

# TECHNICAL REVIEWERS' RATING SUMMARY

R009-D

## G F Truss Plant Gasification System Redesign

Energy & Environmental Research Center  
Principal Investigator: Kerryanne M.B. Leroux  
Request for \$245,656; Total Project Costs \$491,313

<u>Rating Category</u>	<u>Weighting Factor</u>	<u>Technical Reviewer</u>			<u>Average Weighted Score</u>
		<u>5A</u>	<u>5B</u>	<u>5C</u>	
1. Objectives	9	2	4	2	24.00
2. Achievability	9	1	4	2	21.00
3. Methodology	7	1	3	1	11.67
4. Contribution	7	1	4	2	16.33
5. Awareness	5	1	4	1	10.00
6. Background	5	4	4	1	15.00
7. Project Management	2	2	3	2	4.67
8. Equipment Purchase	2	2	3	2	4.67
9. Facilities	2	5	5	3	8.67
10. Budget	2	2	3	2	4.67
<b>Average Weighted Score</b>		88	189	85	<b>120.67</b>
<b>Maximum Weighted Score</b>					<b>250.00</b>

### OVERALL RECOMMENDATION

FUND

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FUNDING MAY BE CONSIDERED

x

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DO NOT FUND

x

x

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G F Truss Plant Gasification System Redesign  
Submitted by Energy & Environmental Research Center  
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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 5A (Rating: 2)*

The goal of this proposal is to redesign the company's gasification system. Redesigning something should not be a goal because it is not directly measurable. The PIs did not show how the redesign can make the system more marketable to meet NDIC/REC goals.

*Reviewer 5B (Rating: 4)*

The work described would be a step toward commercialization of a technology/application of distributed energy production that would use North Dakota biomass feedstocks, produce local energy, and potentially have environmental benefits. Manufacture of the equipment developed by EERC in North Dakota has the potential to employ its citizens in a new market.

It is important to keep in perspective that the research and development proposed in this project would be only a step towards the goal of commercialization. This project is designed to overcome technical barriers to using the equipment.

*Reviewer 5C (Rating:2)*

Details on what is to be done in the study are vague. For example what are some of the specific design modifications will be attempted with the GF Truss gasifier.

**EERC Clarification**

As stated in the Objectives section of the proposal, "The goal of the proposed project is...uninterrupted operation and electricity generation...from biomass and/or coal with minimal environmental impact."

Figure 1 shows the gasifier and general arrangement of the drying, pyrolysis, combustion, and char reduction zones in the gasifier. Downdraft gasifiers of this type (Imbert) produce low gas contaminants for two reasons. The bed is fixed (not fluidized), allowing for low carryover of particulates, and hydrocarbon vapors produced in the pyrolysis zone are drawn down through the high-temperature zone and cracked to lower hydrocarbons (less tar). The gasifier is under vacuum drawn by a high-pressure blower.

Figure 2 shows the commercially available Ankur gasifier currently installed at GF Truss and the demonstration EERC-designed gasifier installed at Northern Excellence. The straight-walled Ankur design has proved to cause bridging and feed flow issues, even with a wood chip feedstock. The conical shape of the EERC gasifier, slightly expanding as the feedstock moves

through each zone, has shown improved feed flow and elimination of bridging issues when using grass seed screenings as a feedstock. It is, therefore, hypothesized that installation of an EERC-designed gasifier at GF Truss will also eliminate feed flow and bridging issues using the wood chip feedstock. The first task of the proposed project is to test this hypothesis.

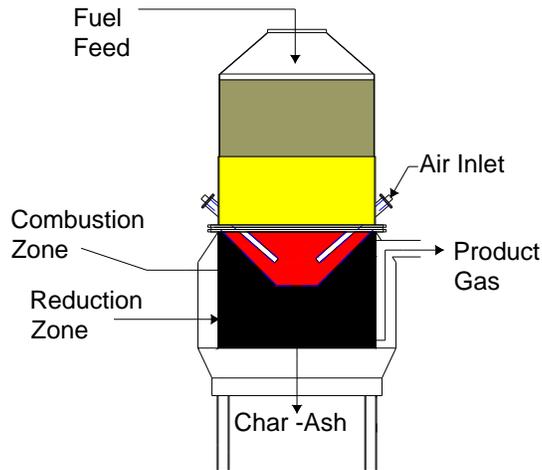


Figure 1. Downdraft gasifier.



Figure 2. Comparison of the Ankur gasifier at GF Truss (left) and the EERC-designed gasifier at Northern Excellence (right).

The proposed redesign of the GF Truss water system would reduce contaminated water by more than two-thirds. The current combined char removal and syngas scrubber system installed at GF Truss circulates about 30 gallons of water. Installation of new equipment to separate the char removal from the syngas cleaning would decrease the water recycle to less than 10 gallons for a single scrubber loop. Further testing is proposed to eliminate or avoid hazardous water generation within the scrubber loop. An economical solution would be a filter cleaning frequency of  $\geq 1$  week. The proposed testing is needed to determine the frequency required to avoid hazardous water generation in addition to the amount of wastewater generated annually.

- 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 5A (Rating: 1)

I give a very low rating on this because the PIs did not show their approach. If they are trying to redesign their gasification system, they have to show their current design and its limitations/shortcomings, and then their strategies/approaches to overcome these limitations. None of these information is included in the proposal, so there is no way to judge whether their goal is achievable.

Reviewer 5B (Rating: 4)

Since the approach is not given in detail, it is hard to judge the time required for this work. There is always a chance that equipment shipping or modification date schedules will get behind. However, one year seems reasonable.

As far as the budget, I think it is more than sufficient for the work.

Reviewer 5C (Rating: 2)

The approach to be used has not been elaborated. For example what will be measured and how and how does the redesign fit into the budget.

**EERC Clarification**

See the EERC's response to Question 1.

- 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 5A (Rating: 1)

The same comment as for question #2. No methodology was presented.

Reviewer 5B (Rating: 3)

With no specifics of the methods for the redesign (i.e. software analysis, lab scale mockup) in the proposal, it is hard to rate redesign methodology.

The methodology to answer the scrubbing water quality questions, which is described and implied based on the lab testing identified in the budget, seems correctly designed.

Reviewer 5C (Rating: 1)

No detail on the methodology has been presented. For example how will successful modification be assessed?

**EERC Clarification**

See Question 1.

In addition, the Standards of Success sections of the proposal states that “Measurable deliverables include system operation for at least 48 uninterrupted hours, with consistent electricity generation from produced syngas during the uninterrupted testing period, and a defined operational plan to avoid generation of hazardous wastewater classification.”

- 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 5A (Rating: 1)

The PIs did not show their technical contribution. I was looking for their innovative design of their gasification system, something like how they make the system uninterrupted operation, how tar/char separation/cleaning system is improved, how energy/mass balances can be improved, how cost is lowered etc. None of these was presented or detailed in the proposal, so no scientific contribution can be seen.

Reviewer 5B (Rating: 4)

The contributions of this work could be very beneficial in bringing the manufacture and use of distributed gasification technology to North Dakota. Financially and environmentally, this technology would be of benefit to the industry and citizens of the state.

Reviewer 5C (Rating: 2)

The PI does not seem to demonstrate a basic understanding of downdraft gasifier technology. Without this knowledge the likelihood of any meaningful contribution is remote.

**EERC Clarification**

See Question 1.

- 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 5A (Rating: 1)

No information about the design of the company’s competitors or start-of-the-art designs of downdraft gasifiers was given.

Reviewer 5B (Rating: 4)

The teams' awareness of current research activity and published literature was not established by citation or references in this literature. However, having knowledge of specific individuals on the project team and EERC as a whole, I believe they have at least a better than average awareness.

Reviewer 5C (Rating: 1)

There is no review of the related literature. Down draft gasifiers have been covered in the literature for decades.

**EERC Clarification**

The EERC has participated in the development of gasification technologies for 30 years. Microgasification technology for the conversion of agricultural residues and wood waste to energy has been under development at the EERC for the past 10 years, documenting operation of a prototype system. A selected list of EERC references and literature follows.

Timpe, R.C.; Mann, M.D.; Schmidt, D.D. *Gasification for Distributed Generation*; Final Topical Report (May 1, 1999 – March 31, 2000) for U.S. Department of Energy Contract No. DE-FC26-98FT40320; EERC Publication 2000-EERC-05-01; Energy & Environmental Research Center: Grand Forks, ND, May 2000.

Schmidt, D.D.; Martin, K.E.; Patel, N.; Richter, J.J. *Portable Biomass Gasification Testing*; Topical Report for U.S. Department of Energy Cooperative Agreement No. DE-FC36-03GO13055; Energy & Environmental Research Center: Grand Fork, ND, July 2005.

Schmidt, D.D.; Martin, K.E.; Patel, N.; Miles, T. *Biomass Gasification Testing Firing 1-in. Wood Cubes*; Final Report (March 1–30, 2005) for Forest and Wood Products Institute, Mount Wachusett Community College; EERC Publication 2005-EERC-06-05; Energy & Environmental Research Center: Grand Forks, ND, June 2005.

Hutton, P.N.; Patel, N.; Martin, K.E.; Singh, D. *Development and Testing of a Thermally Integrated SOFC–Gasification System for Biomass Power Generation*; Phase II Interim Report (July 1, 2003 – May 30, 2005) for Xcel Energy, Inc.; Energy & Environmental Research Center: Grand Forks, ND, July 2005.

Swanson, M.L. *Gasification of Lignin in a Fluid-Bed Gasifier*; Final Report (May 19, 2003 – Dec 31, 2003) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-98FT40321; EERC Publication 2004-EERC-05-01; Energy & Environmental Research Center: Grand Forks, ND, May 2004.

Schmidt, D.D.; Gunderson, J.R. *Opportunities for Hydrogen: An Analysis of the Application of Biomass Gasification to Farming Operations Using Microturbines and Fuel Cells*. Presented at the Hydrogen Review Meeting, San Ramon, CA, May 9-11, 2000.

**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 5A (Rating: 4)*

The PIs seem to be qualified in renewable energy R&D and marketing. The company has already had demonstration systems installed in three places, so they must have had adequate experience to conduct the proposed research. However, since the PIs are doing so many different things in renewable energy, it is not clear if they are specialized in biomass gasification.

*Reviewer 5B (Rating: 4)*

I believe the project team has the background and talents needed to complete the project. However, the proposal does not say what the specific roles of individuals are for this project. Therefore, it is hard to say what work each individual will be completing.

*Reviewer 5C (Rating: 1)*

There is no listing of technical publications for any of the investigators in the vita section of the appendix.

**EERC Clarification**

A list of publications from the proposed project team can be made available upon request.

**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 5A (Rating: 2)*

The timetable/schedule is clear because there are only two tasks in the one year period, however, milestones are not defined. No plans of financial or communication were given.

*Reviewer 5B (Rating: 3)*

Overall, the plan is fair. While I think there are some rough spots in the plan, EERCs' history of research and development indicates that they can effectively manage projects.

I have an issue with a potential for over-management, which is manifested in the budget. The amount of hours/money includes time for a project manager, a PI, and an EERC senior manager. This is in addition to a facilities and administration rate of 60% (NDIC funds), of which a portion should be going to administration of projects. This seems overkill for a redesign of an existing system.

*Reviewer 5C (Rating: 2)*

Since the objectives are vague, the management plan is meaningless.

**EERC Clarification**

See Question 3 for definition of milestones. The financial plan is provided in the budget section of the proposal. Since no subcontractors are proposed, no communication plan was given.

As mentioned in the proposal, the EERC is a nonprofit organization; therefore, all expenses required for the proposed project are included in the estimated budget, covering the cost of labor hours, use of EERC facilities, and travel. The title of PI is arbitrary and shown only as a line in the budget form. The personnel listed as PI and Project Manager work closely together to perform project tasks. Also included in the total labor hours is the supervisory time utilized by senior management to ensure quality of work conducted maintains EERC standards. The facilities and administration rate of 60% is because of the EERC's nonprofit status and supports administrative, technical, and lab staff, as well as accompanying equipment and facilities, needed to conduct and complete the project as proposed.

- 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 5A (Rating: 2)

Although the PIs did not budget for equipment, they use equipment for cost sharing. A total of \$120,000 was budget for cost sharing. However, if it is a redesign, it does not need to build a new system, so it is not justified that \$120,000 is needed.

Reviewer 5B (Rating: 3)

The proposal itself did not address the need for equipment purchases. Therefore, I am basing my response on what I would guess the grantee's intent is. Since this was a redesign, I was expecting that the existing gasifier would be refined. However, it may be simply cheaper to start with a new unit. As far as the other items for the gasifier itself, they seemed like expected purchase in a redesign.

I do question the purchase of a chipper and conveyor as part of this project. While very useful in working with a gasifier, they are not part of the study and I would say they should be leased or paid for from other sources. The length of their research use (2 months spread over a year grant?) may not justify their full purchase on NDIC sponsored funds.

Reviewer 5C (Rating: 2)

Purchases for the proposed "redesign" have not been specified.

**EERC Clarification**

The equipment budget is shown for the overall total project. Because the redesign of the gasifier requires a new shape (Figure 2), it is not feasible to modify the existing gasifier. The water system, ash system, and char burner are required to separate the currently combined char removal and syngas scrubber systems as proposed. The controls, chipper, and conveyor are needed to provide continuous, automated operation of the gasification system for demonstration testing and investor marketing.

- 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 5A (Rating: 5)

The company has the resource and capability to build a gasification system since they already did it.

Reviewer 5B (Rating: 5)

EERC has excellent facilities and equipment, plus knowledgeable, trained staff to operate their equipment. I have no doubt that their facilities rate near the best in the nation.

Reviewer 5C (Rating: 3)

The facilities may be adequate but they have not been revealed. For example what types of analytical instrumentation are available.

**EERC Clarification**

Budgeted testing to be conducted in-house at the EERC includes analysis of fuel properties, analysis of the syngas produced to assess quality, and a wide range of analyses to assess wastewater hazardous levels. A list of specific instrumentation can be made available upon request.

**10. The proposed budget “value”<sup>1</sup> 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 5A (Rating: 2)

The value of the redesign is not clear, and the value of cost-sharing is not justified either.

Reviewer 5B (Rating: 3)

While I think the research proposed is very important and could have a large return, I think that the proposal is more expensive than is justified based on their submitted text. There may be more reasons for the proposed budget, but it is not clearly discussed in the text.

Reviewer 5C (Rating: 2)

This is hard to judge based on what has been presented.

<sup>1</sup> “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.

**EERC Clarification**

See Questions 1, 7, and 8.

**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 5A (Do Not Fund)**

This project should not be funded.

#### Merits

Small-scale downdraft gasifiers are good for small business and rural communities. However, downdraft gasifiers have several limitations. If the proposed project can solve these problems and make the system marketable, it could be a great contribution to renewable energy production.

#### Flaws

1. information of on-market designs or technologies are not given.
2. the proposal did not show the current design of the gasification system and did not show its limitations and why it needs a redesign.
3. the proposal did not show what the new redesign will look like and how the PIs will achieve it.
4. the proposal did not describe how the new redesign will be more marketable.

#### **EERC Clarification**

**See Question 1. Consistent, reliable electrical generation is essential to marketing any power system, commercial or otherwise. Uninterruptible operation of the gasification system is required for generation of electricity from syngas. Since the goal of the proposed redesign project is to attain uninterrupted operation and electrical generation, the redesign, therefore, makes the system more marketable.**

#### **Reviewer 5B (Funding May Be Considered)**

Overall the ideas and principles of this proposal make good sense. The development of the small industry scale distributed energy platform is a worthy goal. I agree very much with the benefits for the State of North Dakota and small businesses/communities in the upper Midwest.

Unfortunately, the proposal seemed incomplete. While the general concepts were clear in the text, it was not clear the magnitude of the issues that limits the system now. For example, how much potentially contaminated water is generated? Nor was it clear the specific benchmarks the grantee hopes to achieve in the redesign. What percentage reduction in contaminated water do you hope to achieve? What 'sustainability' measure are you going to use and what is your goal (i.e. three months continuous operation before filter cleaning?)

I would have liked to have been told the overall plan for bringing this technology to market and more specifically how the work proposed in this grant fits in with future steps.

Expenses listed in the grant indicate that the grant communication work targets national audiences, but you are interested in marketability in North Dakota. What plans do you have to work with local stakeholders? I would say that local industry and business should be the priority. I'm assuming that you will also use your website to disseminate results both nationally and locally, but it was not indicated in the proposal.

This is a one year grant for redesigning an existing piece of equipment. The budget does not reflect this. Expenses should have further justification as should a 5% escalation of personnel costs in a 1 year grant, starting 2 months after grant proposal submission. Expense categories I would primarily question are personnel and equipment. I would also say that for this study, the conference travel budget is excessive (national conferences for 6 people for a 1 year grant). I would focus some of that money on in-state work with stakeholders.

### Summary

While I do think there are some issues with the grant proposal, I do think it should be considered for funding. Based on EERCs' past work and the project teams' experience, I think the work has value and will have a payback over the long term. However, more explanation in the proposal text and a leaner budget would make it stronger in my eyes.

### **EERC Clarification**

See Question 1 for further information on wastewater testing and goals.

The work proposed will make a fully operational and environmentally tested gasification system available for demonstration to potential North Dakota investors. The ability to see the system in action, as well as conduct third-party testing, is essential to marketing the technology for commercialization.

The work targets national audiences to not only entice North Dakota stakeholders to invest in commercialization of the technology but also to bring outside investors to North Dakota, adding economy to the state. As stated in Task 3 of the Methodology section in the EERC proposal submitted, "Presentation of project findings will be conducted at **regional** and national conferences to further disseminate results and garner interest in **North Dakota** biomass distributive energy potential."

The 5% escalation reflects the estimated budget increase for personnel labor after the new fiscal year, which began July 1, 2010. The estimated travel expenses are for two people to attend three regional and national conferences.

### **Reviewer 5C (Do Not Fund)**

The PI does not appear to have a basic understanding of downdraft gasifiers. These devices use co-current flow of air and fuel. The upper most region of the gasifier is a fuel reservoir and is followed by a drying zone. The next region is the flaming pyrolysis of partial combustion zone where gas tar and char are produced. The final zone is the char gasification region where water vapor reacts with hot carbon to produce hydrogen and carbon monoxide. The reactions in this

final zone consume heat and the char gasification reactions are gradually quenched. At the bottom, a grate supports the entire bed. A fan downstream of the grate is generally used to provide for the flow of air and produced gas. Downdrafts can only work properly with feed stocks that have well defined geometries (i.e. chips or pellets). The implication that they can work with sawdust, grass and other residue is nonsense. Proper operation involves a means to control the air to fuel ratio which has not been mentioned in the proposal. The PI needs to clearly explain what design modifications are to be explored including the section of the gasifier involved along with an explanation of why they are needed or how they might improve operation.

My recommendation is not to fund this proposal. See the marked proposal for specifics.

**EERC Clarification**

See Question 1.