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Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation

Michael P. Wilson, with Daniel A. Chia and Bryan C. Ehlers

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.

The 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

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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 innumerable 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 that are registered for commerce in the U.S., 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 the 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 in 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 European Union 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 proposed *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 U.S. 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, and Apple. 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.

This report was prepared in response to a January 2004 request from the California Senate Environmental Quality Committee and the California Assembly Committee on Environmental Safety and Toxic Materials.

Michael P. Wilson is an assistant research scientist with the Northern California Center for Occupational and Environmental Health, School of Public Health, UC Berkeley. He may reached at mpwilson@berkeley.edu or (510) 642-5703. Daniel A. Chia and Bryan C. Ehlers conducted research for the report as part of their graduate studies at the Goldman School of Public Policy at UC Berkeley. The complete report may be found at http://coeh.berkeley.edu/FINALgreenchemistryrpt.pdf and www.ucop.edu/cprc/greenchemistryrpt.pdf.

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California Policy Research Center
1950 Addison Street, Suite 202
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