

TECHNICAL REVIEWERS' COMMENTS
LRC-LXVI (66)–B

“Application of Waste Heat Recovery Generation at Great River Energy’s Coal Creek Station”

Submitted by: Calnetix, Inc.

Request for: \$330,000; Total Project Costs: \$896,745

Principal Investigator: Shamim Imani ; Project Duration: 22 Months.

1. **OBJECTIVES**

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

Reviewer 09-4 (Rating: 4)

The objectives of the Calnetix© proposal are very clear. The objectives are to identify heat sources, validate power recovery sufficiency and demonstrate the technical utility of a Calnetix unit. The objectives are consistent with NDIC/LRC goals and objectives.

Reviewer 09-5 (Rating: 3)

The proposed project is consistent with the NDIC goals. The project addresses an energy efficiency effort that would utilize low-level waste heat to produce additional electricity using an innovative low-level heat recovery generator. If the small scale project is successful, additional power would be produced without increasing pollutant emissions. A successful effort could benefit all ND lignite-fired power plants.

Reviewer 09-6 (Rating: 3)

The proposal does address two of the goals listed by NDIC in that one goal is to preserve jobs in the utilization of North Dakota lignite, which may be threatened by efficiency and CO₂ emissions legislation. The use of waste heat to improve plant efficiency is sound operating practice regardless of legislation. The second goal, creating new jobs, sounds good on paper but I question the reality of this statement. If Calnetix has manufacturing facilities in Florida and California, I question the likelihood of waste heat generators being manufactured in North Dakota.

2. **ACHIEVABILITY**

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 09-4 (Rating: 4)

The objectives are most likely achievable given the approach, time and budget set forth in the proposal. The two step method is a reasonable and logical approach, minimizing development cost and maximizing potential success.

Reviewer 09-5 (Rating: 3)

The project consists of two steps: Step1) Identification and verification of usable power plant waste heat sources (16 weeks). If a viable heat source (e.g. flue gas, fly ash, scrubber sludge) is not identified, the project would not continue and a final report prepared.

Step 2) Assuming the usable waste heat source would be identified, a small scale demonstration of heat recovery unit (Calnetix WHG100) would be installed and operated for 12 months.

Reviewer 09-6 (Rating: 4)

The objectives are most likely achievable with the time and budget that has been proposed for the two phases. The time and budget appear reasonable for what is being proposed.

3. **METHODOLOGY**

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 09-4 (Rating: 4)

The quality of the methodology is above average.

Reviewer 09-5 (Rating: 4)

As noted above, Step 1 activities will conduct detailed studies using plant engineers, consultants and industry vendors, HDR Engineering, GRE and other interested ND industry engineers to identify and evaluate and validate waste heat sources to utilize Calnetix 1-2 MW heat recovery power generator.

Reviewer 09-6 (Rating: 3)

I would have expected more detail in the discussion of the overall project. There is a good description of the waste heat recovery generator and the project background, but there is only a little discussion of potential waste heat sources at the Coal Creek Station. I find this surprising especially since Calnetix visited the site and this project is integrated into a proposal to DOE. I assume that the proposal to DOE includes preliminary mass and energy balances, as this is the detail necessary for a valid proposal review. If that is the case, some of this detail should have been included here. Instead, the proposal was quite repetitive in repeating the same generic type information several times.

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

Reviewer 09-4 (Rating: 3)

The proposed work could make a significant technical contribution which specifically addresses NDIC/LRC goals. The basic technology is established and it is doubtful any new scientific contribution will result from this work. However, the work could increase efficiency (MWh/ton of CO₂). This expression of efficiency is an important consideration for ND lignite power plants.

Reviewer 09-5 (Rating: 4)

The potential of using low value waste heat recovery generation capable of contributing to the overall electrical power (estimated at ~ 10% output) would be a significant contribution to the overall generation load. Since additional no lignite coal would be used, air emissions and sensitive areas would be reduced. The Calnetix WHG100 has developed non-contact magnetic bearings that are apparently friction free. Considering environmental regulations and emission and renewable portfolio standards, utilizing low value waste heat (as low as 250 F) to generate additional power would also address efficiency standards.

The proposed project would be tested at GRE's Coal Creek Station. If successful, the new technology would likely be applicable to ND's lignite-fired generators.

Reviewer 09-6 (Rating: 3)

The concept of utilizing waste heat from lignite-fired boilers is important to NDIC. The specific stream that might be used at the Coal Creek Station may not be applicable to other power plants in North Dakota, but the overall concept utilizing waste heat can be applied to others as well should the generator system be successful.

5. **AWARENESS**

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 09-4 (Rating: 3)

The Principal Investigator's (PI's) awareness of current research activity is not demonstrated by referenced published or unpublished research. However, the experience and qualifications of the PI's are demonstrated by their educations and work experiences.

Reviewer 09-5 (Rating: 4)

The PI is Shamim Imani, He will direct an experienced team of Calnetix engineers and supported by GRE, HRD Engineering engineers.

Reviewer 09-6 (Rating: 3)

There were limited references to other research activity or published literature. Cost comparisons were made in that Calnetix's system is less expensive but no referenced materials were provided to support this claim. Similarly, Calnetix is assuming that 10% of the waste heat from a steam generator can be used. There should be some backup/references to justify this claim.

6. **BACKGROUND**

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 09-4 (Rating: 4)

The backgrounds of the Calnetix and GRE PIs are better than average as related to this work.

Reviewer 09-5 (Rating: 4)

The Calnetix core technologies include high speed magnet motors generators, magnetic bearings, turbines and expanders that include waste heat recovery units. The Calnetix team has over 100 years of combined experience relative to waste heat recovery. In addition, local power plant engineers will be a part of the overall team.

Reviewer 09-6 (Rating: 3)

The background of the investigators appears adequate although resumes should have been included.

7. **PROJECT MANAGEMENT**

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 09-4 (Rating: 4)

The project management plan is very good for the proposed project.

Reviewer 09-5 (Rating: 3)

The overall management plan is sparse but generally informative with Step 1 activities identified that includes delegated responsibilities. Calnetix has requested \$80,000 (Step 1) and \$250,000 (Step 2) from NDIC/LRC

Step 1 Budget:

<u>Calnetix</u>	<u>NDIC/LRC (HRD Engineers)</u>	<u>GRE In-kind</u>	<u>Step 1 Subtotal</u>
\$81,250	\$80,000	\$28,250	\$161,250

Step 2 Budget:

<u>Calnetix</u>	<u>NDIC/LRC*</u>	<u>GRE In-kind</u>	<u>Step 2 Subtotal</u>
\$373,295	\$250,000	\$121,200	\$744,495

- Support WHG100 installation

The proposer is anticipating DOE matching funds. The availability of the DOE contribution has not been identified. The proposer should identify the amount of DOE funds and its use for the project.

Reviewer 09-6 (Rating: 4)

Overall, this aspect of the proposal was very good. The schedule was sufficiently detailed to follow the flow of the project. The schedule appeared reasonable. The budget details were good as was the discussion on communications and responsibilities.

8. EQUIPMENT PURCHASE

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 09-4 (Rating: 4)

The key purchase is the Calnetix heat exchanger unit. This purchase is well justified.

Reviewer 09-5 (Rating: 3)

The equipment would include installation and control accessories of the WHG100 waste heat recovery unit.

Reviewer 09-6 (Rating: 2)

It is not clear to me why Step 2 is using a 100 kWe unit. Apparently this scale has been proven utilizing waste heat. I understand that the sources of waste heat can vary; however, is it necessary to operate at this scale? If the 100 kWe unit is commercial, then the project should use the data from Step 1 and go into large unit development, testing, and demonstration. This appears to be a step that is not needed and is costly.

9. FACILITIES

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 09-4 (Rating: 4)

The facilities and equipment are notably good.

Reviewer 09-5 (Rating: 3)

GRE's Coal Creek Station will be made available. The Calnetix WHG100 waste heat recovery generator will be provided by the Proposer and installed on an appropriate low thermal waste stream.

Reviewer 09-6 (Rating: 3)

The facilities, i.e., power plant are obviously very good; however, the equipment purchased, i.e., the 100 kWe waste heat generator, are not adequately justified.

10. BUDGET

The proposed budget "value"¹ relative to the outlined work and the financial commitment from other sources² is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

IV-B-2-5

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 than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

Reviewer 09-4 (Rating: 2)

In step one, matching funding appears to be all in-kind and difficult to substantiate. In step two, the involvement of DOE enhances the value of the project. A cash contribution from GRE would greatly enhance the “value” of this project.

Reviewer 09-5 (Rating: 3)

The two phases of the proposed project is \$905,745. The project uncertainty is due to an additional need for funding. The proposer has requested fund from the DOE. It is not known if and when the funds will be provided or how much is needed for the Calnetix project. If the DOE funds are available in a timely fashion (or not at all) the project may be at risk.

The proposer should address the need for DOE funds to ensure that the project can be completed in an orderly manner.

Reviewer 09-6 (Rating: 3)

Steps 1 and 2 are requesting approximately 50% and 33% of the project costs from NDIC, respectively, which are considered favorable. However, as stated above, the use of the small waste heat generating system has not been adequately justified and hence, it is not clear if this cost is justified either.

OVERALL COMMENTS AND RECOMMENDATION:

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 09-4 (Rating: FUNDING MAY BE CONSIDERED)

This project appears to be worthy of funding. However, does the lack of financial commitment from industry imply the project lacks sufficient return on investment? If this project received cash financial contribution from industry, then this project would be recommended for funding.

Reviewer 09-5 (Rating: FUND)

The proposer has developed a potential technological improvement that would provide additional power for generation plants by utilizing low energy waste heat to produce additional electricity. The effort proposes to employ a low level heat recovery generator using non-contact magnetic bearings that reduce friction, thus providing addition electricity. If successful, the overall efficiency and electricity output would be increased with additional benefits of reducing emissions (including CO₂) and increase the competitiveness of lignite.

The proposed project would be conducted at the Coal Creek Station. If successful, the thermal efficiency of would be increased, thus providing a more economical plant. The new technology would be also be applicable to the entire ND lignite industry.

Reviewer 09-6 (Rating: FUNDING MAY BE CONSIDERED)

I recommend that funding be considered; however, the proposal is not very convincing. If it were not for GRE’s commitment and interest, not only in the project but overall efficiency improvements, such as the lignite upgrading project, I would have recommended that the project not be funded.

Other comments include:

I question the likelihood of Calnetix building a manufacturing facility for 1-2 MWe waste heat generators in North Dakota if they already have facilities in Florida and California. Unless there activities/communications outside of this proposal that the reviewers are not made aware of, this just seems like verbiage to help sell a proposal. I have seen this too often. If this is not a serious consideration, it should not be in the proposal as I think it cheapens the proposal.

The proposal was very general in nature. There should have been some preliminary mass and energy balances included to show the potential of this technology working.

Too many generalities without referenced backup. For example, Calnetix states that their 100kWe waste heat generator is superior to their competitors with respect to conversion of waste heat to electricity without supporting data. Similarly, there should be a justification as to why they are assuming that 10% of the waste heat from a power plant can be utilized.

Calnetix states that their 1-2 MWe units can be scaled-up from their 100kWe units. This is an increase of 10-20 times the current size. No comments are made if this increase is considered an easy one or if they have concerns.

If the installed cost of the small unit is \$2500/kWe, why is the larger unit's installed cost the same? Wouldn't the cost be less expensive due to economies of scale?

As previously stated but sufficiently important to repeat, it is not clear why the 100 kWe unit needs to be tested before demonstrating the 1-2 MWe unit. If Calnetix is confident in their smaller unit, then the project should skip an unnecessary and costly step and go into the lab testing and demonstration scale.