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CANADA EMISSIONS REDUCTION INNOVATION NETWORK (CERIN) PUBLIC REPORT

1. PROJECT INFORMATION:

Project Title:	Scoping Study for a Clean Combustion Technology Showdown
Alberta Innovates Project Number:	
Submission Date:	April, 2022
Total Project Cost:	$48,212.51
Alberta Innovates Funding:	$23,266.33
AI Project Advisor:	Brian Spiegelmann, PTAC

2. APPLICANT INFORMATION:

Applicant (Organization):	Saskatchewan Research Council
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Applicant Representative Name:	Erin Powell
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3. PROJECT PARTNERS

Please provide an acknowledgement statement for project partners, if appropriate.

RESPOND BELOW

This project is funded by PTAC's CanERIC program, which in turn is funded by Alberta Innovates and NRCan, and by the Saskatchewan Ministry of Energy Resources and Innovation Saskatchewan. The Saskatchewan Research Council (SRC) is grateful for the help provided by Brian Spiegelmann of PTAC, Rob MacNutt of NuVista Energy Ltd., Dr. Vita Martez (NSERC Industrial Research Chair for Colleges, Southern Alberta Institute of Technology), Dr. Jason Olfert (faculty member of the Department of Mechanical Engineering, University of Alberta), as well as producer members of the CanERIC consortium. SRC would also like to acknowledge the feedback from Clear Rush Co., Emission Rx, Kenilworth Combustion, Questor Technology, and TCI Combustors.

A. EXECUTIVE SUMMARY

Provide a high-level description of the project, including the objective, key results, learnings, outcomes and benefits.

RESPOND BELOW

Clean combustion technology includes enclosed combustors and incinerators which combust methane into emissions which have a lower impact on global warming. Although there are recent enclosed combustor tests in the prairie provinces, the CanERIC consortium suggested a larger "showdown" field demonstration of combustion technologies. The objective of this desktop study is to gather information to identify knowledge gaps and vet and assess which clean combustion technologies warrant testing as part of a further field demonstration.

This desktop study provides an overview of methane mitigation with combustion, the advantages and challenges of clean combustion, recent studies on clean combustion, and identifies available clean combustion technologies. This study includes consultation with producers and vendors on current applications and opportunities for clean combustion, barriers preventing installations, and gaps which can be addressed from a field demonstration. Vendor consultation along with the SRC CeDER (Centre for the Demonstration of Emissions Reductions) database, reveal suitable combustion units for field demonstration. This report is not recommending or endorsing any specific vendor or clean combustion model. This study indicates that a field demonstration of combustion technology for difficult waste gas

applications such as tank vents and pneumatic vents will help to address knowledge gaps and help to de-risk the adoption of these technologies. The main knowledge gaps involve the design features and greenhouse gas abatement costs of difficult, low pressure waste gas applications such as tank and pneumatic vents. The study provides recommendations for CanERIC to consider, when requesting proposals from the ISC Committee for a field demonstration.

B. INTRODUCTION

Please provide a narrative introducing the project using the following sub-headings.

- **Sector introduction:** Include a high-level discussion of the sector or area that the project contributes to and provide any relevant background information or context for the project.
- **Knowledge or Technology Gaps:** Explain the knowledge or technology gap that is being addressed along with the context and scope of the technical problem.

RESPOND BELOW

Sector Introduction:

CanERIC's mandate is to encourage the deployment of technologies which reduce greenhouse gas (GHG) emissions, specifically methane, in the oil and gas sector. To accomplish this goal, members of the CanERIC consortium have suggested a "showdown" of clean combustion technologies. These technologies combust waste gas containing methane into emissions which have a lower impact on global warming. Combustion technologies do not eliminate 100% of the methane in a waste gas stream. *Clean combustion* is a term to describe technologies such as incinerators and enclosed combustors which are designed to combust a higher amount of methane in a feed stream than a conventional flare stack. Incinerators and enclosed combustors combust waste gas inside a chamber, without a visible flame. They produce less smoke and are quieter than flare stacks. Some larger clean combustion installations capture waste heat for on-site use.

Knowledge or Technology Gaps:

Although there have been a few recent clean combustion performance tests in the prairie provinces, a demonstration of the performance of units from multiple vendors in a showdown of technologies, would be beneficial to the oil and gas industry to help incorporate these technologies into existing and new designs. Following this work, CanERIC will be better positioned to request proposals for a field-testing program for a demonstration of clean combustion technology.

C. PROJECT DESCRIPTION

Please provide a narrative describing the project using the following sub-headings.

- **Knowledge or Technology Description:** Include a discussion of the project objectives.
- **Updates to Project Objectives:** Describe any changes that have occurred compared to the original objectives of the project.
- **Performance Metrics:** Discuss the project specific metrics that will be used to measure the success of the project.

RESPOND BELOW

Knowledge or Technology Description:

The goal of this project is to gather information to vet and assess which incinerator and enclosed combustor technologies warrant testing, and under what scenarios, as part of a showdown. This scoping study includes a review of past work on clean combustion testing, undertaken both within and outside CanERIC. Furthermore, the project identifies the technological gaps and combustion units which warrant testing via consultation with CanERIC producer members and vendors, and a review of the SRC CeDER Database. This desktop study helps to identify the needs of the field operations related to clean combustion technologies and the sorts of issues presently inhibiting adoption of these technologies.

Updates to Project Objectives:

The initial scope of this desktop study was to investigate only *enclosed combustors*. The scope was expanded to include both the clean combustion technologies of *enclosed combustors* and *incinerators*. Both technologies combust waste gas containing methane into emissions which have a lower impact on global warming.

Performance Metrics:

Metric	Project Target	Values so far	Commercialization / Implementation Target	Comments (as needed)
# Previous combustion studies reviewed	3	5	N/A	
# of Upstream Oil and Gas Producers surveyed	5	6	N/A	Surveyed only members of the CanERIC Industry Solutions Steering Committee

D. METHODOLOGY

Please provide a narrative describing the methodology and facilities that were used to execute and complete the project. Use subheadings as appropriate.

RESPOND BELOW

This project reviewed clean combustion technology, methane mitigation by clean combustion, advantages and challenges of clean combustion, and recent Canadian studies on clean combustion. Six oil and gas companies, who are part of the CanERIC Industry Solutions Steering Committee (ISSC), responded to a survey questionnaire on clean combustion technology. The survey responses provide insight into the current applications and future opportunities of this technology. In addition, the survey highlighted some of the barriers and gaps which are preventing further deployment of enclosed combustors and incinerators. As part of this study, two vendors provided perspectives on the Canadian oil and gas market for clean combustion technology, including current and future applications. Vendor consultation, as well as a review of the SRC CeDER database, revealed clean combustion models suitable for further field demonstration.

E. PROJECT RESULTS

Please provide a narrative describing the key results using the project's milestones as sub-headings.

- Describe the importance of the key results.
- Include a discussion of the project specific metrics and variances between expected and actual performance.

RESPOND BELOW

Clean Combustion Technology and Previous Studies:

- Clean combustion units are a versatile option for GHG mitigation, suited to new or existing sites, with or without electrical service.

- Recent studies have been completed under CanERIC which are relevant to a clean combustion showdown: Catalytic Oxidizer, Enclosed Combustors Treating Vent Gas from Compressors and Pneumatic Equipment, Pipeline Blowdown to Enclosed Combustor, and Electrical Showdown Project (Gas-to-Power technologies).

- The main challenge of clean combustion units treating waste gas from upstream oil and gas sector is that GHG emissions increase during downtime and cycling waste flowrates.

Industry Consultation:

- The gaps to address in a clean combustion field testing program would be:
- Information on clean combustion units with low installed costs.
- Engineering knowledge about difficult applications such as tank vents and pneumatic equipment.
- Information on overall GHG mitigation, including downtime and impact of supplemental, blanket and pilot gas streams.

Vendor and SCR CeDER Database Consultation:

This report is not recommending or endorsing any specific vendor or clean combustion model. The following would be suitable models to test in a clean combustion showdown:

Table 1 – Suitable Models for a Clean Combustion Technology Showdown

Manufacturer	Model	Type of combustion	Waste gas feed flows (standard m^3/d)
Cimarron (Hy-Bon)	CH2.5, CH10.0	Enclosed combustor	226 to 2,800
Clear Rush Co.	Cube 500 to 1000	Enclosed combustor	20 to 1,500
Emission Rx	E-Series	Enclosed combustor	<170 to 10,000
Kenilworth Combustion	Stranded Gas Combustor	Enclosed combustor with features of an incinerator (high minimum exit temperature via supplemental gas)	500 to 3,500
Metan (ETTER) [1]	CMAS 1 ,2,4	Catalytic oxidizer	1.4 to 51
Questor Technology	Q-series 50 to 5000	Enclosed combustor	142 to 141,500
TCI Combustors	Enclosed combustor 60-E to 1200-E	Enclosed combustor	< 40 to 4,811

[1] Do not re-test the Metan unit, and instead consolidate the results of the current CanERIC Metan project with the results of a clean combustion showdown.

F. KEY LEARNINGS

Please provide a narrative that discusses the key learnings from the project.

- Describe the project learnings and importance of those learnings within the project scope. Use milestones as headings, if appropriate.
- Discuss the broader impacts of the learnings to the industry and beyond; this may include changes to regulations, policies, and approval and permitting processes

RESPOND BELOW

This desktop study helps to plan a showdown of clean combustion technologies and has led to the following conclusions:

- Clean combustion technology is a viable option for reducing GHG emissions as the oil and gas sector transitions to lower emissions.
- The recovery of electricity and heat from combustion technologies further reduces GHG emissions.
- There are knowledge gaps on how to install clean combustion technologies on difficult applications such as atmospheric tank vents and pneumatic vents.
- There are knowledge gaps on GHG abatement of difficult applications such as atmospheric tank vents and pneumatic vents.
- There is a market need for clean combustion units which are designed for relatively low flowrates of waste gas (less than 1000 m^3/d), which can treat tank and pneumatic vents.
- A showdown of clean combustion technology should be geared towards waste methane applications which are difficult to treat.

G. RECOMMENDATIONS AND NEXT STEPS

Please provide a narrative outlining the next steps and recommendations for further development of the technology developed or knowledge generated from this project. If appropriate, include a description of potential follow-up projects. Please consider the following in the narrative:

- Describe the long-term plan for commercialization of the technology developed or implementation of the knowledge generated.
- Based on the project learnings, describe the related actions to be undertaken over the next two years to continue advancing the innovation.
- Describe the potential partnerships being developed to advance the development and learnings from this project.

RESPOND BELOW

A second phase of this project would be a showdown of clean combustion technologies, to demonstrate and test several units. Recommendations for this clean combustion showdown are as follows:

- Rather than conducting a showdown of different clean combustion technologies at the same site, complete field testing at 3 to 5 existing installations at different sites. Producers are interested in the safety features, and process, mechanical and instrumentation design of the installations and not just the units themselves. Government regulators also prioritize safety.

- Select sites for a clean combustion showdown, where the combustion units were installed for methane mitigation rather than for reducing emissions of sour gas or volatile organic compounds (VOCs).

- Select sites with clean combustion technologies on difficult applications such as atmospheric tank vents and pneumatic vents.

- Consolidate the results of a clean combustion showdown and the following related CanERIC projects, to provide a side-by-side comparison: Catalytic Oxidizer Test, Enclosed Combustors Treating Vent Gas from Compressors and Pneumatic Equipment, Pipeline Blowdown to Enclosed Combustor, and Electrical Showdown Project (Gas-to-Power technologies).

- Follow the thorough testing program of the CanERIC study on the Enclosed Combustors Treating Vent Gas from Compressors and Pneumatic Equipment. Test the combustion units at a low and a high flowrate, measure waste gas feed pressures, flowrates, composition, along with exhaust testing, and methane destruction efficiency calculations. Other parameters to measure include:

- Inlet pressure to the combustion unit, downstream of any pressure regulating device.
- Liquid content of the waste gas.
- Flowrates, compositions, temperature and pressure of additional gas streams such as pilot burner gas, blanket gas, or supplemental feed gas. Use the measurements to calculate overall GHG abatement.
- In addition, log the flowrate to the combustion unit and any atmospheric bypass from the unit over several days to a couple of weeks to evaluate the downtime of the combustion device, and the percentage of waste gas treated by the device.

- Provide estimates of installed costs of the clean combustions units as part of the reporting of the clean combustion showdown.
- Report on qualitative installation features such as ease of operability, type of burner ignition, existence of liquid knockout pot, and types of instrumentation.
- Report on safety aspects of clean combustion models and installations.