

Could flame retardants deter electronics recycling?

There are many reasons to applaud the growing popularity of recycling outdated electronic goods, but new research (*Environ. Sci. Technol.* 2001, 35 (3), 448–454) shows that high levels of potentially toxic flame retardants are released into the air when old computers, TVs, microwaves, and the like are dismantled.

Andreas Sjödin and colleagues at Sweden's Stockholm University found airborne levels of flame-retardant additives were 2 to 3 orders of magnitude higher than those recorded in other work environments, including a printed circuit board assembly plant. The scientists made the measurements at Sweden's Stena-Technoworld AB recycling company. Previous testing at the company found flame retardants in the blood of plant workers (*Environ. Health Perspect.* 1999, 107 (8), 643–648).

Although few regulations cover flame-retardant chemicals, concern has been growing because some of the compounds tend to bioaccumulate (*Environ. Sci. Technol.* 2000, 34 (21), 452A–453A). Sweden has proposed banning one popular group of flame retardants, polybrominated diphenyl ethers (PBDEs). Levels of this retardant in humans are approaching those of PCBs, says Mike DeVito, a toxicologist with the U.S. EPA's National Health and Environmental Effects Research Laboratory. "Our concern with this stuff is that it affects thyroid hormones in a similar dose-response relationship to the PCBs," he explains. Laboratory studies have shown that PBDEs can impair mice's ability to learn, and there is evidence that PBDEs are transformed in the body to metabolites

that may be active as endocrine disrupters, adds Åke Bergman, chair of Stockholm University's environmental chemistry department and a coauthor of the paper.

This new research is important because it helps illuminate the routes by which people are exposed to PBDEs, DeVito says. In addition to the U.S. EPA, the U.S. Centers for Disease Control and Prevention and the European Union are conducting or funding risk assessments of flame

for this article showed that not all facility managers are aware of the problem.

PBDEs are the flame retardants that have received the most attention, but more than 75 different brominated flame retardants are used in plastics, rubbers, and textiles, according to the Bromine Science and Environmental Forum, an industry group. Only three of those brominated flame retardants are PBDEs.

Scientists have "very little information" about most flame retardants, Bergman says. In fact, standards are not even available for some chemicals, so there is no way to test for their presence, he says. In the most recent study, the Stockholm University scientists tested for the presence of PBDEs and four non-PBDE brominated flame retardants, including tetrabromobisphenol A, which is the flame retardant sold in the highest volume, according to the Bromine Science and Environmental Forum. The Swedish scientists also recorded the levels of nine organophosphate esters, a group of flame retardants that has been associated with skin rashes (*Environ. Sci. Technol.* 2000, 34 (18), 3885–3889). They found, for the first time, 1,2-bis(2,4,6-tribromophenoxy)ethane and several arylated phosphate esters in indoor air. Not all of these flame retardants are likely to be persistent, toxic, or bioaccumulative, Bergman acknowledges, but he contends that they all should be carefully evaluated for these tendencies.

The chairman of the Bromine Science and Environmental Forum, Michael Spiegelstein, argues that the levels of flame retardants to which electronics recycling workers are exposed can easily be handled by conventional industrial hygiene practices. However, Sverker Sjölin,



The air in Sweden's Stena Technoworld electronics recycling facilities contained high levels of flame retardants, including some chemicals that were never before recorded in a workplace setting.

retardants, studying their toxicology, and building a database about where the chemicals have been found.

The issue is also noteworthy because the "electronics recycling industry is definitely on a fast growth curve," according to Peter Muscanelli, president of the International Association of Electronics Recyclers, Inc. Although Bergman is convinced that flame retardants can be found in all electronics recycling facilities, research conducted

the environment and process manager for Stena-Technoworld, says his company found that implementing procedures to reduce workers' exposure to airborne flame retardants can be "quite expensive", explaining that his company had to rebuild its

ventilation system and now regularly conducts extensive cleaning operations. He suspects that the cost might prohibit some companies from making such changes in the absence of legislation. —KELLYN S. BETTS

Everglades mercury debate

Sulfur-based fertilizers used by Florida sugarcane farmers may be increasing methylmercury production in the Everglades, according to preliminary results from the U.S. Geological Survey's ongoing Aquatic Cycling of Mercury in the Everglades (ACME) project.

In the Everglades' marshes, methylmercury concentrations in fish, alligators, wading birds, and fish-eating mammals are among the world's highest. Fish consumption advisories for mercury cover nearly the whole Everglades ecosystem, which stretches south from Lake Okeechobee to the Florida Keys and includes the Everglades National Park.

Over this 1-million-acre area, mercury deposition rates are fairly constant, but methylmercury levels vary significantly. Levels in the north and south are relatively low, but some of the highest methylmercury levels have been found in the center.

The ACME scientists discovered a sulfur gradient in 1998, which they believe explains the methylmercury distribution in the Ever-

glades. Freshwater marshes such as the Everglades usually have low sulfate levels of ~1 mg/L. Sulfate levels in the northern Everglades are about 100 mg/L, according to USGS scientist William Orem. Orem has used stable sulfur isotopic ratios to rule out groundwater as the source of sulfur and to trace the source back to the use of sulfur-based fertilizers in agricultural areas.

The ACME researchers hypothesize that sulfur, which is released from fertilizers as sulfate, dramatically affects the Everglades mercury cycle by stimulating and controlling the location of maximum methylmercury production and bioaccumulation. But the relationship is complex, and the details are still being researched.

Sulfur's role in the mercury problem is coming to light as federal and Florida state agencies embark on the \$8 billion Everglades' restoration project, a vast replumbing scheme to reverse decades of environmental degradation and ensure adequate water supplies for cities and farms. The 30-year plan



Mesocosm studies in the Everglades may help resource managers determine the most effective strategy for limiting mercury methylation.

Government Watch

Goodbye mixing zones

The U.S. EPA is one step closer to developing a national regulation that prohibits discharging toxic chemicals into U.S. waters at levels exceeding federal water quality criteria, following a final rule on the use of "mixing zones" in the Great Lakes that went into effect in December (*Fed. Regist.* 2000, **65**, 67,638–67,651).

Mixing zones are regions beyond the end of a discharge pipe, where pollutants in waste mix with receiving waters. Conceptually, pollutants in wastewater effluent can exceed water quality criteria at the pipe exit because they will be sufficiently diluted when they leave the mixing zone and reach surrounding waters.

The new EPA action will phase out the use of mixing zones for bioaccumulative chemicals of concern in the Great Lakes over the next 10 years for ~600 industrial and municipal facilities that already have disposal permits. All new discharges into the Great Lakes will be immediately prohibited from the practice of using mixing zones to circumvent water quality criteria, except in cases where no cost-effective pollution prevention or treatment technologies exist to meet the water quality criteria at the discharge exit.

An estimated 700,000 lbs of bioaccumulative chemicals, including mercury, dioxin, PCBs, and pesticides, are released annually into the Great Lakes, according to EPA. "The solution to pollution is not dilution. The time has come to phase out the practice of 'mixing zones' in the Great Lakes," says EPA Administrator Carol Browner.

The rest of the country can expect to see mixing zone regulations

Continued on Page 61A

includes constructing a series of interlocking projects to restore the Everglades' natural wet-dry cycles and reestablish the natural flow. The ACME scientists believe that these changes are likely to affect the mercury problem and may even make it worse.

In particular, the restoration project's plan to increase wet-dry cycles could increase methylmercury production, according to USGS scientist David Krabbenhoft, one of the project's principal investigators. Following the drought and fires of 1999, methylmercury production skyrocketed when the waters returned, he says. "The levels were an order of magnitude higher than our previous highest levels." They eventually returned to normal. Krabbenhoft thinks that increased sulfate supplied by reoxidation of reduced sulfur within the sediments is the explanation.

Microbiologists have known for some time that sulfate-reducing bacteria are important mercury methylators in many aquatic sediments, according to Cynthia Gilmour, a microbiologist with the

Academy of Natural Sciences, who is one ACME's principal investigators. Net methylmercury production seems to be optimized when the sulfate levels are just right. Too little sulfate and the bacteria do not go into action; too much sulfate and the bacteria produce excess sulfide, which inhibits mercury methylation, says Gilmour.



Stable isotopes of mercury will be used to follow mercury species in sediments, water, and biota, such as mosquito fish.

The sulfide role appears to involve novel chemistry. Rather than the bacteria taking up free ions, Gilmour thinks they prefer neutral compounds. "Sulfide influences the speciation of mercury and therefore

its bioavailability to methylating bacteria," she says. When bacteria generate high levels of sulfide, charged mercury sulfide complexes form.

These charged complexes do not diffuse rapidly across cell membranes.

This model fits with broad field observations, according to USGS's Orem. The "Goldilocks" area, where the sulfate levels are just right, is

Water Conservation Area 3, he says. There, methylmercury levels in sediments, gambusia (also known as "mosquito fish"), and chick feathers are the highest in the Everglades. Despite the good fit, the model still requires confirmation, according to Gilmour.

Last summer, Orem, Gilmour, and Krabbenhoft started a series of field experiments in the Everglades to do just that. They are adding stable isotopes of mercury and sulfur into small areas corralled in plastic rings (see photo).

By measuring methylation rates and determining into what substrate the isotopes are incorporated, they will be able to trace the system's response to each chemical.

—REBECCA RENNER

States combat ski resort pollution

States are using a controversial Clean Water Act provision to force ski areas to clean up streams impaired by polluted runoff and depleted by snowmaking. The action comes amid a flurry of new reports from the U.S. EPA and a citizens' group, calling attention to the environmental impacts of ski resorts, which in some locales has doubled in acreage since 1985.

Despite only a 2% increase in the number of skiers over the past 20 years, ski resorts have expanded dramatically to encompass condominiums, golf courses, and second homes in sensitive mountain ecosystems, says a December report from the Ski Area Citizens' Coalition in Durango, CO. Drawing

too much water from streams for snowmaking has slashed fish-spawning habitat by as much as 30%. In addition, runoff that is laden with sediment, nutrients, and pesticides from parking lots, roads, urban development, and the cutting of trees for ski runs has gone largely unaddressed by the federal government, charges Jeff Berman, executive director of Colorado Wild and a coauthor of the report.

But in a closely watched action, the state of Vermont has required Stratton Mountain ski resort to implement a total maximum daily load (TMDL) determination in exchange for permission to expand its operations. This is the first time that a TMDL, a cap on the amount

of pollution that a water body can tolerate (*Environ Sci. Technol.* 1998, 32 (15), 364A–365A), has been set for a ski resort.

The streams in Stratton's watershed are federally listed as impaired by sedimentation, nutrients, and increased temperature from loss of streamside vegetation, says Jeffrey Cueto, principal hydrologist with the Vermont Agency of Natural Resources. Under Vermont's 30-year-old land-use law, the state's TMDL agreement requires Stratton to monitor its streams, control erosion, and intercept and treat runoff. When pollution drops below state water quality standards, the resort will be allowed to begin new construction, Cueto says.

A TMDL for phosphorus in Colorado's Dillon Reservoir, which supplies drinking water to Denver, is indirectly setting a limit on runoff from nearby ski resorts, explains Lane Wyatt, an environmental engineer with the Northwest Colorado Council of Governments. Local governments in the watershed have incorporated water quality criteria into zoning laws that limit phosphorus loading to the reservoir. When ski areas apply for rezoning for new construction, they must pledge not to increase phosphorus loading, most of which comes from runoff, Wyatt says.

In contrast to these regulatory approaches, EPA's January report on the environmental impacts of the travel and tourism industry supports voluntary, market-based solutions. The report, which can be accessed at www.epa.gov/ispd/travtour.htm, includes a few environmental indicators for the ski industry. The report encourages dialogue and local partnerships to promote sustainability, says Bob Sachs, manager of sustainable tourism and recreation policy with EPA.

Environmentalists would like more direct action to stem the looming threats posed by golf course and condominium development, Berman says. But the



The state of Vermont requires Stratton Mountain ski resort to use best management practices to stop sediment erosion such as this from ski slopes.

National Ski Area Association (NSAA), an industry group that introduced an environmental charter in June urging members to meet or exceed water quality requirements, argues that this voluntary measure is more effective than command-and-control regulations because it is more innovative and encourages members to go beyond compliance in their environmental performance, according to Geraldine Hughes, NSAA's director of public policy.—JANET PELLEY

Exhaustive test for diesel vehicles

Australia's environmental protection agency is pilot-testing a new method for evaluating diesel vehicle emissions. The technique, which uses laser light-scattering photometry to give on-the-spot pollutant readings, has attracted international attention, thanks to its speed and low cost.

Although smog tests that use chassis dynamometers to simulate real-world driving conditions are routinely used to evaluate emissions from in-use, gasoline-powered vehicles, this is the first major

demonstration project that allows these popular tests to target diesel cars and trucks. The new method, which can determine exhaust NO_x and particulates in only 10 minutes in a drive-up testing station, "represents the holy grail that diesel emissions people have been looking for," claims Steve Brown, the New South Wales state manager for Parsons Australia, the engineering firm that developed the test.

"A lot of people have been talking about measuring particulate

Government Watch

later this year, say EPA officials. In preparation, several states outside the Great Lakes system have already expressed interest in voluntarily prohibiting mixing zones.

More stringent dioxin limits likely in EU

Although Europeans' dietary exposure to dioxins has dropped by about 50% over the past decade, a "considerable proportion" of the population still regularly exceeds tolerable exposure limits, according to reports by two scientific committees of the European Commission.

Food of animal origin is the predominant source of this dioxin exposure, with wild fish and farmed freshwater fish being the most heavily contaminated, followed by eggs, milk and milk products, poultry, beef, veal, and pork. Foods of vegetable origin are the least contaminated.

The reports on dietary dioxin exposure, the health significance of this exposure, and dioxin contamination of feedstocks follow the 1999 crisis in Belgium, where contaminated animal feed was blamed for causing dangerously high levels of dioxins in chickens and eggs. At the time, "there were absolutely no scientific opinions on that subject", says one of the committee members.

On the basis of these findings, the Scientific Committee on Food established a temporary tolerable daily intake of 1 picogram (pg) per kilogram (kg) body weight. The current average daily human dietary intake of dioxins in Europe is estimated to be 1.2–3 pg/kg body weight.

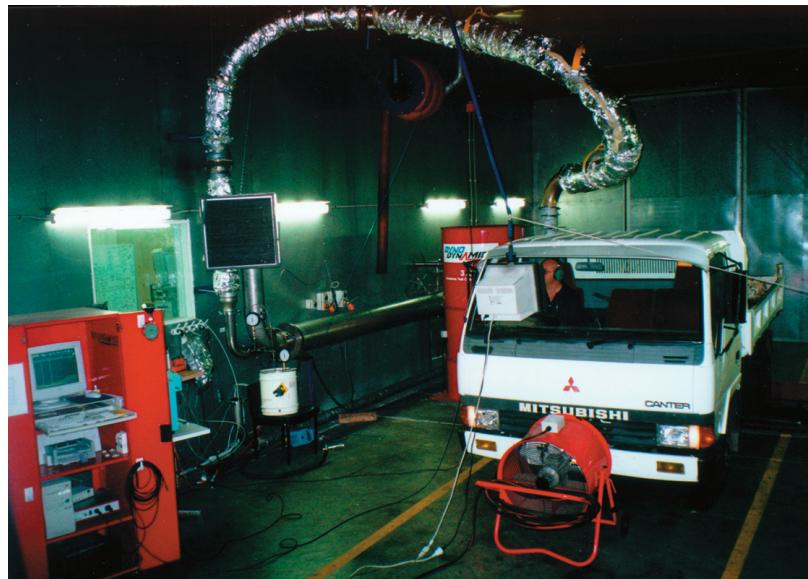
As a result, new measures setting maximum limits for dioxins in food and feedstocks in the European Union are likely, say several committee members. Indeed, one of the Food Committee's recommendations suggests that the most efficient way to reduce dioxins in

Continued on Page 63A

emissions from in-use [diesel] vehicles, but no one has actually been able to do it [until now]," agrees Don Chernich, manager of the Heavy Duty Diesel section for the California Air Resources Board (CARB), which is currently studying this type of test to meet the state's regulatory obligation to limit diesel emissions. "It's very likely that we'll go to some type of real-time testing Being able to verify that vehicles are properly maintained and not tampered with is something that we're very concerned with," adds Mark Burnitzki, an air pollution specialist with CARB.

The Australian test combines three existing technologies: laser light-scattering photometry, which measures the amount of dust in ambient air; a system for measuring the exhaust mass flow of the vehicle being tested; and a chassis dynamometer programmed to simulate driving conditions in Australia. Brown estimates that this equipment will cost about \$200,000 (U.S.), which he says is an order of magnitude lower than other equipment capable of performing the same measurements.

The Australian government expects to use the new test to support the National Environmental Protection Measure that the country is developing to combat NO_x and particulate emissions from diesel engines, according to Vicki



Parsons Australia

This new Australian test's ability to instantaneously evaluate emissions from diesel vehicles has earned it international attention.

Ratliff, assistant director of the Air Quality Section for Environment Australia. The regulations should be finalized by next June, according to government sources.

The new test is superior to the "10-s visible smoke" test, which is currently used in Australia to evaluate emissions. Comparisons with benchmark tests show that in a group of 500 vehicles, the visible smoke test identified up to 30% of high-polluting vehicles, whereas the new test pinpointed 70–80% of the high polluters, says Ratliff.

According to Chernich, the light-

scattering photometry results must still be correlated with the benchmark test of collecting particulates from a car or truck's exhaust on a gravimetric filter and measuring the mass. "With any type of optical measurement, you have the problem of the particles reacting differently depending upon how big and what shape they are and how much water there is. But any existing particulate-matter measuring technology is problematic in one way or another, including the existing reference method," Burnitzki adds.

—KELLYN S. BETTS

Solar PV markets surge in the United States and Canada

Data indicate that the use of solar photovoltaics (PV) in the United States and Canada is on the rise.

Annual shipments of PV modules and cells reported by U.S. manufacturers in 1999 reached a record level of 77,000 peak kilowatts (kWp), which refer to the maximum electric power output of the cells and modules, up 52% from 1998, according to a recent U.S. Energy Information Administration report, *Annual Photovoltaic Module/Cell Manufacturers Survey*. In Canada, the use of PV applications has grown at an average annual rate of 29% over the past seven years,

with total revenues estimated in 1999 at ~\$US27 million (\$C40 million), according to *Canadian PV Power Market 1999*, a Natural Resources Canada (NRC) report published in June 2000.

The growth in U.S. sales is largely due to a strong export market, which accounted for 72% of the shipments in 1999. Germany and Japan, countries with increased residential demand for PVs due to subsidies for PV systems for housing and favorable tax credits for the use of PV applications and loan repayment time frames, each received over 25% of U.S. export shipments.

Most of the 1999 growth in Canada is due to increased cottage and recreational PV market applications. "This market is mainly off-grid applications where PV has been proven to be a reliable and cost-effective solution," says one of the report's authors, Lisa Dignard-Bailey of NRC's Energy Diversification Research Laboratory in Varennes, Québec.

Industrial applications in Canada are off-grid and remote; and according to Dignard-Bailey, they include "telecommunications repeater sites on companies." Off-grid commercial and industrial applications in Canada rose from 2825 kWp in 1998 to 3375 kWp in 1999.—PATRICIA E. DEMPSEY

Danes get the lead out

Denmark, which became the first nation in the world to ban lead last November, is gearing up to implement the ban next month.

Forbidding the use of lead in a few products is "not sufficient," says Svend Auken, Denmark's minister for environment and energy. "We need to tackle the problem more vigorously," he said when announcing the ban. The Danes moved to limit lead in their environment because the metal "is harmful to children's learning ability, behavior, and intelligence," says Henri Heron, spokesperson for the Danish EPA.

Denmark consumes approximately 18,000 metric tons of lead annually. By focusing on the largest sources of emissions of lead in both its metallic form and in chemical

compounds, the country expects to cut consumption by 5000 metric tons, Heron says. By the time the ban is "almost completely implemented" in 2003, he estimates that it will reduce the spread of lead into the environment by 50%.

"The Danish EPA is convinced that the lead products that are being banned . . . can be replaced by lead-free products," Heron says. The agency has identified lead alternatives for the products in the construction, fishing, cables, and plastics industries. For example, Heron notes that plastic materials can be used in place of lead in building roofings, flashings, and rainwater products; and zinc can replace the metal in fishing equipment. Both aluminum and plastic can be used to create the mantles that cover underground electric cables, and both zinc and calcium can serve as stabilizers in PVC plastic, he says.

Although lead-acid batteries account for half of the country's annual use of lead, they do not generate significant lead emissions and are therefore not targeted by the regulation, Heron explains.

"The Danish wish to regulate lead has been an important signal internationally," says Auken, noting that the country already regulates the use of cadmium, mercury, and nickel. "We expect/hope that other European countries and possibly the whole EU will within some years regulate lead in products," Heron says.

In the United States, the EPA has recently tightened its lead regulations, but there has been no move to ban lead-containing products.

—KELLYN S. BETTS



Digital imagery copyright 2001 Photodisc, Inc.

In Europe, lead is commonly used in roofing materials like the ones atop London's St. Paul's Cathedral. Because this lead can leach out into the environment, the Danish government is banning the use of the heavy metal in building roofing, flashings, and rainwater products.

Government Watch

the food chain is to limit their releases to the lowest levels technically achievable. But, "measures to be taken will be expensive and have to be carefully studied because we're talking about measuring dioxins at very low levels," a committee member cautions.

Abandoned underground petroleum tanks

Grant money is now available from the U.S. EPA to clean up abandoned underground petroleum tanks under a new initiative called USTfields. Ten community pilot projects were awarded \$100,000 each in November, with special consideration given to those cities with MTBE contamination. Forty more USTfields projects are expected to be funded during 2001.

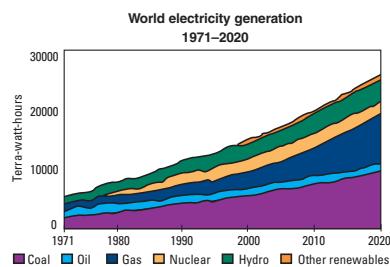
The new program is similar to EPA's Brownfields program, which funds community projects that clean up and redevelop abandoned or underused properties or facilities, said EPA's Deputy Administrator Michael McCabe. The USTfields program, however, targets contamination excluded by the Brownfields program, in particular, contamination due to underground petroleum storage tanks.

Petroleum contamination is exempt from coverage under the Comprehensive Environmental Response, Compensation, and Liability Act, and therefore cleanup of underground petroleum storage tanks is not covered within the Brownfields program. Yet, an estimated 100,000–200,000 of the 450,000 brownfields sites contain abandoned underground storage tanks. The USTfields initiative addresses petroleum contamination from these tanks. According to EPA officials, selected USTfields sites "are intended to be a supplement to an existing cleanup or redevelopment project such as a Brownfields assessment". More information about the USTfields initiative can be found at www.epa.gov/oust/ustfield.

Ships in European waters emit as much pollution as 390 50-MW power plants running continuously, according to a report contracted by the European Commission. The net effect corresponds to 1.9 million tons of SO₂ and 2.3 million tons of NO_x generated annually. Moreover, the report projects that uncurbed SO₂ and NO_x emissions from ships will comprise as much as 30–40% of total emissions in the European Union by 2010, making policies to restrict these emissions likely. *Study on the Economic, Legal, Environmental, and Practical Implications of a European Union System To Reduce Ship Emissions of SO₂ and NO_x* can be downloaded at europa.eu.int/comm/environment/enveco/studies2.htm#27.

Federal, state, and local governments need to work together to sufficiently manage ocean resources, says a National Research Council report. The report calls for establishing a national system of protected marine areas in which human activity is limited. Marine reserves currently compose less than 1% of U.S. waters, whereas terrestrial conservation reserves cover about 10% of public land. *Marine Protected Areas: Tools for Sustaining Ocean Ecosystems* can be ordered from the National Academy Press by calling (202) 334-3313 or (800) 624-6242.

Many large dam projects have caused significant and irreversible loss of species and ecosystems, finds a report by the World Commission on Dams (WCD). WCD was initiated by the World Bank and the World Conservation Union to review the performance and impacts of some 45,000 large dams worldwide. The report concludes that the benefits gleaned from large dams worldwide have been considerable, but oftentimes, the projects have exacted too high a price, particularly in social and environmental terms. *Dams and Development: A New Framework for Decisionmaking* can be downloaded at www.dams.org.



Both renewable energy use and CO₂ emissions will grow steadily, according to the International Energy Agency's *Annual Energy Outlook 2001*. The report's projections for U.S. CO₂ emissions have been revised upward since last year: They are now expected to reach 2041 million metric tons of carbon equivalents in 2020, which is 51% higher than 1990 levels. Taken as a whole, CO₂ emissions from Organization for Economic Cooperation and Development countries will be "significantly higher" than the Kyoto targets. Although IEA expects that renewable energy will grow to 3% from its present 2% over the next 20 years, it will not make a significant impact on CO₂ emissions. To see the report, go to www.iea.org/weo/index.htm.

Smart U.S. public policies could significantly reduce CO₂ emissions, air pollution, and petroleum dependence, according to the U.S. Department of Energy (DOE). Written by researchers from five DOE national laboratories, *Scenarios for a Clean Energy Future* calculates that the overall benefits of implementing public policies and programs that foster the development of clean and efficient energy technologies would be comparable to their cost. A carbon trading system is one of the centerpieces of the policies envisioned in the report, together with a doubling of the federal research and development budget. For a copy of the report, go to www.ornl.gov/ORNL/Energy_Eff/CEF.htm.

Central and eastern European countries seeking to join the European Union (EU) made some progress last year in bringing their

environmental laws in alignment with EU standards, but much remains to be done, according to the latest reports from the European Commission. Estonia and Slovenia saw substantial progress; Bulgaria, the Czech Republic, Latvia, and Lithuania made some progress; whereas Hungary, Poland, Romania, and Slovakia made very limited progress, according to the report. But implementation of adopted legislation and sufficient funding remain problems for all the accession countries. The reports can be accessed at europa.eu.int/comm/enlargement/index.htm.

Europe's freshwater resources continue to be plagued by eutrophication, acidification, and groundwater contamination by pesticides, hydrocarbons, and heavy metals, concludes a report by the European Environment Agency (EEA). The report provides an overview of the current state of Europe's water resources. Presently, only 21% of available water is being used, but that water is far from evenly distributed throughout the European Union and does not take into account the amount of water needed to sustain aquatic life, the EEA finds. However, future EU water demand is projected to increase only slightly. *Sustainable Use of Europe's Water: State, Prospects, and Issues* can be accessed at www.eea.eu.int under "themes".

There are "fundamental gaps" in integrating the issues raised by corporate environmental reports into wider business activities, according to Sustainability, a London-based consulting firm. The firm's fourth *Global Reporters* survey, carried out with backing from the United Nations Environment Programme, assesses the environmental reports of 50 international corporations. The quality of many leading companies' reporting is continuing to improve, the survey found, but "a huge—and growing—challenge remains." For information about how to order the report, go to www.sustainability.co.uk.