VAREBERG
ENGINEERING
1331 32nd AVENUE SOUTH, SUITE 1 - FARGO, ND 58103
PHONE: (701)234-0926 - FAX: (701)234-0576

May 28, 2021

Ms. Karlene Fine, Executive Director
North Dakota Industrial Commission
ATTN: Oil and Gas Research Program
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Re: Proposal Entitled "Well Site Thief Hatch Methane Detectors"

Dear Ms. Fine:

On behalf of Vareberg Engineering, Ltd. and Blue Rock Solutions, LLC, we are pleased to submit the original proposal in electronic format and two (2) copies as directed. Also enclosed with the paper copies is the $100 Application Contribution. It is our hope that the proposed project will result in an alternate method to monitor fugitive emissions from oil and gas production site thief hatches that is more accurate, efficient and economical than the current options available to oil and gas producers.

The Statement of Tax Liability as required:
Vareberg Engineering, Ltd. Does not have any tax liability owed to the State of North Dakota or any of its political subdivisions.

This transmittal letter represents a binding commitment by Vareberg Engineering, Ltd. and Blue Rock Solutions, LLC to complete the project described in this proposal. If you have any questions, please feel free to contact me at 701-234-0926 or by email at troy@vareberg ltd.com.

Respectfully submitted,

VAREBERG ENGINEERING, LTD.

Troy D. Vareberg, PE

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title: Well Site Thief Hatch Methane Detectors

Applicant: Vareberg Engineering, Ltd. And Blue Rock Solutions, LLC

Principal Investigator: Troy D. Vareberg. PE

Collaborators: Appareo Systems, LLC
c2renew
Dr. Chad Ulven
Dr. Benjamin Braaten

Date of Application: May 28, 2021

Amount of Request: $139,300

Total Amount of Proposed Project: $285,200

Duration of Project: 18 months

Point of Contact (POC): Troy D. Vareberg, PE

POC Telephone: 701-234-0926

POC E-Mail Address: troy@varebergltd.com

POC Address: 1331 32nd Ave S,
Fargo, ND 58103

TABLE OF CONTENTS

ABSTRACT

Objective:

This project is to enhance an existing prototype methane detector that addresses the largest source of methane leaks on an oil and gas production site and incorporate it into a producer's Leak Detection and Repair (LDAR) program.

This shall increase the reliability of gas monitoring, shorten response time for repairs and help with the public's perception of the environmental impacts by reducing emissions.

Expected Results:

The proposed project is expected to further develop and build multiple prototype methane detection devices to be used in a Pilot Program. This program will demonstrate how the devices will detect leaks and emissions at a much faster rate than traditional monitoring practices resulting in a substantial reduction of fugitive methane emissions from the production site.

Duration:

The pilot project shall last approximately (18) months. This will consist of six (6) months of final device development, followed by a twelve (12) month Pilot Program.

Total Project Cost:

The total cost of the project is expected to be $285,200. The amount requested from the NDIC Oil and Gas Commission is $139,300.

Participants:

It is anticipated that all entities previously involved in the initial product development phase will participate in the project. These participants include

Vareberg Engineering, Ltd. and Blue Rock Solutions, LLC
Appareo Systems, LLC
c2renew
Oil & Gas Producer (existing Vareberg Engineering, Ltd. Client)

PROJECT DESCRIPTION

Background:

With the ever-increasing scrutiny of the world's production of Green House Gases (GHG's), industries are placing additional emphasis on following Environmental, Social and Governance (ESG) criteria. From the environmental standpoint, this translates to reductions of GHG's such as carbon dioxide and methane being released into the atmosphere.

In the oil and gas industry one of the largest sources of GHG emissions stems from methane leaks on the thousands of production sites located throughout the United States. Under existing federal, state and local regulations, each site is required to be inspected on initial start-up as well as on a semi-annual basis after that. This has historically been accomplished through the utilization of hand-held gas detectors. Actual monitoring techniques or steps are outlined in the Environmental Protection Agency (EPA) Method 21- Determination of Volatile Organic Compound Leaks. This is derived from the Federal Regulation 40 CFR Part 60, SubPart 0000a – Standard for Performance of Crude Oil and Natural Gas Production, which was published in 1988. This process is very time-consuming and requires personnel to be on the production site, in very close proximity to potential hazards.

In 2008, an Alternate Method was accepted by the EPA which allows the use of Optical Gas Imaging (OGI) cameras in lieu of the hand-held gas detectors. This option allows a camera operator to survey the entire site from a few select "safe" locations in a shorter time span than the previously accepted gas detectors. However, it still requires personnel to physically travel to each site. In addition, the cameras require a high capital expenditure of $80,000 to $100,000 each.

Additional techniques being considered are also outlined in a recent Climate and Clean Air Coalition (CCAC) survey, which indicates that direct field measurements are most accurate for determining methane emissions. While methods such as IR imaging, laser detection, soap bubble screening, and other similar approaches offer solutions to quantifying leaks, they each have major setbacks and limitations. IR cameras are robust and accurate, but often still require manual operation and involve a high purchase cost. Laser detection and soap bubble screening require short distance, manual operations, while products like vapor analyzers are slow to operate. Many of these methods also require optimal weather conditions, which is not a feasible expectation for northwest North Dakota.

Project:

For this particular project, it is our intent to address the one particular area of each site that tends to be the source of a major portion of gas leaks – thief hatches. After discussions with multiple producers, it was determined that thief hatches on storage tanks and various processing equipment are responsible for more methane leaks than any other locations on a typical production site. Our main client estimates approximately 80% of the methane leaks on their sites can be attributed to open or leaking thief hatches.

We have recently developed a prototype for a direct-mount gas monitoring device that can be integrated into thief hatches found on well production site storage tanks and other equipment. This device will be further optimized to include communication capabilities that will allow for continuous remote monitoring. In theory, this could eliminate the need for personnel to visit each site to survey the thief hatches on a semi-annual basis. This will also allow for notification of leaks to certain Environmental, Safety and Health (ESH) personnel in a much timelier manner, allowing for a more responsive Leak Detection and Repair (LDAR) program.

Objectives:

The primary objective of this project is to build on an existing prototype for methane detector developed by Vareberg Engineering & Blue Rock Solutions. This detector addresses the largest source of methane leaks on an oil and gas production site and incorporate it into a Producer's Leak Detection and Repair (LDAR) program. Individual objectives include:

- Finalize device design including housing, sensor selection, antenna selection, battery selection and overall assembly.
- Develop data acquisition and networking/communications capabilities for use by oil and gas producers.
- Build (20) prototypes for use in Pilot Program with major US oil and gas producer (existing client)
- Administer Pilot Program over 12-month period to document effectiveness of methane leak reductions.
- Obtain all required listings from a Nationally Recognized Testing Laboratory (NRTL).
- Identify potential sources for mass production of devices and determine associated costs.
- Identify other potential opportunities to expand product line for other types of leaks and for other industries.

Methodology:

Hardware Development

The initial design of the gas monitoring device is complete and was developed around existing, low-cost, mass-produced methane sensors. Each methane sensor is housed in a standard hazardous location assembly that also includes a power supply, microprocessor, wireless communications, and an antenna. The housing is custom designed to be secured to a standard thief hatch cover

assembly. As the overall capabilities are added and refined, the final assemblies shall be revised as needed to optimize battery performance and communication capabilities.

Software Development

The ability for the gas monitoring devices to broadcast their status is a main goal for this proposal. To accomplish this, each assembly shall include RF, cellular, Bluetooth or IoT communications. In addition, all devices shall be capable of being networked and programmed to report status information to various Environment, Safety and Health personnel for use in determining effectiveness of devices, as well as helping to meet federal documentation requirements.

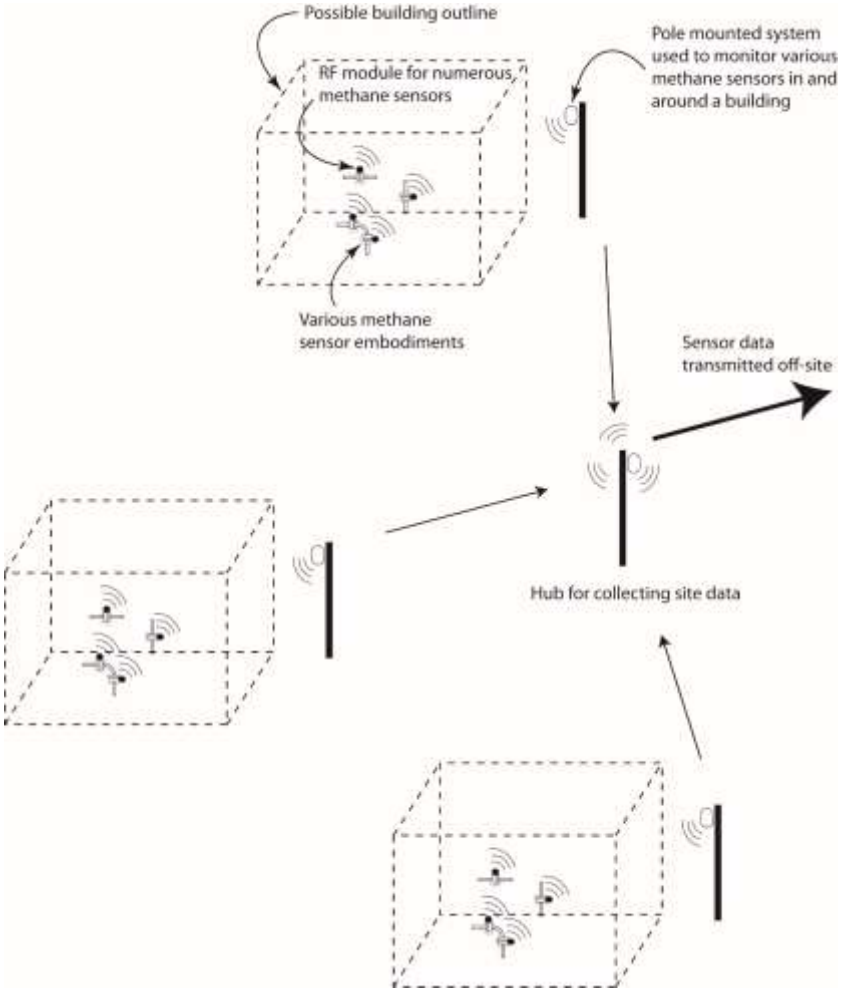


Figure 1: Topology of the proposed methane sensor network.

Pilot Project

After the monitoring devices and telecommunications have been fully developed, a group of 10-20 devices shall be field installed at an existing production site to monitor the overall system performance. The pilot project will take place over a 12-month period to allow the effects of all four (4) seasons to be observed and documented. This will allow the design team to make adjustments and changes as needed prior to moving into the mass production phase. The pilot project will also allow the Producer to interact with the system and give any feedback.

Anticipated Results:

This project shall result in the following:

- Finalize overall device design and produce twenty (20) fully-functioning prototypes for use in pilot project.
- Successful completion of pilot project.
- Demonstration of how the proposed system will detect leaks and emissions at a much faster rate than traditional monitoring and how that will reduce emissions from oil and gas production site by up to 80%.

Facilities:

Primary design and partial testing have already been done on the campus of North Dakota State University through the College of Engineering. Further design and testing, as well as fabrication of remaining prototype devices and device enclosures shall be completed in Fargo. All field testing shall be performed on an existing oil & gas production site provided by of one of Vareberg Engineering's existing clients located near Tioga, North Dakota.

Resources:

In addition to the staff of Vareberg Engineering and Blue Rock Solutions, the staff at Appareo Systems and c2renew in Fargo will be a valuable resource for this project. Dr. Chad Ulven and Dr. Benjamin Braaten, both professors in the College of Engineering at North Dakota State University shall add their expertise for the success of the project.

Techniques to Be Used, Their Availability and Capability:

The Project is based on utilizing pre-existing methane detection devices and supplementing with automation and communication capabilities. The basic components are commercially available and already meet anticipated performance specifications. Each newly created device shall be intrinsically safe and shall be suitable for the environment for which they are installed.

Environmental and Economic Impacts while Project is Underway:

Ideally, it is anticipated that during the field-testing portion of the Project, fugitive gases will decrease due to a quicker response time to leaks and containment failures. With real-time monitoring, the potential exists to address leaks and/or failures within hours rather than months. This may allow Producers to virtually ELIMINATE fugitive emissions from the points being monitored.

Ultimate Technological and Economic Impacts:

Automation in the oil and gas production industry is beginning to take hold and is showing great promise for increasing production, safety and reliability. This Project is an expansion of these capabilities by automating a historically time-consuming process. Lessons learned form this Project shall also help accelerate the growth of utilizing additional sensors throughout an entire production site. Finally, reducing human involvement in this task increases safety and provides relief for the ongoing labor shortage in the region by allowing individuals to be utilized in better ways.

Why the Project is Needed:

This Project is needed to help develop economically and technically feasible alternatives to the existing time consuming and costly options of monitoring for fugitive gas emissions. With constantly increasing pressure from government agencies and the general public, high-level monitoring and control of fugitive emissions will soon become a necessity.

In addition, this Project will help carry out Governor Doug Burgum's goal of making the State of North Dakota "carbon-neutral" by the year 2030. While this will mainly be accomplished with the implementation of mega-sized projects such as Project Tundra, there are still other well-deserving, effective, small projects such as in this proposal.

STANDARDS OF SUCCESS

With the well-documented detrimental effects of greenhouse gases on the environment, along with the increase in ESG legislation and criteria, any reduction of fugitive emissions from oil well production sites would be considered a success.

As a result of this project, it will be technically feasible to reduce the overall leakage or emissions from each site by up to 80%. Such a reduction will have definite financial benefit for the Producers in both increased revenue and lowered maintenance / remediation costs. Producers could also use the results of this project to expand on the use of "big data" to predict and address failures before they occur.

The successful completion of this project will also help keep the State of North Dakota at the forefront of the US Energy arena and help with the Governor's goal of carbon neutrality by 2030. Continued development in the areas of gas monitoring, emission control and remediation could have a profound impact in North Dakota, the Bakken and throughout the United States.

With nearly 15,000 active wells currently in North Dakota and plans to more than double that quantity, the devices developed under this Project have the potential of capturing nearly 200,000 tonnes of methane annually. That is equivalent to the removal of nearly 1,000,000 passenger cars from the roads annually.

BACKGROUND/QUALIFICIATIONS

Vareberg Engineering, Ltd. is a North Dakota consulting engineering firm that has been involved in the design of well production sites for the past 10 years. Primarily, design has included power systems and control system wiring for more than 100 well sites throughout the Bakken. Additionally, our expertise includes the analysis and documentation of more than 600 well sites for electrical deficiencies and arc flash hazards.

Blue Rock Solutions, LLC is a North Dakota engineering firm specializing in custom engineering solutions for the energy and industrial sectors. It was founded by the partners of Vareberg Engineering, Ltd. as an entity dedicated to product design and development.

c2renew is a North Dakota engineering firm with expertise in composites and sensor development. Previous work has included fully networked sensors for the agricultural market and custom materials or various hazardous and non-hazardous environments.

Appareo Systems, LLC is a product development and technology company based in Fargo, North Dakota that specializes in software and hardware for industrial and commercial electronics. They research, develop, design and manufacture tangible technology that utilizes AI, mechatronics and innovative electronics designed to deliver exceptional customer value.

Troy D. Vareberg, PE received his B.S. degree from North Dakota State University (NDSU) in Electrical and Electronics Engineering (1990). He has been involved with the electrical design in the built environment since 1985, including (4) years as the primary electrical engineer for the Department of Energy at Ames Laboratory in Ames Iowa. He has been the President of Vareberg Engineering, Ltd. since its inception in 1997.

Chad A. Ulven received his B.S. degree in Mechanical Engineering from NDS (2001) and M.S. and Ph.D. degrees in Materials Engineering from the University of Alabama at Birmingham (2003 & 2005). He has been a faculty member in the Mechanical Engineering Department at NDSU since August of 2005. He has been involved in the research of polymer matrix composites (PMCs) for various commercial and defense applications for the past 18 years. He has co-authored 6 book chapters, 70 journal articles, and over 100 conference papers related to PMCs. He has been a co-author of 5 patent applications which have led to 2 patents awarded and 2 spin-out companies (c2renew inc. and c2sensor corp.). Most recently he was awarded a multi-million-dollar research project to help develop advanced composite material 3D printers for Army applications.

Benjamin D. Braaten received the Ph.D. degree in electrical and computer engineering from NDSU (2009). During the 2009 Fall semester, he held a Postdoctoral Research position at the South Dakota School of Mines and Technology in Rapid City, SD. He is currently a Professor in the Department of Electrical and Computer Engineering, North Dakota State University. His research knowledge includes printed antennas, conformal self-adapting antennas, microwave devices, topics in EMC, wireless sensing technology and methods in computational electromagnetics. Dr. Braaten received the College of Engineering and Architecture Graduate Researcher of the Year Award. He also serves as an Associate

Editor for the IEEE Antennas and Wireless Propagation Letters and the IET Microwaves, Antennas and Propagation journal.

MANAGEMENT

The Project Manager, Troy Vareberg, will be working directly with all parties to guarantee objectives and milestones are met. During the design phase, bi-weekly meetings shall be held to review the progress of each participant. Short-term and long-term schedules shall be adjusted (accelerated or extended) as needed for the project to continue towards the desired outcomes. Tasks shall be assigned to each participant and documented for review at the subsequent meeting. Any deviations from the schedule (planned or unplanned) and /or assigned tasks will be discussed among all participants and either resolved or adopted in a timely manner.

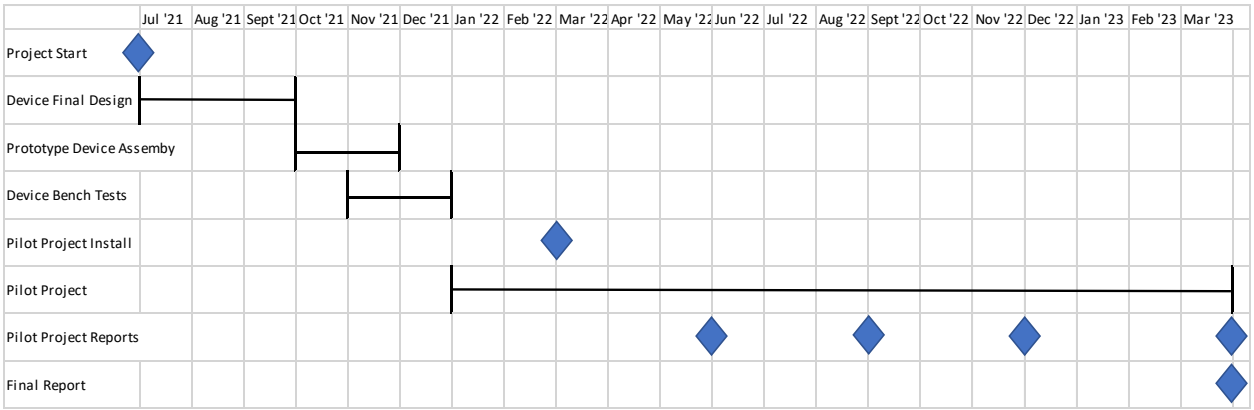
During the testing and pilot project phase, the Project Manager will coordinate the installation of the sensors with the Oil and Gas Producer. Team members from Vareberg Engineering and the Producer shall then meet on-site on a monthly basis to inspect the installed devices to verify proper performance and to verify their capabilities to withstand the various environmental factors found on site.

All parties of the team will also have access to data obtained and transmitted via the system in order to monitor the site in real time and develop methods to collect/interpret data, and produce various reports to meet government requirements.

For documentation of project progress, the Project Manager shall file quarterly reports to indicate current status, milestones met, deviations from timeline, necessary adjustments and projections for the next report. Within each quarterly report, the progress of the project shall be evaluated based on the following:

- Were milestones met?
- Were there any unanticipated roadblocks in the process of meeting those milestones?
- What lessons were learned to help reduce any future roadblocks?
- Are costs in line with the published grant application?
- With the results obtained to this date, does the project continue to present itself as a viable solution to effectively monitor methane gas leaks?

TIMETABLE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Project Start
Device Final Design
Prototype Device Assemby
Device Bench Tests
Pilot Project Install
Pilot Project
Pilot Project Reports
Final Report

BUDGET

Project Associated Expense	Hrs	Rate/hour	Total Cost	NDIC Share	Applicant's Share
Engineering/Design					
Project Manager (Blue Rock)	80	$150	$12,000	$0	$12,000
Design Engineer (Blue Rock)	100	$120	$12,000	$0	$12,000
Contractor (Appareo Systems)			$48,000	$36,000	$12,000
Fabrication / Lab Testing					
Project Manager (Blue Rock)	40	$150	$6,000	$0	$6,000
Design Engineer (Blue Rock)	40	$120	$4,800	$0	$4,800
Contractor (Appareo Systems)			$20,000	$15,000	$5,000
Software Development					
Project Manager (Blue Rock)	40	$150	$6,000	$0	$6,000
Design Engineer (Blue Rock)	40	$120	$4,800	$0	$4,800
Contractor (Appareo Systems)			$24,000	$16,000	$8,000
Field Installation- Pilot Project					
Project Manager (Blue Rock)	40	$150	$6,000	$0	$6,000
Design Engineer (Blue Rock)	40	$120	$4,800	$0	$4,800
Producer	40	$120	$4,800	$4,800	$0
Follow-up Site Visits - Pilot Project					
Design Engineer (Blue Rock)	50	$120	$6,000	$0	$6,000
Producer	50	$120	$6,000	$6,000	$0
Reporting / Documentation					
Project Manager (Blue Rock)	60	$150	$9,000	$6,000	$3,000
Materials / Equipment			$20,000	$10,000	$10,000
Travel Expenses			$16,000	$8,000	$8,000
		Totals	$285,200	$139,300	$145,900

CONFIDENTIAL INFORMATION

The name of Vareberg Engineering, Ltd's client in the oil and gas production industry has been left out of this report due to confidentiality reasons.

PATENTS/RIGHTS TO TECHNICAL DATA

A provisional patent has been submitted for the methane detection device being proposed for this project.

STATUS OF ONGOING PROJECTS

There are currently no ongoing or previous projects receiving funding from the Commission.

APPENDIX A

LETTERS OF SUPPORT

Please see the attachment.

9-13-19

Troy Vareberg, PE
1331 32 Ave S
Fargo, ND 58103

Dear Mr. Vareberg,

RE: Proposal: "Well Site Fugitive Emissions Networked Monitoring System"

With this letter, I would like to confirm that c2renew is interested in participating in the above stated project that is being coordinated by Vareberg Engineering. Through our collaborative activities, we are currently working with Vareberg Engineering in a Phase I development of the proposed emissions monitoring system and are excited to continue the work to achieve a fully networked gas monitoring system.

With the oil and gas industry struggling with worker shortages and oil companies identifying remote monitoring systems as needed technology, the work Vareberg Engineering is proposing is critical to addressing this problem. With Vareberg's current work in the oil and gas industry and c2renew's work on composites and sensor development, I feel the collaboration will yield the results to solve these challenges.

c2renew is very much looking forward to collaborating with Vareberg to develop devices and systems for monitoring and limiting the release of fugitive emissions.

Sincerely,

Corey Kratcha
ceo

NDSU NORTH DAKOTA STATE UNIVERSITY

September 16th, 2019

Troy Vareberg, PE
1331 32 Ave S
Fargo, ND 58103

RE: Oil and Gas Research Program Proposal

Dear Troy,

I am excited to support your proposal entitled: "Well Site Fugitive Emissions Networked Monitoring System" as a collaborator. I believe the technology you are proposing to develop is very timely and important for the industry's growing needs. Specifically, my group at North Dakota State University in the Mechanical Engineering Department would focus on the design and prototype manufacture of enclosures needed to house the electronic sensors and attach to the well site components of interest. We very much look forward to working with Vareberg Engineering and Dr. Braaten's group in Electrical Engineering to come up with a unique, robust solution.

Regards,

Chad A. Ulven, PhD

Professor and Associate Chair

DEPARTMENT OF MECHANICAL ENGINEERING
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NDSU NORTH DAKOTA STATE UNIVERSITY

9/13/2019

Troy Vareberg, PE
1331 32 Ave S
Fargo, ND 58103

Mr. Vareberg,

This is a letter conforming our willingness to collaborate on the proposal entitled: **"Well Site Fugitive Emissions Networked Monitoring System"**, which is being coordinated by Vareberg Engineering. In particular, our group at North Dakota State Universtiy will research and design the wireless sensor portion of the project, and will work closly with the group at Vareberg Engineering and Dr. Chad Ulven's group (also at NDSU) on the application of this sensor.

We look forward to this collaboration. If more information is needed, please do not hesitate to contact me. We are happy to help!

Regards,

Benjamin D. Braaten, Ph.D.
Professor and Chair of the Electrical and Computer Engineering Department
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North Dakota State University
Fargo, ND 58102
Office: 701-231-7608
benjamin.braaten@ndsu.edu