Part II of a Three-Part Series—
Integrating Science and Technical Education

Department of Energy Strategic Plans And Activities in Energy Education

Brian Castelli, Chief of Staff
Estelle S. Wiser
Energy Efficiency and Renewable Energy
U.S. Department of Energy

(*Editor's Note:*) This is the second part of a three-part series of articles organized by Dr. James J. Winebrake, Ph.D., of James Madison University's Integrated Science and Technology Program. The series which he has collocated describes ways to integrate science and technical education—a process which we must achieve if we are to meet the growing energy and environmental activities of the 21st century.

Many departments of the federal government are involved in the integration of energy education, and it is impossible to list all of these activities in this issue. We have chosen, instead, to concentrate on one group—The Department of Energy—which is a leader in expanding the knowledge of energy conservation measures.

Part III will conclude this series in the Spring 1997 issue. In it, industrial leaders will discuss industry's contribution toward educating our society about ways to achieve greater energy and environmental efficiencies.

INTRODUCTION

This Administration is dedicated to the Goals 2000 principle that, by the turn of the century, U.S. students again will be "the first in the world in science and mathematics achievement." To realize this goal, Secretary O'Leary committed Department of Energy (DOE) resources to help train the next generation of scientists and engineers for the high-

tech industries upon which our national defense, sustainable economy and environmental quality will rely.

Our strategic plans for education extend beyond the replenishment of a scientific and engineering pool. To ensure this Nation's leadership in world markets, the Department envisions a total citizenry that is technology literate and energy concerned. In partnership with other government agencies, industry, and the academic world, we seek to revitalize science studies and provide all Americans information on which they can base knowledgeable energy investment decisions.

ENERGY EDUCATION—DOE PRIORITY

Energy education has been a Department priority since 1977 when Congress directed us to help "assure an adequate supply of manpower for the accomplishment of energy research and development programs, by sponsoring and assisting in education and training activities in institutions of higher education, vocational schools and other institutions... ."

Congressional appropriations largely determine the extent of our ability to conduct science education programs. Despite budgetary limitations, the Department is making use of advanced management tools and evaluation instruments to incorporate the foremost educational techniques into our programs.

> "...utilize the scientific and technical resources of the Department of Energy's laboratories to enhance the development of a diverse, well-educated and scientifically literate workforce."
>
> *University and Science Education Program Mission*

In FY 1995, DOE entered into agreement with the Department of Education to plan collaborative strategies of our National Laboratories and Education's Regional Laboratories that would result in high quality science, mathematics and education technology programs. Our joint goal of improved student achievement in the most needy urban and rural schools included the commitment to upgrade teacher preparation and help develop challenging curricula and effective evaluation systems. This Education/Energy Laboratory Compact has already produced a series of case studies, among them "The

Sun's Joules" and "Science Understanding Promotes Environmental Responsibility!"

DOE also developed a Memorandum of Understanding with the National Science Foundation to ensure effective planning, information exchange, evaluation and collaboration at all school levels. Under preexisting agreements, we already jointly funded programs to expand the scientific literacy of teachers and whet student interest in science careers. Lead responsibility for improving science education currently is the province of the University and Science Education Program within the Office of Energy Research.

In addition, other offices in DOE provide educational programs specific to their mission. This article will discuss the variety of programs provided by three offices—the Office of Energy Research, the Office of Economic Impact and Diversity, and the Office of Energy Efficiency and Renewable Energy.

DEPARTMENT LABORATORIES AND RESEARCH FACILITIES: VANGUARDS OF THE EDUCATION PROGRAMS

The Department supports more than 1,200 education programs at our National Laboratories and specialized research facilities. Endowed with a wealth of equipment and intellectual resources, the Laboratories have spearheaded our education initiatives to an extent that their projects promote science literacy for entire communities and are counted among community-based economic development programs. Each scientific and technical center plans and administers pre-college and university science education programs which vary according to the equipment available, Laboratory specialization and local needs.

Secretary O'Leary has frequently expressed her admiration for the collaborative research of the Laboratories and universities that have involved more than 60 Nobel prize winners. Laboratories benefit from the influx of fresh ideas and, in return, their research and knowledge reshape academic curricula in science, math, computers and engineering disciplines. One project typifies the opportunities that have generated student enthusiasm: students in the Iowa Space Grant Consortium worked with scientists at Ames Laboratory and Iowa universities to design an experiment in micro gravity which was carried into space by the shuttle Endeavor.

Typical of the education programs conducted by the National Laboratories and the Department's specialized research facilities, Los Alamos offers more than 40 courses, including research by undergraduates and faculty-student teams, teaching methods and curriculum development and, for middle and high school students, energy and environmental studies. Special classes and recruitment strategies targeted to minorities and women have generated greater representation by them in technical fields.

> "About 15,000 industry-, university-, and government-sponsored scientists based in all 50 states conduct unique, cutting-edge experiments at our facilities each year."
>
> *Secretary Hazel O'Leary*

The Labs often donate used equipment to universities and lower-level schools to expand their research capability. In addition to computer equipment given to K-12 classes, last year DOE gave instructional tools to more than 100,000 teachers in urban and rural school districts; this surpassed our goal for the entire fiscal year by 50 percent.

University research for the Department has been conducted both at Department- and university-owned facilities. In some disciplines work can only be carried out with access to the Department's specialized sites and advanced equipment. As Secretary O'Leary has noted, "We are the clear leader in providing R&D facilities for use by the private sector and invested over $700 million in research at universities in FY 95."

Partnerships with Minority Schools

Committed to the development of a diversified and effective technical workforce, the Department conducts many productive partnerships with minority educational institutions—Hispanic, Native American and Alaskan, and Historically Black Colleges and Universities. Partnerships are rooted in objectives of the Interagency Task Force on Educational Excellence for Hispanic Americans, in DOE's Tribal Colleges Initiative for Native Americans, and requirements of Executive Order 12876: ***"...to advance the development of human potential, to strengthen the capability of historically Black colleges and universities to provide quality education, and to increase opportunities to participate in and benefit from Federal programs... ."***

Linking DOE's mission with the minority schools' programs and

the labor needs of energy industries, the Department designs bridge programs from junior high school through graduate school with opportunities for internships, scholarships and work as graduate assistants, job placement, curriculum development, teacher training, collaborative R&D, reduction of barriers to technology transfer and rapid commercialization of technology advances.

We have worked independently and with other agencies and academic consortia to enrich minority programs—with the Bureau of Indian Affairs, for example, to support teaching in remote K-12 schools. As evidence of our commitment to increase the number and expertise of minority students entering energy and environmental careers, the Department will continue to fund the Tribal Colleges Initiative for the next four years and support activities of the Southeastern Consortium for Minorities in Engineering, the Minority Undergraduate Training for Energy-Related Careers Program, the National Hispanic Sustainable Energy and Environmental Conference and, jointly with the Environmental Protection Agency, the Hispanic Radio Network and Self-Reliance Foundations that target broadcasts on education, career and business opportunities to students. Our efforts, combined with those of other government agencies and private sector organizations have contributed to the growth in minority representation in engineering studies from only 4.1 percent of all engineering students in 1974 to 12.6 percent in 1993.

Energy Education at Elementary, Middle and High Schools

Our nation's schools are the prime catalysts for changing "energy oblivious" youngsters into energy literate adults. DOE's State Energy Program (SEP) in the Office of Energy Efficiency and Renewable Energy has had broad impact on the thousands of energy education projects conducted by State governments and school districts. Annual SEP grants and oil company overcharge funds returned to the states are used to design and carry out energy plans that combine SEP-required efficiency measures with activities such as information outreach, education and training.

> "We have to bridge the economic divide and unleash the potential of all of our people. And the key issue there is... unrelenting dedication to excellence in education... ."
>
> *Bill Clinton, President*

The **Alabama** Energy Plan, typical of many states' proposals, would "make all [Alabama citizens] aware of the need for wise and efficient use of our resources and assist educators in teaching science, technology, and energy." Public information programs, hands-on workshops, classroom curricula, and outreach events such as the annual Energy Awareness Month provide forums for examining energy options and practices. Other states have expressed similar education goals for their constituents.

States supplement the SEP awards obligated to energy education programs and are assisted by special grants and services from private sector partners. In some states incentive programs enable school districts to use money saved from the installation of energy efficient equipment for classroom activities. Many districts train custodial staffs periodically in the efficient use of boiler systems, energy controls, audit techniques and accounting methods. (A study in **Idaho** and **Utah** found that schools that lacked retraining programs saved an average of 10 percent of their energy demand in the first year following energy retrofits, but only 6.5 percent the next year.)

Teachers and students spread the conservation message to the entire school population through awareness activities such as the operation of energy patrol teams in elementary schools and audit teams in high schools. (The patrol teams particularly seem to enjoy their responsibilities—and the high visibility afforded by specially marked jackets, hats or badges—as they check empty classrooms, halls and bathrooms for lights, open or broken windows and dripping faucets. Polite reminders or thank you notes left by the patrols alert teachers and students to their use or misuse of energy.) **Kentucky's** Energy Office reports that the state's Students Weatherization/Audit Training (SWAT) program not only has produced significant savings in high schools and vocational/technical schools, but also has generated increased community awareness of the importance of conserving energy.

Energy curricula developed by or for the states often reflect local energy and environmental conditions, as in **Arizona** where 50 percent of the elementary schools have programs on solar energy. In the **District of Columbia**, where both efficiency and environmental issues are emphasized, the Energy Office's curriculum module for public schools is supplemented with the establishment of energy patrols, an auditor training course, an annual poster contest/calendar project featuring motor oil recycling and classroom conservation kits for teachers.

Energy topics are rarely addressed as separate courses, but usually

are integrated into other studies—environmental, science, mathematics, language arts and social studies classes. Two **New York State** programs, matched to the State's "Mathematics, Science and Technology Learning Standards," introduce energy topics as part of technology studies. Under the heading, "Technological Development Utilities Resources," module T-2 for the state's middle schools discusses the forms of energy (radiant, mechanical, electrical, chemical, thermal, light and magnetic) and its sources (muscle, fossil fuels, flowing water and tides, solar, wind, nuclear, geothermal and biomass).

For grades 11-12, the "Principles of Engineering" course poses open-ended, real-world engineering problems as case studies in which concepts of engineering design, modeling, systems, optimization, technology-society interactions and ethics in engineering form the basis of the activity. Three cases are devoted to energy problems; in one module, following a brief study of energy sources and transformation into electrical energy, students examine the use of electrical energy in lighting and household appliances. They then have the option to build a model low-energy use home or a model solar-electric car.

Using a different approach, **Pennsylvania's** State Energy Office (now the Bureau of Energy Services) developed six notebooks of lesson plans from which school districts select desired units. The small, self-contained energy plans have been particularly valuable to the State's teachers who prefer to weave the independent modules into their environmental studies classes.

Professional education organizations are widely consulted by States in developing and implementing energy curricula and extra-curricula activities. The National Science Teachers Association, for example, working with "micro units," lists over 300 educational products in its catalog. Currently the Association is designing an integrated science program for grades 7-12 in conjunction with the National Science Foundation, whose "National Science Energy Standards" is the acknowledged reference for curriculum writers.

Another leader in curriculum development, the National Energy Education Development (NEED) Project, has the endorsement of many States. Sponsored by a coalition of energy-related firms, associations, foundations and government agencies, NEED programs encourage students to work in small groups on innovative projects that foster critical thinking, problem solving and leadership skills. Each year outstanding teams compete for NEED's coveted Youth Award for Energy Achieve-

ment.

Various methods are used to educate teachers about energy science instruction. **Alabama**, for example, supplements its workshops on photovoltaics, electricity, magnetism, simple machines and conservation technologies with guidance on how to use the information in class. **Hawaii's** Energy Extension Service has teachers building solar ovens, running solar experiments, and applying solar principles in hands-on activities that integrate natural science, language arts and other disciplines.

Several States provide easily accessible information via clearinghouses and Internet bulletin boards. "Energy Quest," the **California** Energy Commission's home page, is a popular reference whose materials appear as games, puzzles, experiments and other challenging presentations. Strong support for energy education comes DOE's Energy Efficiency and Renewable Energy Clearinghouse which responds each year to thousands of teacher and student inquiries. In addition to the publications sent with each response, special kits of classroom-oriented materials such as "Conservation Activities for the Classroom" are sent to teachers of grades K-12. Teaming with the Clearinghouse, the Department's Energy Efficiency and Renewable Energy Network home page provides an electronic gateway to worldwide energy information resources.

Energy Education for All Americans

DOE's strategic plans for energy education go beyond academia to include every citizen who makes decisions affecting our energy supply or its use. The plans are rooted in our core value that "people are our most important resource," a resource that must remain energy knowledgeable for technology transfer or consumer "buy in" to occur.

We are a cost-conscious society, quickly responding to short-term price increases for energy with conservation activities. Long-term "buy in" requires recognition of other types of energy costs—the security cost of dependence on foreign suppliers, the environmental cost of burning fossil fuels, and, on the positive side, the cost benefits accruing from investment in efficient and renewable technologies. (We also counted costs in terms of the deaths of soldiers stationed in Saudi Arabia to protect the oil supply.)

DOE disseminates energy information through many media—news services, the Internet, publications, demonstrations. Thousands of sports fans at the Olympics last summer saw photovoltaic technologies in opera-

tion, providing power to the Atlanta swimming complex; millions more may have watched it on TV or read about it on the sports pages. When the Department brings solar-powered electricity to a Native American household in New Mexico, word of mouth and the local press teach the entire community about PV power. If 10,000 California families should benefit from the results of Solar Two tests in the Mojave Desert, the entire Southwest will become aware of technologies favorable to their interests.

Student Competitions

Well-publicized competitions among student teams have been among the most effective means of rousing public interest in advanced energy technologies and focusing student attention on the challenges and attractions of studies and careers in science and engineering.

In addition to the National Science Bowl in which more than 30,000 high school students have answered questions on science, math and technology over the last six years, thousands of college and high school students have designed, built and driven alternative fuel vehicles in 21 different Student Engineering Research Competitions, including the following races:

Tour de Sol—a road rally for electric and hybrid electric vehicles (which set a record this year of 373 miles on a single charge);

Propane Vehicle Challenge Competition—featuring engines designed or modified by university teams to run on efficient and environmentally benign propane fuel;

Sunrayce—solar-powered cars designed and driven by college-level students from Canada, the United States and Mexico in a race cosponsored with General Motors and Electronic Data Systems;

Solar BikeRayce USA—a solar-assisted race for high-school students whose pedal-powered bikes get added power from solar panels, an electric motor and batteries;.

Junior Solar Sprint—solar-powered model cars designed, built and raced by middle-school students;

FutureCar Challenge—mid-sized cars modified by engineering university teams into "super" fuel-efficient vehicles (some getting nearly 60 miles per gallon on the highway and 50 miles in city driving, and most with more than one power source);

International Environmental Design Contest—college- and university-team solutions to waste cleanup problems frequently involving radioactive and hazardous materials. Many of the proposals have been applied

at Federal and industrial sites.

Programs for the General Public

DOE's education strategies for audiences outside the academic world foster consumer support for, and adoption of, advanced technologies and practices. The Office of Energy Efficiency and Renewable Energy's (EERE) Energy Star Retailer Initiative, for example, instructs shoppers about the lifetime energy costs of major appliances. Sales personnel, trained in the use of data cards on each model offered, explain the appliances' energy efficiency ratings and the advantages of high-efficiency products. Shoppers receive brochures that help them compute appliances' operating costs into "second price tags." During Energy Star's test phase, informed shoppers reported that energy efficiency moved from 7th or 8th place into 2nd place among their purchasing criteria.

Another education program, EERE's Center of Excellence for Sustainable Development, coaches entire communities in the design of development measures that protect their environment and quality of life as well as their economies. Using a tool kit of manuals, data bases, case studies, and model codes and ordinances, the Center teaches communities of every size how to link with technical and financial assistance sources to accomplish their plans. Christine Ervin, Assistant Secretary for Energy Efficiency and Renewable Energy, has high expectations for the sustainable development process, advocating it as "a way for communities to bridge the gap between economic progress and environmental quality."

Mission-related training programs are sponsored repeatedly by EERE sectors. Last year, for example, its Buildings Office established a training program for builders in California and Nevada. This year, it followed up in California with a pilot training program in high-performance duct systems.

Since 1978 the Office of Industrial Technologies has trained teams of engineering students and faculty to conduct energy audits of small- and mid-sized manufacturing plants and to develop energy efficiency recommendations for the operators. In recent years the teams also have informed plant managers about waste reduction and productivity improvement options. Modifications to plant facilities and processes resulting from the recommendations are estimated to have saved industry cumulatively more than $50 million.

Over four million low-income households have reduced their energy use significantly following weatherization installations funded by

the Department's Weatherization Assistance Program. In a test of education effectiveness, residents who received explanations of the installations, guidance on operating or maintaining them and a list of energy-saving practices were found to have larger energy savings than people who did not receive additional instruction. To improve opportunities for energy education by the weatherization providers, DOE prepared a bibliography of training materials for its nationwide network of 700 local agencies and serves as a clearinghouse for information on successful projects.

An element of paramount importance in our strategic education plans has been the contribution of the network of stakeholders who have championed the Department's energy and environmental themes. Since 1977 when energy-concerned groups in every State delivered the Department's energy efficiency and renewable messages in the first Sun Day celebration, our publications have been reprinted or distributed by businesses, civic groups and government agencies at every level, including the Congress. We cannot overstate the value of their service, for example, the Boy Scouts' delivery to neighborhood households of four million copies of Tips for Energy Savers in a joint project with the Alliance to Save Energy.

Conclusion

We believe the success of our education strategies and activities is evident in the nation's commitment to the research and development of advanced technologies, the increasingly efficient use of energy by every sector of the economy, and U.S. leadership in the production and export of renewable energy resources. As we approach the year 2000, industrializing nations are looking to this country for the technologies that will make optimal use of their energy resources, offer the reality of inexhaustible supplies and ensure a healthy global environment. Thus, it is critical that we continue our successes and take a proactive role in educating our citizenry about the efficient use of energy.

Acknowledgment

Our thanks are extended to Dr. James J. Winebrake, Integrated Science and Technology Program, James Madison University, for organizing this important three-part series of articles.

Part III of this series will appear in the Spring 1997 issue of this journal. It will present industry's perspectives on the ways to educate the energy and environmental professionals and technicians who will be needed to meet the challenges of the 21st century.

ABOUT THE AUTHORS

Mr. Brian Castelli is Chief of Staff to the Assistant Secretary for Energy Efficiency and Renewable Energy (EE) at the U.S. Department of Energy (USDOE). He provides management oversight of EE's nearly $1 billion of programs and initiatives. His responsibilities include: policy and program development, program execution activities, policy guidance to the Deputy Assistant Secretaries and senior staff members, integrating cross-cutting activities among the five EE sectors, planning, organizing and assigning projects to appropriate field, program, and staff offices, directs staff in preparation of quick responses to inquiries from the Secretary and other senior Department officials, and coordinates EE international, Congressional and public relation activities.

Mr. Castelli previously served as the Executive Director of the Pennsylvania Energy Office (PEO). His responsibilities included: directing the energy policies and programs for the Commonwealth, managing the state energy office and the Pennsylvania Energy Development Authority (PEDA), representing the Governor at the National Governor's Association (NGA) and the Coalition of Northeastern Governors (CONEG), serving as a board member on the National Association of State Energy Officials (NASEO), the State Energy advisory Board (STEAB) to the USDOE, the United States Association for Renewable Energy and Energy Efficiency Development (USAFREED), and the Ben Franklin Partnership. Mr. Castelli began working at the PEO as the Deputy Director for Administration and Public Affairs. His main responsibilities included administration and budgeting, liaison with the state and federal legislative delegations, public information, and policy issues concerning various energy programs.

Estelle S. Wiser has specialized in energy issues and technologies with a career in publishing and technology transfer services. She has worked in both government and industry. Since the oil embargo days of 1973, she has served in the U.S. Department of Energy and its predecessor agencies as public affairs officer, publications manager and writer/editor. Mrs. Wiser conducts technology transfer activities for DOE's Office of Energy Efficiency and Renewable Energy.