TECHNICAL REVIEWERS' RATING SUMMARY

R025-A

Sugar Beet Tailings to Advanced Ethanol

BioMass Solution, LLC
Principal Investigator: Jacek Chmielewski
Request for $500,000; Total Project Costs $1,000,000

Rating Category	Weighting Factor	Technical Reviewer 1A Rating	2A Rating	3A Rating	Average Weighted Score
1. Objectives	9	5	4	4	39.00
2. Achievability	9	4	4	2	30.00
3. Methodology	7	4	3	4	25.67
4. Contribution	7	5	3	3	25.67
5. Awareness	5	4	2	2	13.33
6. Background	5	4	3	3	16.67
7. Project Management	2	4	3	3	6.67
8. Equipment Purchase	2	5	5	5	10.00
9. Facilities	2	4	3	3	6.67
10. Budget	2	5	3	3	7.33
Average Weighted Score		220	167	156	**181.00**
Maximum Weighted Score					**250.00**

OVERALL RECOMMENDATION

FUND	x		
FUNDING MAY BE CONSIDERED		x	x
DO NOT FUND			

R025-A
Sugar Beet Tailings to Advanced Ethanol
Submitted by BioMass Solution, LLC
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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: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 1A (Rating: 5)
The applicants have laid out a clear plan to prepare an 8 million gal/year bioethanol facility in Grand Forks, ND, using sugar beet tailings, a waste product currently sent to landfills. The proposed facilities would create jobs in North Dakota, and therefore fulfills NDIC goals. The proposal will enable the construction of the biorefinery via performance of a front-end engineering and design (FEED), and other preliminary assessments. The applicants have also addressed the potential value of the distiller's solids and a co-product for animal feed.

Reviewer 2A (Rating: 4)
This project is relevant to the NDIC mission of developing higher value uses for ND resources. The specific goal is to convert a negative value material, sugar beet tailings, into the biofuel ethanol. The applicants have conducted additional work on some of the potentially troublesome aspects of this technology, however there two main concerns remain: 1) the proposed feedstock will only be available for part of the year, and 2) the limitation of feedstock supply restricts the size of the facility to 10 mgy, which is 5-10X smaller than the corn ethanol biorefineries they will be competing with. While the low or potentially negative feedstock cost is very attractive, the CAPEX on this project in relation to annual production are very unattractive. How these balance out will determine whether this project is economically viable.

It was mentioned in the prior proposal that feeding trials were underway with the byproduct. Is and data yet available? Is there any basis for assuming this material will be acceptable to feeders? How can a potential value for this co-product be established?

Reviewer 3A (Rating: 4)
The stated goal is very clear.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 1A (Rating: 4)
The objectives, to perform a FEED, and obtain permits, is achievable.

Reviewer 2A (Rating: 4)
I assume the applicants have continued to work on this project since the last application.

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. Some small scale data was included in this updated proposal, but I would be much more confident if they had pilot scale data over a longer period of time.

Reviewer 3A (Rating: 2)
My biggest ding the last time around was that it was unknown how viable the utilization of SBT in the production of ethanol actually is. There didn't appear to be any advancement or clarification on this front (i.e. is it being done elsewhere? Is there academic literature on the viability?), that is until the very end. The appendix that included the bench test results was in fact very helpful. Granted, it's an incredibly long and arduous path from there to commercial production quantities, but I was more so pleased with what I saw as a re-prioritization. I really felt the first submission was putting the cart before the horse – they had even gone so far as to select the site – but little, if any, work had been done on the viability of the process (or at least was explained in the submission). There's still a big element to that here, but the bench test results at least speak to this new focus.

The rest of the submission still falls short on the overall funding pathway. If this is to be funded, it should be done on a milestone basis. The FEL 1 results should reveal the viability of the process, and very importantly, the estimated production cost on a $/gallon basis. I'll give them the benefit of the doubt on the RIN classification as this wouldn't be producing ethanol for 2+ years anyway.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 1A (Rating: 4)
BMS and their partners have provided appropriate methodology to complete the deliverables: FEED, plant design, downstream separations, and environmental assessment and compliance**.**

Reviewer 2A (Rating: 3)
The project proposes a paper engineering study that should be achievable by any reputable group of engineers. These is nothing out of the ordinary with respect to the proposed methodologies. My main concerns remain the limited amount of data presented on the various unit operations, and the lack of operations at a pilot scale on the proposed feedstock. While HPLC data is provided on the feedstock before and after processing, the scale and length of this work is not provided. The sugar beet tailing feedstock is a waste product of another industry, and as with any waste product 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 still no mention of this issue or how they might propose to address this problem. Additional still unanswered questions include:

- What are the storage conditions for the SBT and unmarketable beets?

- What is the fate of the wash water used to clean the SBTs and beets?
- What is the polymer enhanced stratification process and what are its benefits?
- If solids are removed prior to distillation, how will ethanol be recovered from these solids?
- 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.

Reviewer 3A (Rating: 4)
It's detailed and is a viable plan on the surface, but important gaps remain. What, exactly, is the special pre-processing approach that will be used? It is a major leap and where most waste-to-fuel efforts fall short. Also, it was hard to see from the project development timeline (it was very blurred in my PDF) whether or not my prior criticism was rectified – namely starting subsequent phases prior completion of those preceding them.

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: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 1A (Rating: 5)
The use of NDIC/REC funds for preliminary designs and assessment of a bioethanol biorefinery in Grand Forks using a waste product currently sent to landfills, that would create 20 permanent jobs, fulfills NDIC/REC goals.

Reviewer 2A (Rating: 3)
The project is largely focused on design of the FEED process, but still provides little if any information on how the process works, let alone any performance data. Without adequate background on the process it is impossible to judge if it can be a workable system. This process needs to be tested and performance validated before it can be assumed to be workable.

Reviewer 3A (Rating: 3)
Again, the pre-processing approach is a big unknown. I've seen several different waste to fuel opportunities and this is usually the biggest issue. Also what's not discussed here – the actual aggregation of the SBT. The added costs often aren't properly accounted for and can severely negatively impact economic profitability.

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: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1A (Rating: 4)
The applicants appear to be knowledgeable on biorefinery operations and unit operations. They propose the innovation is novel "pre-processing" technology applicable to sugar beet tailings, for

their preparation in fermentation. But, we are given only a small glimpse of the technology in Appendix 3.

Reviewer 2A (Rating: 2)
There is still no literature citation section. While the applicants have provided some new data from small scale trials, data is lacking at a pilot scale. There is also no hard data provided from the various unit operations that are claimed to be in operation elsewhere.

Reviewer 3A (Rating:2)
I would still love to see some prior 3rd party validation regarding the viability of SBT to ethanol production. What work has been done previously? Sugar beets account for 20% of worldwide sugar production…surely someone has done research on SBT conversion. Europe is also more advanced than the US and already processes beets for ethanol – has work been done there?

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 1A (Rating: 4)
From viewing their website and reading this proposal, BMS and the PI do have experience in renewable fuels area; but, it is not clear if they have the expertise to prepare a relatively large 8 million gallon per year bioethanol facility. The collaborating organizations: BGI, UTI, and REA, all have the necessary expertise. The use of BGI for third-party review of the FEED is a good idea.

Reviewer 2A (Rating: 3)
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. The Background and Qualifications section indicates that the PI and Norm Scheels have experience in designing and operating ethanol plants, but does not provide enough information to judge whether the team actually 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.)

Reviewer 3A (Rating: 3)
No updated comments from prior submission.

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: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 1A (Rating: 4)
The Gantt chart provided on page 14 is not readable in the proposal version provided to me. This deficiency makes a definitive "exceptionally good" rating hard to justify. But, based on the narrative provided, and the use of BGI in the review of the FEED is sufficient to justify "very good".

Reviewer 2A (Rating: 3)
Nothing out of the ordinary.

Reviewer 3A (Rating: 3)
Funding should still coincide with successful completion of each of the various FEL steps. The additional detail is helpful in breaking out specifics, but regardless funding should stop if for whatever reason the design/EPC work results in a non-viable process (if, for instance, production costs balloon beyond reasonable levels).

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 1A (Rating: 5)
No equipment is to be purchased.

Reviewer 2A (Rating: 5)
No equipment requested.

Reviewer 3A (Rating: 5)
No equipment purchases.

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 1A (Rating: 4)
It is not clear, but probable, that BMS has the necessary facilities to evaluate the FEED assessment. The permits and surveys will occur on the proposed biorefinery site in Grand Forks.

Reviewer 2A (Rating: 3)
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.

Reviewer 3A (Rating: 3)
No equipment necessary.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 1A (Rating: 5)
The investment $500 K from NDIC/REC to set up a biorefinery that will produce bioethanol and distiller's grains as a co-product that will produce 20 jobs and use a waste product currently being landfilled is of high value.

Reviewer 2A (Rating: 3)
Financial commitment from other sources meets the minimum. It would be preferable to have pilot scale data to use in making design and engineering projections for the commercial facility. Without hard data at this scale, the value of the output will be based on the assumptions going into the input.

Reviewer 3A (Rating: 3)
$700k is a significant lump sum to exclusively fund engineering work. Then again, it's difficult to say without knowing the overall size of the expected facility. Is this a $20m or $200m project once completed? Regardless, all the engineering work needs to be done up-front, and it's a contemplated 500/200 split.

[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.

Reviewer 1A ***(Fund)***
The applicants propose to use NDIC/REC funds to prepare a front-end engineering design (FEED), receiving permits, and do pre-construction to produce bioethanol and distiller's grains as a co-product (animal feed) at a biorefinery in Grand Forks. The project ranks high in sustainability: conversion of sugar beet tailings, waste products that take up landfill, into value-added products. The applicants have secured their supply of feedstock. The biorefinery would produce 20 jobs. The project plan is very achievable, through use of expertise of subcontractors and the use of a third-party review for the FEED. This project appears to be the largest venture undertaken by the applicants, and is ambitious. But, I believe they have a reasonably sound plan to achieve their long-term goals, given a favorable political and economic environment, and continued government support for biofuels.

Reviewer 2A ***(Funding May Be Considered)***
The applicants have added new information to the proposal since late 2014, and that has improved the score to the upper range of the "funding may be considered" category. However the proposed process still has many unanswered challenges that could "make or break" economic feasibility. Economic feasibility of processing operations requires operating full time during the year, and making the most of "economies of scale." Using a low or negative cost feedstock is definitely an advantage, but may not be enough to off-set some of the disadvantages. Perhaps by conducting this engineering study the team will be able to answer these questions sufficiently to make a sound decision on commercialization.

Reviewer 3A ***(Funding May Be Considered)***
I was less concerned about the RIN component than it would appear other commenters were. Rather, I was more concerned with 1) the actual viability of the production process and 2) how that money would be spent. There was some additional work provided here to address the former, but not a sufficient enough amount to address the majority of my concerns. Regarding the latter, my view holds that the grant should only be provided on a milestone basis, with the real target obviously being the FEL 1 phase.