APPLICATION RATING FORM

Reviewer's Identification Number: **3A** (no name please)

Date: 1/17/2015

Principal Investigator(s): *Jacek Chmielewski*

Proposal Number: *R024-A*

Application Title: *Sugar Beet Tailings to Advanced Ethanol*

Section A. Summary of Ratings:

Please complete the questions below and then fill in this summary.

	Statement	Checked Number	X	Weighting Factor	=	Subrating
1.	Objectives	3	x	9	=	27
2.	Achievability	1	x	9	=	9
3.	Methodology	2	x	7	=	14
4.	Contribution	2	x	7	=	14
5.	Awareness	1	x	5	=	5
6.	Background	1	x	5	=	5
7.	Project Management	3	x	2	=	6
8.	Equipment Purchase	5	x	2	=	10
9.	Facilities	3	x	2	=	6
10.	Budget	1	x	2	=	2
	Total					**98/250**

Note: While points are necessary to establish an overall rating, comments on the various criteria are critical to truly understanding the value of a proposed project. **Please elaborate in the comment sections to the maximum extent possible.**

Overall Recommendation: If > 170 ____ _____ Fund
130 -170 _____ Funding May Be Considered
If < 130 _____x___ Do Not Fund

Section B. Ratings and Comments:

Please indicate your response to each statement by placing an "x" in the box above the number and transfer the number selected to the column entitled "Checked Number" on the first page of this form. **Please comment on each criterion.**

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

		x		
1 - Very Unclear	2 - Unclear	3 - Clear	4 - Very Clear	5 - Exceptionally Clear

Please comment:

The overall goal of this project is relevant to the NDIC mission. However there are many gaps in the project in key areas, and the authors appear to believe that they simply need to pull various technologies off the shelf, cobble them together, and they will have a working, automated system. This is very naïve from several viewpoints: 1) the feedstocks they are using are not uniform and the composition will change during the course of the year during storage, 2) the feedstocks are unlikely to be available all year round, based on the sugar beet processing season, 3) performance of at least the fermentation stage will be different than that found in corn ethanol production, and downstream processes will also be different (coproduct feed recovery and drying). This proposal is for a 5 month engineering design. What is really needed is some actual process data and validation at some scale to show that this technology can work.

Response to comments

General Response

A significant amount of work has been done to date to validate the ability to produce alcohol from the ACS SBTs. To date, the BMS team has done testing and validation of the process at the bench scale and has shared this with ACS.

The results have been positive and allowed BMS to move the last gate which is the proposed project. Extensive testing has been completed with sample SBTs from ACS to validate the viability of the alcohol production (specifics are outlined in sections below). Additional testing is underway to optimize the process but the initial tests have validated the ability to generate alcohol from SBTs. Despite this, the project is still very financially attractive to our financing partners.

The critical gate for moving to the next step will be the completion of this proposed project.

The proposed project with the NDIC includes additional testing along with the engineering design work. The testing components are highlighted in the project phases. The FEL details are in Appendix 10 (Same detail as was provided in the original application).

FEL-1	FEL-2	FEL-3
▪ Material balance ▪ Energy balance ▪ Project charter ▪ Validation Bench Testing	▪ Preliminary equipment design ▪ Preliminary layout ▪ Preliminary schedule ▪ Preliminary estimate ▪ Validation Pilot Testing	▪ Purchase-ready major equipment specifications ▪ Definitive estimate ▪ Project execution plan ▪ Preliminary 3-D model ▪ Electrical equipment list ▪ Line list ▪ Process 3rd Party Testing

Figure 1 – FEL Description

1) **The feedstocks they are using are not uniform and the composition will change during the course of the year during storage**

   *Additional detail is provided in **Appendix 1** of this document that outlines the testing that has been completed to date. Details on the process are included in **Appendix 2** of this document.*

2) **The feedstocks are unlikely to be available all year round, based on the sugar beet processing season**

   It is the intention of BMS to process additional feedstocks and utilize the plant to its fullest capacity but the financial model does not require it.

   The financial components of these are not included in any of the financial modeling at this time.

3) **Performance of at least the fermentation stage will be different than that found in corn ethanol production, and downstream processes will also be different (coproduct feed recovery and drying).**

4) **This proposal is for a 5 month engineering design. What is really needed is some actual process data and validation at some scale to show that this technology can work.**

*Please see **Appendix 1 and 2** as noted above. Significant testing has been completed to date.*

Another objective of the process is production of "*high quality animal feed as a byproduct.*" However the potential composition and market value of this product are never discussed. Have any feeding trials with this material been performed? Is there any basis for assuming this material will be acceptable to feeders?

It is our expectation and initial findings that various blending components will be locally purchased in order to complete the final formulations. These will include, proteins, carbohydrates, vitamins and minerals.

Feed trial in this are currently being undertaken, with assistance from animal feed formulation specialists and consultants. Initial assessments on viability of the available feedstock for the formulations was confirmed by one industry consultant.

*The financial projections currently incorporate a conservative value for the feed (See **Appendix 5** for financial projections).*

The price of the feedstock beet tailings or unmarketed beets are also not described. This is a key "selling point" for the process but it is glossed over.

Base terms are agreed to in principle but final agreement is based on the successful completion of the proposed FEED project.

The idea of small scale, distributed ethanol production has been around since the late 1970s, but has never materialized due to economies of scale issues. This project proposes an 8 million gallon/yr facility that would be at a severe economic disadvantage to the industry standard of 50-100 mgy facilities. The saving grace would be procuring feedstock (beet tailings, waste beets) at low or even negative costs, but the feedstock costs are never discussed in the proposal. Another disadvantage of these feedstocks is their lack of availability from May through September, and the fact that their composition will be quite variable. A facility that operates only 9 months out of the year is doomed.

The BMS plant has a much lower cost of production per gallon compared to traditional corn ethanol plants due to the following attributes:

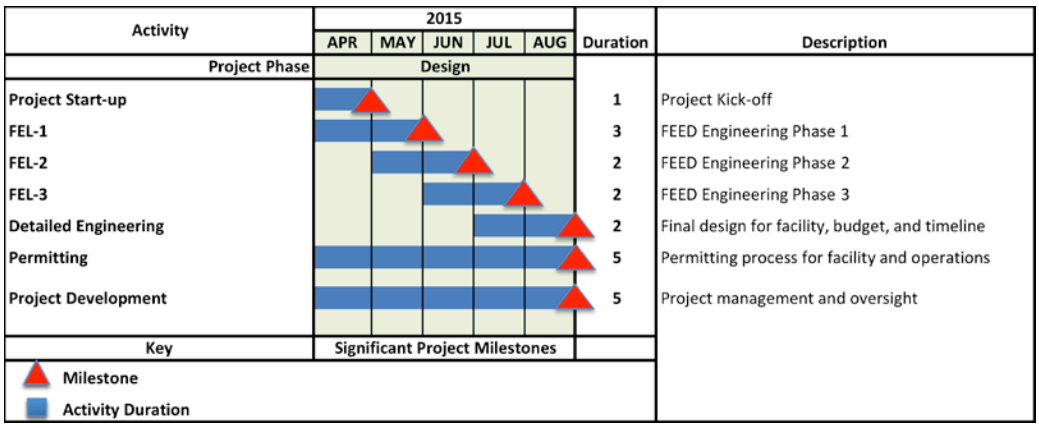
2. With the approach suggested and time and budget available, the objectives are:

X				
1 - Not Achievable	2 - Possibly Achievable	3 - Likely Achievable	4 - Most Likely Achievable	5 - Certainly Achievable

Please comment:

The timeline of this project in relation to the overall construction objectives are not anywhere close to feasible. For one, they indicate the project should be completed by "*the end of May 2015*" and indicate a 5 month duration. That means the project needed to start January 1, 2015. It is already the middle of January, and the NIDC program policies indicate that it can be up to 60 days following submission that the projects are awarded, and up to another 60 days before contractual agreements are signed. This puts the actual start date into March or April of 2015. They later indicate that the May 2015 end date is critical so they can begin construction of the commercial facility at that date, so it would be operational in the fall of 2016 for the sugar beet harvest. This timing is impossible to make work.

A revised timeline is provided below. The initial timeline in the application for the full project included a significant contingency buffer time for plant construction and facility construction due to the winter. Additional conversation with several local construction companies has provided confidence that much of the construction activities could be done over the winter months. In addition, the testing and process work done to date with suppliers has given additional confidence to the suppliers that the timelines provided previously will be shortened. BMS has a high degree of confidence with the equipment providers given long-standing relationships with each of the companies that they can deliver in the committed timelines. An overall project timeline is provided in ***Appendix 6****.*



For a "paper only" engineering study, 5 months might be sufficient. However what is really needed is some hard performance data by operating the FEED system with the proposed feedstocks. If this information was available, it wasn't included in the proposal. If it is not available, this should be the first order of business. How can engineering projections be made without performance information???

As noted earlier, the extensive pre-work and testing that has been done to date and was not included in the original application. Seven months of pre-work has been done. There

will be close to 14 months of work completed at the conclusion of this project. Additional data is available in ***Appendix 1 and 2.***

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

	x			
1 - Well Below Average	2 - Below Average	3 - Average	4 - Above Average	5 - Well Above Average

Please comment:

The project proposes to use an upstream feedstock processing method that "*has similarities to existing processes deployed all over Europe*" in order to convert the feedstocks (sugar beet tailings and unmarketable sugar beets) into a form that can be processed by "*industry standard ethanol production technologies*." Unfortunately the PI fails to provide any insight into this method used in Europe and how it will be modified for their purposes. The feedstocks they will use are wastes or lower value beets, which will have a highly variable composition throughout the year (and will not be available during the summer months after the beet campaign has ended). These feedstocks will be contaminated with a wide range of organisms that will ferment the sugars into lactic and acetic acid, thus reducing the ethanol yield potential. More problematic is that even if the bacteria are removed in the front end of the process, the organic acids will pass through into the fermentation process and inhibit yeast metabolism, resulting in "stuck" fermentations. There is no mention of this issue or how they might propose to address this problem.

Please see ***Appendix 1 and 2*** *as noted earlier.*

The Front End Engineering and Design (FEED) stages are claimed to provide "*additional level of detail, testing, and validation of the overall plant design*." However the proposal only focuses on the design aspects, without adequately addressing testing and validation. Within the 5 month project duration it is impossible to conduct the needed testing and validation of the FEED aspects. As noted above, there are many elements of the FEED process that need to be optimized and validated, with the resulting slurry tested in the fermentation process. Thus there are major gaps in the needed work plan, and if these were included the project would require at least 1 year. Additional questions I have are listed below:

- What are the storage conditions for the SBT and unmarketable beets?
  Please see previous answer regarding the collection supply chain and storage of SBTs.
- What is the fate of the wash water used to clean the SBTs and beets?
  Based upon supply chain changes for using collection vessels and validation through testing the need for the water wash has been eliminated.
- What is the polymer enhanced stratification process and what are its benefits?
- What is the anticipated sugar and ethanol titer of the process streams?
  Addressed in previous section.

- If solids are removed prior to distillation, how will ethanol be recovered from these solids?
  See previous remarks on re-location of the polymer-enhanced solids separation process.
- Why are the animal feeds to be pelleted? Corn DDGS isn't pelleted.
- What is the advantage of the UV light photoelectrocatalytic water treatment process over biomethanators that are commonly used in ethanol plants.

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

	X			
1 - Extremely Small	2 - Small	3 - Significant	4 - Very Significant	5 - Extremely Significant

Please comment:

The project is largely focused on design of the FEED process, and provides little if any information on how the process works, let alone any performance data. The PI indicates the "*SBT handling and pre-processing is a new process that is being introduced in ND*." Without adequate background on the process it is impossible to judge if it can be a workable system. The PI appears to believe that this is a turn-key solution to processing the SBT and unmarketable/waste beets, but this does not convince me, due to the issues mentioned in #3 above. This process needs to be tested and performance validated before it can be assumed to be workable.

The PI correctly indicates that fermentation and the following downstream processes are well known. However those technologies are based on a completely different feedstock (corn) and a beer that is readily flowable and contains 15% ethanol. The fermented slurry from beet processing will contain far lower ethanol levels and have a much higher viscosity. Therefore energy and capital costs per gallon of ethanol will be substantially higher.

*Addressed earlier in the write-up and through data provided in **Appendix 2**.*

5. The principal investigator's 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:

x				
1 - Very Limited	2 - Limited	3 - Adequate	4 - Better Than Average	5 – Exceptional

Please comment:

There is no literature citation section and as per my comments above, it appears that this team has little if any background on processing beets or beet tailings. I even question their understanding of the corn ethanol industry based on some of the assumptions they make concerning fermentation and downstream processing.

Additional detail on the backgrounds of the team members is included in ***Appendix 8.***

6. The background of the investigator(s) as related to the proposed work is:

X				
1 - Very Limited	2 - Limited	3 - Adequate	4 - Better Than Average	5 – Exceptional

Please comment:

The project participant section just lists the roles of each of the participants, but does not describe any level of prior expertise in the ethanol industry. Thus it is not possible to judge whether the team has the needed background and expertise. This engineering design project looks to be a "paper only" study working from assumptions that have not been proven (at least they have not provided such data.)

7. 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:

		X		
1 - Very Inadequate	2 - Inadequate	3 - Adequate	4 - Very Good	5 – Exceptionally Good

Please comment:

Nothing out of the ordinary.

8. The proposed purchase of equipment is:

				X
1 - Extremely Poorly Justified	2 - Poorly Justified	3 - Justified	4 - Well Justified	5 – Extremely Well Justified

(Check 5 if no equipment is to be purchased.)

Please comment:

No equipment requested.

9. The facilities and equipment available and to be purchased for the proposed research are:

		X		
1 - Very Inadequate	2 - Inadequate	3 - Adequate	4 - Notably Good	5 – Exceptionally Good

Please comment:

As a "paper study" the needed items are available. However what is really needed is a pilot scale facility to test and validate performance of the FEED system and how it will integrate into the ethanol production process. These are evidently not available.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources[2] is of:

x				
1 - Very Low Value	2 – Low Value	3 – Average Value	4 – High Value	5 – Very High Value

Please comment:

Without solid performance data for the entire system, any design/engineering projections made will be based on assumptions. The value of the output will equal the value of the input.

Additional data provided in earlier sections and appendix data included provide additional background and detail.

[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.*

[2] *Financial commitment from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Higher priority is to be given if the application has private industry investment equal to or at least 50% or more of total cost.*

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

General comments:

Conversion of beet wastes or unmarketable beets into useful products has the potential to solve an environmental problem, while creating economic development. Key issues to be addressed include: 1) feedstock storage and availability to allow 12 month/yr operation, and 2) methods to overcome the low bulk density of beets in a liquid processing format, so that conventional fermentation and distillation technology can be used.

This proposal is aimed at conducting an engineering design for such an integrated system, based on a combination of a FEED technology adapted from Europe, combined with fermentation and downstream processing unit operations from corn ethanol.

Unfortunately the proposal fails to provide sufficient detail on the design and performance of the FEED system, so that it is not possible to judge whether this technology will work. The applicants also fail to mention the several technical challenges (chief among them feedstock spoilage and production of organic acids) that stand in the path of successfully deploying this technology. These oversights lead me to question the understanding of the applicants, and therefore the value of the results this project would generate. Thus I strongly recommend NOT FUNDING this project.