

TECHNICAL REVIEWERS' RATING SUMMARY

R018-A

Biocomposite Development for Industrial and Consumer Products

c2renew Corporation, Earth-Kind, NDSU

Principal Investigator: Chad Ulven

Request for \$150,000; Total Project Costs \$300,000

<u>Rating Category</u>	<u>Weighting Factor</u>	<u>Technical Reviewer</u>			<u>Average Weighted Score</u>
		<u>2A</u>	<u>2B</u>	<u>2C</u>	
1. Objectives	9	4	5	2	33.00
2. Achievability	9	3	4	2	27.00
3. Methodology	7	2	3	2	16.33
4. Contribution	7	4	5	3	28.00
5. Awareness	5	2	2	1	8.33
6. Background	5	5	5	4	23.33
7. Project Management	2	4	4	3	7.33
8. Equipment Purchase	2	5	4	5	9.33
9. Facilities	2	3	5	4	8.00
10. Budget	2	3	4	5	8.00
Average Weighted Score		170	206	130	168.67
Maximum Weighted Score					250.00

OVERALL RECOMMENDATION

If > 170	<u>Fund</u>	<u>x</u>	
130 - 170	<u>Funding May Be Considered</u>	<u>x</u>	<u>x</u>
If < 130	<u>Do Not Fund</u>		

R018-A
Biocomposite Development for Industrial and Consumer Products
Submitted by c2renew Corporation, Earth-Kind, NDSU
Principal Investigators: Chad Ulven
Request for \$150,000; Total Project Costs \$300,000

- 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 2A (Rating: 4)

The goal is clear, but without specific objectives.

Reviewer 2B (Rating: 5)

Proposal includes specific references to metrics (use of biomass, ND job creation, etc).

Reviewer 2C (Rating: 2)

The specific polymers and biomasses that will be used are not even listed in the abstract and objectives. The abstract does not pull the reader in. I think there are valid points in the proposal but these points need to be made clear in the objectives section.

The expressed goals later in the paper are in line with the NDIC goals (particularly the commercialization and popularization of biomass), but they are also vague and more specifics should be used to make it defensible.

There is a section at the end of the proposal called “Why This Project is Needed” (p. 10) that states the problem much more clearly than it was stated in the abstract.

- 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 2A (Rating: 3)

The objective of this proposal is to continue development and industrial trial of biocomposite materials produced by c2renew corporation into consumer products by Earth-Kind and industrial applications for Bobcat Co., John Deere Co., and Toshiba Corp. The proposal did not discuss the performance of the current C2new products and the specifications of the related products from Bobcat Co., John Deere Co., and Toshiba Corp. The proposal talks a lot about the market size, but without cost analysis. Even though it is a 100% biocompiste, will it be more expensive than the petroleum analogs? It is also unclear whether the proposed products can meet the specifications of the targeted consumer products.

Reviewer 2B (Rating: 4)

The investigator team appears to have a well-suited background for tackling this project, and has done a significant amount of work already toward these objectives. There doesn't appear to be significant scientific risk and the technical risk seems feasible, although there are risks that specific solutions for specifically identified customer projects won't be found.

Reviewer 2C (Rating: 2)

The Rodent Repellent Holder timeline is set for 6 months, which includes acquiring samples, testing, developing, and developing a process. To me this does not seem feasible.

I would need to see more details about the polymer chemistry and related specific polymer processing literature in order to evaluate if the rest of the objectives were achievable – this level of detail is lacking in the proposal. Currently it is too vague to evaluate by a strict timeline.

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 2A (Rating: 2)

The methodology is very brief. For each of these products, it needs to be tested against the specifications of the products? What are these specifications for each product? When the biopolymers and biomass are purchased, what kinds of analysis will be conducted to maintain the quality of the feedstock and finally quality control for the final products? The biomass feedstocks need to be screened due to varied composition and thermal stability. Deterioration of biomass during storage will also affect the quality of biocomposite.

Reviewer 2B (Rating: 3)

I give high points for having specifically identified projects and a reasonable product development process in the methodology. However, the specific techniques used are taken as a given rather than given full airing in this proposal. Assuming that these approaches will be using fairly well-understood processes for developing biomaterials this doesn't raise concerns, but would be best if not left to the imagination.

Volume manufacturing isn't fully addressed; also, issues of feedstock management are likely to be more difficult given the flexible and variable nature intended for this business proposal. That is acceptable at this stage, but should be given focus as areas of potential concern/challenge going forward.

Reviewer 2C (Rating: 2)

The methodology is vague. There are nine steps listed and only about two sentences after each step. I would like to see more polymer chemistry and processing details. For instance, there is one step that says it will be completed by the “injection molding process”, but I would like to know what type of equipment will be used for this and what process control parameters will be investigated.

It is difficult to evaluate the methodology for its viability when there are not sufficient details provided.

- 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 2A (Rating: 4)

This project very addresses the North Dakota Industrial Commission/Renewable Energy Council goals.

Reviewer 2B (Rating: 5)

This proposal is very well suited for the particular goals of the Council and the attributes of North Dakota. The use of agricultural waste as a flexible feedstock for packaging for ND-based and regional manufacturers is a good win-win opportunity for these entrepreneurs, the local agriculture industry, and local manufacturing facilities looking to contribute to their overall corporate green directives and goals. Even if this particular entrepreneurial enterprise doesn't succeed, the establishment of a commercialized process for utilizing these flexible feedstocks would be additive to the ND sustainability story.

Reviewer 2C (Rating: 3)

In certain parts of the proposal, it seemed like the NDIC goals were merely a second thought, like when they said that the invention of the biocomposites would spur more biocomposite creation, which was not substantiated by further evidence in the paper.

However, the businesses involved are all ND businesses, and they are promoting job creation and developing products using biomass, which were all stated goals of the NDIC.

Again, the viability of the chemistry and polymer processing is key to determining if the proposal will be successful. If it is not successful due to a lack of planning, it will do nothing to help the ND economy as stated.

- 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 2A (Rating: 2)

The PI failed to discuss and compare the proposed activities and products with the current research and development efforts in this country. There are already similar biocomposite research and development activities in some major land grant universities and automobile industries, even though some of proposed applications of biocomposite in this proposal such as the Rodent Repellent Holder for Earth-Kind maybe new. The PI did not discuss the IP status of

the technology. Without IP protection, it will be difficult to compete with other companies which have their own IP protection on the similar products.

Reviewer 2B (Rating: 2)

Certainly the principal investigator appears well-qualified for this project, based upon review of CV/bio, and has published relevant research. However, this reviewer didn't find any reference to any outside literature or review of other existing commercialized efforts in the marketplace for competitive offerings. This is a major gap in the business plan. Given the qualifications of the team involved it is not a prohibitive gap, but this reviewer would urge that a thorough competitor and external literature search be undertaken, for the good of the project.

Reviewer 2C (Rating: 1)

There was no literature cited in the proposal. It definitely weakened the overall proposal and the claims made in the proposal.

Papers about the use of biomass in composites or processing of biopolymers would have been very useful in supporting the author's claims.

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 2A (Rating: 5)

The background of the investigators is highly related to the proposed work. The PI has already worked on this topic for several years.

Reviewer 2B (Rating: 5)

It is impossible to say from a simple review of bio/CV, of course, but on paper this team seems to be particularly well suited for this effort.

Reviewer 2C (Rating: 4)

The principal investigator, Dr. Ulven, has a PhD in Materials Engineering and has written numerous journal publications about the polymers and biomasses listed in the paper. The lead engineer at c2renew (Mr. Ehresmann) did his Master's thesis work on the biomaterials listed in the proposal and has a mechanical engineering and manufacturing background, which would support the proposal's intent of manufacturing biomaterials.

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 2A (Rating: 4)

Milestone chart, schedule, budget narrative, and project management were provided in the proposal, but without support letters from the Original Equipment Manufacturers (OEM). Have

these companies expressed any interest in the proposed products? What kind of support have they committed?

Reviewer 2B (Rating: 4)

The proposal does a good job of laying out a specific schedule and project management plan that seems reasonable and feasible. Monthly meetings for coordination are planned for. The timeframes shown in the milestone chart do not appear unreasonable.

Reviewer 2C (Rating: 3)

The project management plan is fairly standard. Major tasks are identified, but milestones are lacking. Also, as stated earlier, I believe that the timeline for the Rodent Repellent Holder is far too ambitious, and will set back the other objectives significantly as a result.

- 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 2A (Rating: 5)

No equipment purchase.

Reviewer 2B (Rating: 4)

Compounding extruder, tooling, and software purchases seem reasonable and directly relevant to the needs of this project. Aside from tooling, they do not appear too customized and thus are low risk of design failure or other functionality failure.

Reviewer 2C (Rating: 5)

- 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 2A (Rating: 3)

The proposal did not discuss the quality control related feedstock and product analysis, it is not easy to judge whether they have the related facilities and equipment, however as the PI is from NDSU, the related equipment should be able to be located on campus.

Reviewer 2B (Rating: 5)

Access to not only research lab space but also a collaborating initial customer is a rarity and speaks highly to the quality of this proposal

Reviewer 2C (Rating: 4)

The facilities, in connection with those at the University of North Dakota seem to be a strength of the proposed project; however, the polymer processing facilities were only mentioned as a building and there was no mechanical testing capabilities mentioned.

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 2A (Rating: 3)

Half of the total project cost will be provided by Earth-Kind or C2New.

Reviewer 2B (Rating: 4)

An effort like this in a region like Silicon Valley would likely cost significantly more. By taking advantage of the existing research, feedstock network and manufacturing base in the ND region this team seems to be able to push forward a compelling opportunity at a reasonable expenditure level.

The financial commitment minimum is met, but there is not outside investment to support the project (beyond the principal collaborators, that is) and it is only a 50-50 split.

Reviewer 2C (Rating: 5)

Value is enhanced by significant cost sharing (\$80K in cash). Project associated expenses are reasonable.

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.

10a. 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.

The minimum 50% cash match is demonstrated.

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 2A (Funding May Be Considered)

The proposal has a clear goal for targeted consumer products, but without specific approaches. The proposed technology for biocomposite development might be successful, but it is not very new. The similar products and technologies are already existed on the market. Some applications of the products are very likely to be successful such as the Rodent Repellent Holder for Earth-Kind. The proposal failed to discuss and compare the proposed technology with those of the competitors. The proposed project can be funded if fund is available.

Reviewer 2B (Fund)

This proposal seems very well matched to both the resources of North Dakota and the goals of the Renewable Energy Council. Biomaterials are a fast-growing market opportunity, and such products that are based on agricultural waste can achieve both green objectives and the aspirations of the Council for promoting regional jobs growth and the competitiveness of landowners and agriculture producers.

This team has a background that lends itself well to this effort, and they appear to have made good progress already that positions the effort for potential success.

Reviewer 2C (Funding May Be Considered)

My overall issues with the proposal are as follows:

- Absolutely no literature cited in the paper
- The polymers to be used in the biocomposites were not even mentioned by name until the “Budget Justification” section, and no diagrams were included of their chemical structure or processing
- The polymer processing mechanisms were only referred to in vague terms, with no specific equipment named. Even with the mechanical testing, details were not revealed for whether the testing would be DMA, Instron, or something else. It is almost impossible to evaluate the proposal without these details. In addition, when the proposal talked about resources, the polymer processing facilities were only mentioned as a building and there was no mechanical testing capabilities mentioned.
- The proposal in general was not very well-structured to draw interest to the important points. The most compelling problem statement and objectives were buried deep in the paper after much less interesting points.