Green Chemistry Symposium
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California Environmental Protection Agency
Department of Toxic Substances Control
Maureen Gorsen, Director

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

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Est. 1978 (AB 3414)

Berkeley, Davis, San Francisco (northern California).

- Toxicology
- Epidemiology
- Industrial hygiene
- Environmental health policy
- Occupational and environmental medicine
- Occupational health nursing
- Ergonomics
- Labor occupational health education
- Continuing professional education
The UC Report:
• Fiscal sponsor: California Policy Research Center, UCOP
• Assesses problems and opportunities in chemicals policy
• Proposes broad policy goals

Commissioned January 2004 by:
• Byron Sher (Chair, SEQC)
• John Laird (Chair, ACESTM)

Released to Legislature March 14, 2006 to:
• Joseph Simitian (Chair, SEQC)
• Ira Ruskin (Chair, ACESTM)

Download etc:
http://coeh.berkeley.edu/news/06_wilson_policy.htm
Methods

- Literature review
- Key informant interviews
- Survey data from 37 electronics companies
- 35 conferences
- Presentations at 17 conferences
- Advisory Committee review
Advisory Committee Members

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Christine Rosen, PhD
Haas School of Business, UC Berkeley

David J. Vogel, PhD
Haas School of Business, UC Berkeley
Report’s findings are similar to those of:

- National Academy of Sciences 1984
- U.S. General Accounting Office 1994
- Congressional Office of Technology Assessment 1995
- Environmental Defense 1997
- U.S. EPA 1998
- former EPA officials 2002
- RAND Science and Technology Institute 2003
- U.S. Government Accountability Office 2005
- National Academy of Sciences 2005
The challenge of chemicals policy: Hexane/acetone-induced neurological disease in the California vehicle repair industry.

Harrison et al. MMWR, Nov 16, 2001, Vol 50 #5
Accelerating Rotorod

Fig. 3. Accelerating rotorod score (mean seconds before the rat falls of ± S.D.) of male rats treated with 2,5-hexanediol (0.5%), acetone (0.5%) or 2,5-hexanediol (0.5%) + acetone (0.5%) in the drinking water for 6 weeks followed by a 10-week dose-free period. The arrow indicates the end of treatment. *: P < 0.05. Control →, 2,5-hexanediol ←, acetone ←, 2,5-hexanediol + acetone ←.
8h time-weighted average exposure concentration, mg/m³

- **Toluene**
- **Acetone**
- **Hexane**
Solvent use in 14,400 California vehicle repair shop, 2001

- Chlorinated: 3,600
- Hexane-acetone: 4,320
- Other non-chlorinated: 2,880
- Aqueous, other: 4,320
1988: Introduction of hexane products in CA.

Survey data for 17 companies, 90% of market.
Introduction of hexane, 1988:
An unintended consequence of listing chlorine-contaminated oil as a hazardous waste.

Introduction of hexane-acetone blends, 1997:
An unintended consequence of exempting acetone from California VOC rules.
Chemical management over the last 30 years

Stage 1: Disposal and dilution

Stage 2: Waste treatment and pollution control

Stage 3: Toxics policy (chemical-by-chemical approaches)

Stage 4: Chemicals policy (chemical design, markets, life cycles)
UC report: A systems approach to public policy is needed to produce enduring changes, including in the chemical sector.
Example: electricity use.
• From a policy perspective,
• green chemistry links solutions to chemical problems…
• with new business & investment opportunities.
Global chemical production is expected to double every 25-years.

Production index = 131 today, where 1997 = 100

Production index = 231 in 2022, where 1997 = 100
California’s expected population growth, 1990-2050

2006 = 36 million

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Source: California Dept of Finance, CA pop. trends, 1990 – 2050
UC chemicals policy analysis

Barriers to green chemistry

Drivers of green chemistry

TSCA

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• Data Gap:
  – TSCA does not require producers to generate chemical hazard data for EPA or downstream users.

• Safety Gap:
  – TSCA has constrained government’s ability to assess and control chemical hazards.

• Technology Gap:
  – TSCA has dampened private sector interest in green chemistry, which is reflected in research and education.
Implications of the Data and Safety Gaps for green chemistry:

1) Businesses and consumers are unable to identify hazardous chemicals or choose safer ones.

2) The market thus “undervalues” the hazardous properties of chemicals relative to their function, price, & performance.

3) Hazardous chemicals have therefore remained competitive in the market.

4) This has impeded the market for green chemistry…

5) …and has left businesses with the costs and liabilities that result from using hazardous chemicals.
Example 1. Data Gap
To make informed purchasing decisions about chemicals, buyers need four pieces of information:

<table>
<thead>
<tr>
<th>Function</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Hazards</td>
</tr>
</tbody>
</table>
Hazard information (e.g. toxicity) is essentially absent.
Example 2. Data Gap

To assess & prioritize chemical hazards, state agencies need at least four pieces of information:

<table>
<thead>
<tr>
<th>Identity</th>
<th>Sales volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses</td>
<td>Hazards</td>
</tr>
</tbody>
</table>
This information is routinely unavailable to agencies.
Example 3. Safety Gap

Government carries the burden of proving risk, yet producers are under no obligation to provide the information necessary for government to do so = a logical paralysis.
University teaching and research in chemistry reflect conditions in the chemicals market.

Example 4. Technology Gap.

With very few exceptions, one can earn a Ph.D in chemistry in the U.S. without demonstrating a basic understanding of toxicology…

…or the principles of green chemistry.
The Technology Gap: E.U. policies are driving E.U. investment in cleaner technologies, including green chemistry.

- Waste in Electrical and Electronic Equipment (WEEE): 2005
- Restriction on Hazardous Substances (RoHS): 2006
“G.E. Chief Points to ‘Green’ Handicap”

Financial Times
May 10, 2005
Stephanie Kirchgaessner in Washington

“…the deregulatory agenda favored by the U.S. business community – particularly on environmental issues – is not providing American companies with a competitive advantage over their European counterparts.”

Jeffrey Immelt, Chairman and CEO (Ecomagination)
UC chemicals policy analysis

Barriers to green chemistry

- TSCA, other statutes
- Data Gap
- Safety Gap
- Tech. Gap
  - Markets
    - Buyers: no haz data
    - Sellers: no case for GC
  - Government
    - Inability to assess haz
    - Inability to control haz
      - Hazard undervalued against price, function
      - Hazardous chemicals competitive in market
      - Green chemistry innovation impeded

Drivers of green chemistry

Markets

Government
The E.U. REACH initiative

- **Registration**: tiered tox and use data
  - About 30,000 chemicals
    - 3, 6, 11-yr phase-in
      - About 5,000 chemicals
        - Evaluation: >100 tons/year
          - About 1,400 – 2,000 “chemicals of very high concern” (no 1 ton trigger for these)

- **Authorization**: for CMR, PBT, vPvB
- **De-authorization**: inadequate control
- **Data requirements depend on volume**
- **Chemicals produced or imported at >1 ton/year/producer**
  - About 30,000 chemicals
  - Authorization
  - De-authorization: benefit too small
Some downstream users…

are demanding that suppliers fill toxicity data gaps.

Kaiser, Consorta, S.C. Johnson, Catholic Health Care, Alta Bates, Shaw, Herman-Miller etc.

30 hospitals, 432 medical office buildings, growing.
1) Why focus on hazard?

2) What are the barriers to green chemistry?

3) How can California address these barriers?
UC chemicals policy analysis

Policy objectives:
Close the Data, Safety & Technology Gaps:
* Improve the flow of information in the chemicals market.
* Improve government capacity to act.
* Implement other incentives for green chemistry.

Issues, models, mechanisms:
* Leverage market forces.
* Address chemical life cycle.
* Place least demands on government.
* Motivate technology innovation and diffusion, etc.

Barriers to green chemistry

Drivers of green chemistry

Recommendations
In choosing not to act:
* Existing problems will expand in California.
* U.S. & California could become “dumping ground.”
* CA will cede leadership in green chemistry.
A properly functioning chemicals market will motivate investment in green chemistry, which will solve public environmental health problems and stimulate new growth.

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Courtesy John Wilson, CA Energy Commission
Thank you!