BC Bioenergy Network Challenge: RNG Supply Chain Enhancement

Call for Proposals from Innovators

**Challenge Synopsis**

BC Bioenergy Network (BCBN) and the Foresight Advanced Resource Clean Technology Innovation Centre (ARCTIC) are putting forth a Challenge focused on improving the economics of B.C.’s Renewable Natural Gas (RNG) Supply Chain. Nutrient recovery technologies (NRTs) produce a concentrated nutrient product that may more easily/cost-effectively be transported off-site and/or potentially transformed into a higher value product (e.g., organic fertilizer).

This Challenge seeks solutions to convert nutrients from anaerobic digestate into more concentrated and/or higher value products. This conversion will enhance the economics of current and potential future anaerobic digestion (AD) facilities operating in the Province of BC, and potentially create exportable solutions that could impact the economic viability of AD technology globally.

**Challenge Statement**

BCBN is seeking technology options and processes that can improve the economics of the RNG supply chain through conversion of anaerobic digestate into more concentrated and/or higher value products. The objective is to make AD facilities more economically viable by addressing technology pain points across the supply chain and, in turn, increasing the overall supply of pipeline-grade RNG in the Province over the long-term.

This challenge is focused on improving the economics of AD facilities by converting digestate into more concentrated and/or higher value product(s).

**Funding Opportunity:** Up to $300,000 (Canadian) for the current Sprint Phase outlined in this Call for Proposals.

Response Due Date: **FEBRUARY 28, 2018 at 11:59 PM PST**

**Contact Information:**

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***Only non-confidential information should be included in the response ***
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The ARCTIC Program Process

This Challenge has been designed and enabled by the Advanced Resource Clean Technology Innovation Centre (ARCTIC) Program, which is designed to model a new approach for industry and innovator collaboration. There are four critical phases of activity designed to produce relevant field trials that will validate solutions to resource sector-defined challenges. An outline and summarized description of the phases is provided below, with a detailed description found in Appendix 4.

Phase 1: Challenge Definition (3 months) - Completed
Along with resource sector partners and ARCTIC program participants, Foresight defines a specific challenge to focus innovators on the most promising market opportunities.

Phase 2: Innovator Selection (2 months) – Current Phase
A panel of industry, investor, and selected subject-matter experts will select 2 to 5 solutions from the pool of respondents to the Challenge to take part in a Challenge Sprint.

Phase 3: Challenge Sprint (Up to 5 months)
This Challenge Sprint will be sponsored by BCBN and will leverage the ARCTIC program and its mentorship services to advance the development of the proposed solutions. In this Challenge, proponents will be asked what activity or activities (e.g., testing, material validation) are needed to advance their solution towards implementation and can be completed in the time frame for the Challenge Sprint Phase.

Phase 4: Field Trial Preparation (Up to 10 months)
Following the Challenge Sprint, one solution may be selected for field-testing, or for the next appropriate level of development. The Field Trial Phase will focus on advancing the technology towards commercial readiness, including equipment specification requirements.
The Size of the Opportunity (for Innovators)
The total funding available for projects supported through this Call for Proposals is up to $300,000 Canadian Dollars (CAD), subject to the discretion of BCBN, ARCTIC / Foresight, and the availability of funds.

The Challenge Sprint Phase is designed to involve 2 to 5 proponents in advancing proposed solutions. The per project costs can vary based on the final number of projects in the Sprint. The maximum contribution includes provision for lab space and overheads, marketing, a lab manager, equipment, materials, accelerator mentoring and cash.

The winner(s) of the Challenge Sprint will be invited to undertake the next step in the development of the innovation process (i.e., field trial or equivalent). The contribution from BCBN and the ARCTIC Program to this Field Trial Phase includes support for a test site, test support, equipment, materials and cash.

Background Context for this Challenge

The Business Driver
The Government of B.C. has taken action to support investments by natural gas utilities that will increase the production of RNG. B.C.’s gas utilities are now able to pay up to $30/GJ for RNG, with access for up to 5% RNG in pipeline content. At this price point, the RNG market in B.C. is expected to grow over the next few years, creating exciting opportunities to turn manure, food waste, yard waste, biosolids, woody biomass, and other biomass into RNG.

RNG can be produced from many feedstocks and through many processes. After consultation with stakeholders from various industries, it was determined that a significant opportunity to improve the business environment for RNG production in B.C. in the immediate-term is to focus this Challenge on improving the economics of on-farm AD solutions that utilize food waste, animal manure and crop waste as feedstocks. In particular, this Challenge will focus specifically on technologies that can convert digestate into a higher value and/or more easily transportable product(s).
Background on Anaerobic Digestion

Biogas and RNG are produced via a well-established process using anaerobic digestion (AD) technology. AD technology has been a commercialized technology for decades, with thousands of anaerobic digesters in operation around the world.

AD involves a series of biological processes that take place in the absence of oxygen, to break down organic materials into biogas and digestate. More than two dozen types of AD technologies exist and are in use around the world, with technology varying based on the application and feedstock characteristics.

Biogas typically contains 55%-65% methane (CH₄), 35%-45% carbon dioxide (CO₂), some hydrogen sulfide (H₂S), moisture, and other trace compounds.¹ Before injection into the natural gas pipeline and/or use for transportation fuel, the impurities in biogas, such as CO₂, H₂S and moisture, must be removed.

Background on RNG Production in B.C.

In B.C., there are approximately 20-35 dairy farms with more than 200 milk cows. Due to volume of manure, these farms are most suited to the production of biogas / RNG. At the moment, however, only two farms / agricultural facilities in B.C. have built AD facilities to produce RNG for injection into the pipeline (see Appendix 2). There are multiple reasons for this low uptake of AD technology by farmers in B.C. to date, including:

- Until March 2017, natural gas utilities in B.C. were only allowed to pay up to $15/GJ of RNG. This made the economics of on-farm AD plants challenging;
- A range of regulatory hurdles which can be complex and are time consuming and costly to overcome; and
- The handling of digestate can be a challenge in areas with many livestock operations and limited agricultural land.

By focusing on the last point above (i.e., digestate management) this Challenge seeks to address a critical pain point for B.C. farmers by exploring the potential to improve the business case for AD facilities by finding new market opportunities for digestate through Nutrient Recovery Technologies (NRTs) and the development of market-viable end-products.

**Nutrient Recovery & Related Technologies**

A farm’s ability to apply or sell the digestate and related nutrients produced by its on-farm AD process impacts the size of the system and associated operating costs for nutrient recovery, land costs, and associated digestate transportation costs.

B.C. farms with AD facilities are required to operate under a Nutrient Management Plan (NMP). The purpose of a NMP is to ensure crops are supplied with nutrients at the appropriate rate and timing to minimize the risk of pollution by loss of nutrients via runoff, leaching, emissions to the air, or other loss mechanisms.

In areas with many livestock operations and limited agricultural land, on-farm AD facilities face nutrient management challenges as the addition of non-agricultural feedstock, such as food waste, significantly increase the availability of nitrogen and phosphorous in digestate when compared to dairy manure. If land applied locally, this digestate can cause nutrient overloading in fields.

For this reason, RNG production from on-farm AD technology in B.C. is often only possible when using Nutrient Recovery Technologies (NRTs). This is because NRTs can concentrate nutrients and potentially create higher value co-products to improve the economics of AD facilities.

NRTs can enable the concentration and removal of nutrients, as illustrated in Figure 1 (the latter pathway of recovered nutrients for export or sale being the focus of this BCBN ARCTIC Challenge).

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Figure 1: Nutrient Recovery Process

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NRTs produce a concentrated nutrient by-product that can be transformed into a higher value product which may be more easily transported off-farm. NRTs can be mechanical (such as screens, screws or belt presses, centrifuges, membranes, and dryers), biological (enhanced biological phosphorous removal, ammonia-N stripping, microalgae, etc.), and chemical (flocculation, struvite precipitation, etc.).

This Challenge is focused on improving the economics of AD facilities by converting digestate into more concentrated and/or higher value product(s).

**Nutrient Extraction Challenge Overview**

This Challenge will focus on advancing solutions / technologies at **Technology Readiness Levels** ("TRL") 5-9. Partial solution submissions are encouraged and consortium applications are welcome. Through the ARCTIC Program and its multiple stages, the technology will be de-risked as it advances in maturity. Details on the stages are provided in the section below entitled *The ARCTIC Program Process*.

**The Challenge Statement**

BCBN is seeking technology options and processes that can improve the economics of the RNG supply chain through innovative Nutrient Recovery Technologies from digestate. The objective and end goal is to improve the RNG supply chain in B.C. and/or make projects more economically viable by addressing technology pain points across the supply chain and, in turn, increase the overall supply of pipeline-grade RNG in B.C. over the long-term.

This challenge is focused on improving the economics of AD with enhanced nutrient recovery solutions.

The successful technologies or engineering process improvements will:

- Improve the business case for pipeline-grade RNG production by developing or adapting a technology to improve nutrient recovery processes and/or the development of higher value products from digestate.
- Describe a path to commercial viability.

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Solutions, complete or partial, at Technology Readiness Levels 5-9 of technical maturity are of interest. The objective of this Challenge is to accelerate the development and application of short listed solutions.

Proposed technology solutions should have the potential to be replicated and/or scaled to other RNG production projects in B.C. and/or other jurisdictions across Canada or internationally.

**The Challenge – Key Performance Indicators (KPIs)**

The evaluation of proposed solutions for Phase 3 (i.e., the Challenge Sprint Phase) of this Challenge will be based on the KPIs presented below. BCBN is interested in information regarding how each proposed solution relates to the following key performance indicators, where possible. Detailed questions for proponents to respond to are included in the Response Template found in Appendix 1.

1. Technology and business readiness
2. Business Case Feasibility
3. Solution process requirements
4. Nutrient by-product benefits, value, and quality
5. Size, mobility, and versatility
6. Supplementary indicators:
   a. Technology development plan
   b. Project team

**Technology and Business Readiness**

Table 1 describes Technology Readiness Scale. Technologies from TRL levels 5-9 are of interest. Please indicate in your submission the TRL level of the proposed solution. If the proposed technology solution is currently operating in another sector or market, please note which sector and considerations for adapting it to B.C.’s on-farm AD facilities. Please refer to question 2.8 in Appendix 1 for submission details.
<table>
<thead>
<tr>
<th>Basic Description (TRL #)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic principles observed and reported (TRL 1)</td>
<td>Lowest level of technology maturation. At this level, scientific research begins to be translated into applied research and development.</td>
</tr>
<tr>
<td>Technology concept and/or application formulated (TRL 2)</td>
<td>Once basic physical principles are observed, practical applications of those characteristics can be “invented” or identified. Application is still speculative. Experimental proof or detailed analysis to support is conjecture.</td>
</tr>
<tr>
<td>Analytical and experimental critical function and/or</td>
<td>Research and development is initiated including studies to set the technology into an appropriate context and to physically validate that the analytical predictions are correct. This includes “proof of concept” validation of the applications of the discovery phase.</td>
</tr>
<tr>
<td>characteristic proof of concept (TRL 3)</td>
<td></td>
</tr>
<tr>
<td>Component validation (TRL 4)</td>
<td>Following successful “proof of concept”, basic technological elements are integrated to establish that the “pieces” will work together to achieve concept-enabling levels of performance. Validation to support the concept that was formulated earlier.</td>
</tr>
<tr>
<td>System validation in relevant environment (TRL 5)</td>
<td>Increased effort to validate the components. The basic technological elements must be integrated with reasonably realistic supporting elements so that the total applications (component-level, subsystem level, or system-level) can be tested in a somewhat realistic environment.</td>
</tr>
<tr>
<td>System/subsystem model or prototype demonstration in a relevant environment (TRL 6)</td>
<td>A representative model or prototype system would be tested in a relevant environment. At this level, if the only “relevant environment” is the environment of space, then the model/prototype must be demonstrated in space.</td>
</tr>
<tr>
<td>System prototype demonstration in an actual environment (TRL 7)</td>
<td>System prototype demonstration in a relevant environment. The prototype should be near or at the scale of the planned operational system with an actual and realistic (e.g. field) system demonstration.</td>
</tr>
<tr>
<td>Final system test and demonstration (TRL 8)</td>
<td>In almost all cases, this level is the end of true “system development” for most technology elements. This might include integration of new technology into an existing system.</td>
</tr>
<tr>
<td>True system demonstration (TRL 9)</td>
<td>In almost all cases, the end of last “bug fixing” aspects of true “system development”. This might include integration of new technology into an existing system. This TRL does not include planned product improvement of ongoing or reusable systems.</td>
</tr>
</tbody>
</table>
Business Case Feasibility
Outline any critical business case assumptions to evaluate your solution’s impact on the operations of an existing AD facility, including:

<table>
<thead>
<tr>
<th>Business Case</th>
<th>Startup</th>
<th>Annual</th>
<th>3 Year Total Cost of Ownership</th>
</tr>
</thead>
</table>

**Revenue Sources** *(only include revenue derived from your proposed solution)*
- Digestate
- Recovered Nutrients
  - NPK Ratios
  - Volumes
  - Unit Value
- Other By-Products
  **TOTAL Revenue (A)**

**Direct Costs**
- Capital Costs *(Equipment and Installation)*
- Operating Costs
  **TOTAL Direct Costs (B)**

**Cost Avoidance**
- Power Savings
- Transportation
- Other
  **TOTAL Cost Avoidance (C)**

**TOTAL Costs (B+C)**

**Net Benefit** *(A-(B+C))*

Please outline key assumptions used to justify your proposed business case, including:

- Recovery efficiency of the technology / solution
  - NPK Values;
  - Cake quality (% Dry Matter);
- Capital Costs *(CapEx)* & Operating costs *(OpEx)*;
- Target size of the operation for the application of this solution;
- Portability;
Versatility (requirements around pre-treatment and estimated costs);
- Potential market value of resulting products such as nutrients, resulting digestate cake and/or other by products; and
- Avoided costs, such as transportation cost savings resulting from reduced volumes.

**Solution Process Requirements**

To evaluate the proposed solution(s), the process requirements will need to be provided. The process requirements should use the following information as the reference case for B.C. in terms of the nutrient values from the digestate produced from the AD of agricultural waste resulting from a complete mix digester:

**Digestate (pre-nutrient recovery):**

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Pounds/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>5.00%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.22%</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.04%</td>
</tr>
<tr>
<td>Potash</td>
<td>0.10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Pounds/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>4.4</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.8</td>
</tr>
<tr>
<td>Potash</td>
<td>2.0</td>
</tr>
</tbody>
</table>

In addition, this ARCTIC Challenge is open to considering technologies for turning the nutrients extracted from the digestate following the NRT process into a marketable product (e.g., cake, pellets, etc.) for sale and export off the farm / off-site.

**The current reference case for “cake” composition**

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Pounds/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>15.40%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.374%</td>
</tr>
<tr>
<td>NH₃N</td>
<td>1136 ppm</td>
</tr>
<tr>
<td>Phosphate (P as P205)</td>
<td>0.239%</td>
</tr>
<tr>
<td>Potash (K as K-20)</td>
<td>0.466%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Pounds/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>7.50</td>
</tr>
<tr>
<td>NH₃N</td>
<td>2.30</td>
</tr>
<tr>
<td>Phosphate (P as P205)</td>
<td>4.80</td>
</tr>
<tr>
<td>Potash (K as K-20)</td>
<td>9.30</td>
</tr>
</tbody>
</table>

The cake’s moisture content makes it difficult to store and also expensive to move for land application.

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4 The “cake” is the resulting material after digestate has gone through the nutrient recovery process.
a. Extracted Nutrient Benefit Value and Quality
The type, value, and quality of extracted nutrients should be identified as well as the potential downstream upgrading to the processed by-product (e.g., cake, pellets, etc.) to further maximize economic potential of the technology.

b. Material and Energy Balance
A simplified process flow diagram should be included with known (or estimated) energy and mass balances. Please include equipment in the process flow diagram. Please refer to question 2.3 in Appendix 1 for submission details.

Supplementary Information
a. Technology Development Plan
Applicants should describe their technology development plan with milestones, capital requirements, and other information that will help reviewers understand the time to commercialization. Please refer to question 2.8 in Appendix 1 for submission details.

b. Project Team
Applicants should provide project team members, project roles, experience, and additional background on the project team as appropriate. If there are existing partners, their names and roles should be stated.
Response Evaluation Criteria

The evaluation criteria used for selecting innovators for Phase 3 (Challenge Sprint) of this Challenge are:

- **Solution Performance (Weight = 30%)**
  - Improvements to the duration and processes associated with one or more of the following steps:
    - AD digestate nutrient recovery
    - Drying of digestate
    - Converting the digestate cake into a valuable product
  - Capital and operating costs
  - Reliability
  - Environmental impacts and benefits

- **By-Product Economic Benefits (20%)**
  - Payback period
  - Ability to improve the operating costs associated with on-farm anaerobic digestion.

- **Readiness (30%)**
  - Demonstration, proof-of-concept, experience, sector fit
  - Delivery time / product readiness
  - Technology Readiness Level (TRL)
  - Modularity
  - Operational scalability

- **Execution (10%)**
  - Ease of application and adoption by industry
  - Capital required by industry to adopt the solution

- **Proponent (10%)**
  - Proponent experience, projects, clients, understanding of the challenge
Expected Project Deliverables

If the information is available, secondary evaluation criteria will include:

- Already met government regulations (provide links to relevant regulations)
- Training requirements for use of the technology
- Robustness and reliability

Phase 3 (Sprint) participants will be expected to produce the following deliverables:

- Third party verification of solution technical and projected economic performance (report);
- Demonstration of the performance of technology with a sample of digestate or cake; and
- Others deemed necessary based on the proposed solution.

Phase 4 (Field Trial) evaluation criteria will include these same factors, with a greater emphasis on the scalability of the technology solution, the business case and proponent. A field demonstration will be expected.

**NOTE: Shortlisted Companies could be required to provide additional documents, including financial statements, and a business plan. These are not required for responding to this request.**
The Challenge Sponsors

**BC Bioenergy Network**

Since its establishment in 2008, BC Bioenergy Network (BCBN) has been the leading agency accelerating the demonstration of bioenergy technologies in the Province. This has been realized through project investment, championing the utilization of BC biomass, forming partnerships between B.C.’s research institutions and the private sector, attracting international partnerships, and by actively communicating the importance and potential of bioenergy.

To achieve this, BC Bioenergy Network invests in capital and technology demonstration, targeted capacity building, as well as education and advocacy. These efforts promote the utilization of BC’s biomass—specifically using waste streams in the forest, agriculture, and municipal sectors to produce energy and value-added products. To date, BC Bioenergy Network has invested $15 million in 17 capital projects; $1.4 million into 12 capacity-building projects; and more than $375,000 into conferences, workshops and other educational initiatives.

As steward to one of the largest forested areas on earth, B.C. is well-positioned to become a major player in developing clean energy for the global bioenergy sector. BCBN is aligned with the B.C. Government’s mission to decarbonize the economy. BCBN is focused on implementing innovative solutions involving low-carbon renewable fuel supply chains. Current areas of focus include the RNG supply chain and decarbonizing long-distance transportation including the marine, aviation, rail and trucking sectors.

**Foresight CAC & the ARCTIC Program**

The Foresight Cleantech Accelerator Centre (CAC) is a catalyst and connector, providing Canadian and international innovators with access to resources, expertise, talent and partners to mature and implement innovative solutions quickly.

The Advanced Resource Clean Technology Innovation Centre (ARCTIC) is a Foresight program designed to fulfill the need for a demand-pull approach while identifying both specific environmental, operational and environmental challenges in the resource sector and potential sources of innovation from across Canada, and connecting them to drive performance improvements and accelerate the commercialization of new technologies.
The ARCTIC program is funded with support from the British Columbia Innovation Council ("BCIC") and Western Economic Diversification ("WD"). In this Challenge, the ARCTIC program is working with BCBN to search for technologies that convert anaerobic digestate into a higher value product.

Additional Challenge Context

SME Resources
In kind resources, such as time for a technical person, as well as potentially senior management, are a necessary contribution to participation in ARCTIC.

Leveraging Other Opportunities
The ARCTIC program and BCBN do not have restrictions on leveraging other sources of external funding, provided this works with the timelines of the Challenge Sprint. Other financing opportunities could include Export Development Canada, Sustainable Development Technology Canada, or others. The ARCTIC program evaluation process could be leveraged to support accessing other investment\(^5\).

ARCTIC & BCBN Non-Financial Support
BCBN technical experts will be involved in the evaluation process and will be available to the Sprint winners for technical support. Foresight will also provide access to executives in residence and executive business advisors, respectively, on business and commercial support, and exposure to financing experts.

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\(^5\) Western Economic Development, a funder of the ARCTIC program, might have conditions with regards to other Federal funding applied to this program. It is the responsibility of the applicant to understand and abide by those restrictions. Of prime concern is the application of stacking limits with Federal funding not accounting for more than 75% of the project budget.
Schedule
The following table outlines the anticipated timeline for the Innovator Selection phase. Please refer to the ARCTIC website for updated information.

Table 2 – Innovator Selection Schedule

<table>
<thead>
<tr>
<th>Action</th>
<th>By Whom</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential applicants and innovation ecosystem partner program briefing webinar</td>
<td>ARCTIC/BCBN</td>
<td>January 11, 2018, 9 am PT, 10 MT, 12 ET</td>
</tr>
<tr>
<td>Proposals Submitted</td>
<td>Proponents</td>
<td>February 28, 2018</td>
</tr>
<tr>
<td>Shortlisted proponents contacted for presentations</td>
<td>ARCTIC Review Team</td>
<td>March 14, 2018</td>
</tr>
<tr>
<td>Final Sprint Decisions and Start Sprint (prototype or test, or equivalent)</td>
<td>Proponents and ARCTIC/BCBN</td>
<td>April 4, 2018</td>
</tr>
<tr>
<td>Wrap up Sprint, choose Field trial winner</td>
<td>Proponents and ARCTIC/BCBN</td>
<td>August 31, 2018</td>
</tr>
</tbody>
</table>
Appendix 1: Response Template

ONLY NON-CONFIDENTIAL INFORMATION SHOULD BE INCLUDED IN THIS RESPONSE

The evaluation criteria used for selecting innovators for Phase 3 (Challenge Sprint) of this Challenge are:

- **Performance**
  - Solution process requirements
  - By-product economic benefits
  - Other environmental impacts and benefits.

- **Technology and Business Readiness**
  - Demonstration, proof-of-concept, experience, sector fit
  - Technology Readiness Level (TRL)
  - Modularity/scalability
  - Candidate experience, projects, clients, understanding of the challenge

This response template has two main sections: one that focuses on your technology and the other on your business.

1. **Candidate Info**

<table>
<thead>
<tr>
<th><strong>Company Contact Information:</strong> Fill out all applicable fields.</th>
<th><strong>Company Representative Contact Information:</strong> Fill out all applicable fields if different from Applicant.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal Name:</td>
<td>First Name:</td>
</tr>
<tr>
<td>Trade Name:</td>
<td>Last Name:</td>
</tr>
<tr>
<td>Department/Division:</td>
<td>Position:</td>
</tr>
<tr>
<td>Street Address:</td>
<td>Street Address:</td>
</tr>
<tr>
<td>City:</td>
<td>City:</td>
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<td>Country:</td>
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<tr>
<td>Postal/Zip Code:</td>
<td>Phone: ( ) -</td>
</tr>
<tr>
<td>Phone: ( ) -</td>
<td>Postal/Zip Code:</td>
</tr>
<tr>
<td>Email:</td>
<td>Email:</td>
</tr>
<tr>
<td>Website (if applicable):</td>
<td></td>
</tr>
</tbody>
</table>

If there are other partners other than the lead proponent, please list their name(s) and describe their role(s).
2. Solution and Technology Requirements:

In submitting responses to this Request For Proposal, please respond to the questions in the order they are presented below. Where multiple sub-questions exist within a question, please respond to those sub-questions in the order they appear. Cross-references to relevant information within the body of the Challenge Statement document are included where applicable. Please refer to the cross-references for additional information that may help to prepare a response for that particular question.

1. Technology is... (Check all that apply)
   - Strategic
   - Scalable
   - Ability to create jobs
   - Generate revenue through sales
   - Attract investment
   - Benefit society
   - Make a profit

2.1. Overview of solution including where applicable the tool(s), technology(ies) and innovations to processes, practices or technologies involved.

2.2. If proposing only a component of an entire solution, indicate remaining requirements in order to fully address the challenge.

2.3. Please provide a simplified process flow diagram (KPI #5) with known (or estimated) energy and mass balances. Please include equipment on the process flow diagram.

2.4. Please describe the activity or activities (e.g. testing, validation) that are proposed for the Challenge Sprint that will help to advance the proposed solution forward towards commercialization. What needs or challenges do the activity or activities help to overcome? Note: the activity/activities must be completed in the Challenge Sprint timeframe (i.e. 6 months).
2.5. Please provide information on following attributes of the proposed solution for a commercial application (KPI #3). Please provide a best estimate if attributes for a commercial application are unknown.
   a) List of equipment needed, or projected equipment required
   b) List of consumables, or expected consumables
   c) Anticipated energy use (electricity, natural gas, heat, etc.)
   d) Is the process continuous? What is the anticipated downtime?
   e) Expected maintenance issues that may arise, or maintenance requirements
   f) Expected lifetime of equipment. Which units of equipment are expected to need replacement?
   g) Projected technology life span

2.6. Technology Readiness Levels 5-9 are of interest in this Challenge. Please indicate the following information in the submission:
   o Current Technology Readiness Level (TRL) (KPI #1);
   o Technology development plan (KPI #6a) including milestones, capital requirements, and timelines; and
   o If the proposed technology is currently operating in another sector, please note which sector and considerations in adapting it to B.C.-based on-farm AD facilities.

2.7. Any other necessary assumptions.

2.8. Any information on independent technical reviews.

2.9. IP status (list any relevant patents or patent applications by number and jurisdiction).
Business Description

Please answer the following questions, for your business in general, as applicable:

1. Experience and background of management and project team

2. Technology Offering (if there are non-technical aspects of your technology offering not covered in the above technical questions that you would like to share)

3. Market Description: (who is your target market, how big is it, etc.)

4. Do you have current customers?
   - Yes, paying
   - Yes, no revenue
   - Commitments to purchase
   - None

5. How many T4 salaried employees do you currently have and in which provinces?

6. Will your business create new jobs? How many and how?
   - Unknown
   - Low Paying (<$80,000)
   - High Paying ($>80,000)

7. Please provide a Business Plan executive summary. Please be prepared to provide financial statements upon request.

8. Is your business incorporated?
   - Yes
     - Incorporation Date:
     - Jurisdiction of incorporation:
   - No

9. List 2 or 3 specific technical and business goals for the next 12 months:

10. Current annual revenue
11. Has your company ever applied for funding through IRAP or the B.C. Innovative Clean Energy Fund?
   ○ Yes
   ○ No

12. If you answered yes to 11, which funding programs and what were the decisions?

<table>
<thead>
<tr>
<th>Funding Organization</th>
<th>Program</th>
<th>Result</th>
<th>$ Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

13. How much money is invested in your company currently?

14. Who has invested in your company?
Appendix 2: Current State of RNG Production in BC

There are currently four FortisBC pipeline-connected RNG production sites in B.C.\textsuperscript{6}, as well as three additional proposed RNG production sites that have received approval from the B.C. Utilities Commission and are expected to connect to FortisBC’s pipeline system in the near future (see Figure A1).

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Ownership of Upgrader Equipment</th>
<th>Facility Type</th>
<th>Online Date</th>
<th>Annual Production of RNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraser Valley Biogas</td>
<td>Fraser Valley Biogas</td>
<td>Agricultural and Off-Farm Wastes</td>
<td>Oct. 2010</td>
<td>90,000 GJ</td>
</tr>
<tr>
<td>Salmon Arm Landfill</td>
<td>FortisBC</td>
<td>Landfill Gas</td>
<td>Feb. 2013</td>
<td>15,000 GJ</td>
</tr>
<tr>
<td>Seabreeze Farm</td>
<td>Seabreeze</td>
<td>Agricultural and Off-Farm Wastes</td>
<td>Feb. 2015</td>
<td>45,000 GJ</td>
</tr>
<tr>
<td>Glenmore Landfill</td>
<td>FortisBC</td>
<td>Landfill Gas</td>
<td>Sept. 2016</td>
<td>45,000 GJ</td>
</tr>
<tr>
<td>Surrey Biofuel</td>
<td>City of Surrey</td>
<td>AD of Organic Waste</td>
<td>2018</td>
<td>100,000 GJ (predicted)</td>
</tr>
<tr>
<td>Metro Vancouver Lulu Island WWTP</td>
<td>Metro Vancouver</td>
<td>Wastewater Treatment</td>
<td>Q3 2018</td>
<td>N/A</td>
</tr>
<tr>
<td>Dicklands Farm</td>
<td>Dicklands Farm</td>
<td>Agricultural and Off-Farm Wastes</td>
<td>TBD</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Source: FortisBC*

Figure A1: Current and proposed pipeline-connected RNG production sites in British Columbia.

\textsuperscript{6} See: https://www.fortisbc.com/NaturalGas/RenewableNaturalGas/OurSuppliers
Appendix 3: Anaerobic Digestion Facility Reference Benchmarks

Reference documentation on-farm AD facilities can be found at the following link:

https://www.bcac.bc.ca/sites/bcac.localhost/files/AD%20Benchmarking%20Study_0.pdf

British Columbia’s Agricultural Research and Development corporation (ARDCorp) released the results of the *On-Farm Anaerobic Digestion Benchmark Study* in late December 2011. It was undertaken to provide an informational benchmark from which individuals and groups in B.C.'s agricultural sector can inform decisions pertaining to the development of on-farm AD systems.

The benchmarks have been drawn based on the analysis and summation of feasibility studies developed for twelve farm-sites in B.C. The twelve sites were selected with the intention of representing geographic, demographic and circumstantial variances.
Appendix 4: ARCTIC Program Process (Detailed Description)

This Challenge has been designed and enabled by the ARCTIC Program, which is designed to model a new approach for industry and innovator collaboration. There are four critical phases of activity designed to produce relevant field trials that will validate solutions to resource sector-defined challenges.

Phase 1: Challenge Definition (3 months) - Completed
In conjunction with resource sector partners/ARCTIC participants, Foresight will define challenges in order to focus innovators on the most promising market opportunities.

Outcomes:

- Resource sector consultation events delivered in conjunction with communications or industry partners.
- Definition of resource sector challenges to focus innovators.
- Development of a broad community of industry and cleantech innovators.

Phase 2: Innovator Selection (2 months) – Current Phase
Foresight and BCBN are launching this RNG Challenge and inviting potential solution providers to respond by filling out the attached Response Template (Appendix 1). A panel of industry, investors, and selected experts will select 2 to 5 solutions from the pool of innovators that responded to the Challenge for a four-month development Sprint.

Phase 3: Challenge Sprint (up to 5 months)
This Challenge Sprint will be sponsored by resource sector industry partners and will leverage the Foresight Accelerator and its mentorship program to:

- Further advance the development of the proposed solutions through activities that advance the solution – such as developing a prototype or performing a feasibility study of the technology; (and)/or
- Further advance the development of proposed solutions through testing in a laboratory or other environment.
- Move the companies to a point where they can seek first funding
- Deliver a focused stream of companies to operate within Foresight/ARCTIC’s facilities. The ARCTIC program has access to specialized facilities in Alberta, BC and Saskatchewan that can respond to the needs of the selected innovators and solutions, if required. Alternatively, selected solution providers can use their own facilities for the Sprint.
Expected Outcomes:

- 2 to 5 promising solutions identified and evaluated.
- 1 technology/solution selected for field trial.
- 1 industry showcase event delivered with a marketing partner.

Phase 4: Field Trial Preparation (up to 10 months)

Following the Challenge Sprint, one solution could be selected for field-testing, or for the next appropriate level of development.

The Field Trial Phase will focus on advancing the technology towards commercial readiness, including equipment specification requirements. Foresight will coordinate with the industrial partner(s) existing stage-gating process to determine the test parameters the technology must meet to achieve field trial readiness. The process will include quarterly progress reviews with the industry partner to ensure the development remains on track.