Senior High A+ for Energy Application

YOUR A+ FOR ENERGY PROJECT

What is the title of your A+ for Energy Project?

Algae Bioreactors

Briefly describe your project idea. This summary communicates the overall intent and outcomes of your project.

Over the past year, students in different classes have studied different aspects that contribute to the development of a bioreactor. The Science 20 class has studied the process of how to produce biofuels from oils and has done initial research on bioreactors and algae strains. Culturing practices have also been researched and practiced along with small-scale models. Our current biology class is practicing oil extraction methods from C. Vulgaris Algae. The Robotics team is currently developing and programming a 30L algae bioreactor. The team is hoping that this project will be able to develop into a kit that would be available for other schools to use and build bioreactors of their own. As an extension of this project, we would like to request funding to invest in small-scale algae Chi.bioreactors. The use of small-scale reactors would help students rapidly test changes in conditions, algae strains, and nutrients and their effects on biofuel output potential. Students will use the Chi.bioreactors to create small-scale test batches and evaluate efficiency. Various strains of algae will be evaluated for testing biofuel production and potential. As an extension of our project, we intend to work with younger grades using Algae culture kits and presentations about the project to share our goal. The team has a goal of reducing carbon emissions to offset climate change, by creating bioreactors for students in all schools.

Approximately how many students will be directly involved in the A+ for Energy project?
101-150

Approximately how many students will be indirectly impacted by the A+ for Energy project?
151-250

What grades will participate directly in the project?
7-9, 10-12

Which subject areas will you incorporate into your A+ for Energy Project? (By selecting a subject, you are indicating that you will be meeting learning objectives from the curriculum for this subject.)

Science, Math, Environmental/Outdoor Education, Indigenous Studies, CTS/CTF - Career Education

Identify the energy topic(s) that will be the focus of your project
Renewable/Alternative Energy Sources, Energy Technology & Innovation

STUDENT LEARNING & EXPERIENCE

How will this A+ for Energy Project enhance student learning about energy?

We focus on a project-based learning model. This model allows students to approach and engage in a project with a focus on their individual learning strengths. Through this project, students enhance their energy literacy, by understanding how energy transfer and storage happens in a real-world application. They will evaluate biodiesel production from a renewable energy standpoint while also looking at energy efficiency and technological innovations. They will share their knowledge through presentations with students at a younger grade level, and provide interactive activities in the form of algae culture experiments. This interaction will provide the students with the opportunity to take on a leadership role in conveying energy education to younger grades, and in so doing further enhancing the students' energy literacy. This project has already shown an alignment with the Alberta science curriculum, as it was the primary project of a Science 20 classroom. The class learned the chemistry of biodiesel, and calculations for making reagents, the geology of the earth, and current oil deposits and extraction methods. Students covered photosynthesis and the role the sun plays in providing energy on Earth as a global system. These examples show ways the curriculum has been integrated into project-based learning at our school. The school is looking at ways that students can engage in cross-curricular learning. The science program has suggested the use of an interdisciplinary approach to project-based learning. This will allow students to focus on one project across a number of classes, looking at the ethics and implications of the work they are completing, as well as enhancing their written skills by focusing on papers they write as extensions of this work. Use the skills they develop in math class to help model the research and fit numbers to a graph. The bioreactor project is designed for hands-on learning by the students, encouraging them to research and develop inquiry-based questions about their work. Students frequently face problems in their projects and this action-based approach allows them to develop critical thinking and analytical skills, as well as an opportunity to test their ideas. Students come to class with various skill sets and strengths, students like to focus on demonstrating their learning in a way they feel they are strong at. Through project-based learning, students get to take on an aspect of the project they are confident in and contribute to the overall outcome of the work. Some past examples have included video documentation and editing, design and construction, social ethics, and evaluation papers.

Explain how your energy project connects to and enhances curriculum outcomes.

Biology 20
Through learning about photosynthesis and energy transfer, the students will cover the outcomes for Unit A, Energy and Matter Exchange in the biosphere, specifically focusing on the constant flow of energy through the biosphere and ecosystems. Components of Unit B will cover exploring the mechanisms involved in the change of populations over time. Unit C, covers photosynthesis and cellular respiration, the role of Algae will allow students to analyze the storage of energy in organic compounds. Followed by the exploration of cellular respiration as a means of releasing potential energy from organic compounds. As some strains of Algae are edible this can play into the function of the human digestive system to absorb nutrients. While some strains of algae are toxic, this allows for investigation into the role of the immune system in protecting the body.

Biology 30
Unit C of this course looks at Cell Division, Genetics, and Molecular Biology. Algae would provide an excellent model organism for students to study these effects, and perform inquiry-based experiments on their effects. Bioreactors would allow students to practice molecular biology techniques such as DNA extractions, Transformation, and bioengineering. This technology would also allow

students to investigate population genetics and dynamics toward calculating, growth rates, reproductive strategies, natural selection, and symbiotic relationships, as topics covered in Unit D.
Science 10

Unit A covers Energy and matter in Chemical Change, students will investigate how compounds form, how to name different types of compounds, and how to write and balance chemical equations. These skills will be used in developing the reagents required for the growth and analysis of the Algae and its by-products. Unit B- looks at Energy flow in technological systems covering the first and second laws of thermodynamics and energy conservation. Upon development and analysis of the biodiesel, students will investigate and evaluate the conversion of the potential energy of the biodiesel to kinetic energy used in an engine. Unit C - Looks at the cycling of matter in living systems, looking at Algae cell structures and functions, to evaluate processes of active and passive transport, along with gas exchange and environmental responses. Unit D - Energy flow in Global systems, Students will look at global energy flow and its impact on climate systems. Students will investigate the role of carbon levels and how Algae will impact carbon cycling through sequestration. An Algae bioreactor will be useful in our Chemistry classroom. We would learn about solutes, solvents, and solutions. The increase/decrease in solvent concentrations from the first to last fermentations would help understand multiple fermentations. The rate of mass change to concentration will also be calculated. Students could learn about hydro-dynamics. There is a unit on agriculture and the environment. A bioreactor will help us conduct a lot of experiments. In Chemistry 20 and Science 20 courses, we have full units on organic chemistry where the focus is on hydrocarbons. There is also one big topic on water recycling. We could learn about the efficiency of a bioreactor in removing hazardous trace organic contaminants.

How will this A+ for Energy project enhance student experience?

As indigenous people, we are stewards of the land and hold the responsibility of speaking out for the well-being and appropriate use of the earth. As indigenous students, it is their time to learn how to carry this responsibility and provide learning to their community. Students will demonstrate this through sharing their knowledge by providing hands-on presentations with students at younger grade levels and providing interactive activities in the form of individual algae culture experiments. Higher grades will teach the lower grades about algae culturing and cell growth. This interaction will provide the students with the opportunity to take on a leadership role in conveying energy education to younger grades, and in so doing further enhancing the student's energy literacy. Students will also be available during our open house to share and demonstrate their learning experiences.

CREATIVITY

What's different? What's innovative? How will the A+ for Energy grant allow you to inspire and engage your students in a new, exciting way?

As the initial steps of this project have already been started, the inspiration and engagement are well underway. The idea came following last year's A+ for Energy Teachers summit, where dirt bioreactors were covered and demonstrated. As a teacher, I found this an exciting idea and built it with my students. We finished them pretty quickly and the students wanted more, so did I. So I decided we needed to do something big and exciting. The student had asked if there were other types of bioreactors and so they began looking. They showed me an Algae bioreactor. Maybe it was the green glow or all the probes and wires but they thought it looked cool. We decided that was what we wanted our semester to look like, building an algae bioreactor. They spent the rest of the semester working on researching, designing, and rapid prototyping their own bioreactor. The project was cool, but not just teacher-cool, it was student-driven cool. Students would come in and ask, "Why don't other teachers teach like this?" or say, " I only come to school so I can come to your class, where we work on the project." Comments like these let me know I am on the right track, truly engaging students in learning. It's even more impressive when a student who has completed their science requirements comes to take an extra unnecessary class because they loved the projects they worked on, so much, last semester. By developing and encouraging projects that feel a little beyond a student's perceived capacity, I find they can engage a student to participate, and put the effort in towards a

project. This grant will allow me to continue to enhance, develop, and build on the legacy that this project has started. I imagine that this grant will allow my students to be inspired to optimize their current design and build better, more effective prototypes.

This project will be used to enhance carbon sequestration through algae photosynthesis, students will work to develop methods to evaluate the efficiency of carbon capture by testing different strains of Algae. The primary goal of this project was to tackle global warming, as an application of the United Nations Sustainable Development goals. Including Goal Number 7, Affordable and Clean Energy, and Goal Number 13 Climate Action. One of the outcomes of this project is to create kits for other schools to use a method for reducing carbon dioxide as a greenhouse gas, through carbon sequestration, by having multiple bioreactors set up around the country.

What inspired you and/or your students to develop this idea?

When this project was taken over by the robotics team, their inspiration was to solve a big problem, and they decided on climate change. Their question was how can we make a meaningful impact on climate change, while still doing something on a small scale. The students decided they would build the Algae bioreactor and develop it as a kit that other students in other schools could then build. This would allow a bioreactor to be in every school, each sequestering more CO2, than just one school's project. For me I am inspired to design teaching experiences that my students are excited about, while also encouraging people to question what education can look like.

PROJECT PLANNING & IMPACTS

Please list the total amount of money you are requesting from the A+ for Energy Program.
($) 5000.00

Please complete and attach the budget template available on the Inside Education A+ for Energy webpage.

Item	Quantity	Source	Brief Description of how the item is aligned with project activities	Cost/Item	Total
Chi.Bio reactor	2	Lab Maker	*Chi.bio https://www.labmaker.org/collections/biotechnology/products/chibio*	$999	$1998
Steam Autoclave	1	Biosupply	*Steam Autoclave or similar type for sterilization of equipment. https://www.amazon.ca/Portable-Autoclave-Sterilizer-Pressure-Electric/dp/B00VB5VA84*	1179	1179
Algae Culture kits	5	Algae Research Supply	*Different strains for the students to grow and test*	16	80
Algae	3	Algae	*https://algaeresearchsupply.com/collectio*	75	225

Classroom Culture kits		Research Supply	*ns/algae-culturekits/products/algae-culturing-project-kit-for-25-students*		
Glass ware	20	Finn Scientific	*Various pieces of glassware and equipment to separate oils and pigments*	50	1000
Algae filters	1	Algae Research Supply	*screen filter for algae harvesting*	28	28
Nutrients and reagents	1	Various	*Media, Nutrients and chemicals for algae growth*	200	200
Taxes and shipping	1		*Cost for shipping, customs and taxes*	290	290
				TOTAL	**$5,000.00**

PROJECT TIMELINE (MONTHLY)

- September: Students to research different algae strains, equipment and processes involved
- October: Order strains, and equipment and begin set up and store backup Algae strains
- November: Students run initial growth tests on different strains and evaluate conditions
- December: Testing harvesting and extraction methods and make test batches of biodiesel
- January: Students evaluate calerimetry and efficiency of biodiesel output to input ratios across strains.
- February: Students design outreach program
- March: Students deliver outreach program to different classes
- April: Students evaluate strain optimization and begin testing in Large Algae bioreactor
- May: Students analyze Algae bioreactor output and test oil-producing capacity
- June: First optimized batch of Biodiesel is produced, final video submitted.

Is this A+ Project application an extension of a previous project?

No

Is this grant the sole funding resource for your project? If you are augmenting this grant with others please let us know which ones and how they will work together.

Prior funding for initial prototypes for an Algae bioreactor has been provided by Mindfuel. Funding was used to obtain sensors, microcontrollers, and materials.

Who else will be involved in your project?

Local Organizations, Parents & family members, and Community members

If other, please describe:

Briefly describe how those listed above will be involved in your project.

Students are encouraged to reach out to local organizations and experts to gain insight and advice. Our school encourages community members to be involved in school projects.

How do you plan to measure the impact of this project on student learning?

Student impact will be measured by evaluating student engagement, participation, and interest. Presentations to other students and capacity to explain the project will be evaluated for learning and project success.

What opportunities will there be for project expansion and longevity?

As the equipment from this project is reusable students in future years will be able to expand on the work completed. Since the robotics team is working on a kit for other schools to use, we anticipate this project will be ongoing for a number of years.

Anything else you want to tell us?

Projects like this one and other projects in my classes have helped inspire our schools to move towards a school-wide project-based learning model of education. From this model, we are seeing more student engagement in class and stronger learning uptake.