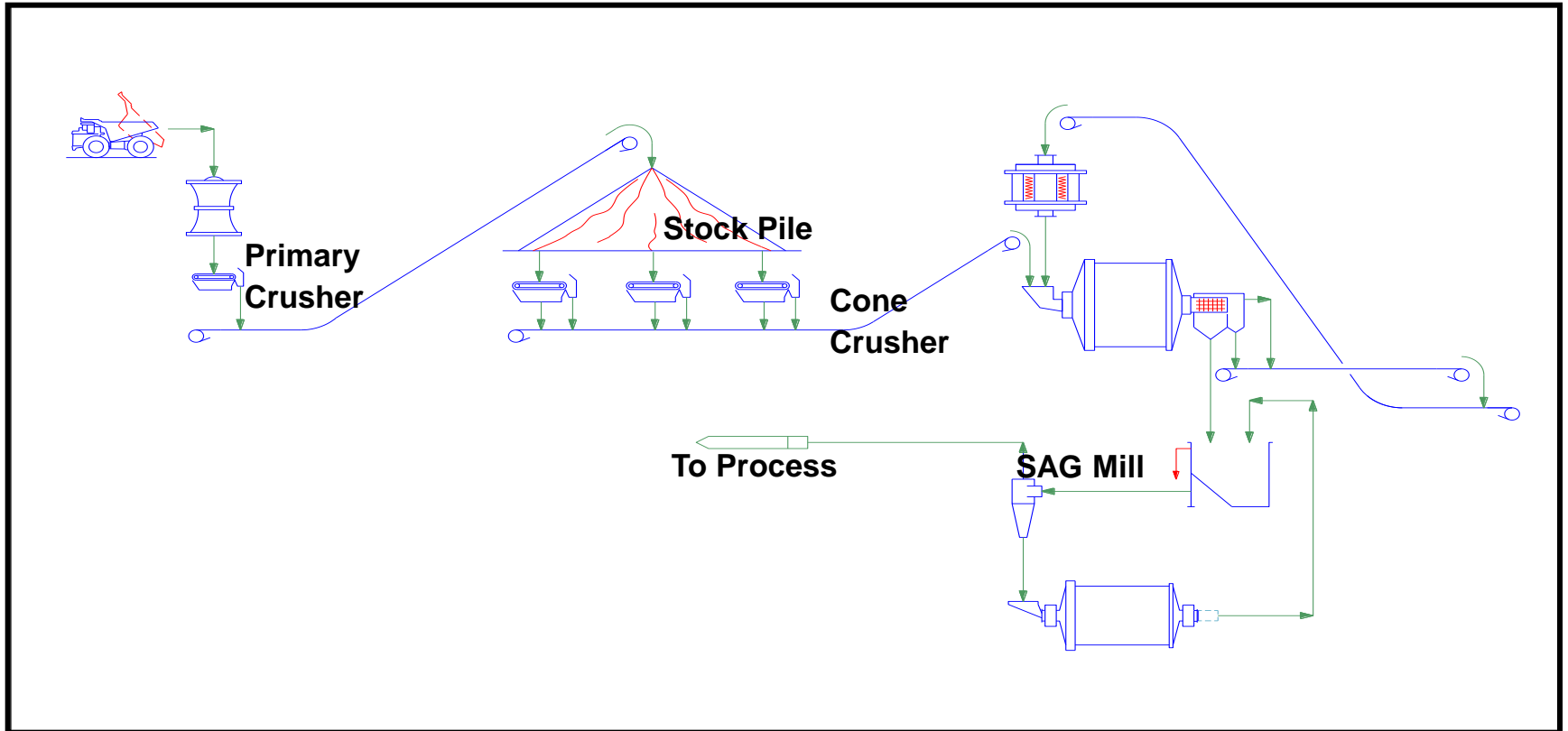
Ball Mill

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# SAG Mill



Ball Mill



# Economic Benefits

Power	SAG	HPGR
• Adanac Moly Corp	4.53 \$/t	3.83 \$/t
• Imperial Metals Inc.	n/a	0.13 \$/t*
• International Moly	2.35 \$/t	1.95 \$/t
• Russian Project	0.78 \$/t	0.53 \$/t
• Seabridge Gold Inc.	3.59 \$/t	2.47 \$/t
• Pacific Booker Minerals Inc.	0.63 \$/t	0.56 \$/t
• Abacus Mining & Exploration	0.60 \$/t	0.47 \$/t

\* Additional costs for expansion project



# Economic Benefits cont.'d

Consumables	SAG	HPGR
• Adanac Moly Corp	0.77 \$/t	0.73 \$/t
• Imperial Metals Inc.	n/a	0.55 \$/t*
• International Moly	2.03 \$/t	1.29 \$/t
• Russian Project	1.46 \$/t	1.10 \$/t
• Seabridge Gold Inc.	1.39 \$/t	1.15 \$/t
• Pacific Booker Minerals Inc.	2.03 \$/t	1.47 \$/t
• Abacus Mining & Exploration	1.83 \$/t	1.38 \$/t

\* Additional costs for expansion project



# Economic Benefits cont.'d

Overall Operating Costs	SAG	HPGR
• Adanac Moly Corp	5.30 \$/t	4.56 \$/t
• Imperial Metals Inc.	n/a	0.73 \$/t*
• International Moly	4.66 \$/t	3.52 \$/t
• Russian Project	2.24 \$/t	1.63 \$/t
• Seabridge Gold Inc.	4.98 \$/t	3.62 \$/t
• Pacific Booker Minerals Inc.	2.66 \$/t	2.03 \$/t
• Abacus Mining & Exploration	2.48 \$/t	1.92 \$/t

\* Additional costs for expansion project



# Capital Costs

## Capital Costs

## SAG vs. HPGR

- Adanac Moly Corp -6.4%
- Imperial Metals Inc. \$35 mln\*
- International Moly -9.6%
- Seabridge Gold Inc. -8.2%
- Pacific Booker Minerals Inc. -9.6%
- Abacus Mining & Exploration -10.2%

\* Additional costs for expansion project



# Power Consumption Greenland Project

Plant Concept	SAG Circuit	HPGR Circuit
Equipment	1 x SAG Mill 9.8 MW	1 x Secondary Crusher 750 kW
	1 x Pebble crusher 450 kW	1 x HPGR 4.0 MW
	2 x Ball Mills 5.6 MW each	2 x Ball Mills 5.6 MW each
	Screens and conveyors 0.5 MW	Screens and Conveyors 1.5 MW
Total drive capacity installed	21.95 MW	17.45 MW





# Power Savings

Installed Power Savings	MW
• Adanac Moly Corp	4.1
• Imperial Metals Inc.	-4.4
• International Moly	4.5
• Seabridge Gold Inc.	8.1
• Pacific Booker Minerals Inc.	4.0
• Abacus Mining & Exploration	14.0



# Environmental Benefits

## Estimation of CO<sub>2</sub> reduction based on EIA\*

Reduction of	TPY, CO <sub>2</sub>
• Adanac Moly Corp	21,000
• Imperial Metals Inc.	n/a
• International Moly	23,000
• Seabridge Gold Inc.	41,000
• Pacific Booker Minerals Inc.	20,000
• Abacus Mining & Exploration	71,000

\* Energy Information Administration

\*\* Based on data for EIA USA, IMWH = 0.606 t CO<sub>2</sub>





Thank You

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