California Workforce 2020: Clear Vision for Green Chemistry

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The Goal

Under the mantle of the California Green Chemistry Initiative, the California Department of Toxic Substances Control (DTSC) seeks to facilitate the development of a scientific and industrial workforce that produces safer alternatives and approaches for materials and products in terms of (1) design and makeup, (2) manufacturing, (3) application and (4) disposition at end-of-life.

DTSC intends to develop a coalition with educational institutions and training organizations, private sector companies, venture capital, and community organizations to (1) show scientific and technical leadership in green chemistry and "cradle-to-cradle" practices, (2) facilitate successful and safe integration these practices into infrastructure, (3) train the workforce of tomorrow, (4) inform and engage communities, and (5) promote innovation and provide the highest level of environmental and public health protection.

DTSC will strengthen partnerships with the University of California, the State Universities, the Community Colleges, California industry and communities to develop a California workforce with the capacity to design and implement a green chemistry economy by 2020.

Perspective: The need for a Green Chemistry in California

Each day, a total of 42 billion pounds of chemical substances are produced and imported in the U.S. for commercial and industrial uses, 90% of which are produced using fossil fuel feedstocks.[1] (Translated into tonnage, this would be approximately 7.7 billion tons

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[1] National Pollution Prevention and Toxics Advisory Committee (NPPTAC), Broader Issues Work Group. How can EPA more efficiently identify potential risks and facilitate risk reduction decision for non-HPV existing chemicals? (2005)

(http://epa.gov/oppt/npptac/pubs/finaldraftnonhpvpaper051006.pdf) On page 4, Table 3 shows that the total pounds produced or imported in 2001, as reported under the 2002 TSCA IUR, is 15,208,921,689,779 pounds, or 41,668,278,602 pounds per day.

U.S. Department of Energy, Office of Industrial Technologies, Renewables Vision 2020, Executive Steering Group. The Technology Roadmap for Plant/Crop-based Renewable Resources 2020 (http://www1.eere.energy.gov/biomass/pdfs/ag_vision.pdf) p. 8. Washington, D.C.:U.S. Government Printing Office, 1999.

National Academy of Sciences, National Research Council. Bio-based Industrial Products: Priorities for Research and Commercialization. National Academy Press, Washington, D.C., 2000.

per year. Global chemical production is doubling every 25 years, rapidly outpacing global population growth.[2]

Many of these substances come in contact with people – in the workplace, in homes, and through air, water, food and waste streams – and most of them enter the earth's ecosystems at some point during their lifecycle.[3] The potential threat to public health and the environment by these industrial chemicals and their associated waste streams are of great importance to policymakers, state regulators, and the public at large.

Green Chemistry is the best way to reduce these threats. It is a preemptive strategy to innovatively moves toward the production and use of less toxic material and away from merely managing the risks of current hazardous materials during use and at disposal.

Green Chemistry is the design of products that do not generate hazardous substances. Green Chemistry focuses on improving the building blocks of manufacturing – the molecules, the feed stocks, and the catalysts used to make things – so products can be engineered to be safer, not persist in the environment and be easily reused. Fewer hazardous substances mean healthier air quality, a safer workplace and cleaner drinking water. The goal of Green Chemistry is to make things "benign by design."

In this report, the NRC evaluated biobased materials in the U.S. and proposed national targets for their adoption. They reported as follows:

		National targets	
Biobased product	**2000 level**	**2020 level**	**2090 level**
Liquid fuels	1-2%	10%	50%
Organic chemicals	10%	25%	90%
Materials	90%	95%	99%

[2] The Organization for Economic Cooperation and Development (OECD), UK Chemicals Industry Association and the American Chemistry Council predict an annual growth rate ranging from 0.026 to 0.035 leading up to 2020. Organization for Economic Cooperation and Development (OECD). *Environmental Outlook for the Chemicals Industry* (http://www.oecd.org/dataoecd/7/45/2375538.pdf) p. 34-36 (2001). This is consistent with production trend data from 1992-2002. ACC: *Guide to the Business of Chemistry*, p 78 (2003).

The population data are from United Nations, Department of Economic and Social Affairs. World Population to 2300. (http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf) New York: United Nations (2004) 4.

[3] Wilson, Chia, Ehlers. *Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation*. Special Report to the California Senate Environmental Quality Committee and Assembly Committee on Environmental Safety and Toxic Materials. University of California, California Policy Research, Office of the President (http://coeh.berkeley.edu/docs/news/06_wilson_policy.pdf) March 2006.

The Green Chemistry Science Advisory Panel Findings of 2008 for a Green Chemistry Workforce

A Green Chemistry Initiative Science Advisory Panel was created in the fall of 2007. This Panel, consisting of leading academics, industrialist, environmentalists and proponents of green chemistry, whose expertise included chemistry, chemical engineering, environmental law, toxicology, public policy, pollution prevention and cleaner production, environmental and public health, risk analysis, materials science, nanotechnology, chemical synthesis, and research, believes that California can motivate new investment and innovation in green chemistry through a variety of "supply" side and "demand" side options.

These two broad set of options are defined and described below.

"[S]upply" side options – initiatives in education, research, economic incentives, etc. that will help to facilitate the creation and dissemination of greener chemicals, processes and technologies, and

"[D]emand" side options – chemicals policy elements that will drive demand for these greener chemicals, processes and technologies, by better informing the market, providing a level playing field on which greener options can fairly compete, and creating a regulatory climate that drives both the development and the adoption of greener alternatives

The Panel's report further states that *"Investing in green chemistry for the future in California requires special attention to the state's educational services. Teaching green chemistry concepts in primary and secondary schools could attract students to science by positioning chemistry as a tool to meet environmental and health challenges. Reformulating college curricula and offering fellowships and internships would prepare new scientists to be innovative in a critical field. Thus, as California businesses adopt green chemistry practices and strive for new green product development, the state will have prepared its workforce in advance to meet these needs."*

They offered the following eight "supply" side options for "Green Chemistry and Engineering Education – The Needed Tools" which will be important in workforce development for green chemistry.

Option 1: Train K-12 Science Educators *- Develop a program to train K-12 science education teachers in the concepts of Green Chemistry*

Option 2: Develop K-12 Green Chemistry Teaching Materials *- Expand California's science education materials programs to include training and laboratory materials for conveying concepts in green chemistry to K-12 classrooms suited to each grade level.*

Option 3: Develop Green Chemistry Interdisciplinary Education Courses *- Develop programs to introduce interdisciplinary green chemistry into the general education curriculum for undergraduates in California colleges and universities.*

Option 4: Integrate Green Chemistry into Higher Education Chemistry and Chemical Engineering Curricula *- Reformulate conventional graduate and undergraduate chemistry and chemical engineering*

curricula in California colleges and universities to emphasize green chemistry and to include aspects of toxicology, health related issues, ecology, environmental science and environmental law.

Option 5: Develop Fellowships and Internships in Green Chemistry *- Develop a program to support graduate education fellowships and both undergraduate and graduate internships focused on green chemistry research and application.*

Option 6: Promote Green Chemistry in Business School Education *- Commission the development of practical teaching cases in green chemistry that can be incorporated into the curricula of business schools through the university systems in California.*

Option 7: Support new Faculty Positions in Green Chemistry *- Encourage and financially support the hiring of faculty qualified in green chemistry throughout the state's colleges and universities.*

Option 8: Introduce Green Chemistry into Vocational and Workforce Development Training Programs *- Support and fund a green chemistry program for vocational schools and other workforce development programs.*

DTSC's Development of a Skilled Workforce

Through the California Green Chemistry Initiative, DTSC wants to facilitate the development of a scientific and industrial workforce that produces safer alternatives for materials and products in terms of (1) design and makeup, (2) manufacturing, (3) application and (4) disposition at end-of-life. Strengthened partnerships with the University of California, the State Universities, the Community Colleges, California industry and communities will be the tools to pursue development of a California workforce with "clear vision" for Green Chemistry by 2020.

Within its current FY 2008-2009 resources, DTSC will initially focus on **Options 3, 4** and **8. Option 1** and **Option 2** will be addressed by an ongoing educational initiative by the Office of the Secretary for Environmental Protection. The approach to **Options 5, 6,** and **7** is described below in the context of future efforts.

1. **Train a new generation of scientists and engineers**. The State of California (DTSC) will work with the University of California to establish new curricula.

    a. **Proposed Short Term Approach:** Work directly with UC Berkeley and UCLA Centers for Occupational and Environmental Health to organize, design and implement green chemistry curriculum on these campuses. This curriculum should include the full range of technical, scientific, legal, economic and policy aspects of green chemistry and its implementation in California. The COEHs are best suited for the interdisciplinary nature of the proposed approach.

        i.
        ii. **Option 3** (*Develop Green Chemistry Interdisciplinary Education Courses)* and **Option 4** *(Integrate Green Chemistry into Higher Education Chemistry and Chemical Engineering Curricula)* could be satisfied here.

b. **Long Term Approach:** Establish the California Institute for Green Chemistry and Green Engineering at UCB and UCLA.
    i. Work with UCB and UCLA COEH to develop the mission, vision and goals of the Institute. Develop short-term and long-term resource plan and funding proposal with draft strategic plan.
    ii.
    iii. Work jointly with UC on the funding proposal and development in the $10-20 million range for FY 2010-2011.
    iv. Dependent upon implementation, the following could be obviously tailored to meet the objectives of described in Panel's **Option 5** *(Develop a program to support graduate education fellowships and both undergraduate and graduate internships focused on green chemistry research and application)***, Option 6** *(Commission the development of practical teaching cases in green chemistry that can be incorporated into the curricula of business schools through the university systems in California)*, and **Option 7** *(Encourage and financially support the hiring of faculty qualified in green chemistry throughout the state's colleges and universities).*

2. **Provide "continuing education" in Green Chemistry principles, sustainable production, and life-cycle analysis for established industrial cultures of scientists and engineers in the "high and clean tech" sectors.**

    a. **Build public-partnership with Industry:** develop DTSC-industry coalitions for "in-house" course development and deployment in Green Chemistry in the "Clean Technology Sector."
        i. Negotiate with private sector, community college, and non-profit partners such as Agilent Technologies, San Bernardino Community College District, and the International Association of Nanotechnology (IANANO), respectively, to develop Green Chemistry "continuing education" in Green Chemistry principles, life-cycle concepts and sustainability. Courses would be directed at trade and professional continuing education. Other potential partners are the Silicon Valley Leadership Group and the California Space Authority.
        ii. Develop initial scope of work for green chemistry curricula to focus upon California*'s* biotechnology, clean technology, aerospace and nanotechnology sectors**.** Seek State funding (through either current contract resources and/or BCP FY 09/10).
        iii. Seek extramural private sector funding for "public-private" partnership for curricula development and deployment.
        iv. Broaden support for this effort to include American Chemistry Council, Chemical Industry Council of California, Procter & Gamble, etc.

v. Jointly pursue and secure Federal funding under the Federal Green Jobs Act of 2007 for curricula development and deployment in green chemistry and engineering.

b. **Build public partnership with community college system**: develop DTSC-community college coalition to "test" in-house course material and to expand course development and deployment options.
   i. Developed course in nanotechnology and the importance of green chemistry for the high technology sector at community colleges, such as San Bernardino Community College's Donald F. Averill Applied Technology Training Center.
   ii. Jointly pursue and secure Federal funding under the Federal Green Jobs Act of 2007 and the National Nanotechnology Initiative for curricula development in green chemistry and engineering.

3. **Re-train displaced scientists, engineers and high technology workers to think in green chemistry principles and innovate toward "cradle-to-cradle" production.**

   a. **Build public-partnership with Industry:** develop DTSC-industry coalitions for course development and deployment in Green Chemistry for the "displaced" high technology workforce.
      i. Negotiate with private sector, community college, and non-profit partners such as Agilent Technologies, San Bernardino Community College District, and the International Association of Nanotechnology (IANANO), respectively, to develop "re-training and new skills" curricula in Green Chemistry principles, life-cycle concepts and sustainability. Courses would be directed at trade and professional re-training to re-join the States workforce.
      ii. Develop initial scope of work for green chemistry curricula to focus upon California's displaced workforce from manufacturing, aerospace, biotechnology, clean technology and nanotechnology sectors, through coalitions between DTSC, the private sector and educational institutions**.** Seek State funding (through either current contract resources and/or BCP FY 09/10).
      iii. Seek extramural private sector funding for "public-private" partnership for curricula development and deployment. Seek support and funding from California Employment Development Department and the private sector.
      iv. Jointly pursue Federal funding under the Federal Green Jobs Act of 2007 for curricula development and deployment in green chemistry with selected non-profit organizations.
      v. DTSC to teach course for nanotechnology and clean technology sectors workforce re-training in risk, hazard and green chemistry principles at the "Work2Future" center in San Jose, California.

b. **Build public partnership with community college system**: Initiate DTSC-community college coalitions to develop course material and education curricula in green chemistry and "cradle-to-cradle" concepts for the re-training of the "general" workforce.
    i. Developed course and curricula on green chemistry for the general work force at community colleges such as San Bernardino Community College's Donald F. Averill Applied Technology Training Center and other community colleges.
    ii. Jointly pursue and secure Federal funding under the Federal Green Jobs Act of 2007 for curricula development in green chemistry.

4. **Prepare disadvantaged communities for employment opportunities as the private and public sector moves toward green chemistry and "Cradle-to-Cradle" strategies:** California needs to harness human resources available in disadvantaged communities to safely work as high technology technicians in the industrial sector.

    a. **Build public-private partnerships with "non-governmental organizations"**: Initiate a DTSC-"non-governmental organization" coalition to develop course material and education curricula in green chemistry and "cradle-to-cradle" concepts for the re-training of the "general" workforce from "disadvantaged" communities.
        i. Develop key contacts.
        ii. Work with non-profits and non-governmental organizations such as the Ella Baker Center in Oakland, California, and other partners within the Apollo Alliance, to identify opportunities in workforce development through educational initiatives in green chemistry and engineering.
        iii. Identify common interests and develop strategy and approach.
        iv. Develop "seed funding" for partners.
        v. Jointly pursue and secure Federal funding under the Federal Green Jobs Act of 2007 for course and curricula development in green chemistry.