Efficient Motor Sustainability Proposal
Date - 10/18/13
Project title - Energy Efficient Motor for Cold Weather Electric Vehicles
Amount requested - $2,000 for the fall semester (trying to raise $10,500 total)
Proposal author/s (first author must be student) - Isaac Thompson
Contact information - nhfreeride@gmail.com
   907 304 1499
   PO box 753462
   Fairbanks, AK 99775
Academic department, year in school, undergraduate or graduate standing - Electrical Engineering, Graduate student, Second Year of grad school (expecting to finish spring 2015)
Sustainability theme - Transportation

Project Summary - This project involves the electric snowmobile, which I have been working on for the last three years. The sustainability board has been very helpful over the course of the project and has already put some funding into the machine. The machine has also been very successful, having taken first place in the Clean Snowmobile Challenge in 2012 and second place in 2013. It also spent most of the summer of 2012 in Greenland, being utilized by NSF scientists. Currently, I am funding a battery management system for the machine mostly out of my own pocket, and using that research towards my thesis. In addition to the Battery Management System (or BMS) I am also trying to upgrade the machine to a new brushless permanent magnet motor, which is where I am asking for help from the sustainability fund.

Project description
- Tell us about your project and how you came up with the idea.
- Define the project goals, total cost, and expected benefits.
- If this proposal builds upon previously funded proposals, please mention that here and provide a progress report on the previously funded project.
- How will you measure results (survey, cost savings, waste reduction)?

This project involves converting an existing snowmobile to electric power and sourcing energy for it from an onboard battery pack. The machine can then be recharged from the electric grid or using renewable resources such as solar, wind, or biomass. I came up with the idea when I was working with the UAF SAE group, but have since moved away from their group and am continuing to develop the machine on my own terms. The goal of the project is to have a machine that can travel at least 30 miles (the current record is just under 20) and deliver as much power as an equivalently sized internal combustion snowmobile. The total cost of this project is $64,000. This covers the chassis, all the wiring, all of the onboard electronics, the battery, and the motor and motor controller. Much of this has already been purchased.
Currently I am working on the battery management system, and will be re-using a battery pack, which was purchased with funds from the TAB board. The expected benefit from this project is that people will realize that renewable energy is a very real possibility, and that it is possible to build a viable electric snowmobile. The goal is to get people away from the idea that electric vehicles are short-range only and only practical in warm weather.

This project builds on a previously funded project, where the sustainability board assisted in the purchase of a lithium polymer battery pack and many of the basic wiring components on the machine. The project has been extremely successful, and although the machine hasn’t been seen driving around campus a lot it has come a long way from where it started. The main thing that it needs to be reliable is a battery management system, which I am focusing on for my graduate thesis. The motor will allow it to be up to 30% more efficient and 50 lbs lighter, which will help it to achieve a 30-mile range.

Results will be measured by how much energy it takes to travel a certain distance compared to the best internal combustion vehicles. The machine’s current best is 20 miles on 8kwh of energy. At $0.20 per kWh (GVEA cost of electricity) that’s only $1.60 for 20 miles. A standard snowmobile would burn about 2 gallons of gasoline to travel the same distance, for a cost of about $8.

Project value

- Detail the project’s value to the student body and UAF campus in terms of sustainability.

This project has great value to the student body because it is a project, which any student can become a part of if they wish to. It is also a very valuable project to the UAF campus because it demonstrates that UAF is doing all that they can to research new, more efficient means of transportation in the arctic.

- Explain how your project fulfills the goals of the Sustainability Fee (fee goals are to promote energy efficiency programs and renewable energy projects). Keep in mind that the students fund the Sustainability Fee, so we have the responsibility to spend money efficiently, responsibly, and in a way that benefits students.

This project fulfills the goals of the Sustainability Fee because it directly promotes energy efficient transportation.

- Describe how your project will involve students in accomplishing its goals.

This project involves myself and other engineering students currently, and in the past has involved students from biology and several other fields. This is because the machine has to be designed as well as built, so there is room for students from any degree field to help with the project.

- Projected long and short-term benefits and savings of the proposed project should be adequately documented with assumptions and details provided.
The short-term benefit of the project is that it will be proven that electric snowmobiles are a viable alternative to the standard internal combustion machine. Long-term goals include showing that UAF is taking an active part in developing sustainable transportation technologies.

Implementation plan

- Describe how you are going to get the project done and lay out how the project goals will be met.
- Present a timeline with important events in a table.
- Include a column that identifies the person(s) responsible for each implementation step and/or oversight.
- Specify when funds will be spent and when project completion will occur.
- Example table:

<table>
<thead>
<tr>
<th>Date</th>
<th>What will be done</th>
<th>Responsible person</th>
<th>Funds used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 2013</td>
<td>Set up Motor account</td>
<td>Isaac Thompson</td>
<td>$0</td>
</tr>
<tr>
<td>Dec 2013-Aug 2014</td>
<td>Raise remaining funds</td>
<td>Isaac Thompson</td>
<td>$0</td>
</tr>
<tr>
<td>Sept 2014</td>
<td>Purchase Motor</td>
<td>Isaac Thompson</td>
<td>$10,500</td>
</tr>
</tbody>
</table>

This project will continue to be worked on whether or not it is funded by the Sustainability Fee, although development will be much slower. The motor that I am exploring for use in the vehicle costs $10,500. This is because it is a very new technology for the motor, and in the future the price will come down considerably. Because it is so expensive, I do not expect the Sustainability fee to cover the entire cost of the motor. Instead, I would like to a percentage of the total funds put forward. In this proposal I am requesting $2,000. This money will remain in the Sustainability Fee account until the remaining $8,500 can be raised. This may come from future sustainability fee grants, or (ideally) would come from another funding source, which could be offered as match. Having match funding already on hand will go a very long ways towards convincing other entities to put money towards the project. I hope to have the full amount of funding by fall semester, 2014.

Outreach Plan – What is the plan for letting students and the broader UAF community know about the project and that it was funded with the Student Sustainability Fund. Include a table that identifies what will happen, the person(s) responsible and dates. All promotional materials much contain the UAF Sustainability Logo.
<table>
<thead>
<tr>
<th>Outreach Activity</th>
<th>Venue</th>
<th>Date</th>
<th>Responsible Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written article</td>
<td>Sun star</td>
<td>Mid Nov</td>
<td>Isaac Thompson</td>
</tr>
<tr>
<td>Class/Workshop</td>
<td>TBD</td>
<td>Nov-Jan</td>
<td>Isaac Thompson</td>
</tr>
<tr>
<td>Flyers</td>
<td>Around campus</td>
<td>Jan</td>
<td>Isaac Thompson</td>
</tr>
<tr>
<td>Radio Interview</td>
<td>KIAK</td>
<td>Feb 2014</td>
<td>Isaac Thompson</td>
</tr>
</tbody>
</table>

**Budget**

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yasa 400 Motor</td>
<td>Yasa motors</td>
<td>1</td>
<td>Per shipment</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Shipping</td>
<td>FedEx</td>
<td>1</td>
<td>Each</td>
<td>$500</td>
<td>$500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$10,500</td>
</tr>
</tbody>
</table>

Budget justification - Yasa Motors was chosen as the supplier because they are the only manufacturer, which was found that does not outsource all their work to a Chinese manufacturer. While the Chinese work is generally acceptable, for a motor of this type very tight tolerances are mandatory. Other motor manufacturers exist but none of them offer as compact of a product, in such a lightweight package, that can deliver the same power. I have spoken in person to a representative of the company (Mike Dowsett, at Electric Vehicle Symposium 26, in Los Angeles 2012) and they were not willing to offer educational discounts at that time, because their product is in very high demand. They may be willing to offer educational discount as the product grows in numbers sold.

Qualification & Experience - I am qualified to carry out this project because I have completed 5 years of study as an undergraduate in electrical engineering with a concentration in power and controls. I have also completed a year of graduate school also in electrical engineering, with a focus on battery management systems and vehicle controls. Relevant experience includes 3 years of work developing the currently existing UAF electric snowmobile, as well as building an eco-trike and a hydrogen powered prototype vehicle, which competed in the shell eco-marathon in Houston.
Technical advisors and collaborators - All projects must list at least one technical adviser or mentor, such as a faculty, facilities services staff or administrator willing to be an adviser on the project. - My technical advisor is Seta Bogosyan. She is a professor at the university and teaches classes in motor control and robotics. She will oversee my work and has given me access to the knowledge of many other universities to collaborate with. Her letter will be sent to Michelle Hebert.

Attachments: Attached any explanatory elements in PDF format such as letters of support from technical advisors, quotes from suppliers, engineering drawings of projects, diagrams or photograph of project components or plot plans for field experiments.

This is the manufacturers website:
http://www.yasamotors.com/

Technical specifications can be seen here:
http://www.yasamotors.com/products/yasa-400/

Email from the company:
Dear Isaac Thompson,

Thank you for your enquiry.

Our YASA 400 motor is available to purchase and has 6/8-week lead-time on receipt of a PO. To be able to meet your delivery schedule we would need to get a purchase order as soon as possible.

Perhaps we should have an introductory phone call to discuss your project. What would be the best time to contact you?

Kind regards

Andy Morley