NEW SOLUTIONS, Vol. 16(4) 365-372, 2006

Scientific Solutions

GREEN CHEMISTRY IN CALIFORNIA: A FRAMEWORK FOR LEADERSHIP IN CHEMICALS POLICY AND INNOVATION

MICHAEL P. WILSON

DANIEL A. CHIA

BRYAN C. EHLERS

University of California, Berkeley

Special Report to the California Senate Environmental Quality Committee and Assembly Committee on Environmental Safety and Toxic Materials, March 2006, From the California Policy Research Center and the Center for Occupational and Environmental Health, University of California.

ABSTRACT

This article summarizes a University of California chemicals policy report commissioned by the California Legislature. The report makes the case that long-standing weaknesses in the Toxic Substances Control Act have produced a flawed chemicals market in the U.S. that "undervalues" the hazardous properties of chemicals relative to their function, price, and performance. These market conditions have dampened industry interest in cleaner chemical technologies, such as green chemistry. A new U.S. chemicals policy will need to improve the flow of chemical information; enhance the capacity of government to control chemical hazards; and increase public investments in green chemistry research and education.

By 2050, California's population is expected to grow by about 50%, from 36 to 55 million residents. This expansion will be accompanied by a growing set of social, economic, and environmental problems whose *magnitude* will be determined in large part by the policy decisions California makes now and in coming years. In charting a course to a sustainable future, policymakers will need to guide industrial development in such a way that it fully integrates matters of environmental quality and human health. In practice, if California is to create a future characterized by improving social, environmental, and economic conditions, industrial development will need to solve, not exacerbate, the public and environmental health problems facing the state today. To move California in this direction, policymakers need the support of research that links the science of public and environmental health to innovative policy solutions. The report summarized here serves that purpose in the area of chemicals policy.

This report makes the case that a modern, comprehensive chemicals policy is essential to placing California on the path to a sustainable future. Problems associated with chemicals are already affecting public and environmental health, business, industry, and government in California. On the current trajectory, the coming years will see these problems broaden and deepen. Correcting these problems will require much more than isolated chemical bans and other piecemeal approaches that currently characterize the Legislature's efforts in this arena. Rather, a comprehensive approach is needed that corrects long-standing federal chemicals policy weaknesses and builds the foundation for new productive capacity in *green chemistry*—the design, manufacture, and use of chemicals that are safer for biological and ecological systems. This approach to chemicals policy will link economic development in California with improved health and environmental quality, but it will require a long-term commitment to leadership on the part of California policymakers.

We describe initiatives by leading California businesses and the European Union (E.U.) that are already driving interest by industry in cleaner technologies, including green chemistry. Given California's unparalleled capacity for innovation and its scientific, technical, and financial resources, a proactive response to these developments in the form of a modern, comprehensive chemicals policy could position California to become a global leader in green chemistry innovation. The report illustrates that to do so, California will need to adopt a chemicals policy that greatly improves chemical information, regulatory oversight, and support for green chemistry research, development, technical assistance, and education.

METHODS

We used four research methods in preparing this report: a literature review, interviews with key informants, participation in chemicals policy meetings, and peer review. Over a two-year period, the primary author held discussions with

chemicals policy experts affiliated with academic institutions, scientific bodies, governmental agencies, chemical producers, downstream users of chemicals, entities within the European Union, small- and medium-sized enterprises, environmental organizations, and labor organizations. In addition, between April 2003 and February 2006, the primary author participated in 35 meetings and conferences pertaining expressly or in part to chemicals policy matters; he presented the report's key concepts at 17 of these meetings. The report reflects feedback produced throughout this process.

MAJOR FINDINGS

The scale of chemical production is immense and will continue to expand globally.

Every day, the U.S. produces or imports 42 billion pounds of chemicals, 90% of which are created using oil, a non-renewable feedstock. Converted to gallons of water, this volume is the equivalent of 623,000 gasoline tanker trucks (each carrying 8,000 gallons), which would reach from San Francisco to Washington, D.C. and back if placed end-to-end. In the course of a year, this line would circle the earth 86 times at the equator. These chemicals are put to use in numerous processes and products, and at some point in their life cycle many of them come in contact with people—in the workplace, in homes, and through air, water, food, and waste streams. Eventually, in one form or another, nearly all of them enter the earth's finite ecosystems.

Global chemical production is expected to double every 25 years for the foreseeable future. Between now and 2033, the U.S. EPA expects 600 new hazardous waste sites to appear each month in the U.S. and require cleanup, adding to 77,000 current sites. Efforts at site mitigation are expected to cost about $250 billion. Given the scale, pace, and burden of chemical production, the toxicity and ecotoxicity of chemicals are of great public importance.

Many chemicals that are useful to society are also hazardous to human biology and ecological processes.

There is growing scientific concern over the biological implications of chemical exposures that occur over the human lifespan, particularly during the biologically sensitive period of fetal and child development. Hundreds of chemicals that are released into the environment are accumulating in human tissues; the U.S. EPA found just under 700 such chemicals in a nationwide survey of Americans in 1987. Many of these chemicals enter the developing organ systems of fetuses and infants through the maternal bloodstream and through breast milk. Animal studies indicate that some can interact with and disrupt the development of these systems, such as the endocrine system, at very low doses. Among children,

chemical exposures are estimated to contribute to 100% of lead poisoning cases, 10% to 35% of asthma cases, 2% to 10% of certain cancers, and 5% to 20% of neurobehavioral disorders.

Occupational disease continues to exact a tremendous toll in California. Each month, an estimated 1,900 Californians are diagnosed with a preventable, deadly chronic disease that is attributable to chemical exposures in the workplace; another 540 Californians die as a result of a chronic disease linked to chemical exposures in the workplace. The U.S. Occupational Safety and Health Administration (OSHA) has adopted workplace exposure limits for only 193, or about 7%, of the 2,943 chemicals produced or imported in the U.S. at more than one million pounds per year. Immigrants, minorities, and lower-income groups—as workers and as residents—are at particular risk of exposure to hazardous chemicals.

There are extensive deficiencies in the federal regulation of chemicals.

Of all federal environmental statutes, the Toxic Substances Control Act of 1976 (TSCA) is the only law that is intended to enable regulation of chemicals both before and after they enter commerce. However, studies conducted by the National Academy of Sciences (1984), the U.S. General Accounting Office (1994), the Congressional Office of Technology Assessment (1995), Environmental Defense (1997), the U.S. EPA (1998), former EPA officials (2002), and the U.S. Government Accountability Office (2005) have all concluded that TSCA has not served as an effective vehicle for the public, industry, or government to *assess* the hazards of chemicals in commerce or *control* those of greatest concern.

- The TSCA inventory lists 81,600 chemicals, 8,282 of which are produced or imported at 10,000 pounds or more per year.
- TSCA does not require chemical producers to generate and disclose information on the health and environmental safety of these chemicals – or on the approximately 2,000 new chemicals that enter the market each year. The result is that there is an enormous lack of information on the toxicity and ecotoxicity of chemicals in commercial circulation.
- TSCA places legal and procedural burdens on the EPA that have constrained the agency's capacity to act. Since 1979, the EPA has used its formal rule-making authority to restrict only five chemicals or chemical classes, though the agency reported in 1994 that about 16,000 chemicals in the U.S. were of some concern on account of their structure and volume in commerce.
- TSCA has not provided a vehicle for channeling federal support to research in cleaner chemical technologies, including green chemistry.

Voluntary initiatives on the part of the chemical industry to correct some of these weaknesses are positive but do not make up for TSCA's structural weaknesses. Other federal laws that pertain to chemicals are essentially

end-of-pipe statutes that do not allow for review of chemicals prior to their introduction into commerce. Together, five major federal statutes apply to only 1,134 chemicals and pollutants. The weaknesses of TSCA and other federal statutes have produced three fundamental problems in the U.S., which we refer to as the chemical Data Gap, Safety Gap, and Technology Gap.

TSCA's weaknesses are adversely affecting California.

The chemical Data Gap, Safety Gap, and Technology Gap have created a broad set of problems for public and environmental health, industry, business, and government for U.S. states, including California.

The Data Gap

Without comprehensive and standardized information on the toxicity and ecotoxicity for most chemicals, it is very difficult even for large firms to identify hazardous chemicals in their supply chains. Along with consumers, workers, and small-business owners, they do not have the right kinds of information to identify safer chemical products. The lack of chemical information weakens the deterrent function of the product liability and workers compensation systems.

The Safety Gap

Government agencies do not have the information they need to identify and prioritize chemical hazards systematically, nor the legal tools to mitigate known hazards efficiently.

The Technology Gap

The lack of both market and regulatory drivers has dampened motivation on the part of U.S. chemical producers and entrepreneurs to invest in new green chemistry technologies. There has been virtually no government investment in green chemistry research and development.

Meanwhile, evidence of public and environmental health problems related to chemicals continues to accumulate. Each year, the California Legislature faces numerous bills related to public concerns over chemicals; on the current trajectory, the number of such bills is likely to grow. Correcting the chemical Data, Safety, and Technology Gaps engendered by TSCA will require a modern, comprehensive approach to chemicals policy in California.

Developments in the European union and among leading California businesses are driving interest in cleaner technologies, including green chemistry.

Facing a similar set of problems, the E.U. is implementing sweeping new chemicals and materials policies that are driving global changes in ways that will favor cleaner technologies, including green chemistry.

- The E.U. *Restriction of Hazardous Substances in Electrical and Electronic Equipment* (RoHS) Directive will prohibit the use of lead, cadmium, mercury, certain flame-retardant chemicals, and other toxic materials in electronic and electrical equipment sold in the E.U.
- The *Waste Electrical and Electronic Equipment* (WEEE) Directive requires electronics producers to take back their products at the end of their useful life.
- The *Registration, Evaluation and Authorization of Chemicals* (REACH) initiative will require chemical producers to register most chemicals that are widely used and will place restrictions on the use of about 1,400 chemicals of very high concern.

It is becoming clear that cleaner technologies will play an increasingly important role in industrial activity globally—among both developed and developing nations. The E.U. government's policies to motivate investment in cleaner technologies, though difficult for some E.U. producers in the short term, are expected to lead to a long-term E.U. competitive advantage in this arena.

Lacking similar government leadership in the U.S., a number of large businesses have been working independently to implement strategies for identifying hazardous chemicals in their supply chains and removing those chemicals from their operations. California businesses at the forefront of this effort include Kaiser Permanente, Catholic Healthcare West, Intel, Hewlett-Packard, IBM, Bentley Prince Street, Apple, and others. These developments signal a growing demand among U.S. businesses for safer chemicals and better chemical information; these efforts, however, are constrained by the Data, Safety, and Technology Gaps. Effective leadership in chemicals policy to close these Gaps is now called for in the U.S.

California needs a modern, comprehensive chemicals policy to address pressing public and environmental health problems and to position itself as a global leader in green chemistry innovation.

These developments have opened an opportunity for California to position itself as a leader in green chemistry science and technology. To do so, California will need to correct the Data, Safety, and Technology Gaps, which have given rise to conditions in the U.S. chemicals market that favor existing chemicals and discourage investment by chemical producers in new green chemistry technologies. Large "sunk" investments by industry in existing chemical technologies will make it

difficult to transition to an industrial system based on cleaner technology, including green chemistry; this transition, however, will have to be made if California is to respond proactively to developments in the E.U. and address a host of chemical problems affecting public and environmental health, business, industry, and government in the state.

We propose three chemicals policy goals that will move California in this direction:

Close the Data Gap — Ensure that chemical producers generate, distribute, and communicate information on chemical toxicity, ecotoxicity, uses, and other key data.

Close the Safety Gap — Strengthen government tools for identifying, prioritizing, and mitigating chemical hazards.

Close the Technology Gap — Support research, development, technical assistance, entrepreneurial activity, and education in green chemistry science and technology.

Because many policy mechanisms could be employed to reach these goals, we recommend that as a first step the Legislature establish a chemicals policy task force to explore various mechanisms and develop a legislative proposal for a comprehensive policy based on the findings of this report. We recommend that the task force be charged with developing the proposal for the 2007 legislative session.

REPORT BACKGROUND, DEVELOPMENTS, AND WEB ACCESS

The California Senate Committee on Environmental Quality and the Assembly Committee on Environmental Safety and Toxic Materials commissioned the University of California (UC) Chemicals Policy report in January 2004. It was completed and released to these Committees in March 2006 by the California Policy Research Center of the UC Office of the President. A 13-member UC Advisory Committee provided technical oversight for the report. California Senator Joseph Simitian (D-Palo Alto) convened public hearings on the report in June and October 2006. Michael P. Wilson presented the report's key findings before the U.S. Senate Committee on Environment and Public Works on August 2, 2006. The full report and related links can be accessed at

http://coeh.berkeley .edu/news/06_wilson_policy.htm

The California Legislature established COEH in 1978 (AB 3414) to improve understanding of occupational and environmental health problems in California and work toward their resolution through research, teaching, and service (http://coeh.berkeley.edu/). The California Policy Research Center (CPRC), under the aegis of the UC Office of the President, applies the UC system's research expertise to analysis, development, and implementation of public policy in California

(http://www.ucop.edu/cprc/#). CPRC, COEH, and the UC Toxic Substances Research and Teaching Program provided funding for the report.

The members of the UC Advisory Committee are: John R. Balmes, MD, Professor, School of Medicine, UC San Francisco, and Professor, Environmental Health Sciences, UC Berkeley; Carl F. Cranor, PhD, Professor, Department of Philosophy, UC Riverside; S. Katharine Hammond, PhD, Professor, Environmental Health Sciences, School of Public Health, UC Berkeley; Bill E. Kastenberg, PhD, Professor, College of Engineering, UC Berkeley; Ann Keller, PhD, Assistant Professor, Health Policy and Management, School of Public Health, UC Berkeley; Amy D. Kyle, PhD, MPH, Research Scientist, Environmental Health Sciences, UC Berkeley; Geoff Lomax, DrPH, Research Director, Environmental Health Investigations Branch, California Department of Health Services; Timothy Malloy, JD, Professor, School of Law, UC Los Angeles; Thomas E. McKone, PhD, Senior Staff Scientist, Lawrence Berkeley National Laboratory, and Adjunct Professor, Environmental Health Sciences, School of Public Health, UC Berkeley; Dara O'Rourke, PhD, Professor, Environmental Science, Policy and Management, College of Natural Resources, UC Berkeley; Julia Quint, PhD, Chief, Hazard Evaluation System and Information Service (HESIS), California Department of Health Services; Christine Rosen, PhD, Professor, Haas School of Business, UC Berkeley; David J. Vogel, PhD, Professor, Haas School of Business, UC Berkeley, and Professor, Department of Political Science, UC Berkeley.

ACKNOWLEDGMENTS

The authors would like to acknowledge the members of the UC Advisory Committee and Holly Brown-Williams, Al Averbach, John Crapo, Andrés Jiménez, Robert Spear, John Balmes, Steve Shortell, and the individuals in California, the United States, and the European Union who freely offered their expertise in chemicals policy.

Direct reprint requests to:

Michael Wilson
Center for Occupational and
Environmental Health
University of California Berkeley
140 Earl Warren Hall #7360
Berkeley, CA 94720-7360
e-mail: mpwilson@berkeley.edu