Technical Reviewers' Rating Summary

Proposal Number	**G-40-05**
Application Title	**Wellhead Reformer for Electricity Production and Other Applications**
Submitted By	**Novorocs Technologies, LLC and Blaise Energy, Inc.**
Request For	**$270,110.00**
Total Project Costs	**$540,220.00**

Section A. Scoring

Statement	**Weight**	**G-40-05A**	**G-40-05B**	**Avg. Score**
1. Objectives	9	3	4	31
2. Achievability	7	2	3	17
3. Methodology	8	3	3	24
4. Contribution	8	2	3	20
5. Awareness / Background	5	3	4	17
6. Project Management	3	2	3	7
7. Equipment / Facilities	2	2	3	5
8. Value / Industry - Budget	4	3	4	14
9. Financial Match - Budget	4	3	4	14
Avg. Weighted Score		**130**	**172**	**151**
OVERALL				
FUND			**X**	
TO BE CONSIDERED		**X**		
DO NOT FUND				

Section B. Ratings and Comments

1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Oil and Gas Research Council goals are:

   "The proposers project goals and objectives are clearly stated and include demonstrating the technical and economic benefit of reforming rich well head gas to produce a high purity methane stream better suited for power, and compressed natural gas applications."

   - Reviewer: G-40-05A

   - Rating: 3 (Clear)

   "Subsequent to submission of the proposal to NDIC, Novorocs has been working with the Gas Technology Institute (GTI) on adapting a flameless infrared clean flare technology developed by GTI. Novorocs plans to include a demonstration of the new GTI clean flare technology as part of the project at no additional cost to NDIC"

   - Applicant

   "I think the Objective is clearly spelled out in the beginning. Build the gas reformer unit; test it at UND; operate it on a wellsite to prove the reforming technology and then run a natural gas generator to produce electricity and a gas compressor to produce CNG; test the reformed gas on a burner assembly and test the emissions generated. Compile the data and look at the financial. operable, & emission reduction success."

   - Reviewer: G-40-05B

   - Rating: 4 (Very Clear)

   "Subsequent to submission of the proposal to NDIC, Novorocs has been working with the Gas Technology Institute (GTI) on adapting a flameless infrared clean flare technology developed by GTI. Novorocs plans to include a demonstration of the new GTI clean flare technology as part of the project at no additional cost to NDIC"

   - Applicant

2. With the approach suggested and time and budget available, the objectives are:

"The proposed budget and schedule seem aggressive. I would expect more time may be needed to fabricate a prototype, shake down at UND, demonstrate in a field application (well site), and achieve the needed system reliability and emissions data."

- Reviewer: G-40-05A

- Rating: 2 (Possibly Achievable)

"The PI has worked with Dr. Micheal Mann of UND in the past and is in close communication with Blaise Energy to ensure good coordination throughout the project. The PI has experience managing multi-million, multi-party demonstration projects."

- Applicant

"The previous successful testing of a small scale unit by Novorocs, handling up to 8.5 mcfd, gives a sound basis for scaling up to a bigger unit, 50-100 mcfd, and makes the timeline reasonable. There will have to be good coordination between the four entities involved to meet the schedule, but they all seem to be ready."

- Reviewer: G-40-05B

- Rating: 3 (Likely Achievable)

"The PI has worked with Dr. Micheal Mann of UND in the past and is in close communication with Blaise Energy to ensure good coordination throughout the project. The PI has experience managing multi-million, multi-party demonstration projects."

- Applicant

3. The quality of the methodology displayed in the proposal is:

“The authors claim to have bench-scale data supporting the technology readiness for field prototype; however that data has not been provided. If the claims are valid, the proposed methodology is appropriate to demonstrate the technology in oil and gas production applications.”

- Reviewer: G-40-05A

- Rating: 3 (Average)

“Early trials with the bench scale system was performed at 2 well sites with different APG compositions. At well site #1 the bench scale reformer converted 70% CH4 and 25% Higher HC to 87% CH4 and less than 1% Higher HC. At well site #2 the bench scale reformer converted 78% CH4 and 17% Higher HC to 93% CH4 and less than 0.1% Higher HC. Data available upon request. The demonstration reformer is designed for typical Bakken gas of 55% CH4 and 42% Higher HC.”

- Applicant

“The methodology is clear and spelled out as well as the time required for each of the seven tasks. Management of the project appears to be sound. To be able to set and test the equipment on an existing well pad (Halcon Resources in Dunn County) and use their facilities makes it a "real world" valuable test.”

- Reviewer: G-40-05B

- Rating: 3 (Average)

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- Applicant

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Oil and Gas Research Council goals will likely be:

"The "rich" nature of ND associated gas creates a challenge to it's processing and use. As such the proposed technology has the potential to mitigate that challenge and create a more uniform and readily usable methane product for power and CNG applications. However, markets for gas (both rich and lean) represents a larger challenge to greater gas use in ND. The proposed project does not necessarily enable greater gas use for power or CNG. Existing technology can be used to produce electricity from rich gas; as evidenced by the significant replacement of diesel generators with gas fired generators on well sites. CNG for transportation fuel is commercial available with well established economics. CNG and LNG is being produced with good economy of scale from existing ND gas processing plants. The economics of small scale rich gas reforming and subsequent CNG production have not been adequately described by the proposal authors. "

- Reviewer: G-40-05A

- Rating: 2 (Small)

"Current CNG and LNG processing plants are economical for very large wells (> 2 mmscfd). The vast majority of wells flaring gases are much smaller than this, and do not have an economical solution to recycle APG. This technology provides an economical solution for converting APG to CNG and LNG for smaller wells. Gas fired engines running on flare gas currently take a 40 - 50% derating and have increased maintenance requirements. In addition, the emissions profile of rich burn engines may be much higher than burning CH4. This technology will reduce maintenance, eliminate the derating, and reduce emissions. CNG production from APG has been hampered by the high cost of NGL processing plants. The technology will significantly reduce the cost of producing CNG from APG, especially for smaller wells, by eliminating the need to separate liquids from APG. The cost of CNG from pipeline natural gas is estimated to be $0.30 - $0.40 per gallon diesel equivalent. Since APG is a waste product and free the cost may be lower or of the same magnitude. This technology also enables well sites to significantly reduce emissions of their flares, helping them remain under Title V limits. This application of the technology may be applied to well sites that are in danger of getting kicked off the pipeline due to low pressure. Clean flaring technology, such as the flameless infrared clean flare technology developed by GTI is designed to run on methane, not rich gas, so the combination of reformer and clean flare technology would minimize criteria pollution emissions."

- Applicant

"The goals of the project are clearly spelled out and the companies have a good understanding of the issues around flared gas and what are some of the best avenues to try and capture it's value when it isn't committed to a processing plant. The knowledge of previous efforts by others as well as some of the conclusions developed by EERC for uses of flared gas was recognized. The potential to help out wells that are in remote or stranded areas has definite potential for the industry and maybe in other areas as well."

- Reviewer: G-40-05B

- Rating: 3 (Significant)

"Current CNG and LNG processing plants are economical for very large wells (> 2 mmscfd). The vast majority of wells flaring gases are much smaller than this, and do not have an economical solution to recycle APG. This technology provides an economical solution for converting APG to CNG and LNG for smaller wells. Gas fired engines running on flare gas currently take a 40 - 50% derating and have increased maintenance requirements. In addition, the emissions profile of rich burn engines may be much higher than burning CH4. This technology will reduce maintenance, eliminate the derating, and reduce emissions. CNG production from APG has been hampered by the high cost of NGL processing plants. The technology will significantly reduce the cost of producing CNG from APG, especially for smaller wells, by eliminating the need to separate liquids from APG. The cost of CNG from pipeline natural gas is estimated to be $0.30 - $0.40 per gallon diesel equivalent. Since APG is a waste product and free the cost may be lower or of the same magnitude. This technology also enables well sites to significantly reduce emissions of their flares, helping them remain under Title V limits. This application of the technology may be applied to well sites that are in danger of getting kicked off the pipeline due to low pressure. Clean flaring technology, such as the

5. The background of the principal investigator and the awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is:

“”

- Reviewer: G-40-05A

- Rating: 3 (Adequate)

“The PI has experience managing multi-million doller, multi-party demonstration projects in distributed energy systems of the same scale as the current proposal.”

- Applicant

“The PI has significant experience. Several references were made to the Century Code, other projects which have tested flared gas and their results, and requirements of the NDIC around flared gas. His previous work and experience with EERC brings valuable knowledge to this project.”

- Reviewer: G-40-05B

- Rating: 4 (Better Than Average)

“The PI has experience managing multi-million doller, multi-party demonstration projects in distributed energy systems of the same scale as the current proposal.”

- Applicant

6. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is:

"The management plan would be improved with several stage-gate or go/no-go decision points. Additionally, the inclusion of some technical accomplishment milestones would be beneficial. "

- Reviewer: G-40-05A

- Rating: 2 (Inadequate)

"The time line is staged sequentially. Quarterly reports will keep the NDIC apprised of the progress of the project.Novorocs proposes to incorporate a mandatory telephone review between the PI and the NDIC project manager at the end of each sequential Task, in order to review results relative to project objectives. Novorocs will not proceed with each subsequent task until approved by the NDIC project manager."

- Applicant

"The plan is clearly defined with a timetable (including 7 Tasks & the duration of each Task) as well as a simple budget. Reports will be given quarterly with an interim and final report."

- Reviewer: G-40-05B

- Rating: 3 (Adequate)

"The time line is staged sequentially. Quarterly reports will keep the NDIC apprised of the progress of the project.Novorocs proposes to incorporate a mandatory telephone review between the PI and the NDIC project manager at the end of each sequential Task, in order to review results relative to project objectives. Novorocs will not proceed with each subsequent task until approved by the NDIC project manager."

- Applicant

7. The proposed purchase of equipment and the facilities available is:

"Cost data is provided. Additional background and/or source data would be beneficial to substantiate the proposed budget."

- Reviewer: G-40-05A

- Rating: 2 (Poorly Justified)

"Source data for equipment costs is provided by a COBEY Quotation No. 16-9918 R0, June 1, 2016 (available upon request). In addition, the costs provided in the quotation was compared with the Department of Energy CNG equipment cost guidlines as provided in the report, Costs Associated With Compressed Natural Gas Vehicle Fueling Infrastructure, Smith et al, Sept 2014."

- Applicant

"Novorocs will build the prototype for testing which will be supplemented by existing equipment from Blaise Energy to test power generation and CNG production/use."

- Reviewer: G-40-05B

- Rating: 3 (Justified)

"Source data for equipment costs is provided by a COBEY Quotation No. 16-9918 R0, June 1, 2016 (available upon request). In addition, the costs provided in the quotation was compared with the Department of Energy CNG equipment cost guidlines as provided in the report, Costs Associated With Compressed Natural Gas Vehicle Fueling Infrastructure, Smith et al, Sept 2014."

- Applicant

8. The proposed budget "value"1 relative to the outlined work and the commitment from other sources is of:

"The value of producing a high quality methane stream from rich gas would benefit significantly by better defining subsequent end use at well sites. Reforming represents an added cost over rich burn engines for power production. Further the demand for gas for power production at well sites is low relative to flared volumes, limiting the scale and subsequent impact on flared volumes. The relatively small scale of well site CNG production compared to larger, gas plant based operation make the economics challenging. The proposal authors would benefit by defining the business arrangement that would enable an economic deployment of their technology in ND."

- Reviewer: G-40-05A

- Rating: 3 (Average Value)

"The economics of CNG production at small well sites are not competitive using current conventional technology. That is precisely the issue this technology will address. This technology will allow CNG to be produced at small well sites economically and with a relatively small capital investment in equipment. The technology allows the production of high quality methane without expensive liquids separation. This allows small wells to monetize their APG stream by producing power, CNG and LNG. It also enables clean flaring of APG in circumstances where criteria pollutants from the well site become an issue. Flaring clean methane produces greater than 98% lower emissions than open flaring APG. While gas engines have been retrofitted to burn Bakken APG, the disadvantages are numerous. Rich burn engines take a 40 - 50% derating, have higher maintenance costs, and higher emissions. Running a reformer in front of a natural gas genset would solve these issues, while simultaneously producing CNG for use, and providing an avenue to flare excess APG cleanly."

- Applicant

"The commitment of equipment from Blaise Energy, the partnering with UND and Halcon Resources (use of existing well pad) for testing the equipment makes this project testing and results valuable."

- Reviewer: G-40-05B

- Rating: 4 (High Value)

"The economics of CNG production at small well sites are not competitive using current conventional technology. That is precisely the issue this technology will address. This technology will allow CNG to be produced at small well sites economically and with a relatively small capital investment in equipment. The technology allows the production of high quality methane without expensive liquids separation. This allows small wells to monetize their APG stream by producing power, CNG and LNG. It also enables clean flaring of APG in circumstances where criteria pollutants from the well site become an issue. Flaring clean methane produces greater than 98% lower emissions than open flaring APG. While gas engines have been retrofitted to burn Bakken APG, the disadvantages are numerous. Rich burn engines take a 40 - 50% derating, have higher maintenance costs, and higher emissions. Running a reformer in front of a natural gas genset would solve these issues, while simultaneously producing CNG for use, and providing an avenue to flare excess APG cleanly."

- Applicant

9. The “financial commitment”2 from other sources in terms of “match funding” have been identified:

“The proposed 50% match consisting of cash and in-kind contributions is acceptable. ”

- Reviewer: G-40-05A

- Rating: 3 (Average Value)

“A minimum of 50% matching funds is provided.The additional proposed demonstration of the GTI clean-flare will also be fully funded by Novorocs.”

- Applicant

“The matching funds value is the minimum required of 50% and will come from Blaise Energy as well as Novorocs Technologies. The partnerships with Blaise Energy as well as Halcon Resources definitely adds to the favorability of this project.”

- Reviewer: G-40-05B

- Rating: 4 (High Value)

“A minimum of 50% matching funds is provided.The additional proposed demonstration of the GTI clean-flare will also be fully funded by Novorocs.”

- Applicant

General Comments

“The proposed methodology and work plan is reasonable for demonstration of technology in a new market.

The proposed technology address one challenge to greater gas use in the Bakken, namely its rich composition. The proposers have not adequately defined how the successful demonstration of their technology will lead to improved gas use, economic deployment, and/or flare gas reduction.”

- Reviewer: G-40-05A

“I think the goal of this project to develop flared gas into electricity for use onsite and or to generate CNG are both viable options. Having worked on both wells and processing plants/gathering system for many years these are both worthwhile pursuits.
When the results are in it will be interesting to see if a scaled-up reformation gas process could compete with conventional processing plants economically in certain cases. It is a great idea for stranded gas or uneconomic areas to gather - finding a valuable use for the flared gas or just reducing the emission products if it has to be flared.”

- Reviewer: G-40-05B

1 “value” – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar. A commitment of support from industry partners equates to a higher value.

2 “financial commitment” from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Support less than 50% from Industrial Commission sources should be evaluated as favorable to the application; industry partnerships equates to increased favorability.