Making the Business & Economic Case for Safer Chemistry

Report for the American Sustainable Business Council and Green Chemistry & Commerce Council

Prepared by Trucost
April 24, 2015

About the Organizations

American Sustainable Business Council

The American Sustainable Business Council is a growing coalition of business organizations and companies committed to advancing market solutions and policies to support a sustainable economy. ASBC and its organizational members represent more than 250,000 businesses and more than 325,000 business leaders across the United States.

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Green Chemistry & Commerce Council

The Green Chemistry & Commerce Council (GC3) is a business-to-business forum that advances the application of green chemistry and design for environment across supply chains. It provides an open forum for cross-sectoral collaboration to share information and experiences about the challenges to and opportunities for safer chemicals and products.

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Trucost

Trucost is an expert consultancy, helping companies, investors, governments, academics and thought leaders to understand the economic consequences of natural capital dependency. Trucost's world leading data and insight enables clients to identify natural capital dependency across companies, products, supply chains and investments; manage risk from volatile commodity prices and increasing environmental costs; and ultimately build more sustainable business models and brands. Trucost's approach not only quantifies natural capital dependency, it also put a price on it, helping clients understand environmental risk in business terms.

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Executive Summary

The American Sustainable Business Council (ASBC) and the Green Chemistry & Commerce Council (GC3) engaged Trucost to evaluate the potential business and economic value of "safer chemistry"—which can include reducing the use and generation of hazardous substances, reducing the human health and environmental impacts of processes and products, and creating safer products. The research included interviews with 17 industry experts, as well as a review of literature and available data on the business and economic opportunities achievable through safer chemistry and the business and economic value at risk from not adopting safer chemistry.

Market growth, capital flows and market demand show upward trajectories during the past 5 years. Large corporations (such as Dow, DuPont or Sigma-Aldrich) have higher sales growth of broadly defined "green chemistry" product portfolios, as compared to sales of conventional chemistry. Smaller companies whose value proposition is based on safer chemistry (such as Seventh Generation or Method) have demonstrated continued growth. The research also identified examples of sizeable business risks posed by traditional chemistry that safer chemistry could alleviate. Expanding regulations, continued NGO and shareholder activism, loss of access to major markets, and chemical mismanagement place significant value at risk.

We found that safer chemistry's potential for creating business and economic value is promising but not yet fully realized. Customers (including consumers, institutions, large retailers and public agencies) are conveying signals to brands, manufacturers, formulators and chemical companies. Actions are being taken, R&D is occurring and chemicals are being reformulated. However, these changes are limited, primarily reactionary (not proactive) and situational (not comprehensive). The potential for innovation may lie with specialty chemicals, relatively niche chemical formulators and small businesses, which can serve the growing demand through their nature as test beds for problem-solving and their often mission-driven approach to product and service development. In addition, there is a need for more comprehensive, robust analyses and data on safer chemistry at the scales of individual sectors and the larger chemical value chain. Further, given the various definitions of "safer chemistry" that stakeholders use, more consistent metrics and precise terminology are needed.

Based on the research findings, we offer the following recommendations:

1. Businesses that have not yet evaluated their individual business case for safer chemistry within their specific product portfolio and market segment are strongly encouraged to do so, given the potential for revenue growth and business value at risk.
2. Safer chemistry metrics that relate to business and economic opportunity (and risk) should be tracked and communicated, to help spur business understanding of safer chemistry and public policy mechanisms for data disclosure.
3. The total societal benefits associated with the addressable market for safer chemistry should be quantified and communicated to policy makers and investors.
4. Existing safer chemistry initiatives should be catalyzed, harmonized and aligned through a value chain approach and used to leverage capital flows toward safer chemistry innovation.
5. Stakeholders should work toward a common understanding and communicate with better clarify on the specific aspects of safer chemistry that they are addressing, since the topic can encompass many different production aspects and product attributes.
6. Priorities for filling data gaps should include gathering more specific market research to quantify the potential for job growth and revenue opportunity for safer chemistry (as more narrowly defined), more specifically by product segment and industry vertical.

Project Objectives & Scope

The American Sustainable Business Council (ASBC) and the Green Chemistry & Commerce Council (GC3) are working to increase the practice of safer chemistry through various programs and initiatives. One important lever is understanding the business and economic value of transitioning to safer chemistry. Economic benefits include, for example, growth in the number of jobs or a reduction in societal costs related to the human health and environmental impacts from the release of hazardous chemicals into businesses and communities. Business benefits include, for example, increased revenues for incorporating safer chemicals into products that open new markets or reduced operating expenses for managing hazardous chemicals.

This research focused on "safer chemistry," which can include reducing the use and generation of hazardous substances, reducing the human health and environmental impacts of processes and products, and creating safer products. The objective of this project was to document the value of safer chemistry, looking at both risks and opportunities for businesses and economies. Trucost was asked to objectively analyze and curate existing data to provide the most compelling insights in an engaging, accessible format, rather than compile an exhaustive summary of anecdotal examples in a lengthy report.

The scope of research included the following aspects:

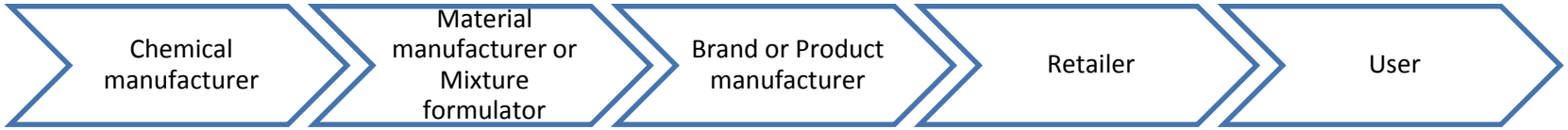
- The research included interviews with experts engaged in adopting safer chemistry practices in a business or economic context, as well as desk top review of readily available data and information. Primary research using Trucost economic models and data was outside the scope of this engagement.
- The analysis and inquiry focused on examples of business and economic risk and opportunity within the US; however, we recognize that most markets and supply chains are global. For example, European Union regulations related to restricted chemicals will have significant implications for US-based manufacturers. We have noted some of the more significant of these risks; however, they were not the focus of the research and where possible we have used US-based case study examples.
- Individuals throughout the chemical value chain use varied definitions of "safer chemistry"—ranging from production techniques to product attributes—and also employ terms such as "green chemistry" and "sustainable chemistry." Therefore, it was not always possible to extract data from the interviews or existing research to address only one definition of "safer chemistry." For example, some interviewees' expertise was related to biobased materials, sustainable chemistry or renewable ingredients, and these perspectives are included as well.

ASBC and GC3 intend to use the research to communicate with a broad audience about the use of safer chemistry. For example, ASBC and GC3 follow-on activities could include making the business case to companies about the benefits of safer chemicals in their products, making the case to government or NGOs for better policy or market-based approaches that drive adoption of safer chemicals, or making the case to investors to direct the flow of capital towards more sustainable business models or new technologies.

Project Objectives & Scope

The research intent was to explore risks and opportunities from a value chain perspective, spanning from chemical manufacturing through formulator, retailer and end user. We also attempted to incorporate the views of representatives from a number of market segments, such as apparel, electronics and personal care, as well as perspectives from both small and large businesses.

The Chemical Value Chain



Examples of Interviewees or Case Studies

AkzoNobel	*NatureWorks*	*Construction Specialties*	*Best Buy*	*Kasier Permanente*
Sigma-Aldrich	*Solazyme*	*Earth Friendly Products*	*Walmart*	
		Patagonia		
		Seventh Generation		

Despite an extensive review of literature and data, there are many gaps in available information. Please see the Appendix, Data Gaps for a description of the gaps and more information on areas of inquiry where ASBC and GC3 can direct research to address future analysis and data tracking.

Research Themes

Since safer chemistry is such a broad topic and the scope of the engagement was limited, Trucost focused its research on 8 predefined themes. The themes describe ways that traditional chemistry or safer chemistry could impact value—either value at risk or the value of opportunities. We developed these themes taking into account where there would be a higher likelihood of having data or information, as well as topics that would be more compelling to demonstrate the business or economic case. The research themes are summarized below.

	Theme	
Opportunities	1. Market growth	What are the growth rates of safer chemistry markets compared to conventional markets, by sectors?
	2. Trends in capital flows	What has been the increase in capital flows (for example, green bonds, investor indices, venture capital deals) toward business with safer chemistry initiatives?
	3. Market demand	How have major brands, OEMs and public agencies increased the adoption of safer chemistry related procurement policies?
	4. Job growth	What are the trends in job creation related to safer chemicals?
Risks	5. Shareholder and NGO activism	What has been the trend in shareholder proxies and NGO activist campaigns related to safer chemicals?
	6. Chemical restrictions	How have chemical restrictions been increasing over time (for example, regulatory restrictions such as REACH or customer-led restrictions such as restricted substances lists in certain industries)?
	7. Business value at risk	What are examples of compelling events, business disruptions, profit warnings, revenue losses or increased operating expenses related to chemical issues?
	8. Societal costs of accidents and incidents	What are the top examples of situations where communities have incurred significant environmental and societal costs related to chemical issues?

Research Findings

Theme 1: Market Growth

Growth Rates of Safer Chemistry vs Conventional Market

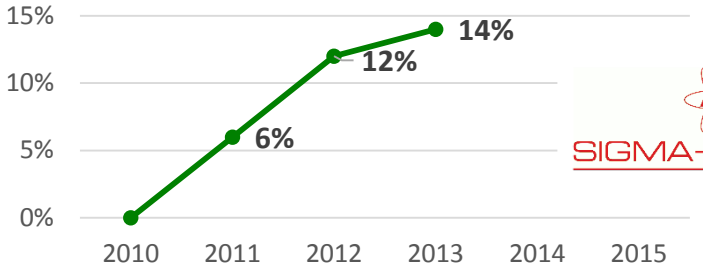
Sector	Safer Chemistry Market	Conventional Market	Time Period
Building Materials	+2000%[1]	+176%[2]	2009-2030
Chemistry	+3200%[3]	+133%[3]	2011-2020
Personal Care	+10.12% CAGR (US)[4]	+4.43% CAGR (global)[5]	2012-2016
Cleaning Products	+20% CAGR[6]	+1.5% CAGR[7]	2007-2011
Company Examples	**Change**	**Basis**	**Time Period**
Shaw (Flooring)	+15%[8]	Sales of EcoWorx Products	2000-2004
Coastwide Laboratories (cleaning)	+8%[9] +35%[10]	Sales New Customers	2000-2005
Clorox Green Works	$200 million annually[11]	Sales	2011
NatureWorks (PLA polymer)	+24%[12]	Sales CAGR	2005-2013

"We have seen 6-10% annual growth in the natural products sector, compared to near-zero growth for conventional products."

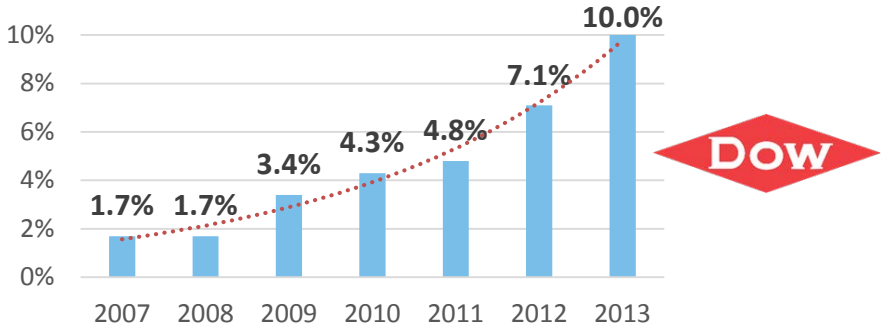
– Martin Wolf, Director, Sustainability & Authenticity, Seventh Generation

- *87% of industry chemists predicted that sustainable chemistry offerings will increase during the next 10-20 years; 42% predicted a significant increase (2011 survey)*[13]
- *62% of chemical producers have said that their customers are interested in sustainable chemicals (2014 survey)*[14]

"Greener Alternative" Product Sales[15]



Sales "Highly Advantaged" by Sustainable Chemistry[16]



Research Findings

Theme 2: Trends in Capital Flow

Investments in Safer Chemistry

Sector	Investment Type	Investment in Safer Chemistry	Time Period
Chemicals	Safer Chemistry R&D	57% of chemical companies in MSCI World invested in green chemistry R&D[17]	2013
Chemicals	Safer Chemistry R&D	11-15% of average chemistry company's R&D budget[18]	2011
Building Materials	Research Grant	$3 million for USGBC research of health hazards, from Google[19]	2013
Advanced Materials	Investment (Various)	$4.9 billion invested in advanced materials industry; can help drive green chemistry[20]	2002-2013
Company Examples	**Investment Type**	**Investment in Safer Chemistry Products**	**Time Period**
DSM	Capital Investment	Manufacturing of sustainable coatings & waterborne resins[21]	2015
Johnson & Johnson	Product Reformulation	$10's of millions to reformulate 100+ baby product ingredients[22]	2014
DuPont	Safer Chemistry R&D	+270%[23]	2007-2012
Dow	Safer Chemistry R&D	Creating architectural coatings to enhance indoor air quality[24]	2013

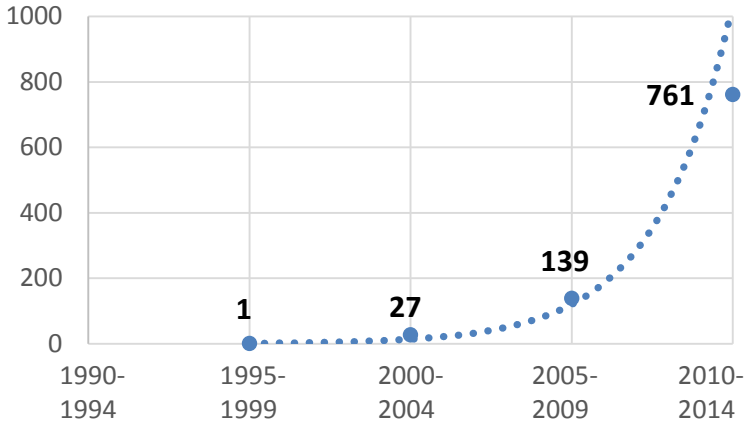
"The demand for greener chemistry is there but, on the supply side, there is a lack of success stories and narratives. The industry needs to draw attention to the successes."

– Adrian Horotan, Elm Street Ventures

"55% of members believe the ROI of green chemistry R&D is greater than for standard investments."[25]

– American Chemistry Society (2013 survey)

US Patents Issued for Sustainable Chemistry[26]



Although the investment in safer chemistry is nascent and difficult to quantify, there are signs that it is growing. The rise in patents for more sustainable chemistry—based on a search of US Patent and Trademark Office records—shows increasing momentum and evolving industry capacity. Interest by investors of various types in advanced materials and technological innovation further underscores how capital could flow toward safer chemistry in the future.

Research Findings

Theme 3: Market Demand

Increased Demand for Safer Chemistry

Sector	Buyer	Purchasing of Safer Chemistry Products	Time Period
Retail	Walmart ($476B in revenue)[27]	Vendor disclosure of priority chemicals and certification of private brands as USEPA DFE[28]	2014-2018
Retail	Target ($72B in revenue)[29]	Chemicals are the most important sustainability issue for Target's customers[30]	2014
Retail	Staples ($23B in revenue)[31]	Corporate customer—who represent 50% of revenue—have increased demand for safer chemistry products[32]	2014
Retail	Various	+500% sales of BPA-free baby bottles[33]	2008
Health Care	Group Purchasing Organizations ($135M in medical product purchasing)	Adoption of standardized questionnaire; top-rated product attributes include being free of heavy metals, persistent synthetic chemicals and PVC[34]	2014
Furniture	Ashley Furniture	Toxic flame retardants no longer added to foam cushions (largest US furniture retailer)[35]	2015
Public	Federal Agencies	95% of new contracting must include sustainability requirements, such as non-toxic or less toxic materials[36]	2009-Present
Public	Federal Agencies ($50B in annual purchasing)	GSA requires buying a product with reduced health or environmental effects that serves the same purpose[37]	2013

"…Walmart would like to work with suppliers and the industry to accelerate the adoption and use of sustainable chemistry practices to meet the needs of our customers and the environment."[38]

– Walmart SustainabilityHUB

"[The GSA is working] to move government purchases toward sustainable products and companies, in order to reduce our environmental footprint and more effectively use taxpayer dollars."[39]

– Martha N. Johnson, Administrator (former), US General Services Administration

KAISER PERMANENTE®

Since 2010, Kaiser Permanente (KP) has required medical product vendors (providing $1B worth of medical products each year) bidding on national contracts to complete a Supplier Sustainability Scorecard about ingredients, internal chemicals policies and social and environmental practices. KP considers that it has a right to know and if a supplier does not disclose the ingredients, then KP presumes the chemicals are hazardous. KP seeks to phase out carcinogens, mutagens, reproductive toxins and persistent bioaccumulative toxins. In June 2014, KP committed to spending its annual $30 million furniture budget on upholstered items that do not contain toxic flame retardants.[40, 41]

Research Findings

Theme 4: Job Growth

Job Growth Rates: Safer Chemistry vs Conventional

Sector	Safer Chemistry Positions	Conventional Positions	Time Period
Chemicals	40,000 chemistry jobs in companies deriving some revenue from "green chemistry"[42]	4.2 million jobs directly depend on the chemical industry and innovation is key[43]	2011
Chemicals	Formulating safer chemistry requires more labor (for R&D and production) compared to more capital-intensive traditional chemistry[44]		2011
Biobased Chemicals	237,000 jobs (20% of all chemical sales), up from 40,000 jobs (3%) in 2011[45]	1.1 million jobs	2011-2025
Company	**Safer Chemistry Positions**	**Description**	**Time Period**
Klean Kanteen	+600%[46]	Stainless steel water bottles instead of plastic	2007-2008
Method Products	7th fastest growing company in the US[47]	Non-toxic cleaning products	2000-2007

"Naturepedic has been experiencing an approximate 20% year-over-year job growth… When consumers become aware of choices, companies can then benefit financially from offering green chemistries."

– Barry Cik, Founder and Technical Director, Naturepedic

Employment in Chemical Manufacturing[48]

Year	Green Goods and Services Employment		Total Employment	
2010	23,124		785,283	
2011*	24,733	+7%	782,367	-0.4%

From 2010 to 2011, the number of US chemical manufacturing jobs classified as "Green Goods and Services" (GGS) positions grew by 7%, whereas total employment in the chemical manufacturing sector decreased by 0.4%. The US Department of Labor defines GGS as "goods and services produced by an establishment that benefit the environment or conserve natural resources." **Note*: The Bureau of Labor Statistics no longer collects this data, due to federal budget limits.

Research Findings

Theme 5: Shareholder and NGO Activism

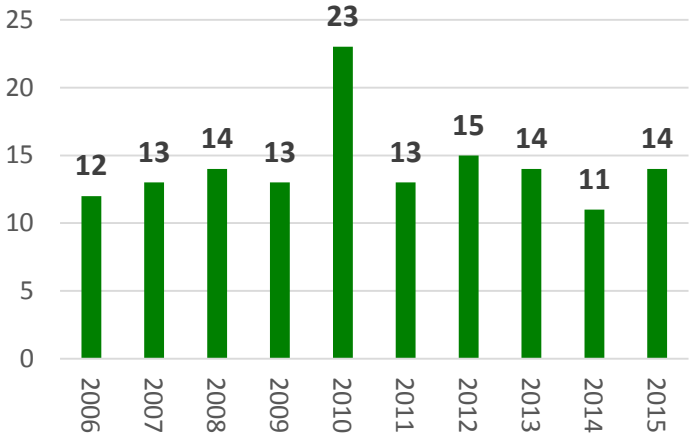
Actions by Shareholders or NGOs

Sector	Pre-2005	2006 – 2008	2010 – 2012	2013 – Present
Personal Care—Cosmetics	NGO testing: 70% of personal care products are positive for phthalates[49]	Campaign for Safe Cosmetics started to remove hazardous chemicals; 175 organizations today Campaign pushes nail polish brands to remove "toxic trio"[50]	322 companies pledge to avoid specific chemicals and disclose ingredients[51]	*Cosmetics Without Cancer* launched in 2014[52] 50,000 sign petition for Revlon to stop using cancer-causing chemicals[53]
Health Care	Health Care Without Harm started in 1996[54] *Green Guide for Health Care* for facility design; 293 projects[55]	90% of purchasers of $1.6B sterile medical packaging commit to remove phthalates[56] Launch of *Guide to Choosing Safer Products & Chemicals*[57]	$135B purchasing replies to Practice Greenhealth supplier queries, for 7,148 partner facilities[58, 59]	
Apparel			Greenpeace *Detox* campaign targets apparel brands[60]	Adidas and Puma agree to remove PFCs (PFC textiles: $1.73B by 2020)[61, 62]
Retail	17 investor groups with $22B in assets call for disclosing capital risk from toxics[63]	22% of Bed, Bath & Beyond investors vote for chemical reporting[64]	NGO testing: 39% of discount stores' PVC packaging has cadmium or lead above state laws[65]	NGO testing: 32% of dollar stores' PVC products have phthalates above CPSC limits[66]
Flame Retardants—Electronics, Furniture & Baby Products	NGO issues first US report on PDBE flame retardants in household dust[67]	Apple shareholder resolution pushes for eliminating PBTs including BFRs[68]	Study links firefighters' exposure and cancer risk[69]	Coalition of groups petition CPSC to ban products with toxic flame retardants[70]

"There is growing momentum in the marketplace for companies to move faster than lagging regulators in tightening up chemical safety standards for their cosmetics and personal care products."[71]

– Richard Liroff, Executive Director, Investor Environmental Health Network

Shareholder Resolutions on Hazardous Chemicals[72]



The Walt Disney Company

In 2014, shareholders led by Boston Common Asset Management filed a resolution for the Walt Disney Company to develop a "safer alternatives policy" to identify and reduce chemical hazards within its consumer products. As a result, Disney committed to this approach and the resolution was withdrawn.[73]

Research Findings

Theme 6: Chemical Restrictions

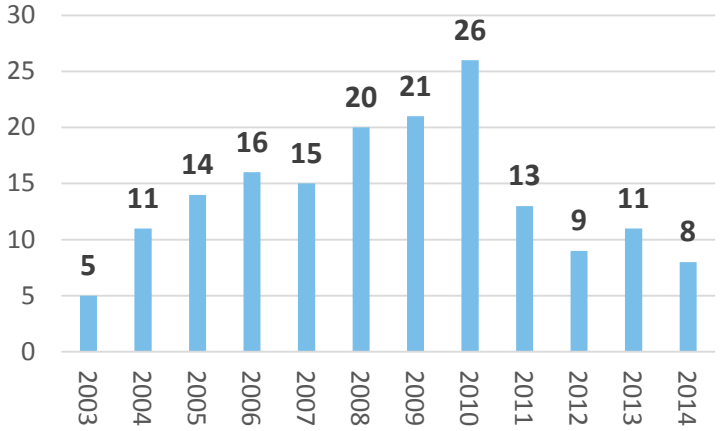
Changing Chemical Restrictions

Sector	Restriction	Impact	Time Period
Personal Care	Minnesota Legislation	Phase out of triclosan from consumer soap by 2017; FDA cost estimates for reformulation: $112-369 million[74, 75]	2014
Consumer Products	California Legislation	Chemical regulatory model and standard for interstate manufacturers and retailers[76]	2008-Present
Building Materials	California Legislation	Lumber Liquidators flooring with formaldehyde 6-20 times the limit; -26% in stock price[77]	2015
Coatings	California Legislation	Manufacturers must provide post-use disposition for architectural paint or face $10,000 daily fines[78]	2012
Electronics	EU RoHS	Apple and HP eliminated substances of concern for market access[79]	2011
Electronics	EU RoHS	29% of US firms lost or delayed EU sales due to non-compliance (average $1.84 million per firm)[80]	2006-2010
Chemicals & Electronics	EU REACH and RoHS	Global compliance: $32 billion for RoHS and $2 billion for REACH[81, 82]	2006-2010

"The EU is legislating the phase out of certain chemicals, such as perfluorinated chemicals, often before the US… In addition, the industry sometimes moves on its own when it's the right thing to do and customers demand it."

– Todd Copeland, Environmental Responsibility Manager, Patagonia

Toxics Bills Adopted by States[83]



Safer States—a network of organizations advocating for and tracking chemical legislation—notes there is greater state regulation than federal regulation, including identifying chemicals of concern and requiring disclosure for consumer products.[84] As a result, companies must choose to comply with numerous restrictions or the most stringent state. A significant number of small businesses actually support stronger chemical regulation to protect health and safety and possibly to reduce the variability of the regulatory landscape.[85]

Research Findings

Theme 7: Business Value at Risk

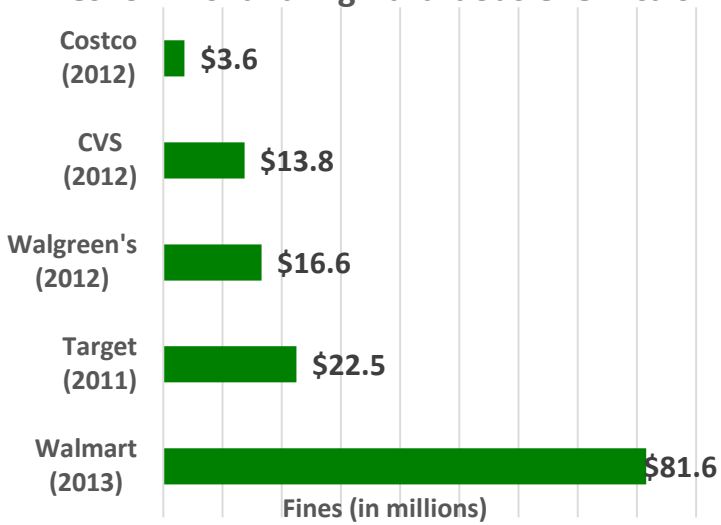
Impacts on Business Value

Sector	Business Value at Risk	Impact	Time Period
All	Federal Enforcement	$9.7 billion in private industry cleanup actions and equipment, along with $163 million in fines[86]	2014
All	Tort Settlements	$17 million in settlements for violating California Prop 65[87]	2013
Consumer Products	Lawsuits	25 lawsuits filed against companies using BPA in their products[88]	2009-2010
Beauty & Personal Care	Market Share	-8.4% in market share of Johnson & Johnson due to consumer concern about ingredients[89]	2008-2010
Toys	Shareholder Value	-25% stock price of RC2 from lead-painted toys[90]	2007
Health Care	Market Share	Existing vendor lost $70 million contract because it could not provide PVC/DEHP-free medical products[91]	2005-2010
Chemicals	Market Value	$200 billion (or 31% of assets' value) due to lawsuits and toxic releases[92]	2001
Chemicals	Regulatory Fines	$16.5 million of DuPont for Teflon® pollution; faced class-action lawsuits[93]	2005-2008

"The industry must get ahead of customers' changing expectations… The definition of a 'good product' is partially about its chemistry."

– Rob Kaplan, Director, Product Sustainability, Walmart

Fines for Mishandling Hazardous Chemicals[94]



Companies must consider the potential business value risks of fines, consumer doubts and product liability from manufacturing or using hazardous chemicals. For example, retailers recently have been fined significantly for mishandling hazardous materials. In addition to the fines, retailers may suffer a tarnished reputation and lost sales and must address any crisis at hand. These considerations factor into retailers' efforts to leverage suppliers to disclose and improve their product ingredients, as well as develop chemical safety policies.

Research Findings

Theme 8: Costs of Accidents and Incidents

Societal Costs and Environmental Impacts

Sector	Accident / Incident	Impact	Time Period
All Sectors	Spills and Accidents	27,500 toxic chemical spills and other accidents (annually), which are associated with 1000 deaths[95]	2012
Chemicals	Remediation & Restoration	$722 million for Dow and $478 million for DuPont[96, 97]	Present liabilities
Chemicals: Herbicides	Agent Orange Production	$93 million by Monsanto for home cleaning and medical testing[98]	2012-2042
All Sectors	General Exposure	$76.6 billion spent annually for results of childhood exposure[99]	2010
All Sectors	General Exposure	$5 billion health care savings yearly by reducing chemical exposure[100]	2011
All Sectors	Workplace Exposure	$1.4 billion in direct medical costs and indirect costs in California[101]	2004

"Let's get chemical data in order to make smarter decisions… In the effort to find replacements for chemicals of concern, let's not make regrettable substitutions."

– Beth Jensen, Director of Corporate Responsibility, Outdoor Industry Association

In 2014, a leaking storage tank was found polluting the Elk River near Charleston, West Virginia—the drinking water source for 300,000 people—with the chemical 4-methylcyclohexane methanol, used to process coal. Almost 600 people visited emergency rooms and 13 were hospitalized with symptoms related to the spill. The local economic impact of lost business activity was $61 million, which does not include the spill's clean-up costs, emergency expenditures or the intangible costs of public health authorities having insufficient toxicity data and being unable to convey the risks to residents. Freedom Industries, which owned and operated the facility, filed for Chapter 11 bankruptcy protection due to dozens of lawsuits from residents and businesses. A class-action lawsuit was settled for $2.9 million, but other lawsuits remain. The company pled guilty to federal crimes for the spill and water contamination. Six employees also were federally indicted.[102-108]

Research Highlights

We found that safer chemistry's potential for creating business and economic value is promising, but not yet fully realized. Customers (including consumers, institutions, large retailers and public agencies) are conveying signals to brands, manufacturers, formulators and chemical companies. Actions are being taken, R&D is occurring and new chemistry is being developed. However, these changes are limited, primarily reactionary (not proactive) and situational (not comprehensive). The potential for innovation may lie within specialty chemicals and relatively niche chemical formulators, although leveraging and scaling that change can be challenging. More widely, small businesses can serve the growing demand through their unique nature as test beds for problem-solving and their often mission-driven approach to product and service development.

In order for the US chemical value chain to realize the potential market growth for safer chemistry, as well as benefit public health and the US economy, it will need to develop formulations that meet the emerging demand and individual companies will need to work together to bring these formulations to market within products. Various initiatives are being undertaken at each stage of the chemical value chain, but these efforts and successes need to be coordinated toward common objectives. Proactive research and substitution of hazardous chemistry with safer alternatives (before it is legislated or becomes the target of NGO activism) is the best strategy for preventing losses in business and economic value. Specific advantages include the following:

- Reduce costs for workplace safety and materials management, including worker compensation, protective equipment and health care.
- Avoid a reactionary approach to the evolving lists of restricted substances that state governments and corporate customers are mandating.
- Prevent chemicals management risks and incidents that can result in fines, decreased demand, NGO and consumer action and long-term reputational damage.
- Demonstrate a company's human health and environmental leadership, as well as innovative design and long-term vision.

Research Highlights

Opportunities to increase business value

Market growth, capital flows and market demand have shown an upward trajectory during the past 5 years. The global market for "green chemistry"—as defined by Pike Research to include biobased chemicals, renewable feedstocks, "green" polymers and less-toxic chemical formulations—has been projected to grow from $11 billion in 2015 to nearly $100 billion by 2020. The North American market for "green chemistry" is projected to grow from $3 billion to over $20 billion during the same period.[109] This opportunity also is underscored by an increasing number of chemical companies reporting that their customers are expressing an interest in "sustainable chemistry"—rising from 57% in 2009 to 62% in 2014—as identified by the research firm ICIS.[110] Large institutional and governmental buyers have declared their intent to purchase materials with safer ingredients and several of the nation's largest retailers have adopted policies to source personal and home care products with safer chemistry. These initiatives have the potential to create significant demand for suppliers as the policies are implemented into purchasing programs.

The interviews and literature provided examples of companies, both large and small, that are able to demonstrate increased business value by incorporating safer chemistry into their products. Large multinational corporations (such as Dow, DuPont or Sigma-Aldrich) have higher sales growth of a safer chemistry product portfolio, as compared to sales of conventional chemistry. Smaller companies whose value proposition is based on safer chemistry (such as Seventh Generation or Method) are able to demonstrate continued growth.

Trend data on capital flows was very limited; however, there is a notable trend in the increase in patents for "sustainable chemistry," suggesting that R&D investment is increasing and companies are viewing safer chemistry as an opportunity for competitive advantage and brand differentiation. The broad clean tech sector received $267 billion in investments between 2007 and 2014 and data from 2009 report $131 million in venture capital investment in "green materials" in the US.[111, 112] Moving forward, investment in safer chemistry could be spurred by new mechanisms, such as green bonds, which to date have focused primarily on climate change.

Interviewees also highlighted the emerging demand for increased transparency of material ingredients. For example, programs such as Health Product Declarations, Zero Discharge of Hazardous Chemicals, and the California Safe Cosmetics Act database create expectations for manufacturers and formulators to disclose on potentially toxic or hazardous material ingredients. These programs are still in their infancy but have the potential to create market demand and a "race to the top" for companies that disclose how they incorporate safer chemistry into their products.

Research Highlights

Business and economic value at risk

This research identified examples of sizeable business risks posed by traditional chemistry that safer chemistry could alleviate. The research findings suggest that expanding regulations and continued NGO and shareholder activism could challenge the almost $700 billion in annual sales produced by the North American chemical industry (2013).[113] Interviewees and the literature pointed to the importance of government regulations—especially by states—of product ingredients and chemicals management as a driving force behind change. Staying ahead of the regulatory and NGO agenda in order to avoid business disruption was a common theme enforced by several interviewees. Loss of access to major markets, such as the examples for the personal care market, places significant value at risk. The research uncovered a number of examples and specific incidents related to chemical accidents or mismanagement where the value of business revenue loss, economic loss and social costs are significant. Quantifying the total business risk to which the chemical industry is exposed, or the overall nationwide societal costs and benefits of safer chemistry, is complex and was beyond the scope of this research.

Data gaps

As expected, the research findings were limited by the lack of comprehensive, robust analyses and data on economic opportunities and risks specific to the adoption of safer chemistry at an industry-wide scale. As an example, although there is a large amount of consumer market research about households' interest in purchasing "greener" products, it is not clear to what extent this interest is related to the specific use of safer chemistry as compared to other product attributes such as recycled content or energy savings. Further, there is limited public disclosure on revenues associated with safer chemistry by large publicly traded corporations. We also were unable to identify any economic studies that quantified the full societal costs and economic benefits of conventional chemicals as compared to safer chemicals. Interviewees provided insightful commentary based on experiences within their own organizations and market segments but in many cases, they were not able to provide primary data on the 8 research themes because data regarding safer chemistry either is unavailable or commercially sensitive. The Appendix to this report provides details on data gaps identified through the research.

Recommendations

1. **Businesses that have not yet evaluated their individual business case for safer chemistry within their specific product portfolio and market segment are strongly encouraged to do so, given the potential for revenue growth and business value at risk.**
   - Businesses should assess their individual cases for adopting safer chemistry. The 8 research themes used in this study—and the range of values that they capture—can provide a framework for the assessment.
2. **Metrics that relate to business and economic opportunity (and risk) should be tracked and communicated, to help spur business understanding of safer chemistry and public policy mechanisms for data disclosure.**
   - Interviewees noted that proactive efforts to stay ahead of state regulations and activist campaigns were very important and effective in avoiding business disruption or loss of product quality. A systematic and regular approach to tracking this information could be very helpful in creating broader awareness and uptake in the business community.
   - Job growth trends are promising but are limited in their coverage. Government agencies should renew their efforts to track and project this information so that communities can be empowered to make a stronger economic case for action.
3. **The total societal benefits associated with the total addressable market for safer chemistry should be quantified and communicated to policy maker and investors.**
   - To date, efforts to implement safer chemistry appear to be largely reactionary and situational. A clear accounting of the societal benefits for safer chemistry (that is, the potential reduction in the societal costs of human health and environmental impacts from conventional chemistry) at an industry-wide scale will provide a stronger basis for policy-related mechanisms. Further, companies that target solutions at major environmental problems will be creating benefits for the global economy.
   - A clear communication of these benefits can influence the regulatory environment, attract capital from impact investors and demonstrate to stakeholders that the investment in innovation provides measurable societal and environmental results.
4. **Existing safer chemistry initiatives should be catalyzed, harmonized and aligned through a value chain approach and used to leverage capital flows toward safer chemistry innovation.**
   - Safer chemistry initiatives should focus on selected market segments or industry verticals where chemicals are the basis for a large portion of the market value.
   - Disparate efforts across the chemical value chain should be focused toward shared objectives for safer chemistry, through cooperative communications and research. Company representatives, industry associations and government agencies can facilitate this cooperation.
   - Stakeholders should engage with the investment community to help explore opportunities to grow or hasten capital flows toward safer chemistry approaches. For example, the recent growth in green bonds, socially responsible investments and new investment products (such as investment indices related to more sustainable business models) may provide opportunities for both large and small companies that are seeking capital for safer chemistry initiatives.

Recommendations

5. **Stakeholders should work toward a common understanding and communicate with clarify on the specific aspects of safer chemistry that they are addressing, since the topic can encompass many different production aspects and product attributes.**
   - The 12 Principles of Green Chemistry are very well defined and incorporate a broad range of goals and activities.[114] However, a number of interviewees noted confusion within the industry around the labels of "safer chemistry," "green chemistry" and "sustainable chemistry." Companies, industry sectors, public agencies and NGOs often speak about different conceptions of safer chemistry. This makes it challenging for businesses across the chemical value chain to work toward shared purposes since individual participants may be addressing different definitions of "green chemistry" (for example, energy efficiency vs lower toxicity). By targeting limited resources around a specific objective—such as developing and using less toxic or hazardous chemicals—stakeholders would be more likely to catalyze action.
   - A number of interviewees noted the difficulty in translating the potential benefits of adopting safer chemistry into conventional business terms for their peers in finance, marketing and procurement. The results of this research, which center on documenting the business and economic value of safer chemistry, should be helpful in bridging this communication gap. We recommend that stakeholders continue to quantify and monetize the value of safer chemistry in cross-sector communications, research and publications.
   - Given the number of different stakeholders in the chemical value chain, more consistent metrics and precise terminology are needed. Without this, progress will be slow. Specificity is needed when discussing "safer chemistry" to help measure the business and economic opportunities that can be achieved.

6. **Priorities for filling data gaps should include gathering more specific market research to quantify the potential for job growth and revenue opportunity for safer chemistry (as more narrowly defined), more specifically by product segment and industry vertical.**
   - Existing market research cited in this study includes a broader range of safer chemistry attributes (for example, biobased) than only product safety and toxicity. Market research should build on the existing data synthesized by Pike Research and also refine the analysis by industry sector, especially for cosmetics and beauty, cleaning products and health care.
   - Measuring and reporting activity within the areas of capital flows and job growth—both existing and prospective—could help motivate industry change. Such data could leverage individual companies, investors, policy makers and communities to push for safer chemistry innovation and work together towards a shared goal, in order to realize the potential benefits and change the marketplace.

Appendix: Research Methodology

1. **Interview experts with working knowledge of the business value of safer chemistry.**

   ASBC, GC3 and Trucost collaborated to identify and invite industry leaders to provide their perspective on how safer chemistry may increase opportunities for positive business value, as well as decrease risks to business value.

2. **Conduct literature research to assemble compelling evidence for each research theme.**

   Trucost applied its perspective of identifying and valuing impacts on natural capital to the chemical industry. Trucost researched the themes objectively and focused on documented examples of business and economic value.

3. **Scale these examples and their impacts to the overall market.**

   Wherever possible, based on the clarity of data and applicability to the entire chemical industry, Trucost scaled the impacts identified through the research to the larger chemical value chain and economy.

Appendix: Data Gaps

Trucost was engaged to gather information via interviews and existing literature on 8 research themes and trends within each. The research was conducted objectively, to identify both quantitative and qualitative examples attributed to traditional chemistry and safer chemistry—defined as developing and using chemicals that are less hazardous—without working to justify any particular perspective. During the research, we identified a number of data gaps, as identified below. One overarching challenge was the variability of how "safer chemistry" was defined for industry sectors, in specific businesses or within publicly-available research. Since the focus of this project was chemistry that is less hazardous, we made a significant effort to examine only those report findings pertaining to that definition. For example, data on socially responsible products was not included in the research. The data gaps below should help define areas for future analysis and tracking.

Research theme	Data gaps identified
1. Market growth	The most significant challenges in evaluating market growth were the lack of reported data, the confidential nature of data that was available and the variety of ways that "safer chemistry" is defined across the industry. These challenges were present for specific participants within the chemistry value chain, as well as for the larger sectors. Collaboration among companies to measure market expansion could enhance data collection and tracking.
2. Trends in capital flows	Measuring the capital flows devoted to safer chemistry was affected by the relative newness of safer chemistry as a target for venture capital, commercial loans or even public funding. The primary capital source for safer chemistry enhancements has been companies' internal funding. There is a need to expand the availability of alternative sources of capital, such as green bonds, which are rapidly growing in use but have not been widely applied to safer chemistry.[115, 116] Still, Unilever recently issued $370 million in green bonds to finance emissions reductions.[117]
3. Market demand	Similar to market growth, limited data on market demand is publicly available due to the confidential nature of the data and the various definitions applied to "safer product" offerings throughout the chemical value chain (congruent with the broad definition of the 12 Principles of Green Chemistry). For example, a manufacturer may address the energy efficiency attributes or renewable resource content of its product under the label of "green chemistry."
4. Job growth	The employment opportunities associated with safer chemistry was the theme most lacking in quantified data. "Green" job trend data was available, but limited for positions associated with less hazardous chemistry. Further, as with many of the research themes, anecdotal data was identified, but studies of the overall potential for job creation have not been conducted. The European Union is beginning to measure such indices, but forecasts for the US are needed.

Appendix: Data Gaps

Research theme	Data gaps identified
5. Shareholder and NGO activism	Data on the impacts of shareholder and NGO activism are more widely available, most likely due to the long history of these initiatives to leverage safer chemistry in the market. However, the full direct costs borne by a company often are unknown, along with the indirect (and, typically larger) costs resulting from reputational harm. Campaigns are pushing for full ingredient disclosure, information on human health impacts and responsible substitution, encouraging companies to utilize safer chemistry.[118] Target product categories include personal care, baby products, apparel and footwear, healthcare, electronics, building materials and furnishings.
6. Chemical restrictions	Governmental chemical restrictions obviously are well documented and publicly available. However, the impacts to business and economic value have not been well measured, at least not in the US. Studies of such impacts have been conducted for legislation in the European Union and other regions where more extensive public restrictions exist. The business value of chemical restrictions implemented by companies for their vendors have not been disclosed publicly, although they increasingly are a cost of doing business within the overall chemical value chain.
7. Business value at risk	There are multiple anecdotal examples of business value at risk from not utilizing safer chemistry across measures such as regulatory fines and losses of market share, shareholder value or reputational value. However, future analysis should collect two additional types of data—empirical valuations of safer chemistry's impact and data on its potential for increasing business value. Such analysis will be aided by clarifying the definition of "safer chemistry" among stakeholders, as well as enhanced data collection throughout the chemical value chain.
8. Societal costs of accidents and incidents	Similar to the research theme of business value at risk, societal costs of accidents and incidents are—by their nature—anecdotal and based on negative impacts. Increasing scientific understanding of the connections between chemical exposures and human health effects will improve the quantification of societal impacts of accidental releases. For example, a recent study estimates that hormone-disrupting chemicals risks causing health problems costing at least $175 billion annually in Europe alone.[119] Similar studies should be conducted for exposures in the US. As available, such data will underscore the potential positive value of the transition toward safer chemistry in various applications.

Appendix: Interviewees

AkzoNobel	Edwin Bisinger, Dale Steichen and Sandy Moran
Best Buy	Alexis Ludwig-Vogen
Cattermole Consulting	Amanda Cattermole
Construction Specialties	Howard Williams
Earth Friendly Products	Kelly Vlahakis-Hanks
Elevance Renewable Sciences	Andy Shafer
Elm Street Ventures	Adrian Horotan
Investor Environmental Health Network	Richard Liroff
Kaiser Permanente	Kathy Gerwig
Naturepedic	Barry Cik
NatureWorks	Steve Davis
Outdoor Industry Association Chemicals Management Working Group	Beth Jensen
Patagonia	Todd Copeland
Seventh Generation	Martin Wolf
Sigma-Aldrich	Jeffrey Whitford and Samy Ponnusamy
Solazyme	Jill Kauffman Johnson
Walmart	Rob Kaplan

Appendix: Interview Notes

The interviews of industry leaders provided valuable real-world context for the current and potential transitions within the chemical value chain toward safer chemistry. Below, we have included brief notes from each interview. In order to respect interviewees' requests for treating many of their comments as confidential, we have limited the reporting and included content approved by each interviewee.

AkzoNobel

- Our company commitment is to employ safer chemistry and safer practices
- We are responding to customer and market demand
- The potential value loss of problematic chemistry could be enormous for any chemical company
- Positive opportunities include USEPA Design for the Environment labeling, which certain customers require
- We perceive an opportunity for increasing market share through more biodegradable materials
- It is somewhat difficult to quantify revenue growth from "greener chemicals" at this time, the green premium is difficult to achieve
- Safer chemistry is an important part of continuous improvement and product stewardship
- "Greener"/"safer" chemistry is seen now as a positive to driving forward or making the business case
- Coming to a more consistent understanding of "greener" and "safer" is important to help drive development of new chemistry

Best Buy

- Primarily a confidential interview
- There is inherent value in safer chemistry
- Redesigned Best Buy branded televisions to have an external power supply which reduced the need for flame retardants
- Providing safe recycling of electronics in stores to keep hazardous chemicals out of the environment

Appendix: Interview Notes

Cattermole Consulting

- Restricted substances lists are being used by companies as a first step
- The goal should be to go above and beyond compliance
- Strategy to manage chemicals in companies' products and supply chains
- Triclosan, antimicrobials, children's toys and baby clothes are examples of safer chemistry efforts being undertaken

Construction Specialties

- Safer chemistry has a business value for Construction Specialties (C/S)
- Customer awareness of C/S and NGOs inviting us to participate in learning efforts
- "Green chemistry" is more talked about in the NGO community versus the purchasing community
- Previous investments are making their way into commerce and spurring further work
- The present market continues to expand and LEED v4, the Living Building Challenge, and AIA's Materials Matter will accelerate this already strong base

Earth Friendly Products

- Manufacture 150 all-natural cleaning products
- All the chemistry we use is "green chemistry"
- Have quadrupled the business in 5 years
- In mainstream markets, such as Costco, Sam's Club and Walmart
- Retail growth in sustainable products has been huge; no longer need to knock on doors, but being pulled in
- "Green chemistry" definition has no one watchdog group
- USEPA DfE (Design for the Environment) is very valuable for us, such as with Sam's Club

Appendix: Interview Notes

Elevance Renewable Sciences

- We make specialty chemicals from renewable feedstocks
- Spur market adoption through government regulation, as well as industry driving itself
- Consumers' desire to have safer products is a driver

Elm Street Ventures

- Confidential conversation
- "Green chemistry" innovation can come in many different ways

Investor Environmental Health Network

- Documents are available through the IEHN website to provide context on safer chemistry initiatives
- Litigation risk and fiduciary responsibility are important factors in safer chemistry
- Issue examples include lead poisoning, Sony PlayStation, skin lightening chemicals, flame retardants, HFCs and others
- Chemical company acquisitions as "green plays"
- Drivers include EU regulations, NGO campaigns and surprise scientific findings

Kaiser Permanente

- Industry must move rather than wait for public policy
- Health care savings by not having people exposed to hazardous chemicals
- Formulate from ground up to be inherently safe instead of chemical-by-chemical restrictions
- Marketplace does not always have what KP wants; purchasers and suppliers need to collaborate
- Clearly signal the market for safer chemistry, but products must also perform well and be cost effective

Appendix: Interview Notes

Naturepedic

- Transparency of the chemicals used in everyday products is necessary to allow consumer market forces to drive change
- When consumers become aware of choices, companies can then benefit financially from offering safer chemistries
- Naturepedic has been experiencing approximately a 20% job growth year-over-year
- While studies question the legitimacy of the BPA replacements, many of which are now seen as questionable "regrettable substitutions," the fact remains the public immediately embraced the claims, looking for ways to select safer chemistries
- Our belief is that for effective change toward safer chemistries to occur, multiple audiences must be addressed
- All indications suggest that the demand for safer chemistries will be rapidly expanding over the next five to ten years
- We frequently get offers from various green capital businesses

NatureWorks

- Have never led with "greener chemistry" or "safer chemistry" argument
- Customers interested in moving away from PVC and polystyrene which are being banned—as litter concern, instead of interest in "green chemistry"
- Interest by customers because NatureWorks PLA is recyclable and compostable
- Such innovation helps generate jobs in the US

Appendix: Interview Notes

Outdoor Industry Association Chemicals Management Working Group (joint effort with the Sustainable Apparel Coalition)

- Developing tools and resources for product designers and developers to make informed decisions about the chemicals they are sourcing
- Industry collaboration with chemical companies to bridge technical and chemical knowledge about products and ingredients
- Having the business case conversation with member companies around chemicals tracking and management to maintain brand reputation and ensure product quality
- Sustainability as means for supply chain resiliency, access to markets and a proactive (vs. reactive) approach to managing regulations
- Water repellency task force as example; understand where data gaps exist for the industry and articulate those needs for research efforts

Patagonia

- Todd leads the Chemicals Management Working Group for Outdoor Industry Association
- Goal is to avoid not complying with legislation, which requires a company to adapt within a short period of time
- There is an advantage in adopting “green chemistry”, including the opportunity to innovate and other benefits, in advance of one’s competitors
- Government laws are always lagging behind change in the industry
- Developed an advanced denim process to eliminate water chemistry
- Company mission statement is environmentally designed products and “green chemistry” is part of that
- PFOS: making an opportunistic change by moving faster and faster away from fluorinated chemistry, even in the absence of US regulations

Appendix: Interview Notes

Seventh Generation

- Value to the consumer comes from quality, consistent delivery and the relationship between price and performance, so that customer can see the incremental value that comes from sustainability
- The mainstream does not see significant value in safer chemistry; the benefits are hidden to the mainstream
- A barrier to embracing safer chemistry is that safer chemistry may not be seen as part of product quality by the consumer; thus one cannot ascribe value to safer chemistry
- Seventh Generation uses ingredients as a point of differentiation; some retailers give preferred placement on retail shelves in response
- 6-10% annual growth in natural products compared to near-zero growth in conventional products

Sigma-Aldrich

- Transition to "green chemistry" can be helped by performance and quality, cost parity and unlimited availability of the "green chemistry" supply chain materials
- Cyclopentyl Methyl Ether (CPME) is a "greener" solvent replacement for ether solvents like THF, ethyl ether and MTBE with a higher resistance to peroxide formation in certain applications
- The regulatory environment will continue to drive increased need for "green chemistry," therefore creating a significant market opportunity for Sigma-Aldrich and those in the industry
- Increased collaboration among academia, governments and industry will accelerate the pace of innovation in "green chemistry"

Solazyme

- A primary driver of "green chemistry" is regulatory requirements
- Consumers want to know what ingredients are in a product
- Also need an internal champion
- A company can demonstrate its leadership by working to reduce toxics

Appendix: Interview Notes

Walmart

- "Green chemistry" regulation has not really occurred at the federal level
- Driven by customer demand, including the Sustainable Chemistry Policy
- The definition of a "good product" is partially its chemistry and customer expectations about ingredients are changing
- Industry needs to bring "green chemicals" to scale and catalyze innovation
- Industry also needs procedures and approaches to make better products and bring them to market
- Transition the focus from only identifying "greener chemicals" to making better products

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**Uncited personal quotations were obtained through the interviews conducted during this project.*

Appendix: Acronyms

Acronym	Term
ASBC	American Sustainable Business Council
BPA	Bisphenol A; a chemical used primarily in the production of polycarbonate polymers and epoxy resins
BFRs	Brominated flame retardants
CAGR	Compound Annual Growth Rate
CPME	Cyclopentyl methyl ether; a solvent
CPSC	Consumer Product Safety Commission
DEHP	Di-(2-ethylhexyl)phthalate; a plasticizer (softener) in many products made of polyvinyl chloride
DfE	USEPA Design for the Environment certification; recently renamed to Safer Choice
GC3	Green Chemistry & Commerce Council
GSA	General Services Administration
HFCs	Hydrofluorocarbons; compounds consisting of hydrogen, fluorine and carbon
MBTE	Methyl tert-butyl ether; an organic compound and gasoline additive
MSCI World	MSCI Inc.; a stock market index of 1,612 ‘world’ stocks
NGO	Non-governmental organization
PBTs	Persistent bioaccumulative and toxic chemicals
PBDE	Polybrominated diphenyl ether; a class of organobromine compounds that are used as flame retardants

Appendix: Acronyms

Acronym	Term
PFOA	Perfluorooctanoic acid; a processing aid in the manufacture of fluoroelastomers and fluoropolymers
PFCs	Perfluorinated chemicals
PFOS	Perfluorooctanyl sulfonate; a perfluorinated chemical
PLA	Polylactic acid; a biobased polyester polymer
Prop 65	California Proposition 65 that became the Safe Drinking Water and Toxic Enforcement Act of 1986; requires businesses to notify Californians about significant amounts of chemicals in the products they purchase, in their homes or workplaces, or that are released into the environment, based on a list of chemicals known to cause cancer or birth defects or other reproductive harm that is published by the state
PVC	Polyvinyl chloride, or vinyl; a polymer
R&D	Research and development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals; a European Union regulation making industry responsible for assessing and managing the risks posed by chemicals and providing appropriate safety information to their users; also, the European Union can take additional measures on highly dangerous substances
RoHS	Restriction of Hazardous Substances Directive; a European Union regulation restricting the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment
ROI	Return on investment
THF	Tetrahydrofuran; a solvent
USEPA	US Environmental Protection Agency
USGBC	US Green Building Council