

**West Hawaii Explorations Academy PCS**

**Kailua-Kona, Hawaii Island**

**Final Report**

**Energy Smart Schools Program**

**2002-2004**

**A PROJECT FUNDED BY A GRANT FROM THE**

**REBUILD AMERICA PROGRAM**

**OF THE**

**US DEPARTMENT OF ENERGY**

## **Acknowledgements**

The staff and students of the West Hawaii Explorations Academy PCS would like to express their appreciation to the US Department of Energy for funding this Energy Smart Schools project under the Rebuild America program.

We would also like to acknowledge the support of the Energy, Resource & Technology Division of the Hawaii State Department of Business, Economic Development and Tourism for facilitating receipt of the grant funding from the US Department of Energy.

Our appreciation goes to the Department of Research & Development of the County of Hawaii for administering the grant to WHEA and providing on-going support and advice during implementation of the project.

We also appreciate the time, energy and expertise of Bill McKown. Mr. McKown's mentorship on this project was invaluable to the students and staff of WHEA in the implementation and completion of the WHEA Energy Smart Schools project.

# West Hawaii Explorations Academy

## Energy Smart Schools Project Final Report

### **Executive Summary**

West Hawaii Explorations Academy (WHEA) is a public charter high school located on the Pacific Ocean on the west side of the Big Island of Hawaii. WHEA is a unique school, the curriculum is project based; students learn by working on 'real-world' projects. Due to the unique curriculum, WHEA's campus is mostly outdoors and utilizes the resources that are readily available; solar energy, deep and surface sea water. Another way WHEA is unique is that the campus is part of the Natural Energy Laboratory of Hawaii Authority (NELHA) Complex, a research park. NELHA is a complex that focuses on alternative energy use, aquaculture and biotechnology utilizing cold deep seawater. The many tenants in the NELHA complex are engaged in cutting edge research and development. WHEA has developed a relationship with the some of these tenants, this relationships allows students who attend WHEA employment opportunities as well as opportunities to work with mentors who are conducting research within the park.

There are approximately 120 students currently attending WHEA. These students range from 9th grade to 12th grade. WHEA's curriculum is project driven, or project based. Project based learning (PBL) focuses on learning through real world projects. Theses projects are centered in three main areas of emphasis, Ocean Science, Plant Life Studies and Alternative Energy.

WHEA has a long and prestigious history in alternative energy competitions, going back ten years when WHEA garnered national attention in the Tour de Sol and the World Solar Challenge. WHEA won the high school division of the World Solar Challenge in 1990 and has continued to be an innovator in alternative energy education.

One of the projects that students who attend WHEA can participate in is the electric car project. The Electron Marathon is a competition that is held on Oahu each year. The objective of this competition is to build an electric car, using a kit, provided by the Hawaiian Electric Company. Each school then competes in a marathon, the car that completes the most laps on the track in an hour wins the race. The school is also judged on documenting their research and development of the car, presenting the project to a panel of judges and a vehicle safety inspection. The focus of this project is not necessarily on winning the race, but the research and development that the students must go through to build their car. Each year students who participate in this project start by learning the basics of electricity, aerodynamics, auto-mechanics and of course, teamwork. WHEA consistently performs well in this annual competition, and currently holds the course record.

The Energy Smart Schools (ESS) project fit very well with the current curriculum at WHEA. The activities for the ESS project included the following categories:

- Saving Electricity
- Alternative Energy Education
- Dissemination

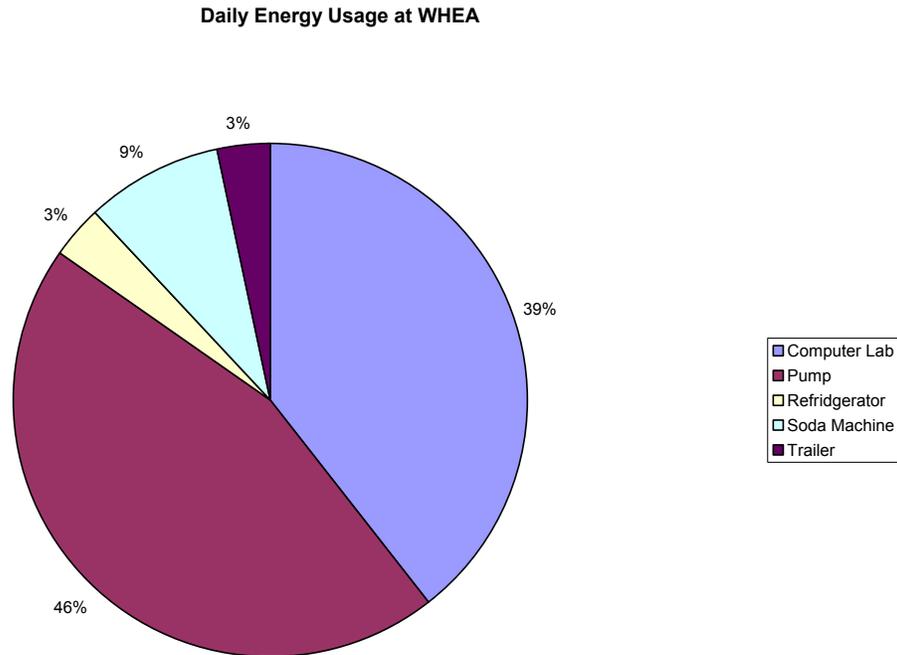
The activities focused on outreach and ongoing energy education. WHEA provides tours to over 3000 grade school students who visit the school as part of the Aloha Kai program. Students who joined the ESS project created an interactive presentation on solar energy for the students who attend an Aloha Kai tour. Student who attend the tour come from the local elementary schools, schools from the Hilo side of the island and even schools from outer islands, like Oahu. Students at WHEA also provide tours to guests of NELHA, parents and adult visitors from schools and businesses across the nation.

All students at WHEA were given a course on energy, Energy Strand. This course was designed to reflect the physical science standards in the Hawaii Content and Performance Standards. In this course, students learned about the different sources of energy (especially solar energy), energy issues, such as the greenhouse effect or the use of alternative energy sources as compared to the use of fossil fuels, and built an electric motor. The students were given an experiment to perform and asked to write a lab report. The students were given a small solar panel, a volt and amp meter and asked to determine the angle of inclination that produced the greatest amount of energy.



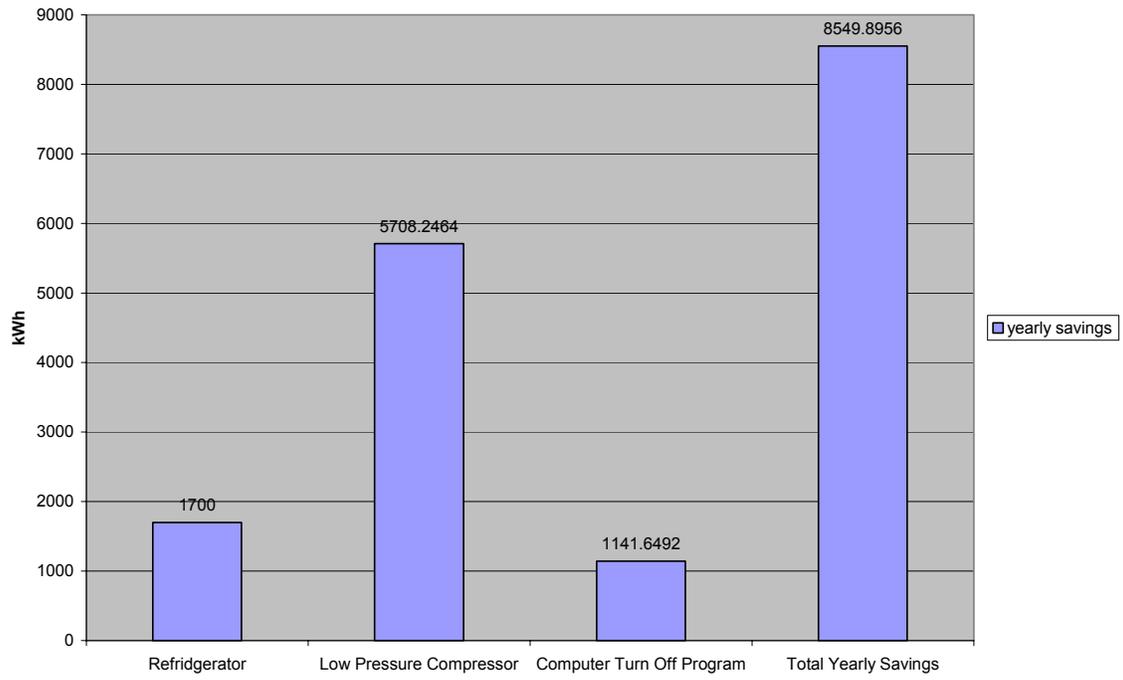
*WHEA students learning about electricity in the Energy Strand.*

Students who were especially interested in energy joined the ESS project. Students in the ESS project learned how to audit the electricity used on campus. They audited the campus and they created a chart to demonstrate how the electricity is used on campus.



Then students determined the rate of electrical usage to discover opportunities to reduce daily electrical usage. For example, students audited the lighting fixtures in the few buildings that utilize lights during the day (most of the campus utilizes day lighting, due to the outdoor nature of the majority of the campus). Students found that the lamps in use were T-8 fluorescent lamps which are the most efficient lamps available. These lamps save from .018 kW-.074 kW per fixture. Since WHEA already had these lamps in place, retrofitting was unnecessary. Also, students audited the refrigerator that was in use on the campus. Students discovered that by purchasing a new, more efficient refrigerator, that the electrical savings for the school would be 1,700 kW per year. Students also initiated a computer turn off program, where school computers were shut down at the end of each day, resulting in a 30% electrical saving per year. In the interest of saving electricity, students researched a low pressure compressor with a more efficient motor. This retrofit reduced electric costs by 6% per year.

### WHEA Retrofit Savings



*WHEA's photo voltaic system*



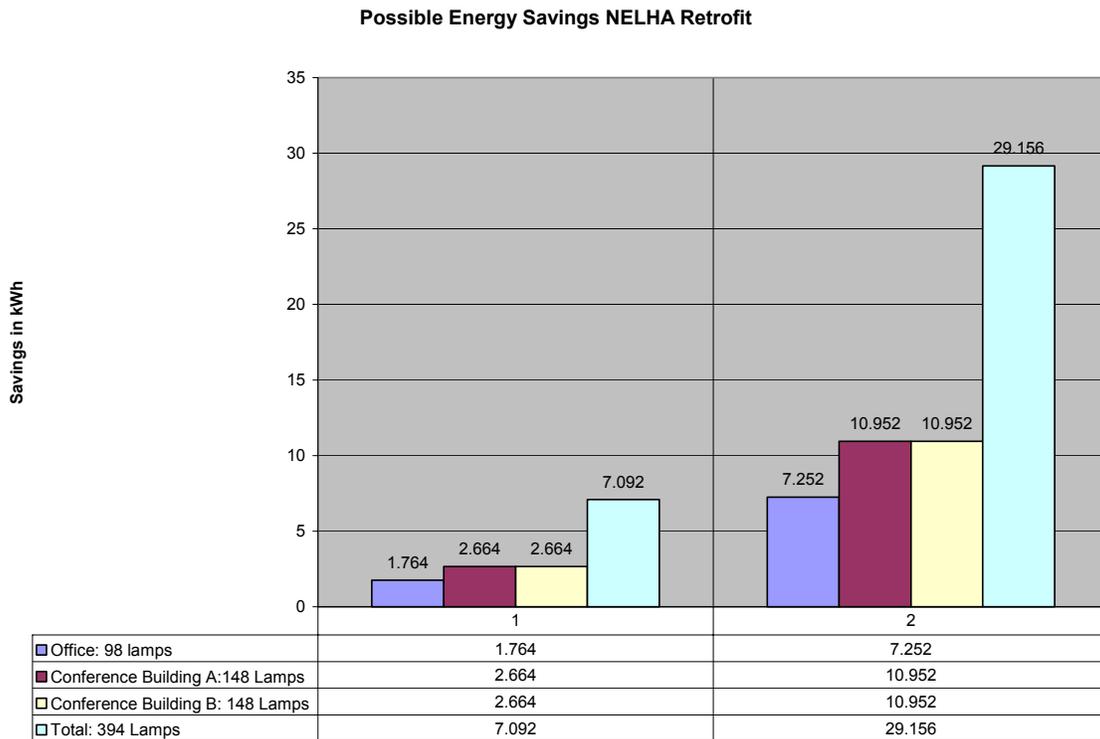
ESS students had an exciting opportunity to learn first-hand about utilizing solar energy to reduce the amount of electricity needed from fossil fuels. WHEA installed a 10 KW photo voltaic system. This system has an average output of approximately 50 KWH per day AC which supplies 110 percent of school needs at peak hours. The use of a photo voltaic system is ideal due to WHEA's location. WHEA is located on the West Hawaiian coast that receives the most sunshine in the United States. In addition, the school's electrical needs tend to rise and fall with the sun, school begins operating after sunrise and is generally closed after sunset. WHEA is also able to sell the excess electricity back to the utility company, Hawaii Electric and Light Company.

WHEA students then took what they learned about energy use and solar energy to create an interactive presentation as part of the Aloha Kai tour. Aloha Kai is a project that offers a tour of the campus projects to approximately 3,000 students from other schools. The ESS portion of the tour gave students an opportunity to teach other students how solar energy is produced in a photo voltaic cell. The students set up a photo voltaic cell that is attached to a light bulb, an electric motor that spins a disk and a water pump. Usually the students who participate in Aloha Kai Tours are younger students, so this is an exciting opportunity for WHEA students to teach the next generation of students about solar energy and how to protect the environment.



*ESS student, Becky Ingram, presenting during an Aloha Kai Tour.*

These students worked not only on the WHEA campus, but also had an opportunity to audit a business. Originally, the students planned to visit several of the tenants in the NELHA complex. However, due to the competitive nature of the research and development that takes place in these businesses, the tenants were not interested in having the students audit their energy use. Fortunately, NELHA, the state agency that is responsible for leasing the land and the resources within the park, was willing to allow students into their buildings to audit the energy use. Students were very interested to learn about the technology that uses cold seawater (39 degrees F.) from offshore depth of 2000 feet to air condition the entire 10,000 square-foot NELHA building. This technology saves \$4,000 per month in electricity costs. WHEA is researching the possibility of using this technology to air condition classrooms when the campus is relocate to a nearby site. Also, students were able to audit the lighting fixtures at the NELHA facility; the facility utilizes 394 florescent lamps, 98 lamps in the office and 148 lamps in each conference building. If NELHA would retrofit and install T-8 fluorescent lamps, the most efficient lamps available, they would save from .018 kW to .074 kW per fixture. This would create a total electrical savings of 7.095 kWh to 29.256 kWh.



In January 2004, students who participated in this project created a power point presentation to present at the Regional Seattle Peer Forum of Rebuild America in Scottsdale Arizona. The students presented their findings in the form of a power point slide show to the participants of the conference. This was an excellent opportunity for students to share the unique outdoor setting of WHEA, the project based curriculum and the NELHA complex with their peers. Also, students were exposed to presentations from other schools that were more traditional, utilizing retrofitted lighting to create substantial energy savings. Students also were able to see different ways of graphing electrical savings and environmental benefits for presentations.

Report of Activities:

### **Saving Electricity**

#### New refrigerator

WHEA students analyzed the efficiency of the old refrigerator and discovered that if WHEA purchased a new, more efficient model, then the new refrigerator would pay for itself in two years. The previous refrigerator consumed approximately 2200 kWh per year. The new, more efficient model will consume approximately 500 kWh annually, a savings that will allow WHEA to recover the cost of the new refrigerator in two years (\$0.22/kWh).

#### Computer turn off program

The students at WHEA initiated a computer turn off program. Basically all the computers on campus are turned off during non school hours. The computer turn off program has saved 30% of the annual electric usage at WHEA.

#### Low pressure compressor

After researching compressors, students learned that a low pressure compressor with a more efficient motor will reduce electric costs by 6% per year. Students replaced the old motor with more efficient motor, which saves 6% per year.

#### Photo Voltaic System

WHEA installed a 10 KW photo voltaic system. This system has an average output of approximately 50 KWH per day AC which supplies 110 percent of school needs at peak hours. The use of a photo voltaic system is ideal due to WHEA's location. WHEA is located on the West Hawaiian coast that receives the most sunshine in the United States. In addition, the school's electrical needs tend to rise and fall with the sun, school begins operating after sunrise and is generally closed after sunset. WHEA is also able to sell the excess electricity back to the utility company, Hawaii Electric and Light Co.

## **Alternative Energy Education**

### Energy Strand

In an effort to educate all WHEA students on the basics of energy, all students attended an energy class, Energy Strand. The goal of this class is to provide students with a working knowledge of electricity, alternative forms of energy and energy issues. This course was designed to address the physical science standards from the Hawaii Performance Standards. Worksheets were used to practice calculating volts, amps, kilowatt hours. Students performed an experiment to determine the most effective angle for a solar panel. Energy issues, such as the greenhouse effect and alternative energy sources compared to fossil fuels, were researched and explained in an issue paper. Students built several electric circuits: buzzer, series and parallel lighting, electric motor.

### E\$S Project

E\$S became a teacher directed project at WHEA, where students who were interested in learning in depth about energy were able to survey home energy usage, analyze ways that WHEA could become a more energy efficient school, and analyze the electrical usage of a commercial building in the NELHA research park. These students came up with many ideas on making WHEA more energy efficient (see energy savings). They were able to implement their ideas and study the effect of these changes. The installation of a photo voltaic system offered an excellent opportunity for the students to see first hand how an alternative energy system like this can impact electricity consumption. These students also attended a national conference in Scottsdale, Arizona to share their experiences and discoveries.

## **Dissemination**

### Aloha Kai

Aloha Kai is a teacher directed project at WHEA, whose goal is to educate students on the conservation and preservation of the environment. WHEA students who participate in Aloha Kai, research an area they are interested in and then present this information to students who attend the tours. Students who attend this tour will learn about the fragility of the coral reefs, the various native species of fish and fauna and other projects on campus. The students who joined E\$S created an interactive presentation that explains solar energy and how alternative forms of energy are important to protect our environment. Aloha Kai provides tours for over 3000 (see attachment) students annually. These students come from local elementary schools from across the state. The interactive presentation explains the concept of solar energy and how the sun can provide electricity to run lights, motors and water pumps. The E\$S project members have the students experiment by blocking the sun, seeing how the shadow they cast can effect the amount of electricity powering the light, motor and water pump.

Attachments

- I. ESS Power Point Presentation
- II. List of Schools Attending Aloha Kai Tours 2003-2004

## Appendix II

### Schools Attending Aloha Kai Tour 2003-2004

Kamehameha School  
Montesori Preschool  
Keola Elementary  
Kealakehe Elementary  
Waianae High School  
St. Joseph School  
Konawaena Elementary  
Aaina Haina Elementary  
Kaimuki Christian School  
Wilson Elementary  
Kohala Elementary  
Waiialai Intermediate  
Ewa Elementary