TECHNICAL REVIEWERS' RATING SUMMARY

R007-A

Dakota Turbines

Posilock Puller Inc.
Principal Investigators: Cris Somerville
Request for $178,500; Total Project Costs $497,000

Rating Category	Weighting Factor	Technical Reviewer 1A Rating	2A Rating	3A Rating	Average Weighted Score
1. Objectives	9	4	4	3	33.00
2. Achievability	9	3	4	3	30.00
3. Methodology	7	2	4	3	21.00
4. Contribution	7	3	4	5	28.00
5. Awareness	5	2	4	4	16.67
6. Background	5	3	3	4	16.67
7. Project Management	2	4	3	3	6.67
8. Equipment Purchase	2	4	4	4	8.00
9. Facilities	2	4	3	4	7.33
10. Budget	2	4	5	5	9.33
Average Weighted Score		155	193	182	**176.67**
Maximum Weighted Score					**250.00**

OVERALL RECOMMENDATION

FUND		x	
FUNDING MAY BE CONSIDERED	x		x
DO NOT FUND			

R007-A
Dakota Turbines
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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: 4)
Dakota Turbines wants to reduce the payback period of their small wind turbine system by two years (~20%), so potential clients will see financial benefits sooner (minimize risk). In addition to producing faster returns for future owners, increased efficiency in the system would yield higher production of wind-generated electricity by utilizing their "sliding stator" technology. This device allows the turbine to engage even when wind speeds are minimal by adjusting the load (ie. Dakota Turbines: low wind speed equals some electricity produced. Traditional system: low wind speed equals no electricity produced.) This technology should help turbines to harvest more of the winds available.

The proposal wants to finish development of a 10-100 kW (single phase) power inverter and have it certified by Underwriters Laboratories (UL) to make it available for commercial sale. Unfortunately, the proposal does not specify where the power inverters would be manufactured and I have found several companies marketing 10-20kW (single phase) power invertors, so I suspect a majority of the product market may already be saturated.

Dakota Turbines plans to certify their turbine following the Small Wind Certification Protocols (SWCP) which includes stress, duration, and noise testing. SWCP, although not yet enacted, should provide side-by-side comparisons of small wind turbines available for consumer purchase. The third-party, unbiased, reports should build consumer confidence and education about small wind turbines.

Most importantly, however, Dakota Turbines plans on building future wind turbines at their existing facility in Cooperstown, ND. This commitment could bring new jobs to the area and state if their turbine can prove financially attractive to land owners and others who may invest in small wind turbines.

Reviewer 2A (Rating: 4)
The applicants contacted me in June of 2009, and attended the Small Wind Conference in WI. They have a very interesting idea that is worth researching its potential for small wind turbines.

Reviewer 3A (Rating:3)
There is no documentation for their cost of energy and payback estimates. It is a worthwhile goal; however, impossible for me to verify. However, after looking at appendix II, I believe they could produce a commercially viable turbine. I think they may want to consider using

commercially available inverters as ARE is currently doing and also team up with someone who has some blade design and construction expertise.

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: 3)
Dakota Turbines have already identified a 22% efficiency increase by using optimal blades designs in their existing turbine. This upgrade should reduce the payback period of future turbines as long as the 'new' blades cost relatively the same as their current design while providing the same reliability. However, although the optimal blades are 22% more efficient, the proposal is unclear as to whether the efficiency was the 'average efficiency' across the entire range of wind speeds and angles of attack, or if it was the 'peak efficiency'. If it was the latter, the 'new' blades may not perform much better than the existing ones in real operating conditions.

The task of obtaining UL listing/certification would be contracted to UL, inc., so the time and budget should be an accurate estimate.

The Small Wind Turbine Protocols (SWTP) appears feasible for the test window specified. However, Dakota Turbines does NOT have a safety margin in their time table if the duration testing, as specified by SWTP, suffers a major component failure and needs to be restarted. In addition, as of today, the SWCP has not been approved and could change, thereby changing the certification process, timeframe, and budget.

Reviewer 2A (Rating: 4)
Provided that the applicants keep to the schedule laid out in their proposal, a determination of the feasibility of their concept should be achievable.

Reviewer 3A (Rating: 3)
The proposal's basic goals of producing a turbine with increased reliability and a lower cost of energy (COE) are laudable and are two of the most significant problems in the small turbine industry in my opinion. However, accomplishing these goals is not an easy task and their ideas about a more complicated generator design, computer controlled blade pitch and yaw may make these goals even more difficult to attain. But they seem to be up to the task and it may prove to be a significant design improvement.

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: 2)
The methodology, as explained in the proposal, is straight-forward, although it lacks detail, and thus, seems ambiguous. The proposal does provide some detail for two areas of concern. The first is the stress and durability testing of the 'sliding stator' and its implementation into the

turbine. This work is not only crucial to the lifetime of the turbine and proof of technology, but may result in overall failure of the proposal if the technology proves unreliable.

The proposal also provides some detail about 'cross-talk' and 'noise' problems currently being experienced in the electrical system. The noise is a source of inefficiency and is trying to be eliminated, yet the current design calls for the use of 'hand-wired' boards, which can cause considerable noise because the 'loose' wire connections. Cross-talk can be due to improper grounding (in addition to 'loose' connections). Fortunately, both these problem sources can be eliminated/ruled-out by printing circuit boards, rather than relying on 'hand-wiring'. Dakota Turbines has chosen to continue with 'hand-wired' boards, rather than investing in printed boards for each variation of the system. Although printed boards do have some costs associated to them, they are relatively small and would eliminate 'loose' connections as being the source of the system's problems. The use of 'hand-wired' boards at this stage of the design suggests a lack of understanding about the electrical system, and that an inefficient, guess-n-check, approach is being used instead.

Reviewer 2A (Rating: 4)
The applicants have very nicely laid out the details of three paths they will be following to test and document the development of their concept. My only question is their claim of achieving an 85% efficiency on their blades. I don't know that this is achievable, but they may have not explained their goal correctly.

Reviewer 3A (Rating: 3)
I am not an expert on generator design so I am not really qualified to assess the merits of their "sliding stator technology", but it sounds interesting and is an idea I have not heard of before. Their commitment to the new small wind certification process is significant and a very positive aspect of their methodology. Their methodology outlines the general areas of work, but does not provide much specificity on the actual tests they will perform.

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: 3)
The proposals overall goal is to introduce another small wind turbine into the market. They hope to stand apart from their competitors by obtaining certification through the Small Wind Turbine Protocols, and by using their 'sliding stator' technology. The 'sliding stator' technology should allow the turbine to very competitive on the market, and, if it's proven reliable (through this proposal), may be acquired by other existing turbines and improve their efficiency. This would be a nice technical contribution to help increase utilization of ND's renewable wind energy.

Reviewer 2A (Rating: 4)
If the applicants succeed in perfecting their "Sliding Stator Technology" and applying it to small wind systems by solving the problems with the alternator, blades, and inverter and microprocessor, the result could be a huge advancement in small wind technology. The

ramifications will reach far beyond the borders of North Dakota, but capital investment and jobs will invariably result from their success.

Reviewer 3A (Rating: 5)
There is a documented rapidly growing global market for wind turbines. North Dakota has great wind resources and would be an ideal place to develop and test wind turbines. So if they are successful in producing a more reliable and less expensive small wind turbine it would be in my opinion a significant contribution. There are not many American companies producing small wind turbines currently. This company seems to have made significant progress on this product already and clearly has many of the skills and expertise needed to develop a small wind turbine. Working with the small wind certification council is a very positive aspect of the proposal and will provide good feedback on their product.

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: 2)
Although the PI is the head of development for the project, he appears to lack understanding of the main subsystem, namely the electrical system, as stated on pp. 3. "Going from hand-wired boards to printed circuits will…solve 'electrical noise' problems…but as I understand it, that also makes it more difficult to identify the source of the problems and to see the results of changes…"

The proposal does not cite any other research activity currently being conducted in the small wind turbine industry. Although the proposal does state that the PI has experience with product development (from concept to manufacturing), it lacks any detail or examples of previous work.

Reviewer 2A (Rating: 4)
While there is no mention of literature cited, the applicants have elicited the support of an impressive group of consultants and engineers, including NREL, EERC, UND Mechanical Engineering Department, and Posedg Software. They are also aware of the proposed AWEA Small Wind Turbine Performance and Safety Standard, and of the Small Wind Certification Council.

Reviewer 3A (Rating: 4)
In general I feel that the PI has demonstrated significant and better than average technological abilities and awareness of small turbine design; however, I am a bit troubled by their claims of 63 – 85% efficient rotor blades. The theoretical maximum efficiency is 59% and to my knowledge not even the best utility or commercial scale turbines have ever done better then this. It is possible that their estimates are referring to a percentage of the theoretical maximum. But this is unclear to me. The work they demonstrated in appendix II did reflect significant awareness of current trends, as did their knowledge of the new small wind certification process. However, it was not clear to me whether their other ideas related to computer controlled blade

pitch and yaw, generator design and inverter design were based on ideas presented in the literature or just ideas that they had about turbine improvements.

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: 3)
The PI is the originator of the project and has been working on it the entire time. This provides some familiar with the basic subsystems. The PI also possesses the requirements and experience to manage the overall project.

The other 'team leads' appear to have plenty of experience in their respective disciplines, although their descriptions lack detail or citation.

Reviewer 2A (Rating: 3)
This is difficult to determine from the bios that are included in the application. While all of the four principals mentions in the application are experienced in their own right, it appears as though none of them have any extensive experience with small wind. This is offset, however, buy the expertise they are apparently relying on from NREL and EERC.

Reviewer 3A (Rating: 4)
I can see from the background/qualifications section of the proposal narrative and appendix II that a qualified team has been assembled to work on this project. They seem to have a good background for this work and have made significant progress on this product. It also seems that they have developed good partnerships with other organizations such as EERC, UND and Posedg software.

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 overall time table seems appropriate, however software and electrical system and data analysis towards optimization should be finished before the second generation turbine undergoes its certification through the Small Wind Turbine Protocols.

Communication should be excellent as a majority of it will happen in-house.

Reviewer 2A (Rating: 3)
Like any significant effort, the Dakota Turbines Project is made up of dozens of individual tasks that have to fall in place in a logical and timely manner for the Project to move forward.

While the applicants mention dozens of individual tasks, the Time Table submitted is much more general in nature. It might have been very interesting for the applicants to have been much more specific relative to all of the tasks that they will be involved with.

Reviewer 3A (Rating: 3)
I feel they are well on their way to completing the tasks within the time frame scheduled and have a good start on the work. The management plan seems adequate for the work 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 1A (Rating: 4)
The equipment to be purchased all seems necessary for the successful completion of the project. Although a breakdown of costs for the new generation turbine and tower would have been appreciated.

Reviewer 2A (Rating: 4)
The detail in this section is adequate, and surprisingly low relative to other grant applications I have reviewed. Their honesty and reasonableness of cost is refreshing.

Reviewer 3A (Rating: 4)
The equipment requests seem very reasonable. Their business already has much of the needed equipment and expertise on board, which would greatly reduce the costs for a venture such as this. In addition they have clearly already completed much work on the turbine.

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)
The facilities at Cooperstown, ND are more than adequate for continued development of the first and second generation Dakota Turbines. However, if they attract a substantial and sustainable market, the facilities may need to be expanded, but this will not be necessary for the scope of this project.

Reviewer 2A (Rating: 3)
This part of the application is thin, but given the work that the applicants are currently engaged in and what they have accomplished to date (from Appendix II), the facility appears to be adequate.

Reviewer 3A (Rating: 4)
Based on the work presented in appendix II it is clear that they have significant facilities and equipment already devoted to the project. The new requested materials and equipment seem very reasonable.

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: 4)
Dakota Turbines is asking for $178,500 from NDIC. The total project is listed at $497,000 plus several unknowns, so NDIC's share is 36% or less. While, the development of another small wind turbine is not thrilling, the 'sliding stator' technology is very interesting and could provide a REAL value to advancement of wind turbines.

Reviewer 2A (Rating: 5)
Given a total project cost of nearly $1.2M, and a project grant projection of nearly $0.5M and with a grant request of less that $180k, this application appears to be of very high value relative to the investment by North Dakota.

Reviewer 3A (Rating: 5)
If they can pull this off I think it would be a great value for the assistance requested. It seems clear that they will be or have already contributed much more than 50% of the projects costs.

[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 1A ***(Funding May Be Considered)***
Dakota Turbines wants to finish development and certification of a small wind turbine. While this, in itself, is not that exciting, the development and implementation of the 'sliding stator' technology is quite interesting and could provide one of the missing steps in utilizing more of the wind energy the state of North Dakota and even the country has to offer.

One aspect of the proposal is the development and certification of a 10-100kW (single phase) power inverter. This seems like an unnecessary expense since 10-20kW (single phase) inverters already exist on the market. In addition, if land owners wanted larger systems requiring 20-100kW power inverters, use of a single phase power inverter seems largely inefficiency. While it is true that a large portion of ND's power grid is only single phase, a 3 phase system offers a much clearer signal, thereby increasing efficiency. This efficiency may pay for the necessary upgrades to the existing power grid in order to accommodate the new power source, or the use of batteries to provide a constant power source to the grid using a smaller inverter.

Overall, the proposal seems achievable, however the proposed time table does not allow for any major setbacks, which is a concern considering the 'sliding stator' is the core component to this system's success and has not yet passed all its durability/reliability testing. In addition, the use of the Small Wind Turbine Protocols provides a good step in establishing an industry standard, but the SWTP has not been approved. This makes it difficult to determine whether the time table and budget, as proposed, are appropreiate.

However, if the sliding stator system is proven successful, Dakota Turbines should be able to capture a large portion of the small wind turbine market by proving future owners with a turbine that is capable of converting a larger portion of the wind energy available. This would lead to development of new jobs in Cooperstown, ND, the home of Dakota Turbines, and site of future production of Dakota Turbines.

Reviewer 2A ***(Fund)***
All in all, I feel that this is project, if it succeeds, will result in a significant advancement for small wind, and North Dakota will reap the benefits based in investments that the applicants' project will invariably garner, and the jobs that will result from the development of their wind turbine.

Reviewer 3A ***(Funding May Be Considered)***
I am impressed with the work accomplished and the qualifications of the team represented in this proposal and believe that they should be able to produce a viable product. They have already demonstrated significant progress on the product.

However, I don't see any detailed documentation for their claim of $.07/KWH electricity and wonder if this is possible with the design they are proposing and at what average annual wind speed, which is an important variable. My basic reaction is that this is an organization with significant experience in developing and producing products; but with little actual wind experience. Whether their previous experience can translate into a successful wind turbine is a difficult question to answer for me. Some of their ideas seem a bit questionable; including a less expensive turbine with a sliding rotor, computer controlled blade pitching and yawing and 85% efficient blades. But for the relatively small amount requested and the significant progress demonstrated this may be an investment worth making. The basic goals of a more efficient, less expensive and more durable small turbine are very significant and essential for the small wind industry. Their proposal to work with the new small wind certification program is a positive sign and aspect of the proposal and will provide good quality objective feedback on their design.