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Renewable Energy and Energy Efficiency Education Program Report

The Governor's Office of Energy Management and Conservation's (OEMC) Renewable Energy and Energy Efficiency Education program provided opportunities for Colorado's K-12 public schools to learn about renewable energy and energy efficiency. The program began in the fall of 1998 and ended in the spring of 1999. It provided financial assistance to offset the initial costs of incorporating learning about renewable energy and energy efficiency into existing curricula. Such costs included purchasing teaching materials and resources and developing specialized lesson plans. All public K-12 schools and school districts in Colorado were eligible to apply for funding. Multi-school proposals were encouraged, as were partnerships with community organizations, businesses, utilities and others. Projects were required to support state education standards, and designed to be long-term and self-sustaining. OEMC sought proposals that involved hands-on learning and drew on existing materials as much as possible. Proposals could range from projects for one grade level in one school to teacher trainings to implement projects in many schools.

OEMC funded 16 projects in a variety of schools around the state. The following describes and summarizes the various projects, their successes and lessons learned:

Four schools, **Aspen Middle School, Glenwood Springs Middle School, Carbondale Middle School and Basalt Middle School**, partnered with Solar Energy International of Carbondale. Four hundred and eighty-three students and 10 teachers participated. Ninety-five of the students from Aspen Middle School were in the sixth grade, 24 of the students from Aspen Community School were in the seventh and eighth grades, 111 students from Carbondale were in the seventh grade and 263 students from Glenwood Springs and Basalt Middle Schools were in the eighth grade.

Students used a human-powered energy bicycle to understand the meaning of terms associated with electricity such as watts, amps, volts, kilowatt hours, etc. Students also made solar cars and presented their cars in a car show, thus learning and demonstrating the power and potential of solar energy.

The program was considered a great success. It allowed an opportunity to incorporate electricity and energy into the science curriculum. The students showed good progress in design, evaluation testing and re-evaluation.

The teachers would like to have had more detail with the car design for sixth graders, and wanted to

integrate this program with other subjects by extending the program to include more math-related activities.

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Falcon School District 49 held a Sun's Joules workshop for 27 Pikes Peak area school teachers. Sun's Joules is an interactive energy education CD-ROM, developed collaboratively by the Center for Renewable Energies and Sustainable Technologies, National Renewable Energy Laboratory, and the Mid-continent Regional Educational Laboratory. Participants used the CD-ROM with a hands-on tutorial and were given an assignment to design and build an energy-efficient home using a given amount of materials. Teachers were asked before beginning the project to define their idea of energy and energy sources. They were asked the same question upon completion of the project and their answers were quite different. Their original ideas of energy sources were the usual dams and coal burning to generate electricity. After the project, they understood alternative sources of energy.

As a result of this project, teachers were grateful they had obtained a more expanded idea of energy sources.

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Arvada High School (Jefferson County School District) held a Sun's Joules workshop for 17 area school teachers. All participants received a class set of Sun's Joules CD-ROM and program guide. Teachers received in-depth information to facilitate educating students about energy concepts, issues and sources of alternative energy. Participants represented a range of subject areas and grade levels taught.

This project succeeded in its goal to disseminate quality instructional materials in classrooms in suburban Denver, impacting more than 500 students to date. Teachers stated they would use the materials in the fall1999.

Students were impressed with the amount of information available regarding energy issues, and gained an understanding of the facts and implications of energy use.

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Mesa County Valley School District 51 held two half-day workshops for fourth through 12th grade teachers. They received information on light, energy, photovoltaic cells and energy transfer systems. Each teacher received a solar energy starter kit and classroom check-out kits were made available. These kits supplied enough materials for 15 two-student teams. Teachers also had their choice of visiting technology web-sites, perusing print resources or building a solar racer. With their hands-on experience, the teachers

were well equipped to facilitate similar experiences in the classroom.

As a result of this training, five teachers created new lessons on renewable energy and seven teachers integrated the activities into existing units of study.

Students participated in the following renewable energy activities:

- Model solar house construction (constructed of cardboard, plastic wrap, construction paper, aluminum foil, tape, glue) in which the only heat source was the sun. (Students supplied the materials.)
- Two stations studied the amount of energy generated by a photovoltaic cell at different distances and angles from a designated light source.
- Three stations studied model solar house construction, the amount of energy generated by a photovoltaic cell at different distances and angles from a designated light source and energy generated through colored filters
- Integrated the CD-ROM, Sun's Joules, to build scale model solar home. This included measuring solar panel storage, output potential and numbers to scale. Students also produced a final report on their project.
- Tractor pull activity. Students determine maximum output from photovoltaic cells and then designed a tractor that would pull the solar trailer.

Teachers felt they needed more time with the check-out kits. The materials, however, served as a vehicle to connect with students who have learning issues such as language and reading barriers. Teachers felt the barriers tended to disappear during hands-on activities.

For vendors and products used in this project, call Penny Teeters.

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Mapleton Public Schools hosted a Sun's Joules workshop for teachers from high schools immediately surrounding the Mapleton area. The CD was utilized in the computer lab. Teachers studied the program guide, The Colorado Model Content Standards, and held discussions on how to best involve this line of activity in the classroom. Fifteen teachers attended these discussions and these 15 have the potential of reaching more than 1,000 students from five different schools.

The Sun's Joules workshop benefited the teachers with hands-on learning so they could conduct lessons in a manner that was different and more motivational for the students.

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Academy School District 20, Mountain Ridge Middle School, conducted an energy education program to introduce students to renewable energy and energy conservation concepts in order to kick off the installation of a new photovoltaic system at Mountain Ridge Middle School in Colorado Springs. The program included two parts: The first part was an energy education presentation for sixth and seventh grade students that introduced them to renewable energy and energy conservation concepts and provided

opportunities to experience firsthand how these technologies work using demonstrations, displays, props, experiments and activities. The second part was an energy conservation challenge - a contest offered to sixth grade students that promoted energy conservation at home and school.

Students were divided into small groups and then studied at five different stations. These stations included solar energy, wind, light, a dollhouse exhibit showing ways that homes could be more-energy efficient, and an energy conservation ideas station where students could brainstorm ideas for home and school.

Six hundred and fifty-four sixth and seventh grade students and nine teachers participated in the energy education presentations for a total of 663 participants. Eighty-one sixth graders participated in the Energy Conservation Challenge.

Teachers and students liked the hands-on demonstrations. Teachers felt the time allotted should be expanded from 70 minutes to 90 minutes for the programs, and the Energy Conservation Challenge time should be expanded from 1 ½ weeks to 2 - 3 weeks.

For vendors and products used in this project call Mark Bissell.

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Boulder Valley School District created an energy conservation and renewable energy curriculum and trained 10 fifth to eighth grade science teachers to implement the new curriculum into their classrooms.

Boulder Valley School District contracted with Eco-Cycle, Inc. of Boulder County to research and create a new curriculum on energy conservation and renewable energy. Eco-Cycle trained the teachers for 2 ½ days, providing them with energy conservation background as well as a review of the training materials. The curriculum contains an eight-day unit that helps students understand and analyze where power comes from, results of using fossil fuels, and the impact of energy consumption on the environment. School and home energy audits were a focus. Additional training included building a pizza box solar oven and a solar air heater. Energy savings for the school district were presented in a chart format so students could see the savings achieved over time.

In the first year of this curriculum, teachers were able to reach approximately 1,260 students and their families. Students learned a great deal and felt they could influence others. Also, students implemented energy conservation ideas in the school such as turning off lights and computers, using natural light for the classrooms, insulating doors better and using compact fluorescent lights instead of incandescent lights.

Teachers felt that a three-day training period would have served them better.

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East Middle School in Aurora, implemented a Solar Development project. Middle school students participated by constructing four different communities chosen to demonstrate various ways of utilizing solar energy. These model communities, 1/24 of the actual size, included an orbiting space station, modern suburban community, rural Indian village and a futuristic martian colony. Photovoltaic panels were wired in series and in parallel as need demanded, and these energy "generators" produced electricity that powered the various communities. Resistors of various sizes were placed in the communities by students to

demonstrate the effects of varying loads upon electrical systems.

Approximately 90 students in the sixth, seventh and eighth grades were reached by the project. Additionally, many more students were exposed to the project by attending a symposium.

The instructors felt that anyone attempting this project should plan to devote a significant amount of time to the endeavor. Inquiry-based learning is not fast. This project also required a significant amount of space because of the size of the structures.

The project was so successful that Dr. Randall Tagg and Dr. Patrick Roberts of East Middle School are considering writing and publishing papers for education journals describing the project. It was obvious by the end of the program that students were practically teaching themselves. Students demonstrated significant growth on State Science Standard Test #5 and proficiency in State Science Standard Test #1. State Science Standard Test #2 was a staple of this project.

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Idalia School purchased software packages and installed them on their computers. The software packages included Earth Explorer for grades four through nine, Ecosystems for grades four through eight, Our Environment for grades three through eight, Energy Flow for grades six through 12, Producing Energy for grades 10 through 12, Alternative Energies Vidiolab for grades nine through 12 and Reduce, Reuse, Recycle for grades four through eight. The software was integrated into the new science program and is being used by grades five through 12. In addition, a wind generator was purchased to power light poles installed near a gazebo. There are 200 students in the school who benefited from this program.

A wind generator is not easy to install. The entire process was complicated. The software will be used for years to come and the faculty feels the generator will be with them for a very long time.

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Public School 1 in Denver trained teachers in two school districts, Jefferson County and Denver, on renewable energy and energy efficiency concepts. Teachers studied in two workshops/seminars and had follow-up meetings to address their specific sites. More than 300 youth, grades four through eight, conducted Earth Force projects. These projects included conducting an energy audit of their respective schools/homes, gaining an overview of renewable energy and implementing a project to address an energy problem identified by the students. The students identified specific projects encouraging consumers to purchase wind power, helping a nearby day care center examine its energy use, and institutionalizing energy conservation in their schools (including getting photovoltaics through Xcel Energy).

There was a challenge getting educators to start their curriculum and classes. The faculty learned that young people really enjoy learning about energy issues. Teachers thought the content-specific workshops were very effective in helping educators with project-based learning in their classrooms. Upon examining several CD-ROM resources, they found Sun's Joules to be too complex.

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St. Vrain Valley School District, working with Eco-Cycle, devised teacher training and curriculum for eighth grade students to study energy conservation and renewable energy. Students analyzed where power comes from, results of using fossil fuels, and the impact of energy consumption on the environment. School and home energy audits were a focus. Additional activities, such as building a pizza box solar oven and a solar air heater were included as a separate part of the curriculum. In the second semester of the 1998 - 1999 school year, teachers were able to reach 600 students and their families.

Teachers were excited to implement the curriculum and felt the handouts were very instructive. Students demonstrated innovative ideas on posters, stickers, surveys and letters. The students responded that they liked learning about energy conservation because it saves money and is good for the environment. They liked the idea of taking the information home to make a difference there.

Teachers felt that a full three days of training instead of the 1½ days, would have been more beneficial.

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Yampa Mountain High School in Glenwood Springs taught students about energy-efficient building techniques and solar power. The students learned about using strawbales to build homes. They learned the techniques, costs, design constraints, materials, building design and engineering, floor plans and elevations to be used. The students actually took part in the construction. Students also learned about photovoltaic systems, design, installation concerns and mechanics. Twelve to 17 students participated but several students were unable to complete the course.

The curriculum developed included home and school energy audits, calculating energy needs, energy use simulation games, energy use in the classroom, electricity generation using photovoltaic modules, power generation, simulation game, solar design, and planning for passive solar heating and tracking the sun.

The program was successful and retained student interest because of hands-on learning. The students actually got to construct the building that they designed. An improvement in the program would be to start the project at the beginning of the school year in September. An earlier date would have allowed more hands-on work outside when the weather was still warm.

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In conclusion, it became apparent that teachers felt they could use more time to learn about the projects before teaching the students. They also needed more teaching time. The teachers would have liked the program to begin at the beginning of the school year to give them full benefit of the teaching year.

The teachers felt the programs were highly successful due to the hands-on quality of teaching since students generally learn better in this type of environment. Students were eager to learn about energy conservation and renewable energy, and to take their newfound knowledge into their homes and schools where they can put the knowledge to use.

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