

THE CRUSH IT! CHALLENGE

ACCELERATING TRANSFORMATIVE SOLUTIONS
TO REDUCE ENERGY USE AT THE MILL

Applicant's Guide



INTRODUCTION

What is the best way to save energy in the milling circuits of Canada's mining industry? Is it smarter blasting and ore sorting techniques that improve the quality of feed that enters the mill? Is it a novel grinding method that more effectively transfers kinetic energy to rock inside the mill? Or is it a completely different solution altogether – one that allows the liberation of valuable minerals from ore at a much lower energy input than grinding, such as through a new chemical or biological process?

Comminution, the process of crushing and grinding rock to a reduced size as part of the process of liberating valuable minerals, is extremely energy-intensive. It accounts for upwards of 50% of mine site energy consumption and up to 3% of all the electric power generated in the world. It represents a major cost to companies and is a significant contributor to the industry's greenhouse gas (GHG) emissions. However, innovative advances in this process, particularly major breakthroughs, have been limited, and energy inefficient technologies remain the industry standard. Finding and advancing innovative solutions that reduce how much energy is needed for crushing and grinding is a key avenue to a cleaner, more productive, and globally competitive mining industry, and an integral part of Canada's pathway to a low-carbon economy.

CHALLENGE OBJECTIVES

The objectives of the Crush It! Challenge (the Challenge) are to:

1. Accelerate innovative breakthrough advances in mining by tackling one of the industry's most energy-intensive and inefficient processes: crushing and grinding.
2. Mobilize innovators from inside and outside the mining industry to unlock a major step change in this area, and grow 'solver' communities to enhance Canada's mining innovation ecosystem.
3. Provide a unique platform to highlight promising research and development (R&D) ideas and help them overcome barriers to prototyping and demonstration.

CHALLENGE OVERVIEW AND SCOPE

The Challenge is an open call for innovators to develop new clean technologies or processes that produce a transformational reduction in how much energy is needed for crushing and grinding mined material at a mill into a usable product for downstream mineral liberation. For the Challenge, clean technology is defined as a product, process, or service that is less polluting or more resource-efficient than current industry practice.

Example innovation areas for this Challenge could include:

- New technologies or processes that improve the material feed to the mill resulting in less grinding required to achieve the particle size needed for recovery processing (e.g. smarter blasting, improved ore sorting, pre-conditioning techniques, etc.);
- New technologies or processes that increase the physical efficiency of rock crushing and grinding, or the feasibility of renewable/recycled energy sources at the mill;
- Energy optimization via artificial intelligence, digitization, integrated sensing;
- Alternative mining techniques that eliminate the need to crush and grind altogether (e.g. in-situ, continuous mining, etc.); or,
- Something completely novel that represents a transformational change in crushing and grinding for Canada's mining industry.

The Challenge is open to any technological or process solutions proposed in an application, so long as the end-result of implementing the solution in a mining operation is a reduction in the quantity of energy consumed by crushing and grinding mined material at a mill for the downstream liberation of valuable minerals.

The \$5 million Crush It! Challenge Grand Prize will be awarded to the finalist whose solution is evaluated to produce the largest step-change reduction in how much total energy is needed for crushing and grinding mined material in a mill as part of the mineral liberation process, and which simultaneously has a clear path to market in place, and which presents the best overall opportunity to advance the industry's productivity, efficiency, and mitigation of environmental impacts. Success in terms of energy savings will be determined by:

- 1. The total reduction in the quantity of energy (kWh) required to produce one tonne of ground ore with a prescribed initial hardness and at a pre-determined particle size that results from implementing the proposed solution.**
- 2. A second path to winning the Challenge Grand Prize is to develop and demonstrate a solution that reduces the quantity of energy required to crush and grind mined material by eliminating the need for particle size reduction to facilitate liberation altogether. Is it possible to develop a new way to liberate valuable minerals without grinding?**

NOTE: this type of proposed solution will be evaluated on a case-by-case basis, including consideration of (but not limited to) impacts on the overall energy consumption of a mining operation and how it would ensure or improve the effectiveness and efficiency of mineral liberation.

Project proponents are challenged to generate a step-change reduction at least equal to, or better than, a 20% reduction in the energy consumed by crushing and grinding when compared to a pre-established baseline.

The Challenge is structured with the intent that the final concepts considered for the \$5 million Grand Prize will have advanced to technology readiness level (TRL) 6 over the course of the competition. By the end of the Challenge, proponents will be expected to have developed a functioning, testable prototype of their solution and associated documentation, and clearly demonstrated their solution's capability of delivering the required outcomes within the Challenge. Accelerated advancement of solutions from a low to a high TRL is a key area of focus for the Challenge and will be considered in the evaluation of applications. See Annex B for TRL definitions.

TIMELINE

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| • The Crush It! Challenge Launch: | October 2018 |
| • Call for Applications opens (Round 1 start): | October 2018 |
| • Call for Applications closes: | January 2019 |
| • Twelve semi-finalists announced (Round 2 start): | February 2019 |
| • Technical and video presentations at PDAC 2019: | March 2019 |
| • Six finalists announced (Round 3 start): | May 2019 |
| • Final submission deadline | November 2020 |
| • Grand Prize winner announced: | March 2021 |

Specific dates and additional details will be communicated through the Challenge website at: <http://impact.canada.ca>.

GENERAL TERMS AND CONDITIONS

Applicants to the Challenge agree to the following when submitting their application:

- Applicants agree to comply with all applicable laws.
- Applicants must be able to demonstrate ownership of or permission to use any intellectual property (IP) used in the challenge.
- The Minister of Natural Resources Canada has the sole discretion to cancel this Challenge or any part thereof at any time.

PRIVACY

The use and distribution of data collected under this program will comply with both the *Privacy Act* and the *Access to Information Act*.

Pursuant to the *Privacy Act*, the program will keep confidential any personal information it may collect and will not disclose or transmit said information without the applicant's written consent.

Pursuant to the *Access to Information Act*, the program will protect from disclosure any information of a financial, commercial, scientific or technical nature it collects from applicants so long as the applicants treat said information as confidential in their own establishments. If the applicant chooses to send the proposal or other confidential information to Natural Resources Canada by e-mail, Natural Resources Canada will respond to the proposal by e-mail. Similarly, if the applicant's correspondence is through regular mail, Natural Resources Canada's response will be in like manner. However, in all cases, Natural Resources Canada will use e-mail correspondence to the applicants for all non-confidential matters.

Applicants to the Challenge have the option of allowing Natural Resources Canada to share submitted information for the purposes of the Challenge with other organizations who provide funding and support for innovation, such as other Government of Canada departments and initiatives (e.g., the Government of Canada Clean Growth Hub); provincial, territorial or municipal governments; and not-for-profit organizations (e.g., Sustainable Development Technology Canada).

See Annex E for the letter of consent, which must be completed and submitted in order for information to be shared.

THE CRUSH IT! CHALLENGE

The Crush It! Challenge is divided into a series of competitive "Rounds" that applicants will pass through on their way to consideration for the final \$5 million Grand Prize:

ROUND 1 (October 2018 – February 2019): The Challenge will accept and evaluate online applications from any eligible applicant seeking to develop and demonstrate a novel clean technology or process concept that seeks to reduce the total energy that is required for crushing and grinding mined material at the mill for the purposes of downstream liberation of valuable minerals. Proponents must submit an online application to be eligible for subsequent rounds of the Challenge.

Based on an evaluation of submitted applications, up to twelve (12) qualifying Challenge proponents (semi-finalists) will be selected by a Natural Resources Canada (Natural Resources Canada) Technical Review Committee made up of experts in the field to advance to Round 2.

ROUND 2 (March 2019 – May 2019): The semi-finalists will attend the 2019 Prospectors & Developers Association of Canada (PDAC) Convention in Toronto (March 3-6, 2019) and present a fully realized technical project proposal for their solution to the public during the Goldcorp #DisruptMining mining innovation event. With input from the Natural Resources Canada Technical Review Committee, an independent Challenge Jury comprised of senior mining industry and innovation leaders will review each of the proposals presented and select up to six (6) finalists to compete for the final \$5 million Grand Prize in Round 3.

Selected semi-finalists qualifying as a "small-scale innovator"¹ will receive a \$10,000 micro-grant prize to help them develop their presentation and to enable their participation at the #DisruptMining event.

¹See Section 2.3.1 for the definition of a small-scale innovator. To qualify, applicants will need to provide the necessary documentation in the online application form (see Annex D for additional information on the information required).

ROUND 3 (May 2019 – November 2020): The selected finalists will have 18 months to produce a functional prototype or model, and to demonstrate and validate the results of their new clean technology or process solution to the Challenge Jury.

Each finalist will be eligible to receive up to \$800,000 in a contribution agreement for the purposes of developing, testing, demonstrating, and validating the results of their solution.

At the conclusion of Round 3, to be considered for the \$5 million prize, each finalist must comprehensively demonstrate how the application of their new technology or process would result in a step-change reduction in the energy required for crushing and grinding mined material at the mill for downstream mineral liberation in a mining operation, while considering all the Challenge evaluation criteria outlined in section 2.3.2. Proponents must submit a Detailed Technical Report, with results and conclusions certified by an accredited third party(ies), which demonstrates how their prototype product or process was tested and how it achieved the results set out by the Challenge.

1. ELIGIBILITY

Eligible applicants to the Challenge include the following:

- Legal entities duly incorporated and validly existing in Canada, including:
 - for-profit and not-for-profit organizations such as companies, industry associations, and research centres;
 - Indigenous organizations and groups; and,
 - Canadian post-secondary institutions.
- Independent innovators, unaffiliated consortium, and individuals who are a Canadian citizen(s) or permanent resident(s) of Canada.

Non-Canadian individuals and entities may be part of a partnership or consortium submitting a proposal as long as the lead proponent meets the above criteria and is associated with a duly incorporated or registered legal entity in Canada.

Solution ideas and concepts can originate from anywhere globally, but to receive funding from the Challenge, the ultimate solutions presented in the submissions must be developed, tested, piloted, demonstrated, and deployed in Canada.

NOTE: Individual innovators are encouraged to submit an application to the Challenge, but in order to be eligible for the up to \$800,000 contribution agreement at the conclusion of Round 2 and for the Challenge Grand Prize, all successful proponents will be required to establish a legal entity (company or corporation) duly incorporated and validly existing in Canada. In addition, to be eligible for the Challenge Grand Prize, proponents will be required to demonstrate that their legal entity has established an internal or external corporate governance mechanism to provide confidence that funds will be directed to further advancing their solution toward adoption and potential future integration into an operating mine site.

2. ROUND 1: APPLICATION REVIEW AND SELECTION OF THE SEMI-FINALISTS

Following the official Challenge launch, applicants will be invited to submit an application via the official Challenge web page before January 15, 2019, which will be used to establish a pool of applicants for **Round 1**. The Natural Resources Canada Technical Review Committee will select a maximum of twelve (12) proposals to advance to **Round 2** (semi-finalists).

2.1. Application Requirements for Round 1

Natural Resources Canada will only accept applications through the Impact Canada website via the designated Crush It! Challenge application portal: <http://impact.canada.ca>. **Applications must be submitted to the site no later than January 15, 2019.**

Challenge documentation, including specific deadlines and Frequently Asked Questions (FAQs) are available on the Challenge website.

In order for a proposal to be considered under the Challenge, each applicant **must** submit the following information **online** by the closing date indicated above and on the Challenge website:

- completed Crush It! Challenge application form, submitted through the Challenge website;
- completed online documentation for supporting applicant eligibility (see Annex C);
- completed online additional requirements for a “small-scale” innovator, if applicable (see Annex D);
- completed online consent form for information sharing (see Annex E); and,
- completed online detailed project proposal and attestation form (see Annex F).

Each online application must provide a sufficient level of detail to enable assessment against the Challenge’s Evaluation Criteria (Section 2.3.2).

2.2. Application Details

Information provided in the online application will be used by the Natural Resources Canada Technical Review Committee to evaluate the quality of the proposal and to determine which applicants will advance as a semi-finalist into **Round 2** of the Challenge. The content of the initial application will also be taken into consideration by the Challenge Jury when evaluating semi-finalists in Round 2.

To enable a thorough assessment of each Challenge proposal, each applicant is required to provide the following information in their online application:

Project lead and participant information:

1. the name(s) and contact information associated with the submission, with the project lead clearly identified;
2. official proof of the project lead's legal structure and eligibility for funding (if applicable) (see Annex C);
3. details regarding the capability and capacity of the project team and any collaborators to undertake the work over the duration of the project and to provide continued support at completion; and,
4. an attestation that the applicant, and the project team, are capable of completing the activities outlined in the submission in the time allocated for the Challenge.

Detailed Project Proposal (Annex F):

1. **PROJECT OVERVIEW** – Describe what the project intends to undertake and how it aligns with the scope of the Challenge program, including identifying the elements of the Mining Cycle (see Annex A for Challenge Definitions) that will be targeted by work undertaken.
2. **PROJECT DESCRIPTION** – Describe, in detail, how the proposed technology or process solution will achieve a major step-change reduction (targeting 20% or more) in the quantity of energy required for crushing and grinding in a mill as indicated by: 1) the total quantity of energy required to produce one tonne of ground ore with a prescribed initial hardness and at a pre-determined particle size; or 2) the total quantity of energy saved through the replacement or elimination of particle size reduction in the process of mineral liberation; as well as how the solution would benefit the productivity, efficiency, and environmental impacts of mining in Canada.
3. **PROJECT STATUS** – Describe any work and/or financial investment that has been completed to date on the project, including an assessment of the current TRL (see Annex B for TRL definitions).
4. **METHODOLOGY** – Describe how the project will be carried out including a description of the tasks and methodology, as well as documentation of key timelines/milestones for each considering the 18-month development window in **Round 3** with the goal of advancing the solution concept to TRL 6. Proponents will need to demonstrate how they will develop a prototype product or process that can be tested with results validated by an accredited third-party provider.
5. **ENVIRONMENTAL IMPACTS** – Beyond anticipated improvements in energy consumption, identify and describe the anticipated environmental impacts (positive or negative) of applying the solution in a mining operation (e.g. impacts on GHG emissions, fresh water consumption, environmental footprint). Both direct and indirect environmental impacts should be outlined in this section.
6. **DOWNSTREAM IMPACTS** – Identify and describe anticipated impacts (positive or negative) of applying the solution on the mining operation on downstream activities (e.g., flotation, concentration, thickening, leaching, recovery, smelting, refining, etc.).
7. **UPTAKE POTENTIAL AND SCALEABILITY** – Describe the anticipated final product(s) that will be generated by the project (e.g., intellectual property, prototypes, business case, technology demonstration), the anticipated adopters in Canada and abroad, and a detailed commercialization plan which outlines a credible path to adoption by the Canadian mining industry (NOTE: for the initial application stage, a commercialization plan can include notional or anticipated items based on exposure via the Challenge competition – a concrete commercialization plan and path to adoption will be a required element for the Grand Prize winning solution, however).

Describe the anticipated scalability and applicability of the project final product or process across the Canadian mining sector (e.g. cost-effective applicability to future or existing mining operations, different geophysical compositions of extracted ores, commodity, geographic location/climate, etc.)

8. **INNOVATIVENESS** – Provide details on how the proposed solution is innovative or novel, including any context on similar projects already being undertaken in Canada and elsewhere, and describe how this project differs or is otherwise transformative.
9. **ECONOMIC AND/OR SOCIAL IMPACT** - Describe the anticipated economic and social impact(s) should the project be successful, both at an operational level and more broadly, sector-wide in Canada (e.g. by reducing costs, creating new revenue streams, new employment or economic opportunities for communities, improving public confidence in mining operations, etc.).

2.3. Evaluation Criteria

2.3.1. Small-scale Innovators

At the conclusion of **Round 1**, “small-scale” innovators selected as part of the up to twelve (12) semi-finalists will be awarded a \$10,000 prize to help them develop their presentation and support their participation at the 2019 PDAC Convention.

Applicants that qualify as a “small-scale” innovator include:

- Small Enterprises², including companies, industry associations, and research centres;
- Not-for-profit organizations;
- Indigenous organizations and groups;
- Canadian post-secondary institutions; and,
- Independent innovators, unaffiliated consortium, and individuals.

2.3.2 Key Evaluation Criteria.

Each application will be evaluated according to the information provided by the applicant as detailed in Section 2.2. **The onus is on the applicant to provide sufficiently detailed information, data, and analysis for the Natural Resources Canada Technical Review Committee and Challenge Jury to fully understand and assess the viability of the proposal.**

The proposed solution of each applicant, as described in their application form, will be evaluated against the following criteria:

- How much of a quantifiable reduction in the energy required to crush and grind material in the mill (targeting a 20% reduction) would be achieved by implementing the solution in a mining operation, as indicated by:
 1. A calculation of the total quantity of energy required to produce one tonne of ground ore with a prescribed initial hardness and at a pre-determined particle size in a mill, as compared to a pre-established baseline level of consumption; OR,
 2. A calculation of the total energy saved through the replacement or elimination of particle size reduction in the process of mineral liberation for a prescribed initial hardness, as compared to a like-mineral liberation process that includes particle size reduction.

Applicants will be responsible for determining the baseline energy consumption measure against which they will compare applications of their solution. Outside of prescribed ore hardness, applicants are free to select the operational conditions (e.g. commodity, region/climate, geophysical characteristics) under which they plan to apply and test their solution. The savings should correspond to net energy savings that include any additional energy that will be consumed by supplementary equipment added to the process.

NOTE: evaluation of proposed solutions will take into consideration the choices made by applicants concerning baseline comparison and testing parameters. The effective applicability of a solution to a wide number of different ore, commodity, and operation types and sizes from across Canada is a key evaluation criteria that should be considered by applicants as they formulate their solutions.

- Whether, and by how much, implementing the solution would improve an operation’s overall productivity and generate ancillary environmental benefits.
 - With implementation of the solution, what would be the anticipated productivity (e.g. speed, efficiency, costs of production) gains for a mining operation?
 - How would implementing the solution reduce potential negative environmental impacts of a mining operation (e.g. greenhouse gas emissions, fresh water consumption, contaminated discharge)?

²A Small Enterprise is defined by Industry Canada as a for-profit organization with less than 100 employees.

- How easily the solution could be scaled or applied to a wide diversity of operation types
 - Could the solution be applied in both above and below ground operations, different regions/climates, operations of differing size, different commodities and extracted ore types, new or existing operations?
- How the solution would preserve or improve the quality of the mill's output, and any implications for downstream activities (i.e. total recovery rate).
 - Will the solution preserve or improve the effectiveness or efficiency of an operation's current liberation process to separate valuable minerals from waste rock?
- The overall business case and path to commercialization vis-à-vis project design, potential outcomes, and economics:
 - Uptake (is there a clear and compelling business case and path to adoption in Canadian mining operations?);
 - Design (does the project have the right project team, expertise, and resources?);
 - Viability (can the project be completed on time, as designed?);
 - Industry Pull (does the applicant have the support of an industry partner(s)?); and,
 - Economic and Social Benefits (revenue, new economic opportunities created, community/Indigenous impacts, etc.).

Consideration may also be given to factors that would help meet overall Impact Canada Program objectives, such as building partnerships, attracting new solvers, supporting high potential ideas, delivering transformative results, and increasing positive impacts across Canada, such as regional diversity and representation within the program.

Quality and thoroughness of the online application's contents will be a critical determinant in the success of the application.

2.4. Technology Readiness Level

The Challenge will focus on accelerating the advancement of new ideas or underdeveloped concepts at earlier TRLs (1-4) up to prototype/model tested TRLs (5-6). To be successful in **Round 1**, the applicant must clearly demonstrate in their online application that proposed activities would result in a testable product that has progressed approximately to TRL 5-6, by the conclusion of the Challenge.

For TRL definitions, see Annex B.

3. ROUND 2: PROPOSAL REFINEMENT, SELECTION OF FINALISTS

In **Round 2**, the up to twelve (12) participants (semi-finalists) selected will be required to develop and deliver a technical presentation for evaluation by the Challenge Jury, including necessary supporting presentation materials and a short video outlining their proposal, to be delivered at the #DisruptMining event at the 2019 PDAC Convention.

Each of the semi-finalists will be allotted a specific presentation space and time at the #DisruptMining event, and will be expected to be present throughout the event to answer any questions from Challenge Jury members and other event attendees.

Based on the Challenge Jury's recommendation, up to six (6) proponents will be selected by Natural Resources Canada as Challenge finalists and will proceed to **Round 3**.

3.1. Application Requirements for Round 2

In order to be considered, each of the chosen semi-finalists must provide the following to Natural Resources Canada (for review and consideration by the Challenge Jury), one week prior to the start of the PDAC 2019 Convention (deadline = February 24, 2019):

- Upload a digital file with a technical presentation outlining the proponent's proposal (approximately 20 minutes);
- Upload any digital file(s) containing any supporting presentation materials (e.g., proposal diagrams, technical drawings, scientific posters, digital models, visual aids, etc.);
- Upload a short video providing a high-level introduction of the project and the introduction of the project team (3-5 minutes);

- Attend the 2019 PDAC Convention and staff a booth at the #DisruptMining day event that displays information, diagrams, models, or other visual aids; and,
- Identification of lead participant, attendee, and presenter for the #DisruptMining evening event.

To the extent possible, these materials should not contain any proprietary or commercially sensitive materials as they may be circulated (all or in part) by Natural Resources Canada at the PDAC 2019 Convention to support collaborative efforts to drive visibility to the event and to facilitate potential connections to enable the development of successful projects.

3.2. Detailed Presentation/Proposal

Information provided in the presentation will be used by the Challenge Jury and the Natural Resources Canada Technical Review Committee to evaluate the capacity of the project to deliver upon its stated goals over an 18 month period. Each presentation is expected to expand on the information submitted in the initial application and be capable of answering detailed questions from the Challenge Jury in each area:

1. PROJECT OVERVIEW
2. PROJECT DESCRIPTION
3. PROJECT STATUS
4. METHODOLOGY
5. ENVIRONMENTAL IMPACTS
6. DOWNSTREAM IMPACTS
7. UPTAKE POTENTIAL AND SCALEABILITY
8. INNOVATIVENESS
9. ECONOMIC AND/OR SOCIAL IMPACT
10. RISK ASSESSMENT AND MITIGATION (*see section 3.2.1 – Risk Assessment*)

3.2.1. Risk Assessment (#10)

Each presentation must outline a risk mitigation plan for the full duration of the Challenge. The plan must identify any project risks, including:

- an overview of the financial, technical, organizational and environmental risks associated with the project;
- intended approaches for overcoming or mitigating risk, including prior experience managing similar or comparable risks; and,
- Details on the regulatory framework that applies to the project, including a summary of the permits/approvals required for the project, a status update and timeline for obtaining them, and the impact any delays in obtaining them may have on the overall project.

This risk assessment is intended to support the assessment of the viability of the project by the Challenge Jury and should cover the lead proponent and any anticipated project partners.

3.3. Challenge Jury Review and Selection

The Challenge Jury will comprise experts in mineral processing and mining innovation, clean technology, academia, and industry (with a maximum of three industry participants).

At the conclusion of **Round 2**, the Challenge Jury will make a recommendation to Natural Resources Canada for selection of the Challenge finalists based on: proponents' online application package and the #DisruptMining technical presentations and associated materials developed in support of the presentation.

4. ROUND 3: GRAND PRIZE WINNER SELECTION

Funding in **Round 3** will support up to six (6) proponents (finalists) with contribution agreements of up to \$800,000 each.

4.1. Contribution Agreement

Based on the recommendation of the Challenge Jury in **Round 2**, Natural Resources Canada will fund contribution agreements worth up to \$800,000 each with each of the up to six (6) finalists. The contribution agreement will be staged with timelines and milestones corresponding to those outlined in proponents' detailed proposal in the **Round 1** application, subject to negotiation between the proponent and Natural Resources Canada.

4.2. Detailed Technical Report

All **Round 3** finalists will be required to build their proposed solution concept into a testable prototype to clearly demonstrate the functionality and impacts of the solution. All evidence of the project's technical results (e.g. energy savings at the mill, impacts on operational productivity) will need to be assessed and validated by an accredited third party.

Each finalist will have an 18-month development window with the goal of achieving at least TRL 5-6.

At the end of the 18-month development window (November 2020), proponents must submit a detailed technical report, validated by an accredited third party, which demonstrates how their prototype product or process was tested and how it achieved the results set out by the Challenge. The detailed technical report must clearly outline the testing methods and results related to how the total reduction in energy required for crushing and grinding at the mill was achieved, the associated environmental impacts, impacts on downstream activities, and an assessment of the solution's applicability and scalability.

4.3. Project Evaluation

At the end of the 18-month development window, the Challenge Jury, with input from the Natural Resources Canada Technical Review Committee, will evaluate the submitted detailed technical reports, including all supporting documentation, and determine the final \$5 million Grand Prize winner.

The Grand Prize will go to the solution that demonstrates the largest total step-change in energy savings at the mill vis-à-vis the baseline measurement identified by the proponent, that also provides the best possible opportunity for the mining industry in terms of:

1. Overall improvement to mining operations' impact on the environment;
2. Preservation or improvement of mining operations' productivity;
3. Quality of output product for downstream recovery;
4. Scalability/applicability to many different mining projects of different size and type; and,
5. Wider beneficial impacts to Canadians (economic opportunity, public confidence),

*as determined by the Challenge Jury in consultation with Natural Resources Canada technical reviewers.

4.4. Grand Prize Winner

Based on the Challenge Jury's final selection and recommendation, Natural Resources Canada will award a single (1) \$5,000,000 Grand Prize to the winning proponent.

Finalists that are unable to produce a testable solution that progresses to approximately TRL 5-6 will be excluded from consideration for the Grand Prize.

Overall assessment and final selection will take into account Key Evaluation Criteria (see section 2.3.2).

The final Grand Prize winner will be announced by March 2021.

The proponent with the winning submission will be awarded a \$5,000,000 grant to further advance its TRL 5-6 solution toward adoption and potential future integration into an operating mine site. The proponent may be asked to provide voluntary updates to Natural Resources Canada on the progress of the project.

5. TERMS OF FUNDING

- Up to twelve (12) applicants selected to participate in **Round 1**, where the Project Lead is a qualified “small-scale” innovator, will receive a \$10,000 prize through a micro-grant from Natural Resources Canada.
- Natural Resources Canada guarantees the availability of up to \$10,000 for each of the eligible semi-finalists in **Round 1**.
- Up to six (6) projects will be eligible for up to \$800,000 through a contribution agreement to be negotiated between Natural Resources Canada and the finalists in **Round 3**.
- Natural Resources Canada guarantees the availability of up to \$800,000 for each of the selected finalists in **Round 3**.
- Natural Resources Canada does not guarantee payment of the full or partial amount of the **Round 3** contribution agreements. Payments can be delayed or withheld if a finalist does not meet the expected milestones identified in the proposal.
- One (1) finalist will be eligible for the \$5,000,000 Grand Prize through a grant to be negotiated between Natural Resources Canada and the Challenge winner in **Round 3**.
- Natural Resources Canada guarantees the availability of \$5,000,000 for the selected Winner at the conclusion of **Round 3**.
- The Minister reserves the right to terminate any and all agreements in the event that the internal evaluation committee determines that some of the milestones could not be achieved.

CONTACT INFORMATION

For any questions or clarifications regarding the Crush It! Challenge, please contact:

Natural Resources Canada Mining Challenge Team

nrcan.miningchallenge-defiminier.nrcan@canada.ca

Updates will be provided on the Challenge website at <http://impact.canada.ca>, where applicants can review the FAQs as well as find out the latest news.

Applicants are encouraged to follow us on social media for the latest developments:



Twitter: @NRCan <https://twitter.com/NRCan?lang=en>



Facebook: Environment and Natural Resources in Canada https://www.facebook.com/EnvironmentandNaturalResourcesinCanada/?ref=br_rs



LinkedIn: Natural Resources Canada <https://www.linkedin.com/company/natural-resources-canada>



Instagram: naturalresourcescanada <https://www.instagram.com/naturalresourcescanada/>

ANNEX A – Challenge Definitions

In the context of Challenge, the following definitions apply.

Comminution: Synonymous of particle size reduction. The process of breaking large particles to smaller particles.

Gangue: The unwanted portion of an ore.

Liberation: The process whereby valuable minerals are separated from the gangue fraction. Percentage of the area of the valuable mineral that is exposed (e.g. 100% means that the area of the valuable particle is completely exposed).

Major step change: a significant change in a process that is not simply optimization and leads to a substantial improvement.

Mill: A plant where ore is processed to concentrate the valuable minerals (also called a concentrator).

Mining Cycle: Refers to the following stages 1) prospecting and exploration, 2) development; 3) extraction, and 4) closure/reclamation.

Particle Size Reduction: Is the operation carried to decrease the size of bigger particles into smaller ones of desired size and shape with the help of external forces.

Sample Size: A portion that represents a whole population. The number of sampling units which are to be included in the sample. In the case of a multi-stage sample this number refers to the number of units at the final stage in the sampling. Also, a mass that represents the entire stream or population. For example, a sample of the flotation feed means that this sample represents (particle size distribution and assays) of the entire flotation feed. If not, it is called a specimen.

ANNEX B – Technology Readiness Levels

Technology Readiness Level (TRL) is a measure used to assess the maturity of evolving technologies (devices, materials, components, software, work processes, etc.) during their development and, in some cases, during early operations. Generally speaking, when a new technology is first invented or conceptualized, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement, and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/subsystem.

The lowest level, TRL 1, indicates that information already learned from basic scientific research is taking its first step from an idea to a practical application of a lesson learned. For example, after learning that hydrogen and oxygen can be combined to generate electricity, some would suggest an idea for building a machine to do just that.

A technology that has achieved TRL 9 is one that has been incorporated fully into a larger system. It has been proven to work smoothly and is considered operational. An example of an operational TRL 9 technology is the fuel cells which combine hydrogen and oxygen to generate electricity for NASA's space shuttle.

Technology Readiness Level Descriptions:

0. R&D not specifically intended for technology development (but could be in support of technology adoption). Examples are knowledge generation to support codes, regulations and standards needed to support domestic adoption and to support Canada's position in opposing non-tariff export barriers. Also includes Basic Research conducted prior to Applied Research.
1. Early-stage scientific research begins the translation to applied R&D - lowest level of technology readiness. Basic scientific research begins to be translated into preparatory applied research and development. Examples include paper studies of a technology's basic properties, algorithms and mathematical formulations.
2. Technology development begins - once basic principles are observed, development of practical and specific applications can be initiated. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies, including concept development.
3. Active R&D is initiated - active research and development is initiated to establish proof of concept, including analytical and laboratory studies to physically validate analytical predictions of separate elements of the technology, i.e., individual components that are not yet integrated into the technology.
4. Basic technological components are integrated to establish that the pieces will work together, i.e. initial operational characterisation of technology. Standalone component prototypes implemented and tested.
5. System / subsystem prototypes are improved significantly - the basic technological components / prototypes are integrated within a reasonably realistic supporting environment so that the technology concept can be tested in a simulated environment. Examples include bench-scale laboratory integration of components and observation of operating characteristics.
6. Model/prototype is tested in relevant environment - representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant test environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype at the pilot scale, integrated with existing systems, if applicable, in a laboratory environment or in a simulated operational environment. Engineering feasibility demonstrated.
7. Prototype near or at planned operational system - represents a major step up from TRL 6, requiring demonstration of an actual system prototype in the intended operational environment. Examples include field testing or field trials over a period sufficient to provide meaningful data on the performance of the technology.
8. Technology is proven to work in a "real world" operating environment - actual technology completed and qualified through test and demonstration. This includes projects currently at the demonstration project stage.
9. System proven through successful demonstration. Actual application of technology is in its final form – commercialisation-ready technology proven through successful operations.

Annex C – Documentation Supporting Applicant Eligibility

The following information must be included, for the lead applicant and any major financial contributors to the project (excluding, governments & academia), combined into a single document and submitted online as part of the application.

For further guidance, please contact the Clean Tech Impact Team at nrcan.cleantechimpact-impacttechpropres.nrcan@canada.ca.

Only for Independent innovators, unaffiliated consortiums, and individuals who are a Canadian citizen(s) or permanent resident(s) of Canada

1. Organizational description – including but not limited to the following:
 - a. A description of what the Applicant does (i.e. industry, product/service offering);
 - b. Number of employees in the Applicant organization (at time of application);
 - c. Provide a scanned copy of a legal proof of address (e.g., driver's licence, property ownership, lease or rental agreement, utility bill, or other identification valid in the local jurisdiction) for the Project Lead) as a separate attachment.

Proof demonstrating that a legal entity (company or corporation) duly incorporated and validly existing in Canada has been established to represent the applicant, must be submitted prior to the announcement of the Challenge finalists (May 2019). This is only required if the project has been selected as a Challenge finalist.

Only for legal entities duly incorporated and validly existing in Canada:

1. Organizational description – including but not limited to the following:
 - a. A description of what the Applicant does (i.e. industry, product/service offering);
 - b. Number of employees in the Applicant organization (at time of application);
 - c. When did the Applicant incorporate and where is it located (principal office);
2. Financial statements (including balance sheet, income statement, cash flow, notes to the financial statements and if available, management discussion and analysis) for the preceding 2 fiscal years. If available, please include the most recent interim internal financial statements and cash flow projections. If financial statements are publicly available, you may refer to the location on your website where they can be found.
3. Letter of credit or bank reference letter from the relevant financial institution, or parent company showing guarantees relating to the Applicant's or any Project partners' credit (if no public credit ratings are available).
4. Documentation and a corresponding dollar value relating to any of the following (if applicable):
 - a. Any current or potential litigation;
 - b. Any significant commitments and contingencies outside the normal course of business;
 - c. Description of any other significant projects under consideration or currently being undertaken by the Applicant.

Annex D – “Small-Scale” Innovator Additional Requirements

This section is only relevant to “small-scale” innovators for the purpose of receiving a \$10,000 micro-grant to facilitate their participation at the 2019 PDAC Convention. Activities may include travelling, developing and presenting a technical presentation before the Challenge Jury at the #DisruptMining evening event, and staffing a booth at the #DisruptMining day event that displays information, diagrams, models, or other visual aids. **Annex D must be reviewed in its entirety, signed, and dated wherever indicated, and included as part the online submission in order to be eligible for the micro-grant.**

Eligibility criteria for the micro-grant:

1. Small-scale innovator:

- a. Small Enterprises, as defined by Industry Canada as for-profit organizations with less than 100 employees, including companies, industry associations, and research centres;
- b. Not-for-profit organizations;
- c. Indigenous organizations and groups;
- d. Canadian post-secondary institutions; and,
- e. Independent innovators, unaffiliated consortium, and individuals.

2. Round 1 Crush It! Challenge Semi-finalist

In addition to the above criteria, recipients agree to publicly share project results on social media on or before April 6, 2019.

Declaration

As the authorized person to sign for the Applicant, I declare that:

- The information in the application is true, accurate and complete;
- I fulfill the eligibility requirements for a “small-scale” innovator as outlined above and will continue to maintain eligibility for the duration of the micro-grant;
- I have all the necessary authorities to undertake the proposed project, or will obtain these authorities prior to the approval of the project;
- If selected as a Challenge finalist, I will become a legal entity (company or corporation) duly incorporated and validly existing in Canada in order to adhere to eligibility requirements;
- I and any person lobbying on my behalf to obtain funding are in compliance with the Lobbying Act and that no actual or potential, direct or indirect, contingency fee arrangement exists;
- No public servant or holder of public office, past or present, will derive a direct benefit from the approved funding in breach of the Values and Ethics Code for the Public Service or the Conflict of Interest Act; and,
- I will act in compliance with applicable statutes, regulations, orders, standards and guidelines governing the program from which funding is being sought.

I acknowledge that the submission of this Application does not constitute a commitment on the part of the Minister of Natural Resources to award funding. The payment of monies by Canada is subject to there being an appropriation by Parliament for the Fiscal Year in which the payment of monies is to be made.

I authorize the Minister of Natural Resources to disclose any information submitted in this Application within the Government of Canada or to outside entities, subject to applicable restrictions associated with privacy, confidentiality and security for the following purposes:

- To reach a decision on the application;
- To support transparency, accountability and citizen engagement; and,
- To respond to requests made under the [Access to Information Act](#) and the [Privacy Act](#).

Signature:

Date:

Official languages

English and French are the official languages of Canada. The Government of Canada is committed to enhancing the vitality and supporting the development of the English and French linguistic minority communities in Canada and to fostering the full recognition and use of both English and French in Canadian society.

Important: you are required to adhere to provincial/territorial regulations or laws.

Signature:

Date:

Attestation

If funds are approved, as the authorized person to sign for the Applicant, I agree that:

- This *Crush It! Challenge Application* in combination with a Funding Approval Notice will constitute the entire Agreement for the \$10,000 micro-grant between myself (the Applicant) and the Minister of Natural Resources Canada, effective as of the date of the Funding Approval Notice;
- This Agreement does not create a partnership, agency or joint venture and I shall not represent myself as an agent, partner or employee of the Department in carrying it out; and,
- I will share results, on social media, if requested.

In addition, I shall:

- Use the funds only for the purposes specified in this Agreement;
- Indemnify the Minister of Natural Resources Canada from any claim or cause of action arising from injury, damage, or death sustained in carrying out this Agreement; and,
- Publicly acknowledge the funding.

Signature:

Date:

Annex E – Consent for Information Sharing

Please complete and attach this form to your submission in order for information to be shared.

Do you give Natural Resources Canada permission to share any information provided for the purposes of The Crush It! Challenge with other funding entities of the:

- Government of Canada;
- provincial, territorial, or municipal governments; or
- not-for-profit sector (e.g., Sustainable Development Technology Canada, the Green Municipal Fund)?

YES ____

Do you give Natural Resources Canada permission to share any information provided for the purposes of the Challenge with the Government of Canada's Clean Growth Hub? The Clean Growth Hub is a whole-of-government focal point for clean technology focused on supporting companies and projects.

YES ____

Do you give Natural Resources Canada permission to share any information provided with the Centre for Excellence in Mining Innovation for the purposes of providing development and commercialization services.

YES ____

Full Name: _____

Address: _____

Signature: _____

Date: _____

ANNEX F – Detailed Project Proposal

A detailed project proposal following the guidelines stated below is required in order to review and assess all submissions.

- PROJECT OVERVIEW
 - What does the project intend to undertake?
 - How does the project align with the scope of the Challenge program?
 - What elements of the mining cycle (e.g. blasting, sorting, sensing, grinding) will the project target?
- PROJECT DESCRIPTION
 - Describe in detail how the proposed solution will achieve a step-change reduction in energy required for crushing and grinding as part of the process of mineral liberation.
 - Describe in detail how the solution would benefit the productivity, efficiency, and environmental impacts of mining in Canada.
- PROJECT STATUS
 - Describe any work and financial investment that has been completed to date on the project, including an assessment of the current technology readiness level (TRL). For TRL definitions (see Annex B).
- METHODOLOGY
 - How will the project be carried out?
 - Include a description of the tasks, methodology, and document key timelines/milestones for each considering the 18-month development window allotted by the project in **Round 2** with the goal to achieve approximately TRL 5-6 and a prototype that can demonstrate results.
 - Use the **project work plan** below; add or delete lines (tasks or phases) as necessary. Note, a version of this table will be used in the agreement if the project is approved for funding.

	Project Tasks	Description	Outputs
1.0	Phase 1: <Insert phase name>		
1.1	Task title <Enter timeline>	<Describe briefly>	(Note only key outputs should be entered that the Project is contingent upon – eg. Building Permit obtained construction can commence)
1.2	Task title <Enter timeline>	<Describe briefly>	
1.3	Task title <Enter timeline>	<Describe briefly>	

	Project Tasks	Description	Outputs
2.0	Phase 2: <Insert phase name>		
2.1	Task title <Enter timeline>	<Describe briefly>	(Note only key outputs should be entered that the Project is contingent upon – eg. First floor is completed)
2.2	Task title <Enter timeline>	<Describe briefly>	
2.3	Task title <Enter timeline>	<Describe briefly>	
3.0	Phase 3: <Insert phase name>		
3.1	Task title <Enter timeline>	<Describe briefly>	(Note only key outputs should be entered that the Project is contingent upon – eg. Second and third floor are completed)
3.2	Task title <Enter timeline>	<Describe briefly>	
3.3	Task title <Enter timeline>	<Describe briefly>	

- ENVIRONMENTAL IMPACTS
 - Beyond anticipated improvements in energy consumption, identify and describe in detail the anticipated environmental impacts (positive or negative) of applying the solution in a mining operation (e.g. impacts on GHG emissions, fresh water consumption, environmental footprint). Both direct and indirect environmental impacts should be outlined in this section.
- DOWNSTREAM IMPACTS
 - Identify and describe anticipated impacts (positive or negative) of applying the solution on the mining operation on downstream activities (e.g., flotation, concentration, thickening, leaching, recovery, smelting, refining, etc.).
- UPTAKE POTENTIAL AND SCALEABILITY
 - Describe anticipated key products that will be generated by the project (e.g., intellectual property, prototypes, business case or feasibility of a demonstrated technology), and the anticipated adopters of the solution in Canada and abroad.
 - Describe in detail your commercialization plan to ensure your solution is adopted by the Canadian mining industry. *(NOTE: for the initial application stage, a commercialization plan can include notional or anticipated items based on exposure via the Challenge competition – a concrete commercialization plan and path to adoption will be a required element for the Grand Prize winning solution, however).*
 - Describe the anticipated scalability and applicability of the project final product or process across the Canadian mining sector (e.g. cost-effective applicability to future or existing mining operations, different geophysical compositions of extracted ores, commodity, geographic location/climate, etc.)
- INNOVATIVENESS
 - How is the proposed project innovative or novel?
 - Provide context on similar projects already being undertaken in Canada and elsewhere, and describe how this project is different or transformative.
- ECONOMIC AND/OR SOCIAL IMPACT
 - Describe the potential economic and social impact(s) should the project be successful, both at an operational level and more broadly, sector-wide in Canada (e.g. by reducing costs, creating new revenue streams, new employment or economic opportunities for communities, improving public confidence in mining operations, etc).

The Detailed Project Proposal must also include the following Attestation signed by the lead applicant:

By submitting this proposal, the Applicant attests that:

- It is duly incorporated and validly existing in Canada or a Small-scale innovator as defined in 2.3.1.
- It is acting on behalf of all partners and collaborators and has received written permission from them to do so.
- Barring unforeseen events that could reduce their capacity, the applicant and participating partners and collaborators have, and will retain over the lifetime of the project, the technical and personnel capacity to undertake and complete the project, and that they have contingency plans in place to minimize, as far as possible, the impact of any such unforeseen events.
- All funding (cash and in-kind) identified by the applicant and its partners and collaborators in the proposal is expected to be available for commitment at the time of the signing of the Contribution Agreement by duly authorized representatives of the project applicant and its partners and collaborators.
- It agrees with the terms and conditions of the Crush It! Challenge .
- Any proprietary or confidential information provided as part of the submission, by any party, is provided with the approval of that party. Federal reviewers are bound by the requirements of the Access to Information Act and the Privacy Act regarding the treatment of confidential information.
- It understands and acknowledges that should the project be accepted for funding from Clean Tech Impact, no liability and no commitment or obligation exists on the part of Natural Resources Canada to make a financial contribution to the project until a written contribution agreement is signed by both parties, and, furthermore, that any costs or expenses incurred or paid by the applicant prior to the execution of a written contribution agreement by both parties are the sole responsibility of the applicant, and no liability exists on the part of Natural Resources Canada.
- It understands and acknowledges that Natural Resources Canada officials will not entertain any request by project proponents to review or revisit Natural Resources Canada's project approval decisions.
- It understands and acknowledges that Natural Resources Canada reserves the right to alter or cancel the currently envisaged process at its sole discretion.
- The individual signing below attests that he / she has the authority to sign a legally binding contribution agreement between Natural Resources Canada and the project proponent.

Please sign below to confirm these attestations:

Name of Duly Authorized Officer for Applicant:

Title:

Date