CHEMICALS
Research Brief

SASB’s Industry Brief provides evidence for the material sustainability issues in the Chemicals industry. The brief opens with a summary of the industry, including relevant legislative and regulatory trends and sustainability risks and opportunities. Following this, evidence for each material sustainability issue (in the categories of Environment, Social Capital, Human Capital, Business Model and Innovation, and Leadership and Governance) is presented. SASB’s Industry Brief can be used to understand the data underlying SASB Sustainability Accounting Standards. For accounting metrics and disclosure guidance, please see SASB’s Sustainability Accounting Standards. For information about the legal basis for SASB and SASB’s standards development process, please see the Conceptual Framework.

SASB identifies the minimum set of sustainability issues likely to be material for companies within a given industry. However, the final determination of materiality is the onus of the company.

Related Documents

• Chemicals Sustainability Accounting Standard
• Industry Working Group Participants
• SASB Conceptual Framework

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INTRODUCTION

The Chemicals industry is a mainstay of modern industrial economies, and its products are found in nearly all consumer and industrial products today, from cosmetics to automobiles. The American Chemistry Council (ACC) estimates that more than 96 percent of all manufactured goods are directly or indirectly reliant on the Chemicals industry’s products. The industry’s products have enabled advancements including greater energy efficiency, improved agricultural productivity, food and beverage preservation, safer and more lightweight vehicles, life-saving pharmaceuticals, durable clothing, modern computing, and myriad other benefits to society.

As the global middle class expands, demand for consumer goods will likely grow, driving increasing chemical production. This will place greater pressure on limited natural resources and on the environment. In addition, there is mounting concern over the possible human health impacts of chemical substances in products that come into contact with humans. Due to the industry’s substantial energy and resource demands and its wide range of potential environmental and social externalities, this sector has been the focus of regulation and public attention. Management (or mismanagement) of material sustainability issues, therefore, has the potential to affect company valuation through impacts on profits, assets, liabilities, and cost of capital.

Investors will obtain a more holistic and comparable view of performance if chemical companies report, in their regulatory filings, metrics on the material sustainability risks and opportunities that could affect value in the near and long term. This would include both positive and negative externalities as well as the non-financial forms of capital that the industry relies on for value creation.

Specifically, performance on the following sustainability issues will drive competitiveness within the Chemicals industry:

SUSTAINABILITY DISCLOSURE TOPICS

ENVIRONMENT
- Greenhouse Gas Emissions
- Air Quality
- Energy & Feedstock Management
- Water Management
- Hazardous Waste Management

BUSINESS MODEL AND INNOVATION
- Safety & Environmental Stewardship of Chemicals & Genetically Modified Organisms
- Product Design for Use-phase Efficiency

LEADERSHIP AND GOVERNANCE
- Political Spending
- Health, Safety, and Emergency Management
Reducing greenhouse gas (GHG) emissions, particularly carbon dioxide emissions;
Reducing non-GHG air pollution, which can create hazards for public health and the environment;
Managing energy use to reduce the cost of inputs and indirect GHG emissions;
Preventing water contamination and securing water supplies without exacerbating local water stress;
Reducing waste generation, which can adversely impact the environment;
Developing products with reduced environmental and human health impacts;
Promoting customer energy efficiency and reducing air emissions through product innovation;
Managing financial contributions to political, lobbying, or special interest groups focused on sustainability-related regulation or action; and
Minimizing the risk of costly and damaging accidents during the production phase and in chemical handling, ensuring worker health and safety, and promoting a strong safety culture.

I A list of five representative companies appears in Appendix I.
II Chemical wholesale companies, also part of the industry, are a relatively small segment of this industry, therefore this brief will focus on the three major segments listed above.

INDUSTRY SUMMARY

Chemical manufacturers transform organic and inorganic feedstocks into more than 70,000 diverse chemical products with a range of industrial and consumer applications. The majority of chemical products are sold to other manufacturing and chemical companies. The Chemicals industry is commonly segmented into basic (or commodity) chemicals, agricultural chemicals, and specialty chemicals. Basic chemicals, the largest segment, involves the manufacture of commoditized component chemicals or intermediaries in high volumes. Basic chemicals include bulk polymers, petrochemicals, inorganic chemicals, and other industrial chemicals. Agricultural chemicals include fertilizers, crop chemicals, and agricultural biotechnology such as genetically modified (GM) crop seeds. Specialty chemicals include formulated chemical products with special applications, including paints and coatings, sealants, adhesives, dyes, industrial gases, resins, and catalysts. Basic chemicals are a mature, high-volume market. Specialty chemicals are produced in relatively low volumes and earn higher profit margins because of patent protection and/or difficulty in manufacture.

Global Chemicals industry revenue in 2013 was approximately $2.2 trillion. Growth has been

II The chemical subsidiaries of oil companies account for a large proportion of bulk chemical production.
most rapid in the Asia-Pacific region—the ACC reports that sales in the region rose fivefold between 2002 and 2012, while U.S. sales rose by 84 percent in the same period.\(^5\) According to the ACC, the U.S. Chemicals industry currently produces approximately 15 percent of global output,\(^6\) and U.S. domestic sales are expected to exceed $1 trillion by 2018.\(^7\) China, which experienced rapid industrial growth over the past decade, is currently the world’s largest producer, with more than $1.3 trillion in global sales in 2012.\(^8\)

Key industry revenue drivers include domestic product per capita, industrial production, construction activity, and spending on consumer goods. Major cost drivers include the price of feedstocks and energy. Chemical plants are highly complex, research- and capital-intensive facilities. Companies typically allocate between four and six percent of sales to research and development.\(^9\) Key feedstocks include petrochemicals, coal, natural gas, air, minerals, and water. The Chemicals industry is heavily reliant on the oil and gas production industry for petroleum-based feedstocks such as natural gas.\(^10\) Energy is also a key input: chemical plants utilize oil, natural gas, and other fuels to generate the majority of energy on-site, rather than purchasing electricity.\(^11\)

Raw material and energy costs as a percentage of revenue vary depending on the chemicals being produced.\(^12\) Raw materials, energy, and feedstocks account for more than 60 percent of purchases for basic chemical production, while for specialty chemicals, they account for approximately 35 percent. Labor costs as a percentage of revenue are typically less than 15 percent of revenue across the industry’s segments.\(^13\); \(^14\); \(^15\) As discussed earlier, the Chemicals industry is global, and emerging markets have driven much of industry growth in the past decade. OECD\(^iv\) countries’ share of global output fell from 77 to 63 percent between 2000 and 2009, while the combined share of Brazil, Russia, India, Indonesia, China, and South Africa (referred to as the “BRIICS” countries) rose from 17 to 28 percent over the same period. In an attempt to avoid price competition with companies in emerging markets, companies in OECD countries have increasingly turned toward producing higher-value specialty and pharmaceutical chemicals, which require capital, advanced technology, and skilled labor. However, developing nations’ share of specialty chemicals is also on the rise, according to the OECD.\(^16\) The majority of global investment (roughly 80 percent) is currently focused in developing nations, as OECD multinational firms seek to benefit from lower labor costs, reduced trade barriers, and rising demand in non-OECD countries.\(^17\)

A few large, vertically integrated corporations dominate the Chemicals industry, notably Du

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\(^iv\) The Organization for Economic Co-operation and Development (OECD) is an international economic organization that promotes cooperation on key economic and social policies. Members include the U.S., Germany, France, the UK, Canada, and Japan.
Pont, Dow Chemical, Monsanto, Potash, and LyondellBasell.\textsuperscript{18} However, small firms specializing in a few products manufacture the majority of chemical types in the U.S.: 95 percent of the chemical species produced are manufactured by companies with less than $50 million in revenue and fewer than 50 employees.\textsuperscript{19}

During the economic downturn of 2007-2009, tumbling demand for products such as automobiles, appliances, construction materials, and industrial goods caused a sharp decline in chemical sales. The value of monthly U.S. chemical shipments fell from more than $60 billion in June 2008 to less than $50 billion by January 2009, while total industry output fell by 6.7 percent in 2008 and a further 8.4 percent in 2009. In order to reduce costs, companies reduced capital spending by an average of 20.1 percent during the recession and laid off more than 66,000 workers, or approximately 7.7 percent of the Chemicals industry workforce. Even such drastic cost-cutting measures proved insufficient for some firms. The number of annual bankruptcy filings in the U.S. Chemicals industry rose from 12 in 2006 to 55 in 2009.\textsuperscript{20}

Since the mid-2000s, the boom in U.S. natural gas production has reduced prices of crucial chemical feedstocks such as ethane. This has driven increased capital expenditures by North American chemical companies, including expenditures on ethylene crackers (plants). Ethylene is used to make many plastic products. China, meanwhile, has invested in coal feedstock plants (due to extensive domestic coal supplies), which require large amounts of water.\textsuperscript{21}

Financial analysis of the Chemicals industry focuses on volumes of products shipped, prices of feedstocks, and demand in key markets. The price of natural gas and oil affect many feedstock prices, while a company’s production capacity for different feedstocks can also play a role, as some feedstocks are cheaper than others.\textsuperscript{22}

**LEGISLATIVE AND REGULATORY TRENDS IN THE CHEMICALS INDUSTRY**

Regulations in the U.S. and abroad represent the formal boundaries of companies’ operations, and are often designed to address the social and environmental externalities that businesses can create. Beyond formal regulation, industry practices and self-regulatory efforts act as quasi-regulation and also form part of the social contract between business and society. In this section, SASB provides a brief summary of key regulations and legislative efforts related to this industry, focusing on social and environmental factors. SASB also describes self-regulatory efforts on
the part of the industry, which could serve to preempt further regulation.\textsuperscript{9}

The Chemicals industry is one of the most heavily regulated industries.\textsuperscript{23} Federal, state, and local requirements control the release of substances during manufacturing and processing, the toxicity of end products, and the industry’s impacts on human and environmental health. Broadly, environmental and human health regulations are becoming increasingly stringent in most markets, and regulations may impact the industry across operations, supply chains, and end markets.\textsuperscript{24}

Chemicals manufacturing also faces a variety of environmental regulations. In the U.S., the Clean Air Act (CAA) regulates air emissions from operations, while government-instituted cap-and-trade systems governing emissions of nitrogen oxides ($\text{NO}_x$), sulfur oxides ($\text{SO}_x$), and carbon dioxide ($\text{CO}_2$) exist in some areas. This includes a regional NO\textsubscript{x} trading program in the U.S. Northeast and a nationwide acid rain program.\textsuperscript{25}

The E.U. emissions trading system is the largest international system for trading GHG emissions allowances and has the goal of reducing GHG emissions of covered sectors by 21 percent by 2020 from 2005 levels.\textsuperscript{26} Additionally, under the U.S. Environmental Protection Agency’s (EPA) Greenhouse Gas Reporting Program (GHGRP), facilities emitting greater than 25,000 metric tons of carbon dioxide equivalent ($\text{CO}_2\text{e}$) must report total GHG emissions. The GHGRP is designed to collect data to inform future policy decisions, including programs to reduce emissions.\textsuperscript{27} China, which accounts for nearly 30 percent of global GHG emissions, has also promulgated GHG emission-reduction legislation, including a pledge under the 2009 Copenhagen Accord to achieve a 40 to 45 percent reduction in carbon intensity from 2005 levels by 2020.\textsuperscript{28} The country also pledged in 2014 to cap its emissions growth by 2030.\textsuperscript{29} China will achieve these reductions partly through a national carbon trading market set to launch in 2016. The program will cap emissions for large industrial sources, including chemical manufacturers. When finalized, it will be the world’s largest emissions trading scheme.\textsuperscript{30}

Although there is currently no federal carbon emissions-reduction regulation in the U.S., certain states and regions have implemented carbon cap-and-trade programs in order to reduce emissions. The most prominent example is California’s GHG reduction law, commonly known as AB 32, which took effect in January 2012. The program introduced an emissions cap for industrial and other major emitters, which will be reduced by approximately three percent annually. Facilities must reduce emissions or offset them by obtaining emissions credits.\textsuperscript{31} International GHG regulation may also affect the industry. In Canada, Quebec Province

\textsuperscript{9} This section does not purport to contain a comprehensive review of all regulations related to this industry, but is intended to highlight some ways in which regulatory trends are impacting the industry.
maintains a cap-and-trade program for industrial emitters that emit 25,000 metric tons or more of CO₂e annually. As the urgency of addressing climate change increases, such policies aimed at mitigating GHGs, particularly from high emitters, are likely to increasingly impact companies in the Chemicals industry.

The Clean Water Act (CWA) of 1972 set water discharge quality requirements for industrial sources, including chemicals facilities. In the U.S., chemical companies must apply for National Pollutant Discharge Elimination System (NPDES) permits in order to emit process wastewater directly to surface waterways. The Resource Conservation and Recovery Act (RCRA) directs the EPA to track hazardous wastes from “cradle to grave,” and includes solid waste in its definition of hazardous wastes. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or “Superfund”) established regulations for funding the remediation of current and past discharges of CERCLA-listed hazardous wastes, as well as measures to mitigate hazardous waste disposal. The EPA has the authority to levy fines against entities that do not comply with the above regulations, and the agency may also require violators to make necessary adjustments to processes or equipment in order to achieve compliance.

The Emergency Planning and Community Right-to-Know Act (1986) requires U.S. industrial facilities to report annual toxics released to air, land, and water to the EPA in the Toxics Release Inventory (TRI). TRI substances represent possible chronic and acute human health risks and adverse environmental impacts. Within the first ten years of the passage of the Right-to-Know Act, emissions of TRI-listed chemicals fell by 44 percent.

The U.S. Toxic Substances Control Act of 1976 (TSCA) requires the EPA to publish a list of chemical substances manufactured or processed in the U.S. Exclusions to TSCA include substances found in foods, drugs, cosmetics, and pesticides. Today there are more than 84,000 chemical substances on the list. TSCA establishes rules for the production, importation, use, and disposal of toxic material in commerce and authorizes the EPA to ban, label, and test substances. New chemicals coming to market must be reviewed, and the EPA maintains regulatory control over new chemicals at the pre-manufacture stage and has the authority to ban substances from production. The TSCA and similar legislation balance the need for chemical safety transparency with the need to protect companies’ intellectual property. Banned substances or otherwise regulated production can negatively impact revenue.

However, slow modernization of the TSCA has led many states to adopt their own chemical policies, including a focus on safer alternatives. The TSCA has received criticism for being outdated, failing to keep pace with the rapid pace of chemical innovation, and not being stringent enough about requiring
chemical safety to be determined before substances are allowed to be sold. Efforts have also been made at the federal level to introduce more stringent chemicals regulation. In 2011, the Safe Chemicals Act was introduced to the U.S. Congress. The Act aims to amend the existing TSCA framework, including provisions that necessitate manufacturers to require that a chemical is safe before it can be sold. The bill was reintroduced into Congress in April 2013.

Due to the global nature of chemical manufacturing and trade, companies have to operate under multiple chemical safety regulatory frameworks. The E.U.’s Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is one of the most comprehensive chemicals regulations, and affects the importation of chemicals into the E.U. The system, which entered into force in 2007, controls production, marketing, and application of chemicals within the E.U., including products imported from outside the region. Manufacturers are required to submit registration of chemicals produced or imported in volumes greater than one metric ton, including substances in mixtures. Registered chemicals of high concern may eventually be banned from sale unless a company exemption is granted. Implementation of REACH registration requirements is staggered by production volume over several years. Approximately 30,000 chemicals are expected to be registered by 2018. The European Commission estimates direct costs of REACH to the European Chemicals industry to be €5.2 billion between 2007 and 2022.

The Stockholm Convention on Persistent Organic Pollutants is an international United Nations treaty, effective May 2004, which aims to reduce or eliminate the production, use, and release of critical persistent organic pollutants (POPs). POPs remain intact for long periods of time in the environment, become widely distributed, accumulate in the tissue of living organisms, and are toxic to humans and wildlife. Well-known POPs include polychlorinated biphenyls (PCBs) and Dichlorodiphenyltrichloroethane (DDT). Most countries, excluding the U.S., have ratified the convention. Parties to the convention meet periodically to update the list of substances targeted for elimination or reduction.

Much of the current chemical safety regulatory framework is directed at individual chemical substances, but there is growing concern about the potential health impacts of simultaneous exposure to multiple chemicals, termed “mixture toxicity.” As these considerations are likely to be incorporated into legislation in the future, the uncertainty and magnitude of impacts on the industry could increase. A number of voluntary chemical safety and environmental initiatives exist. Responsible Care is a voluntary global chemical manufacturers’ initiative with the aim of improving health, safety, and environmental performance of products throughout their lifecycle. Another initiative embraced by industry and regulators is
green chemistry, a philosophy that centers on the design of chemical products and processes, following 12 principles that broadly address the use of renewable feedstocks, waste minimization, reduced product toxicity, and process energy efficiency. The industry’s adoption of the green chemistry discipline is driven by key sustainability trends including rising energy costs, risks from the industry’s reliance on petroleum-based feedstocks, concern over chemical safety, technological advances, and environmental regulation.50

The Long-Range Research Initiative (LRI) aids investment in chemical safety research, especially with regards to human health. The LRI directly supports scientific research to further the understanding of chemicals’ impact on human health and the environment through innovations in exposure science and toxicity testing.51 The LRI seeks funding from corporations, research institutions, academia, and governmental agencies that are interested in filling gaps in scientific knowledge surrounding chemical safety.52

The industry is also required to adhere to specific employee health and safety standards in manufacturing, including regulations that address process safety and chemical storage. In the U.S., these standards are enforced by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor. OSHA has a National Emphasis Program for chemical facilities, which targets worker protection against hazardous chemical substances, including safety training and chemical handling and storage protocols. Facilities with sufficient quantities of hazardous chemicals covered under the program are subject to random safety inspections to ensure compliance with the program. Companies are also liable for fines.53 Health and safety regulation has typically focused on acute hazards, while chronic health impacts from long-term exposure to chemicals are, in many instances, unknown and loosely regulated.

SUSTAINABILITY-RELATED RISKS AND OPPORTUNITIES

Industry drivers and recent regulations suggest that traditional value drivers will continue to impact financial performance. However, intangible assets such as social, human, and environmental capitals, company leadership and governance, and a company’s ability to innovate to address these issues are likely to increasingly contribute to financial and business value.

Broad industry trends and characteristics are driving the importance of sustainability performance in the Chemicals industry:

- **Intensive use of natural resources:** Chemical companies are heavy users of natural capital inputs such as energy, water, and hydrocarbon feedstocks in their production processes. These inputs also account for a significant
share of total costs for the industry. Regulation related to environmental concerns such as climate change, as well as increasing resource constraints, could lead to higher costs or unstable supplies of these resources, affecting company valuation.

- **Environmental and social externalities of chemical production and use:** The chemical production phase can create negative environmental externalities such as GHG emissions, air and water pollution, and hazardous wastes. Furthermore, some chemicals can harm human health and the environment. With improving knowledge about the toxicity of chemicals, increasing concerns about exposure to, and impacts of, chemicals are driving shifts in demand and increasingly stringent regulations. Such changes could affect the demand for, or constrain the supply of, chemical products.

- **Importance of innovation in a mature industry:** The industry faces progressively stringent regulation and public concern over the lifecycle impacts of chemical products. This is increasing the importance of innovation to create products with reduced externalities and sustainability benefits for customers.

- **Social contract and governance risks:** The industry’s political influence may affect its ability to address environmental externalities in the short term, increasing the probability of adverse regulatory developments in the future. In addition, strong management of operational and process safety can reduce the risk of costly accidents as well as chronic health impacts for workers.

As described above, the regulatory and legislative environment surrounding the Chemicals industry emphasizes the importance of sustainability management and performance. Specifically, recent trends suggest a regulatory emphasis on environmental protection and consumer safety, which will serve to align the interests of society with those of investors.

The following section provides a brief description of each sustainability issue that is likely to have material implications for companies in the Chemicals industry. This includes an explanation of how the issue could impact valuation and evidence of actual financial impact. Further information on the nature of the value impact, based on SASB’s research and analysis, is provided in Appendix IIA and IIB.

Appendix IIA also provides a summary of the evidence of investor interest in the issues. This is based on a systematic analysis of companies’ 10-K and 20-F filings, shareholder resolutions, and other public documents, which highlights the frequency with which each topic is discussed in these documents. The evidence of
interest is also based on the results of consultation with experts participating in an industry working group (IWG) convened by SASB. The IWG results represent the perspective of a balanced group of stakeholders, including corporations, investors or market participants, and public interest intermediaries.

The industry-specific sustainability disclosure topics and metrics identified in this brief are the result of a year-long standards development process, which takes into account the aforementioned evidence of interest, evidence of financial impact discussed in detail in this brief, inputs from a 90-day public comment period, and additional inputs from conversations with industry or issue experts.

A summary of the recommended disclosure framework and accounting metrics appears in Appendix III. The complete SASB standards for the industry, including technical protocols, can be downloaded from www.sasb.org. Finally, Appendix IV provides an analysis of the quality of current disclosure on these issues in Securities and Exchange Commission (SEC) filings by the leading companies in the industry.

ENVIRONMENT

The environmental dimension of sustainability includes corporate impacts on the environment. This could be through the use of natural resources as inputs to the factors of production (e.g., water, minerals, ecosystems, and biodiversity) or environmental externalities and harmful releases in the environment, such as air and water pollution, waste disposal, and GHG emissions.

As discussed above, the Chemicals industry depends on environmental capital such as fossil fuels and water for inputs to production, which is associated with externalities including air and water pollution and biodiversity loss. At the same time, the manufacture and use of chemical products can generate varied environmental impacts affecting land, air, and water resources, as well as impacts on human health.54

As resources become limited, their price and supply may become volatile; at the same time, legislation may seek to address environmental externalities. These factors may affect company valuation through impacts on operating efficiency, the valuation of assets and liabilities, and cost of capital.

Greenhouse Gas Emissions

The Chemicals industry is among the top emitters of GHGs globally, accounting for approximately seven percent of total GHG emissions.55 The stationary combustion of fossil fuels for energy consumption and process emissions resulting from chemical transformation both contribute significantly to the industry’s total direct GHG emissions.56 Natural gas, liquefied petroleum gases, and
natural gas liquids are the primary fossil energy sources within the Chemicals industry. Certain chemicals are more GHG-intensive to produce due to large energy requirements or high levels of process emissions from chemical conversion. These include hydrogen, ammonia, nitric acid, and adipic acid. The production of the top 18 bulk chemicals by volume is responsible for approximately 75 percent of total Chemicals industry emissions and 80 percent of energy demand. Emissions of fluorinated compounds, including refrigerants such as hydrofluorocarbons (HFCs), also contribute to the industry’s GHG emissions due to their high global warming potential. Carbon dioxide represents the vast majority of GHG emissions in the industry, or approximately 85 percent, followed by nitrous oxide (eight percent), and lesser amounts of fluorinated gases and methane.

In developed regions, the industry has achieved substantial improvements in energy efficiency and GHG emissions reduction over the past several decades. In fact, U.S. chemical companies reduced energy consumption per unit of output by almost one-half since 1974, while total GHG emissions fell by 23 percent from 1990 to 2010. In the E.U. between 1990 and 2005, chemical production rose by 60 percent while total energy use was stable, and total GHG emissions fell by 30 percent.

In contrast, rapid expansion of production in China and other developing nations where emissions regulations may be less stringent has been accompanied by higher GHG emissions in those countries. The net result has been a rise in global GHG emissions attributed to the industry.

Chemical companies may face operating and capital expenditures for mitigating GHG emissions and meeting regulatory requirements to purchase carbon credits, pay carbon taxes, or report GHG emissions, including obtaining third-party verification. Conversely, improvements in fuel efficiency and the use of renewable or alternative energy can reduce emissions, giving companies an opportunity to reduce operating costs associated with energy consumption, avoid supply risks associated with traditional energy sources, and lower their regulatory burden. Companies could also possibly earn revenues from the sale of captured carbon or carbon credits under emissions trading programs.

Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

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VI Global warming potential is a relative measure of how much heat a substance traps in the Earth’s atmosphere, typically measured in an equivalent amount of carbon dioxide.
- Gross global Scope 1 emissions, percentage covered under a regulatory program; and
- Description of long-term and short-term strategy or plan to manage Scope 1 emissions, emission-reduction targets, and an analysis of performance against those targets.

Evidence

The Chemicals industry is among the largest industrial consumers of fossil fuel energy, which is a main source of its high GHG emissions. According to data from the U.S. Census Bureau’s 2011 Annual Survey of Manufacturers, the Chemicals industry spent more than $32 billion on purchased fuels. This comprised approximately 2.7 percent of the cost of materials.

Facilities in the U.S. are required to report GHG emissions annually to the EPA under the GHGRP (see the Regulatory Trends section above), at the facility level, if emissions exceed 25,000 metric tons per year. Within the Chemicals industry, 473 facilities reported total carbon dioxide-equivalent (CO₂e) emissions of 174.6 million metric tons in 2013, making the industry the country’s fourth-greatest carbon emitter, responsible for 5.5 percent of the total emissions across all industries in the U.S.

Chemical companies that have emissions above the reporting threshold may face greater risk of additional operating expenses or capital expenditures in the event of additional GHG regulations.

Company financial disclosures reflect concern over GHG emissions regulation trends and potential financial impacts. LyondellBasell Industries warns investors that “…any future potential regulations and legislation could result in increased compliance costs, additional operating restrictions or delays in implementing growth projects or other capital investments, and could have a material adverse effect on our business and results of operations.” There are opportunities related to carbon regulation as well as risks: in FY2014, LyondellBasell garnered surplus emissions allowances under the ETS by maintaining emissions below what the company was permitted to emit. The company values these allowances as intangible assets on its balance sheet, showing the potential financial value of emissions reduction.

Given the link between fuel consumption and GHG emissions, companies have focused their efforts to reduce GHG emissions on energy efficiency improvements. PPG Industries states in its FY2014 Form 10-K, “Since PPG’s GHG emissions arise principally from combustion of fossil fuels, PPG has for some time recognized the desirability of reducing energy consumption and GHG generation. From 2012 to 2013, energy consumption was reduced by 36% and GHG emission generation was reduced by 33%.”

As mentioned above, companies have significantly improved energy and emissions performance in recent years. Dow Chemical,
the 44th largest GHG-emitting entity in the U.S. in 2011, reports in its FY2012 Form 10-K that energy efficiency measures have significantly reduced its GHG footprint and associated costs: the company’s energy consumption in British Thermal Units (BTU) per pound of product fell 40 percent since 1990, eliminating over 200 million tons of GHG emissions, 5.4 quadrillion BTUs of energy, and $25 billion in energy costs.69, 70

**Value Impact**

Managing GHG emissions can directly affect the cost structure of companies in the industry. Specifically, mandated emissions reductions through regulations can increase operational costs and capital expenditures, which lower operating income. At the same time, reducing emissions through improved energy efficiency, the use of renewable energy, or other process improvements can create operational efficiency, reduce costs, and protect companies from further regulations that limit or put a price on emissions. This can reduce business uncertainty and therefore lower the cost of capital. Accrued carbon allowances may increase assets on a company’s balance sheet, while sale of allowances could generate additional revenue.

Furthermore, regulatory fines for non-compliance with emissions regulation can result in extraordinary expenses from fines or legal settlements.

As international and national climate change mitigation efforts continue, the probability and magnitude of these impacts are likely to increase in the near to medium term.

The magnitude of regulatory impacts can be estimated using companies’ Global Scope 1 GHG emissions and the ratio of those covered by regulatory programs. GHG mitigation strategies and targets constitute forward looking indicators of a company risk exposure to stringent emissions reduction schemes, which could significant impact high emitters in the form of taxes or cap-and-trade.

**Air Quality**

Apart from GHGs, which have global impacts, other regulated air emissions from chemical manufacturing include Hazardous Air Pollutants (HAPs), Criteria Air Pollutants (CAPs), and Volatile Organic Compounds (VOCs).71

Specific chemicals released include butadiene, carbon disulfide, carbonyl sulfide, chlorine, chromium, ethylene, methanol, toluene, and xylene.72 HAPs, which account for over half of the industry’s air emissions by weight, include pollutants such as benzene that are known human carcinogens, as well as persistent bioaccumulative pollutants such as mercury.73 VOCs are a precursor to particulate matter (PM) and ozone formation. Particulate matter is associated with health effects such as premature mortality for adults and infants, heart attacks, asthma attacks, and loss of work days, and ozone is associated with impacts on
vegetation and the climate, in addition to its human health effects.

In general, releases of air pollutants stem from the combustion of fuels as well as the processing of raw materials. In addition, the production of key chemicals including sulfuric acid (the most-produced chemical in the U.S.) and nitric acid, used in the manufacture of fertilizers and organic and inorganic chemicals, generates significant volumes of sulfur oxides (SOx), PM, and nitrogen oxides (NOx).74

Although air emissions from chemicals facilities are strictly regulated, increasingly stringent emissions regulations as well as risks stemming from facilities near populated areas could result in increased costs and public health concerns in local communities. Chemical companies could also face restrictions on, or delays in, obtaining permits from state and local agencies if their facilities do not meet specific emissions criteria.75 Furthermore, human health impacts and financial consequences for Chemicals companies are likely to be exacerbated if a facility is closer to a local community.

As with GHG emissions, releases of harmful air emissions from the industry have declined considerably over the past few decades, including a drop by over 50 percent between 1996 and 2005 alone.76 Nonetheless, the industry’s relatively high air emissions generate regulatory risk, and companies must ensure, at a minimum, that facility emissions comply with standards. Non-compliance can result in fines and may require the installation of emissions-reduction equipment. In addition, the industry may face risks from currently unregulated air emissions, or emissions below regulatory thresholds, as public and regulatory concern over air quality drive more stringent air quality legislation or regulatory action.

Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Air emissions for the following pollutants: NOx (excluding N2O), SOx, volatile organic compounds (VOCs), and hazardous air pollutants (HAPs); and
- Number of production facilities in or near areas of dense population.

**Evidence**

The Chemicals industry generates substantial amounts of air pollutants. According to the EPA's 2014 National Emissions Inventory, the Chemicals industry accounted for nearly 43 percent of butadiene, 15 percent of acetaldehyde, 12 percent of VOCs, and 11 percent of benzene emissions among all industrial facilities in the U.S.77 The EPA’s Toxic Release Inventory (TRI) is a database of the on-site and off-site disposal of more than 650 toxic chemicals. According to 2013 EPA TRI data, the Chemicals industry (NAICS 325)78 released about 235 million pounds of HAPs in 2013, or
approximately 11.6 percent of the total for all industrial facilities.\textsuperscript{79}

In most countries, air emissions are regulated, leading to financial impacts for large emitters. In the U.S., the EPA inventories emissions and sets limits for emissions sources. Manufacturers are required to estimate their emissions in order to pay requisite permitting costs. Companies may also be required to invest in emissions-reduction technologies to comply with regulations or stricter permit requirements. The EPA or state environmental agencies have the authority to levy monetary penalties or restrict permits when companies violate emissions laws. Most permits under Title V of the CAA are issued by states.\textsuperscript{80} In Canada, air regulations currently require industrial emitters to reduce emissions of the following gases by set percentages from a 2006 baseline by 2020: SO\(_2\) (55 percent), NO\(_x\) (40 percent), VOCs (45 percent), and PM (20 percent).\textsuperscript{81} In 2012, China enacted controls on emissions from the Chemicals industry, including SO\(_2\), NO\(_x\), VOCs, and PM. The rules are both national and regionally targeted in areas of high industrial production. The total estimated cost of the program for all covered industries is approximately $56 billion.\textsuperscript{82}

Treatment of air emissions results in operating costs and capital expenditures. Data from the EPA’s Pollution Abatement and Capital Expenditures (PACE) survey shows that capital expenditures on air pollution abatement in the U.S. Chemicals industry were approximately $631.7 million in 2005, representing approximately 16.3 percent of the manufacturing sector’s total capital expenditures for air pollution abatement. Furthermore, operating costs for air pollution abatement totaled $1.53 billion, or 17.6 percent of the total for the manufacturing sector.\textsuperscript{83} This data, although not recent, suggests that the industry spends considerable amounts of money to comply with air emissions regulations. More stringent regulations in the future could result in additional costs.

Violations of emissions regulations can include monetary penalties and costly requirements to upgrade facilities to meet current or anticipated emissions standards. The EPA fined Mosaic Fertilizer $2.4 million in 2009 for CAA violations pertaining to toxic air emissions, and required the company to spend approximately $30 million to install pollution controls to limit emissions of SO\(_2\) and sulfuric acid mist. The company allegedly made alterations to three sulfuric acid plants without first obtaining proper permits, causing significant increases in emissions.\textsuperscript{84} In another example, Rhodia Inc., a subsidiary of French chemical firm Rhodia SA, paid a $2 million civil penalty and committed $50 million to upgrade sulfur air pollution controls at eight facilities across the U.S. in 2007.\textsuperscript{85}

In addition to higher operating costs and impacts from existing regulations, chemical companies could face concern from neighboring communities about local air quality
in proximity to chemical facilities. One such example is Richmond, California, where the existence of densely populated neighborhoods near five refineries and three chemicals facilities has aroused concerns about local air quality. Basic chemical facilities generate many of the same air emissions as oil and gas refineries, including VOCs and benzene, which can create similar health concerns for local communities.86

Besides regulatory fines and costs, company value may also be affected by compensation payments to the local population and businesses in the event of significant releases of pollutants, for example, as a result of accidental leaks and explosions. A fire at the Richmond, California, Chevron refinery in 2012 led to shelter-in-place orders for area residents as a result of the smoke. The incident led to approximately 23,900 claims being initiated against the company, and the company provided approximately $10 million in compensation to local hospitals, affected community members, and local government agencies.87

Effects on local communities can result in regulatory action. The EPA is committed to bringing air quality improvements to communities in the U.S. as part of the agency’s national effort to advance environmental protection in disproportionately affected communities. This includes requiring chemical companies to improve their facilities’ emissions profile. For example, in 2014, the EPA fined a propylene and ethylene chemical plant in Port Arthur, Texas, $350,000 and required the firm to implement innovative air control equipment to reduce emissions of VOCs and HAPs. The company estimated that it would spend $28 million to upgrade equipment to prevent fugitive emissions. The settlement is expected to improve the air quality for residents living near the plant.88

Long-term health risks to workers and communities posed by chemical facilities can also result in legal action by potentially affected parties. Former and current residents of counties surrounding Nitro, West Virginia, filed a class action against Monsanto in 2004 alleging exposure to dioxins and furans between 1949 and the present. Monsanto stated in its FY2014 Form 10-K that it had “reached a settlement in principle as to both the medical monitoring and the property class claims. The proposed settlement provides for a 30-year medical monitoring program consisting of a primary fund of up to $21 million and an additional fund of up to $63 million over the life of the program, and a three-year property remediation plan with funding up to $9 million.”89

Value Impact
Management of air emissions can have an ongoing impact on the operational efficiency and cost structure of companies, as well as one-time effects on cash flows from regulatory fines and litigation.
Harmful air emissions from operations may result in regulatory penalties, higher regulatory compliance costs, or new capital expenditures to install the best-in-class control technology. Companies may also face legal challenges from the local population or other businesses, resulting in one-time costs and increased contingent liabilities. Financial impacts of air pollution will vary depending on the specific location of companies’ operations and the prevailing air emissions regulations, which may be less developed in some regions and countries than others.

Furthermore, companies could face delays in obtaining necessary air emissions permits required for production or expansion of facilities. Production may be also be affected by the facility down-time that is required for upgrades to air pollution mitigation equipment.

As concerns about the health effects from air emissions grow around the world, the probability and magnitude of impacts from this issue are likely to increase in the future.

The quantity of key pollutants emitted is an indicator of a company’s operational efficiency and its success in mitigating regulatory risk and one-time costs associated with harmful emissions. The number of production facilities in or near areas of dense population provides additional context for analyzing a company’s risk exposure.

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**Energy & Feedstock Management**

Chemical companies are reliant on purchased electrical energy and fossil hydrocarbon feedstocks for value creation. The long-term prospect of increased demand from the developing world as well as concerns about energy security, climate change, and the use of nuclear energy suggest increasing upward pressure on price and constraints on the availability of conventional sources of electricity and fossil hydrocarbons. In the U.S., approximately 67 percent of grid electricity is produced from burning fossil fuels such as coal and natural gas. Thus, emissions from electricity production can result in indirect risks for the Chemicals industry, as regulations limiting the emissions of electrical utilities may result in higher electricity costs for the Chemicals industry. In addition, the industry’s use of hydrocarbon feedstocks presents a similar channel of financial impact, driven by indirect effects of GHG regulation. The production and refining of hydrocarbon feedstocks such as natural gas generate GHG emissions and represent the release of stored fossil carbon from reserves within the Earth’s crust. Thus, regulation will likely seek to limit the extraction of fossil feedstocks in the future, raising the cost of feedstocks or reducing their availability. The use of renewable feedstocks is a priority for the industry, and it is one of the 12 green chemistry principles.
Producing electricity on-site as opposed to relying on grid-sourced electricity, as well as using alternative energy and feedstocks, can play an important role in influencing both the costs and reliability of energy supply. The use of cogeneration to produce electrical energy on-site presents the industry with a tradeoff—increased cogeneration will typically increase direct GHG emissions, yet it will reduce indirect emissions by reducing grid electricity purchases. The use of renewable feedstocks in lieu of fossil hydrocarbon feedstocks can mitigate the effects of higher feedstock prices or limited supply in the future.

As a result, the way in which a company manages its overall electricity and feedstock use and its sources of power and feedstock is likely to be financially material. Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Total energy consumed, percentage grid electricity, percentage renewable; and
- Percentage of raw materials from renewable resources.

**Evidence**

The Chemicals industry is the largest consumer of electricity among U.S. manufacturing industries. In 2012, purchased electricity consumption was approximately 539 trillion British thermal units (BTU), nearly 19 percent of the industry's total fuel and power energy consumption. The industry also uses a significant amount of hydrocarbons as a raw material (feedstock): according to the ACC, the industry consumed 2,874 trillion BTU of fossil fuel feedstock in 2012. Approximately 96 percent of the industry's feedstock is in the form of natural gas, natural gas liquids, and liquefied petroleum gases. Approximately half of the total energy (purchased fossil fuel and electricity) used by the industry is feedstock that is incorporated in chemical products, while the other half is used to transform the feedstocks into chemical products. The potential financial implications of burning hydrocarbons used in feedstock transformation is discussed in the Greenhouse Gas Emissions issue in this brief. Rising prices of electricity and hydrocarbon feedstock present a long-term challenge for the industry, while carbon emission regulatory policy may increase the magnitude of possible financial impacts. In 2011, the U.S. Energy Information Administration (EIA) projected the likely prices for electricity and fossil fuel under three carbon policies of varying stringency between 2014 and 2020. The projections suggest that prices for natural gas and electricity would rise by approximately 15 and 33 percent, respectively, under the “high” cap-and-trade scenario. Under the “no policy” scenario, prices of natural gas and electricity would rise by about 10 percent and two percent, respectively.
Purchased electricity costs are a key factor in value creation and a substantial expense for companies in the Chemicals industry. Approximately 65 percent of electricity is used to power electric motors, pumps, and fans.97 The Chemicals industry accounts for approximately 22 percent of the total machine-drive electricity used in the manufacturing sector.98 According to 2011 Bureau of Labor Statistics Annually Survey of Manufacturers (ASM) data, purchased electricity comprised 2.1 percent of the Chemicals industry’s cost of materials. This is greater than the share for all U.S. manufacturing facilities included in the survey, for which purchased electricity is 1.6 percent of the total cost of materials. The more than 435 billion kWh of purchased electricity consumed by the Chemicals industry represents nearly 16 percent of the manufacturing sector’s total, with a total cost to the Chemicals industry of $24.4 billion.99 This indicates an above-average risk to this industry in the face of rising or volatile energy costs and grid disturbances.

An analysis by the International Energy Agency (IEA) of potential global electricity savings from using best-practice technologies in the Chemicals industry estimated that electricity savings could amount to up to 20 percent of current usage. The majority of savings could be achieved through more efficient motors and motor systems, processes such as electrolysis, and lighting.100 Companies have achieved cost savings and direct or indirect emissions reductions through energy efficiency improvements. For example, Hexion Specialty Chemical, Inc. achieved a 21 percent reduction in electricity consumption by installing a backpressure turbine electricity generator powered by excess process steam.101

The reliance on hydrocarbon feedstocks presents a long-term challenge for the industry, as climate regulation that limits the availability of fossil hydrocarbon feedstocks could lead to higher or more volatile feedstock purchase costs. Companies may spend a significant portion of their production costs on feedstocks. In its FY2014 Form 10-K, Dow Chemical reports, “The Company purchases natural gas, primarily to generate electricity, and purchases electric power to supplement internal generation. Expenditures for hydrocarbon feedstocks and energy accounted for 38 percent of the Company’s production costs and operating expenses for the year ended December 31, 2014.”102

Reliance on non-renewable energy can affect credit risk as well as costs. An analysis by Standard & Poor’s and the World Resources Institute examined the effect of the American Power Act (APA) of 2010, which sought to implement a GHG cap-and-trade policy on U.S. industrial and energy sources, on the credit profile of 13 GHG-intensive chemical subsectors. The EIA’s projected costs of natural gas-derived feedstock prices under the APA scenario suggests these subsectors would face higher feedstock costs, making companies less
competitive in some markets and adversely affecting their cost of capital.¹⁰³

Some companies are directly addressing the reliance on non-renewable feedstocks by utilizing more renewable feedstocks. For example, Du Pont reported that it increased its revenue from products “based on non-depletable resources” from $5.9 billion in 2007 to $11.8 billion in 2013.¹⁰⁴

Recent shareholder resolutions demonstrate investor interest in corporate performance on energy management. In 2013, Wesleyan University filed a shareholder resolution with Rockwood Holdings, a major chemical producer, requesting that the company report energy management practices. However, the resolution did not go to vote. Similarly, in early 2014, the California Teachers’ Retirement System filed a shareholder resolution with C.F. Industries, a major fertilizer producer, requesting that the company report on internal energy efficiency standards. The resolution was withdrawn after the company agreed to begin disclosure.¹⁰⁵

**Value Impact**

Energy management primarily impacts current and future costs of operation. Higher electricity and hydrocarbon prices in the future, due to the factors outlined earlier, can increase operating costs for chemical companies. Likewise, there is an opportunity for companies to generate cost savings through improved energy efficiency or greater use of renewable energy. In addition to operating costs, there could be one-time effects on cash flows through capital expenditures for energy-related projects. Active energy management can also reduce a company’s risk profile and its cost of capital by mitigating cost fluctuations or supply issues due to volatile electricity and feedstock prices, as well as reducing dependence on grid power and hydrocarbon feedstocks.

Increasingly stringent emissions regulation is likely to increase electricity and feedstock costs over time, increasing the probability and magnitude of potential financial impacts in the medium term.

The more hydrocarbon feedstocks and electricity a company uses from traditional sources of energy, the more vulnerable it is to rising prices of specific energy sources and the indirect impact of costs from internalization of carbon prices by utilities. The use of independent energy sources (non-grid) also indicates a degree of control and a company’s ability to provide continuous energy for its facilities. The percentage energy and materials from renewables indicates a firm’s ability to mitigate its environmental footprint, its exposure to energy and materials costs increases, as well as its energy independence.

**Water Management**

Chemical manufacturing is a water-intensive process. Water usage within the industry varies depending on the product manufactured and
the production process. For example, silicon-based chemicals are water-intensive to manufacture, while bulk chemicals, including ethylene ammonia and propylene, require significantly less water. Nonetheless, chemical plants generally use relatively large quantities of water, primarily for cooling, steam generation, and processing. According to the EPA, more than 80 percent of cooling and steam water consumed by the industry is recycled, while process water recycling rates vary widely.

Water loss occurs primarily through evaporative cooling, however, process water may accumulate contaminants. Water effluents may become contaminated with process chemicals, resulting in environmental harm or drinking water contamination. These externalities create regulatory risk, including penalties for violations of water quality permits and standards and the potential for tension with local communities.

In addition to water contamination, the industry faces possible issues surrounding water availability. Water is becoming a scarce resource around the world, due to increasing consumption as a result of population growth and rapid urbanization as well as reduced supplies due to climate change. Furthermore, water pollution in developing countries makes available water supplies unusable or expensive to treat. Based on recent trends, it is estimated that by 2025, important river basins in the U.S., Mexico, Western Europe, China, India, and Africa will face severe water problems as demand overtakes renewable supplies. Many important river basins can already be considered “stressed.” Water scarcity can result in higher supply costs, supply disruptions, and social tensions, which companies across different industries, particularly water-intensive ones, will need to contend with.

Chemical manufacturing facilities, depending on their location, may be exposed to the risk of reduced water availability due to the factors discussed above and related cost increases. Extraction of water from sensitive areas for the purposes of manufacturing, as well as contamination of water supplies due to chemical operations, could also create tensions with local communities—for example, if they are deprived of drinking water as a result of a company’s actions.

Companies can adopt various strategies to address water supply and treatment issues, such as recycling process water, improving production techniques to lower water intensity, and treating water effluents. The green chemistry discipline emphasizes the use of less harmful chemical substances during manufacturing, which could reduce water effluent treatment costs and potential externalities. Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):
- Total water withdrawn, percentage in regions with High or Extremely High Baseline Water Stress and percentage recycled water usage; and
- Number of incidents of non-compliance with water quality permits, standards, and regulations.

**Evidence**

The Chemicals industry is relatively water intensive. A 2013 ranking of 130 Global Industry Classification System sub-industries by the importance of water to the sub-industry, placed the diversified chemicals, specialty chemicals, industrial gases, fertilizers and agricultural chemicals, and commodity chemicals industry segments among the top 15 industries. The ranking measured water value-added by cubic meters of water use per dollar of output. These Chemicals industry segments use between five and six cubic meters of water per dollar of output. 109 Recent total industry-wide water usage data is not readily available, however, of all OECD manufacturing industries, the Chemicals industry was the largest consumer of water in 1995, with 43 percent of the total.110

The industry also generates significant volumes of process wastewater, which must be treated to remove contaminants. In 2005, 801 chemical facilities reported total water discharges of TRI chemicals of 42.7 million pounds, a decline of 57 percent from 1996 levels.111 Treatment of process water can result in significant operating costs and capital expenditures. Data from the EPA’s PACE survey shows that the capital expenditures for water pollution abatement in the Chemicals industry were approximately $307.3 million in 2005, representing approximately 23 percent of the manufacturing sector’s total capital expenditures for water pollution abatement. The PACE data also shows that water pollution abatement operating costs were $1.75 billion, or 26 percent of the manufacturing sector’s total operating costs for water pollution abatement.112 This data suggests that the industry regularly spends considerable sums to comply with water quality regulations, including for permitting.113 More stringent regulations in the future could result in additional costs.

Water availability can directly affect the operations of water-intensive industries, with water constraints possibly resulting in lost production or higher operating expenses. Ongoing drought in the American West underscores chemical companies’ reliance on stable water supplies. LyondellBasell reports in its FY2014 10-K that “there is growing concern over the reliability of water sources, including around the Texas Gulf Coast where several of our facilities are located. The decreased availability or less favorable pricing for water as a result of population growth, drought or regulation could negatively impact our operations.”114

Dow Chemical’s manufacturing facility in Freeport, Texas relies heavily on the nearby Brazos River for its supply of water. Dow is a
senior owner of water rights in the watershed, however, persistent low flow and high salinity in recent years have impacted the company’s Freeport plant. Higher water treatment costs and capital expenditures on additional pumping, storage, and water purchases has resulted in increased costs, including an additional $6 million to desalinate water in 2005 and 2006.115

Dow claimed in November 2012 that upstream water-rights holders had withdrawn so much water from the river that the company could not draw all of the water that it was entitled to.116 The 2012 Texas Regional Water Plan projected industrial water shortfalls of as much as 46 percent by 2060 as the region’s precipitation patterns change—a climate study suggests that the annual Brazos River water flow may fall between 20 and 26 percent from current levels by 2050. Dow is collaborating with Freeport on water analyses that will assist the company and other water users in the area in mitigating future supply and demand concerns.117

Water stress can affect a large proportion of a company’s manufacturing locations, suggesting that the issue could become critical if conditions worsen. Air Liquide, a major French chemical and industrial gas manufacturer, reported that approximately five percent of its annual water supply is located in areas of very high water stress, while 100 of the company’s 276 industrial sites analyzed are located in areas of high or moderate water stress.118

**Value Impact**

Excessive water consumption and wastewater can influence companies’ operational risks, with potentially acute impacts on value from disruptions to production. Water-intensive operations are subject to operational risks related to the price and availability of water, potentially disrupting production, creating additional permitting requirements, and thereby affecting companies’ ability to meet demand. Furthermore, tension with local water users could result in reduced access to water. These issues could have an impact on long-term growth prospects and market share as well as a company’s risk profile, and therefore its cost of capital. Finally, reduced access to water rights could adversely affect the value of water rights allotted to companies, reducing the value of these intangible assets.

Water use and contamination can also affect ongoing operating costs and impact cash flows through one-off capital expenditures or regulatory penalties, while more efficient use of water over time could generate cost savings and lower operating expenses.

As regulations become more stringent over time, and the effects of climate change become more acute, the probability and magnitude of future financial impacts due to water effluents and withdrawals are likely to increase.

Withdrawals of water in water-stressed regions indicate a company’s exposure to water supply and cost risks. Fines and instances of non-
compliance with water standards and regulations indicate a company’s management of water within operations and oversight of water treatment, which is indicative of regulatory risk over the medium term.

**Hazardous Waste Management**

Chemical companies face regulatory and operational challenges in managing processing waste, as these substances can be hazardous to human health and the environment. Chemical manufacturing generates hazardous and non-hazardous solid wastes as by-products, and these must be treated and disposed of according to regulation.

Chemical manufacturing generates wastes that are subject to environmental regulation. Wastes are generated from processing and pollution-control equipment and include wastewater treatment sludge and hazardous by-products. The top hazardous wastes generated by plants include nitrate compounds, manganese, ammonia, acetonitrile, methanol, zinc, and lead. Hazardous waste generation increases the risk of long-term liability in the form of environmental cleanup and mitigation expenses, including those required under the U.S. EPA’s RCRA and CERCLA programs. Although many of these current liabilities stem from a decades-long legacy of poor waste management practices, continued waste production results in ongoing costs and the possibility of future mitigation requirements. Non-hazardous wastes also result in disposal costs, while companies that can reuse wastes as raw material or energy sources could benefit from operational efficiency gains.

To mitigate potential externalities, companies in the industry have made efforts to reduce hazardous and non-hazardous waste. In addition to mitigation of regulatory risks, waste management, particularly waste reduction, can result in lower disposal and treatment costs, and may also improve materials and energy efficiency through waste recovery and reduced purchases of raw materials. Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Amount of hazardous waste, percentage recycled.

**Evidence**

The Chemicals industry generates significant quantities of waste and faces relatively high costs related to waste treatment and disposal. The industry’s share of hazardous waste generation is significant. In 2011, the industry generated approximately 21 million tons, or 61.5 percent of the total reported solid hazardous waste generated in the U.S. 120

Waste disposal and treatment, especially of hazardous materials, can represent significant
operating costs and capital expenditures for chemical manufacturers. According to data from the 2005 PACE survey, the Chemicals industry incurred operating costs for pollution abatement for solid waste of around $1.3 billion, accounting for roughly 24.5 percent of the total operating costs for solid waste abatement for all manufacturing industries. Related capital expenditures accounted for $182 million, or 27 percent of capital expenditures for solid waste abatement for all manufacturing industries.\textsuperscript{121}

Companies have undertaken measures to reduce waste generation and improve recycling. For example, Dow Chemical reduced overall process waste by 17 percent between 2005 and 2010, while 97 percent of the company’s TRI waste was managed by recycling, treatment, or energy recovery.\textsuperscript{122}

According to the ACC, hazardous waste cleanup amounted to 12 percent of the $14.7 billion its members spent on environment, health, and safety in 2012. While some of these costs are related to legacy waste pollution, minimizing the amount of waste generated and continued improvement in waste management practices can help lower future expenditures.\textsuperscript{123}

Expenses tied to environmental remediation from past or current operations can be significant. In the U.S., remediation liability under CERCLA (Superfund) can be highly uncertain. Although many waste-related environmental issues are due to costs associated with legacy waste sites, the ongoing high levels of hazardous waste generation by the industry increases the likelihood that future waste remediation expenses may occur. Du Pont reports that as of December 31, 2013, the company had accrued $478 million in remediation costs, however, the company’s potential liability may be up to three times the current estimates under “adverse conditions.”\textsuperscript{124}

**Value Impact**

The generation of hazardous wastes creates operating and regulatory risks for chemical companies. Waste treatment or disposal requirements can result in ongoing operating expenditures. Furthermore, waste generation creates the risk of acute regulatory impacts such as fines and contingent liabilities from legal action.

Waste management may require capital expenditures or regulatory compliance costs related to generating large quantities of hazardous wastes, reducing operating income. Frequent fines or unexpected abatement costs could result in a higher cost of capital.

The quantity of hazardous waste generated and percentage recycled gives insight into the likelihood of regulatory fines and remedial action, as well as ongoing operational costs and capital expenditures related to solid waste pollution abatement.
SOCIAL CAPITAL

Social capital relates to the perceived role of business in society, or the expectation of business contribution to society in return for its license to operate. It addresses the management of relationships with key outside stakeholders, such as customers, local communities, the public, and the government.

Chemical manufacturing operations can affect local communities and the broader society through air pollution, the release of hazardous substances, and process safety incidents. Community impacts can hurt a company’s social license to operate and affect brand value. Public pressure can make it difficult for companies to gain regulatory approvals for expanding facilities, or they may face more stringent regulations. Companies could also have legal liabilities related to their community impacts. These impacts are addressed by the disclosure topics of “Air Quality,” “Hazardous Waste Management,” and “Health, Safety, and Emergency Management.”

HUMAN CAPITAL

Human capital addresses the management of a company’s human resources (employees and individual contractors), as a key asset to delivering long-term value. It includes factors that affect the productivity of employees, such as employee engagement, diversity, and incentives and compensation, as well as the attraction and retention of employees in highly competitive or constrained markets for specific talent, skills, or education. It also addresses the management of labor relations in industries that rely on economies of scale and compete on the price of products and services. Lastly, it includes the management of the health and safety of employees and the ability to create a safety culture within companies that operate in dangerous working environments.

Chemical manufacturing uses flammable fossil fuels as inputs, high-temperature and high-pressure processes, and harmful chemical substances, all of which create acute and chronic health and safety risks for workers. A safety culture is critical to proactively guard against accidents or other incidents that have negative environmental and social impacts. A company’s ability to protect employee health and safety, and to create a culture of safety at all levels of the organization, can directly influence the results of its operations.

Company performance on ensuring workforce health and process safety, as well as preparedness for emergency situations such as catastrophic releases of hazardous substances, is addressed by the disclosure topic “Health, Safety, and Emergency Management” below. The safety culture of a chemical company can impact both environmental and social capitals in addition to its human capital.
BUSINESS MODEL AND INNOVATION

This dimension of sustainability is concerned with the impact of environmental and social factors on innovation and business models. It addresses the integration of environmental and social factors in the value-creation process of companies, including resource efficiency and other innovation in the production process. It also includes product innovation, efficiency, and responsibility in the design, use-phase, and disposal of products. Finally, it includes management of environmental and social impacts on tangible and financial assets—either a company’s own or those it manages as the fiduciary for others.

While chemicals have provided many societal benefits, the potential for adverse environmental and human health impacts from chemicals is of increasing importance to the industry. Concern over chemicals’ externalities has resulted in consumer activism and regulatory action, yet has also been a primary driver of innovation in the industry, including the adoption of green chemistry principles.

As sustainability is becoming embedded into modern economies, the Chemicals industry is also developing new products that improve the sustainability performance of customers. These innovations focus on enhancing customers’ energy and materials efficiency and reducing air and GHG emissions. Such innovations are likely to be a driver of growth in the industry over the long term.

Safety & Environmental Stewardship of Chemicals & Genetically Modified Organisms

Chemicals are found in nearly all man-made products today. Chemicals have provided immeasurable societal benefits: for example chemical industry innovation has played a central role in the development of life-saving pharmaceuticals. While chemicals provide numerous benefits, they also carry the potential for adverse human and environmental impacts. Such impacts include the bioaccumulation of chemicals in ecosystems, which can cause harm to wildlife and loss of biodiversity. Human health impacts from chemicals include damage to the nervous system, reproductive and development impacts, genetic impacts, and cancer. The possible effects of chemical exposure may not become known for many years, creating additional uncertainty for manufacturers, consumers, and regulators. As a result, chemical companies face the potential for reduced demand, adverse reputational impacts among customers or consumers, and regulatory bans or mandatory recalls of products.

Regulations have been enacted worldwide to manage the risks from harmful chemical substances by evaluating chemicals’ risks and
hazards, restricting or banning their sale or importation, and finding suitable alternatives. For example, the E.U.’s REACH legislation was adopted partly in response to the uncertainty surrounding the environmental and human health hazards of a large number of chemicals. REACH establishes the progressive substitution of substances of very high concern when appropriate alternatives are identified.\textsuperscript{128}

In addition to traditional chemicals, companies produce genetically modified (GM) and bred crop seeds. The industry’s GM seed products have contributed to gains in crop productivity through decreased negative impacts of pests, drought, and disease. Crops including corn, soy, cotton, canola, and others have been engineered to resist pesticide and herbicide application and increase drought tolerance. These advantages can prevent crop loss and increase total yields. However, increasing public and government concern about the human and environmental health impacts of GM crops has brought scrutiny to the products. Concerns include the possibility that GM crops may accelerate weed and insect resistance to herbicides and may spread genes to non-GM plants, with unknown ecological impacts.\textsuperscript{129}

Despite a lack of scientific consensus on the possible environmental or health impacts of GM crops, consumer concerns have manifested themselves in consumer groups worldwide that advocate, in some cases successfully, for the ban of GM crops for use in food or altogether.\textsuperscript{130} Such bans, and reputational impacts that may come with the production of GM products, can directly affect the revenues of chemical companies that produce GM seeds.

The issues outlined above are likely to be of continued increasing importance to the industry over the long-term due to rising consumer awareness of chemical hazards and a more stringent regulatory environment. Managing the known impacts and evaluating the potential for adverse effects of products is therefore paramount to sustaining the industry’s social license to operate. Companies can mitigate risks by conducting thorough risk assessments for all products, for both acute toxicity and chronic impacts over the long term, and incorporating these understandings into product design and communication. Precautionary measures need to be taken even if product hazards are unknown.

In addition to facing risks, the industry has opportunities to capture demand for chemicals for which use-phase hazards are reduced. The development of such chemicals is likely to be a prominent factor in the industry’s long-term evolution, facilitated by industry and regulatory initiatives such as green chemistry.

Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):
- Percentage of products that contain Registration, Evaluation, Authorisation and Restriction of Chemical (REACH) substances of very high concern (SVHC);
- Percentage of products that contain Class I World Health Organization (WHO) Acute Toxicity Hazard Categories pesticides;
- Discussion of strategy to (a) manage chemicals of concern and (b) develop alternatives with reduced human and/or environmental impact; and
- Percentage of products by revenue that contain genetically modified organisms (GMOs).

**Evidence**

The toxicity of some chemical substances, such as chlorine, has long been known. According to the EPA, however, many of the tens of thousands of chemicals in production have “not been thoroughly evaluated for effects on human health, wildlife, and the environment, particularly when considering the consequences of use over a chemical’s life cycle (production, use and disposal).” 131 While the Chemicals industry’s products provide key societal benefits, as outlined earlier, a 2012 report by the United Nations Environmental Programme’s (UNEP) Global Chemicals Organization (GCO) concluded that a number of substances used or produced by the Chemicals industry, including pesticides and lead, cause an estimated 964,000 deaths worldwide annually and 21 million disability-adjusted life years.132 Examples of chemicals of concern produced by the Chemicals industry include the common pesticide DDT, which can cause harm to wildlife, including reproductive failure in some bird species, polyvinyl chloride (PVC), used in piping, bottles, and building materials, which has been shown to cause cancer, and other endocrine-disrupting chemicals found in some antifouling paints, insecticides, and fungicides.133

In some instances, the uncertainty surrounding a chemical’s potential externalities is sufficient to generate public concern and regulatory or legal action. Atrazine, a common pesticide used in the U.S., has been found to persist in the environment and may have adverse effects on wildlife, and there is also some concern over its possible human health impacts. The chemical was banned in the E.U. in 2004 because it was found in groundwater at concentrations above allowable limits. In fact, the E.U. has set allowable groundwater concentration limits on all pesticides, regardless of the hazard level. The EPA is currently performing a periodic review of atrazine, which is expected to be completed by 2016.

Although atrazine is not banned for use as a pesticide in the U.S., drinking water quality regulations limit the concentration of many chemical substances. In 2012, a major Swiss chemical producer settled a class action with nearly 2,000 Midwestern U.S. water utilities that stemmed from high atrazine levels in the
utilities’ water supplies. The utilities in the lawsuit claimed that they faced additional costs from filtering atrazine out of their water supplies. Three hundred utilities with the highest atrazine levels were expected to recover all of their additional filtration costs from the settlement funds. The $105 million settlement lowered the chemical maker’s FY2012 earning per share by approximately $0.5.

In its FY2012 Form 10-K, chemical producer DuPont highlights the risks associated with some of the substances that it manufactures, including their known impacts on wildlife and humans. For example, the company discusses the risks associated with PFOA (perfluorooctanoic acid and its salts, including ammonium salt), which is a bio-persistent chemical and has been detected in the blood of the broader human population. In response to concern over the use of the chemical, DuPont ceased manufacturing PFOA as of the fourth quarter 2013 and eliminated the chemical as a raw material in certain resins. In response to safety concerns, chemical companies are also improving performance and due diligence surrounding their products. For example, Dow Chemical intends to complete product safety assessments for all of its products by 2015 as part of its 2015 Sustainability Goals.

The Chemicals industry acknowledges in financial disclosure the potential risk to financial performance posed by chemical safety: “Governmental, regulatory and societal demands for increasing levels of product safety and environmental protection could result in increased pressure for more stringent regulatory control with respect to the chemical industry. In addition, these concerns could influence public perceptions regarding our products and operations, the viability of certain products, our reputation, the cost to comply with regulations, and the ability to attract and retain employees.”

Products that do not meet regulatory standards may be prohibited from use, and in turn banned from sale. For example, in 2011, DuPont was ordered to cease the sale, distribution, and use of one of its herbicide products due to non-compliance with the Federal Insecticide, Fungicide, and Rodenticide Act. The product was found to be lethal to trees in addition to the weeds it targeted. The company introduced a refund program and faced lawsuits from property owners who lost trees.

More than 60 countries have banned or limited the production, sale, or importation of GM crops. During 2013 and 2014, China rejected several U.S. crop imports due to concerns over GM crops possibly contained within the shipments. Seed producers Syngenta and Dow AgroSciences responded by limiting U.S. launches of new GM corn and soybean seed varieties. Bayer CropScience has allegedly delayed a new soybean variety until it receives Chinese approval for the crop.
address the potential impacts of product bans and consumer resistance in their financial disclosures. Syngenta reports, “Actions by consumer groups and others may disrupt research and development or production of genetically modified seeds or crop protection chemicals. In addition, some government authorities have enacted, and others in the future might enact, regulations regarding genetically modified organisms or crop protection chemicals, which may delay and limit or even prohibit the development and sale of such products.”  

The industry’s ability to innovate will be central in overcoming the challenges described above. Construction and consumer products are key industries driving demand for less harmful chemical products. Furthermore, the growth in products that align with the green chemistry discipline, which has a significant focus on reduced toxicity and degradability, is expected to be a major driver of business growth in the Chemicals industry. A 2011 Pike Research report indicates that green chemistry represents a potential market opportunity that will grow from $2.8 billion in 2011 to $98.5 billion by 2020. This market is based on three primary themes applicable to sustainability within the Chemicals industry: the production of products with reduced toxicity, minimized waste generation during manufacturing, and the use of renewable feedstocks.  

The adoption of green building codes and standards, such as the U.S. Green Building Council’s (USGBC) Leadership in Energy and Environmental Design (LEED) rating system, encourages the design and construction of buildings that are environmentally friendly, as well as safer for their occupants, by eliminating the use of materials with hazardous substances that can affect indoor air quality. Many chemical products are incorporated into building materials, including paints, furniture, insulation, and windows, and thus can play a role in the health of building occupants. According to Navigant Research, the market for green building materials could reach $254 billion by 2020.  

Consumer-facing chemical products are also a channel for voluntary industry efforts to reduce toxicity. The EPA’s “Safer Choice” program is a system to label consumer goods, primarily cleaning products that meet the EPA’s criteria for reduced toxicity to human health and the environment. The EPA maintains a list of approved chemical ingredients, as well as requirements for performance, packaging, pH, and VOC levels. Although this program has a relatively narrow focus, the concept could be applied to a broader suite of chemical products.  

**Value Impact**

Increasing public concern over environmental and human health risks due to chemical exposure is likely to shift demand toward products with lower impacts, affecting revenue growth and competitiveness over the long term.
Adverse product lifecycle impacts can affect companies through reputational impacts and reduced demand for products as well as regulatory action such as recalls or penalties. The Chemicals industry’s customers may shift demand away from substances that are proven or believed to have harmful effects. This directly lowers revenues and profitability. Product bans would similarly have negative revenue impacts. Recalls could result in lost revenues and additional costs related to product recall and disposal. Legal action by consumers or regulators due to adverse health impacts could result in contingent liabilities and legal costs. In addition, companies that manufacture products for which there is a high likelihood of regulatory bans or other demand risks could face a higher cost of capital.

Furthermore, investment into research and development (R&D) of less harmful products increases costs in the short term, which can lower profitability. However, new products with reduced externalities can result in increased market share and revenues over the medium to long term.

As the regulatory environment regarding human and environmental health is likely to become more stringent over time, and new scientific evidence may reveal previously unknown hazards, the probability and magnitude of financial impacts are likely to increase over the medium term.

The percentage of products that contain substances of high concern or present an acute toxicity hazard is an indication of potential downside risks to a company’s revenues in the event of product bans, recalls, or reduced sales stemming from lower customer demand or regulatory changes. Furthermore, the percentage of products containing GMOs similarly indicates potential revenue risk if such products face lower demand or regulatory bans in the U.S. or elsewhere. The discussion gives insight into how a company is preempting possible demand-side risks due to toxicity concerns and the potential for access to new markets.

**Product Design for Use-phase Efficiency**

Increased societal, business, and regulatory emphasis on improved energy and materials efficiency is a key trend affecting the Chemicals industry. Chemical products can provide sustainability benefits to customers, including improved resource and energy efficiency and reduced air emissions. Companies are innovating to develop products that enhance customer sustainability, including energy, water, and material efficiency, thereby addressing new market needs. These benefits can help customers reduce costs and meet regulatory requirements. Transportation and construction are major end markets for products that provide such sustainability benefits. One such innovation is the use of...
polymer plastics in motor vehicles, which reduces vehicle weight and thus improves fuel economy. Although short-term costs to develop commercially viable products can be significant, chemical company investments in R&D for sustainable products can advance long-term profitability.

The Chemicals industry’s ability to innovate is crucial to accessing new markets for products that enhance energy and materials efficiency and reduce customers’ air and GHG emissions. Addressing this market could contribute to shareholder value for chemical companies through improved competitive positioning and greater revenues and market share. Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Revenue from products designed for use-phase resource efficiency.

Evidence

Energy efficiency in buildings is a major channel through which chemical products can help improve customers’ sustainability profile. Numerous building and energy codes across the U.S. and elsewhere emphasize energy efficiency.\textsuperscript{146} In a 2013 report, the International Council of Chemical Associations (ICCA) estimated that building products derived from chemicals saved 100 megatons of oil equivalent of energy in 2010, or about 10 percent of all energy consumed for space heating in buildings. These savings are achieved through products such as roof and wall insulation, pipe insulation, air sealing products, and reflective roof and window coatings. By 2050, the amount of energy used in buildings globally is expected to rise by 62 percent, suggesting that the market for efficiency-enhancing building products is expanding.\textsuperscript{147} Individual companies have developed products to meet demand for improved efficiency. Dow Chemical states on its sustainability website that the company’s air-sealing products can eliminate up to 20 percent of heating and cooling system costs, while the company’s Styrofoam insulation products reportedly save over $10 billion in annual energy costs for customers.\textsuperscript{148}

Chemical use can also provide sustainability benefits in the transportation sector, which is responsible for approximately a quarter of global GHG emissions. For example, antifouling chemical applications in the marine shipping industry are estimated to improve fuel efficiency by 29 percent, reducing gross CO\textsubscript{2}e emissions by 200Mt per year. In a report titled \textit{Innovations for Greenhouse Gas Reduction}, the ICCA states that in 2005, the industry’s products enabled between 2.1 and 2.6 units of CO\textsubscript{2} abatement elsewhere in the economy for every unit of CO\textsubscript{2} emitted during chemicals manufacturing. The report states that among the primary applications for the industry’s contributions to emissions reduction are insulation, lighting, packaging, marine antifouling, synthetic textile manufacturing,
automotive weight reduction, detergents, engine efficiency, and piping. In the automotive industry, for example, the use of composites and polymers can reduce vehicle weight, in turn increasing fuel efficiency. Furthermore, the ICCA estimates annual chemical-induced savings of approximately 120 Mt CO2e in transport emissions due to the application of some 10.4 million tons of plastic materials.\textsuperscript{149}

Major chemical companies currently offer a suite of sustainability-focused products, including those that help reduce customer emissions during the use phase of chemical products. Praxair reports in its FY2014 Form 10-K that the company “continues to develop new applications technologies that can lower emissions, including GHG emissions, in Praxair’s processes and help customers lower energy consumption and increase product throughput.”\textsuperscript{150} Similarly, DuPont states in its FY2014 Form 10-K, “The company continuously evaluates opportunities for existing and new product and service offerings in light of the anticipated demands of a low-carbon economy. About $2.5 billion of the company’s 2013 revenue was generated from sales of products that help direct and downstream customers improve energy efficiency and/or reduce GHG emissions.\textsuperscript{151} The company also invested $640 million in 2013 into R&D of products with direct, quantifiable environmental benefits for consumers, including benefits with respect to energy use and material use.\textsuperscript{152} The company expects that such efforts will provide customers with greater regulatory certainty. Furthermore, nine percent of chemical company BASF’s 2012 revenues came from products that help reduce customers’ GHG emissions.\textsuperscript{153} One such example is the company’s catalyst for decomposing nitrous oxide emissions from a nitric acid plant in Poland, which reduces nitrous oxide emissions by 1.1 million metric tons CO2e annually.\textsuperscript{154}

The principles of green chemistry are again applicable to innovation for customer efficiency in the industry. The 2011 Pike Research report mentioned earlier estimated that green chemistry could save the industry’s customers a total of $65.5 billion by 2020 through various efficiency benefits, including energy and materials efficiency.\textsuperscript{155}

Investment in alternative fuels is another way in which the Chemicals industry can capitalize on customer demand for efficiency-enhancing products. British Petroleum, together with DuPont, opened a $520 million wheat-to-ethanol facility in the U.K. in 2013, with plans to eventually make biobutanol, which is a more efficient transportation fuel than ethanol due to its higher energy density.\textsuperscript{156}

**Value Impact**

The development of products that enhance the energy efficiency or environmental sustainability of customers is an area of growth for the Chemicals industry. This could result in increased demand for products and services,
driving revenues, market share, and increased brand value.

The development of such products is likely to require capital expenditures and R&D investment, which may reduce short-term profitability. However, in the long term, these investments can result in revenue growth due to increased demand from customers. Companies unable to adapt to changing consumer preferences may also face higher costs of capital in the future.

As climate change regulation and energy and resource constraints worldwide drive continued demand for improved efficiency, the probability and likelihood of financial impacts are likely to increase in the medium term.

Revenues from products that enhance customer resource efficiency are an indicator of a company’s competitive positioning in the growing market products with lower energy and environmental footprint.

**LEADERSHIP AND GOVERNANCE**

As applied to sustainability, governance involves the management of issues that are inherent to the business model or common practice in the industry and are in potential conflict with the interest of broader stakeholder groups (government, community, customers, and employees). They therefore create a potential liability, or worse, a limitation or removal of license to operate. This includes regulatory compliance, lobbying, and political contributions. It also includes risk management, safety management, supply chain and resource management, conflict of interest, anti-competitive behavior, and corruption and bribery.

The Chemicals industry is a mainstay of the global economy and continues to expand through innovation and growing consumer demand. Due to its environmental and social externalities, the industry is subject to multiple current and proposed regulations. Some special interest groups and corporations advocate on behalf of the industry regarding regulatory policy. Sustainable management of regulatory and political influence includes consideration of long-term social and environmental externalities that result from this influence.

Furthermore, the management of complex, potentially dangerous chemical manufacturing and storage is paramount to preventing accidents that can impact human populations and the environment. In addition, chemical manufacturing poses inherent dangers to employees. Exposure to chemicals, heat, heavy machinery, and pressurized equipment poses physical risks.

Safety culture is critical to proactively guarding against accidents or other incidents with negative environmental and social impacts. A company’s ability to protect employee health and safety and create a culture of safety for
employees at all levels of the organization can directly influence the results of its operations.

Political Spending

Companies in the Chemicals industry spend significant sums of money on lobbying and campaign contributions related to long-term sustainability risks, including climate change and chemical safety. Companies may also benefit, at least in the short term, by influencing regulators with regard to legislation that affects the industry’s products or operating ability, such as bans on certain types of chemicals. Such actions and subsequent changes or delays to regulations may lead to positive outcomes for chemical companies and their shareholders in the short term. However, the broader societal implications such legislation could create pose medium- to long-term regulatory risks for the industry and could have an adverse impact on value.

There is debate about how lobbying efforts and campaign contributions impact companies. In the current economic and political environment, more money is flowing into politics. If companies are seen as having undue influence on regulators and policymakers, they are likely to face reputational harm. For example, few public companies have directly contributed to super PACs, even though the practice is now permitted under the Supreme Court’s Citizens United decision. Instead, companies have made contributions to trade associations and industry groups that are engaged in lobbying efforts, possibly due to concerns that direct contributions could damage their brand. Reputational impacts are especially relevant in cases where lobbying campaigns are misaligned with corporate social responsibility initiatives.

Companies with a clear strategy for engaging policymakers and regulators that is aligned with corporate goals and activities for long-term sustainable outcomes and accounts for societal externalities could benefit from a stronger long-term license to operate. Such strategies can help companies adjust to medium- to long-term regulatory changes, especially those that concern topics that directly affect the industry’s products or operations. Such companies could thereby achieve a lower risk profile relative to peers.

Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Amount of political campaign spending, lobbying expenditures, and contributions to tax-exempt groups, including trade associations; and
- Five largest political, lobbying, or tax-exempt group expenditures.

Evidence

There appears to be strong investor interest in corporate lobbying disclosure. Between 2011
and 2013, the SEC received a record-breaking 643,599 comment letters on a petition that called for a corporate disclosure rule on political contributions and lobbying across all industries. A majority of comments supported the rule.\textsuperscript{160}

After indicating that it might consider formally proposing regulation, the SEC dropped disclosure of corporate lobbying from its list of regulatory priorities in late 2013.\textsuperscript{161} Despite this, the agency is not precluded from acting on the matter. Furthermore, the U.S. Treasury Department indicated that it might restrain certain tax-exempt groups if they do not disclose their donors.\textsuperscript{162}

The SEC has previously recognized that political activity may be significant to an issuer’s business, even if this is not apparent from an economic viewpoint.\textsuperscript{163} In general terms, it is not clear whether expenditures related to lobbying and campaign contributions result in favorable regulations that offset these costs. It is also unclear what the magnitude and direction of the impact on shareholder value is for companies that engage in lobbying and campaign contributions. Some studies indicate that campaign contributions affect politicians’

stance toward specific companies. Others show that campaign finance has limited impacts on election outcomes.\textsuperscript{164} According to an article published by the \textit{New York Times}, companies that lobby intensely outperform those that do not, but “the evidence suggests most companies do not get any return from their lobbying expenditures.”\textsuperscript{164}

Lobbying expenditures by the U.S. Chemicals industry totaled approximately $61 million in 2013, which was up from approximately $30 million in 2005. Total corporate lobbying expenditures in the U.S. in 2013 were $3.1 billion, an increase of approximately one-third in the same period of time. The Chemicals industry ranked 18th out of 121 industries for which data was gathered. The top corporate contributors within the Chemicals industry were DuPont and Dow Chemical, while the ACC contributed $12.25 million in 2013, up from just over $2 million in 2007. While the Chemicals industry’s total lobbying spending is not as high as some other industries (for example, lobbying spending in the insurance industry was $153 million in 2013), the growth in lobbying spending over the past several years is notable.\textsuperscript{165} As the industry is global, lobbying in countries outside of the U.S. could have

similar implications. One of the top Chemicals industry companies listed in Appendix I had the 17th-largest lobbying spending in the E.U. among all industries in 2014.\textsuperscript{166}

Some chemical companies may lobby against legislation that might adversely affect their business in the short term, but ultimately aims to service society. One such issue is climate change. In 2009, a major U.S. chemicals producer spent 20 percent more to fund members of U.S. Congress that do not support measures to combat climate change than those with neutral or supportive stances. The company spent approximately $12.4 million on lobbying expenditures in that year.\textsuperscript{167}

Chemical company shareholders have introduced resolutions to some chemical companies in regard to expenditures on lobbying for sustainability-related industry regulations as well as requesting increased lobbying transparency. In 2009, the Nathan Cummings Foundation filed a resolution with Albemarle Corporation in regard to the manufacture of brominated flame retardants, which have been linked to reproductive, brain, liver, and thyroid problems in animals. The resolution requested that the company issue a report within six months on expenditures for attorneys’ and experts’ fees, lobbying, and public relations related to the health and environmental consequences of brominated flame retardants. The resolution was withdrawn after the company agreed to address the request.\textsuperscript{168} Similarly, Trillium Asset Management filed a resolution in 2009 with Dow Chemical concerning lobbying and public relations fees involving the health and environmental impacts of the herbicide 2,4-D. Although Dow did not respond to the resolution, it is an example of investor interest in the issue.\textsuperscript{169}

In 2014, the CEO of As You Sow filed a resolution with Monsanto requesting a report on lobbying expenditures and recipients, stating, “As shareowners, we encourage transparency and accountability in the use of corporate funds to influence legislation and regulation both directly and indirectly… Absent a system of accountability, company assets could be used for objectives contrary to Monsanto’s long-term interests.”\textsuperscript{170} The resolution received nearly 25 percent of shareholder votes in favor.\textsuperscript{171}

**Value Impact**

Lobbying, campaign contributions, or other politically influential spending related to the industry’s social or environmental impacts could erode companies’ social license to operate over the long term. While successful lobbying can result in positive short-term revenue gains, these benefits could subsequently be reversed to reflect the balance of corporate and public interest in those issues, leading to a more burdensome regulatory environment. Lobbying can therefore create regulatory uncertainty, increases the risk profile of companies and their cost of capital.
Lobbying expenses and political contributions increase non-operating extraordinary expenses, reducing net income.

Regulatory risk associated with political spending can be assessed by the level and recipient of a company’s political spending.

Health, Safety, and Emergency Management

Chemicals industry employees face numerous occupational hazards. These include fires, explosions, travel- or equipment-related accidents, and use of hazardous substances. Technical failure, human error, or external factors such as weather can lead to accidental releases of chemical substances into the environment at processing facilities or during storage and transportation, while the combustible nature of commonly produced chemicals and the high operating temperatures and pressures during production contribute to the risk of fires and explosions. In addition to acute impacts, workers may develop chronic health conditions from exposure to hazardous chemicals.

The health and well-being of employees in the industry is inextricably linked to the safety performance of the companies they work for. Employee health and well-being can also affect the probability and magnitude of significant releases of hazardous substances and pollutants as a result of accidents or leaks. In addition to worker injuries and fatalities, such incidents can have a variety of detrimental externalities that affect the environment and local communities. The transportation of chemical substances via rail or road increases the likelihood of such impacts.

A strong safety culture and a thorough, systematic approach to safety, risk management (including emergency preparedness and response), and operational integrity are essential to avoiding accidents and maintaining employee health and safety. Organizational research shows that it is important for a company to develop a culture of safety that reduces the likelihood of accidents and other health and safety incidents. If accidents and other emergencies do occur, companies with a strong safety culture can effectively detect and respond to such incidents. Inclusive workforce participation programs can help to identify and address potential health and safety problems. A culture that engages and empowers employees as well as contractors to work with management to safeguard their own health and safety and prevent accidents is likely to help companies mitigate or eliminate costs and ensure workforce productivity.

Chemical producers have adopted voluntary measures to improve operational safety. The ACC’s Responsible Care initiative, launched in 1984, is a global environment, health, and safety initiative for the Council’s members. Participating companies have collectively reduced the number of process safety incidents
(which can result in product spills, fires, explosions, or injuries) by 58 percent since 1995 through implementation of safety best practices, monitoring, and training.

However, recent incidents underscore the continued importance of strong internal management of process safety in order to mitigate possible financial impacts from safety issues. Company performance in this area can be analyzed in a cost-beneficial way internally and externally through the following direct or indirect performance metrics (see Appendix III for metrics with their full detail):

- Process Safety Incidents Count (PSIC), Process Safety Total Incident Rate (PSTIR), and Process Safety Incident Severity Rate (PSISR);
- Number of transport incidents;
- Challenges to the Safety Systems indicator rate (Tier 3);
- (1) Total recordable injury rate (TRIR) and (2) fatality rate for (a) direct employees and (b) contract employees; and
- Discussion of efforts to assess, monitor, and reduce exposure of employees and contract workers to long-term (chronic) health risks.

**Evidence**

While the frequency of process accidents has fallen over recent decades, there continue to be incidents that affect environmental and human health and have financial impacts on chemical companies. As DuPont succinctly states in its FY2014 Form 10-K, “Failure to appropriately manage safety, human health, product liability and environmental risks associated with the company's products, product life cycles and production processes could adversely impact employees, communities, stakeholders, the environment, the company's reputation and its results of operations.” Recent examples of process safety incidents highlight some of the risks that companies, communities, and the environment face.

In January 2014, at a Freedom Industries chemical facility in Charleston, West Virginia, a 35,000-gallon tank used to store two hazardous chemicals (known as MCHM and PPH) ruptured, releasing approximately 7,500 gallons of the substance into the nearby Elk River. This release was upstream of a municipal water treatment facility. Freedom Industries is a producer of specialty chemicals including flotation reagents, mining chemicals, water treatment products, and freeze conditioning chemicals. The cause of the spill is still under investigation, but the company hypothesized that a local waterline break had caused the ground beneath the storage tank to freeze.

Following the incident, authorities banned the use of public water for more than 300,000 people, and more than 100 people were sent to the hospital over health concerns. President Barack Obama declared a state of emergency in the counties affected by the water contamination. The U.S. opened a criminal
investigation of the spill, as failure to report and prevent spills of hazardous substances into waterways can be a violation of the Clean Water Act and federal reporting laws. On January 17, 2014, Freedom Industries filed for bankruptcy protection after a string of lawsuits were filed against the company as a result of the spill.  

In April 2013, an explosion at a fertilizer plant in West Texas resulted in 15 fatalities, including 12 emergency response workers. Ammonium nitrate, used to produce fertilizer, is believed to have fueled the explosion. In response to the incident, President Obama issued an Executive Order in August 2013 for a review of chemical plant safety and chemical storage rules, which resulted in a task force that worked to develop improved coordination between chemical companies and regulators, including improved training, increased use of electronic reporting and data management, technical assistance to state emergency response commissions, and engagement of the chemical-regulated community in local emergency planning processes. This example underscores the risk of increased regulatory scrutiny when major process incidents occur.

In another example, a June 2013 explosion at an ethylene and propylene plant in Geismar, Louisiana killed two and injured 77. The company is a major midstream and petrochemical producer and its chemical division operated the Geismar plant. Authorities subsequently ordered residents within a two-mile radius of the plant to remain indoors because of smoke inhalation fears. Propylene, a flammable petrochemical, was the cause of the blast. The facility had reported numerous leaks at the plant in prior years. The owner of the plant reported a net second-quarter 2013 loss from the June 2013 incident of $95 million from property damage, business interruption, and insurance proceeds. Production at the plant was halted after the incident and did not resume until February 2015. This event underscores the potential impact on local communities.

Transportation accidents can result in damage to the environment or harm to communities far from chemical facilities. For example, in 2005, a freight train derailed in Graniteville, South Carolina, spilling 60 tons of chlorine gas from a ruptured tanker car. The incident resulted in the evacuation of more than 5,000 people in the town, and a cloud of gas that spread from the crash site killed nine people. While a third-party carrier may be responsible for the occurrence of transportation incidents, the chemical company that ships a product involved in an accident can be liable for environmental damage or other harm, either directly, by paying for remediation, or indirectly, through litigation and cost recovery by the carrier. Legal liability may be established based on the shipper’s negligence in cases of improper packaging or storage of transported products, or if the shipper owns the container from which the release of hazardous substances occurred. Major chemical companies also
own transportation fleets, including tanker rail cars.

Safety statistics suggest that fatalities in the industry are a primary concern. According to data from the U.S. Bureau of Labor Statistics (BLS), chemical facilities experienced an illness and injury rate of 2.0 per 100,000 full-time equivalent (FTE) U.S. workers in 2012, compared to the U.S. manufacturing-sector average of 4.0. However, the industry’s number of fatal occupational injuries was above the manufacturing-sector average in recent years: chemical companies accounted for 7.6 percent, 7.3 percent, and 6 percent of fatal injuries in the manufacturing sector in 2011, 2012, and 2013, respectively, according to the BLS. According to the National Safety Council, each lost-time injury or illness costs a company an average of $37,000, while each fatality costs companies an average of $1.4 million. The costs to a company can quickly accumulate with frequent accidents and fatalities. Furthermore, in a survey of CFOs conducted by Liberty Mutual Insurance, 60 percent of respondents reported that $1 of investment in injury prevention returned $2 or more in savings, and more than 40 percent said that productivity is the chief benefit of strong workplace safety programs.

Chemical workers are inherently at risk of exposure to hazardous substances. Chronic health impacts can develop as a result of repeated or prolonged exposure. The most well-known example of this is the numerous cases of exposure to asbestos during chemical manufacturing from the 1940s to 1970s. Asbestos was used extensively in the industry’s products in the past, as a plastic filler, molding compound, and insulation and fireproofing material. Asbestos fibers can enter the lung and cause respiratory ailments and cancer. Major Chemical industry companies have faced asbestos-related lawsuits from chemical plant workers, with settlements running into hundreds of millions of dollars.

While asbestos has largely been phased out of chemical production, workers are at risk of exposure to many thousands of other potentially hazardous chemicals currently being manufactured or used in chemicals production processes, including the known carcinogens benzene and formaldehyde.

OSHA, which enforces workplace safety in the U.S., has largely focused on acute health impacts from accidents and immediate process safety, while risks from long-term exposure to hazardous substances has received less attention. Nonetheless, the agency currently regulates exposure to approximately 400 hazardous substances. OSHA’s Hazard Communication Standard requires chemical manufacturers and importers to report physical and health hazards of chemicals to employees and companies in the supply chain. OSHA enforces permissible exposure limits (PELs) for an eight-hour time-weighted average exposure to concentrations of toxics in the air or for contact with skin. Where hazardous
substances are not addressed by OSHA, companies may have to establish their own exposure criteria, which may not be standardized or adequate.\(^{192}\)

**Value Impact**

A company’s performance on health, safety, and emergency management can lead to acute impacts on value from high-impact incidents. Conversely, maintaining a safety culture and placing importance on worker well-being can have positive long-term and ongoing impacts on value.

Violations of health and safety standards could result in monetary and non-monetary penalties and additional costs of corrective actions, with an impact on profits and contingent liabilities. Adverse litigation rulings against a company from personal-injury or class action lawsuits could similarly result in contingent liabilities and litigation expenses. Performance on health and safety is also likely to be material in foreign operations, irrespective of whether local regulations are as stringent as those in the U.S., as it could affect the company’s reputation and ability to expand market share and operations. Reputational damage can result in lower brand value, potentially making it difficult for companies to attract and retain employees.

Health and safety incidents can result in downtime or reduced-capacity operations and ultimately a loss of revenue-generating opportunities. Workforce productivity may be lower if there are frequent health or safety incidents, reducing operating profits.

Additionally, the lack of a safety culture can increase the probability and magnitude of accidents, with significant impact on operations. Companies seen as having a poor safety record can also face higher costs of capital or insurance premiums due to an increased risk profile.

The value impact of this issue may increase over the medium to long term as the quality and availability of data on health hazards improves and companies face new regulations.

Incident-based safety metrics (process safety, transport incidents, injury rates and fatality rates) characterize past performance as a proxy for how well companies manage this issue, and the strength of internal governance surrounding the issue. It also provides an understanding of the probability and magnitude of incidents.

Challenges to safety systems, together with a discussion of employee exposure to health risks, provide complementary forward-looking insight on how companies are likely to perform in the future.
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2 Ibid.
4 Bloomberg Professional service, accessed March 20, 2015, using the BICS <GO> command. The data represents global revenues of companies listed on global exchanges and traded over-the-counter (OTC) from the Chemicals industry, using Levels 3 and 4 of the Bloomberg Industry Classification System.
6 Ibid., p. 46.
17 Ibid., p. 16.
21 Ibid.
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33 Ibid.


42 Ibid.


54 Global Chemicals Outlook: Toward Sound Management of Chemicals, United Nations Environmental Programme, p. 10.


61 Shannon, The Outlook for the U.S. Chemical Industry, p. 16.


64 Author’s calculation based on data from the 2011 United States Census Bureau Annual Survey of Manufacturers, 2011. The following NAICS codes were used in the calculation:

3251 Basic chemical manufacturing
3252 Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
3253 Pesticide, fertilizer, and other agricultural chemical manufacturing
3255 Paint, coating, and adhesive manufacturing
3259 Other chemical product and preparation manufacturing


Cyrus Lotfipour and Véronique Menou, “Executive Summary: Water Upstream and Downstream Impacts from a Well Running Dry,” MSCI ESG Research, September 2013, p. 2.


IBID


Author’s calculation based on the United States Environmental Protection Agency National Biennial RCRA Hazardous Waste Report using NAICS 3251, 3252, 3253, 3255, and 3259, exhibit 1.1 and exhibit 1.9.


Du Pont, FY2014 Form 10-K for the period ending December 31, 2014 (filed on February 5, 2015), section 3, p. 3.


138 Huntsman Corp., FY2014 Form 10-K for the period ending December 31, 2014 (filed on February 18, 2015), p. 44.


Ibid.


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174 Dupont, Inc., FY2014 Form 10-K for the period ending December 31, 2014 (filed on February 5, 2015), Section 1A, p. 2.


180 “Williams and Williams Partners L.P.


APPENDIX I:
Five Representative Chemicals Companies

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<th>COMPANY NAME (TICKER SYMBOL)</th>
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</table>

This list includes five companies representative of the Chemicals industry and its activities. This includes only companies for which the Chemicals industry is the primary industry, companies that are U.S.-listed but are not primarily traded over the counter, and for which at least 20 percent of revenue is generated by activities in this industry, according to the latest information available on Bloomberg Professional Services. Retrieved on March 10, 2015.
## APPENDIX IIA: Evidence for Sustainability Disclosure Topics

<table>
<thead>
<tr>
<th>Sustainability Disclosure Topics</th>
<th>EVIDENCE OF INTEREST</th>
<th>EVIDENCE OF FINANCIAL IMPACT</th>
<th>FORWARD-LOOKING IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HM (1-100)</td>
<td>IWGs</td>
<td>Ei</td>
</tr>
<tr>
<td>Greenhouse Gas Emissions</td>
<td>90*</td>
<td>86</td>
<td>2</td>
</tr>
<tr>
<td>Air Quality</td>
<td>90*</td>
<td>88</td>
<td>6</td>
</tr>
<tr>
<td>Energy &amp; Feedstock Management</td>
<td>85*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Water Management</td>
<td>60*</td>
<td>88</td>
<td>5</td>
</tr>
<tr>
<td>Hazardous Waste Management</td>
<td>55*</td>
<td>88</td>
<td>4</td>
</tr>
<tr>
<td>Safety &amp; Environmental Stewardship of Chemicals &amp; Genetically Modified Organisms</td>
<td>83*</td>
<td>83T</td>
<td>3t</td>
</tr>
<tr>
<td>Product Design for Use-phase Efficiency</td>
<td>93*</td>
<td>83T</td>
<td>3t</td>
</tr>
</tbody>
</table>

**HM:** Heat Map, a score out of 100 indicating the relative importance of the topic among SASB’s initial list of 43 generic sustainability issues. Asterisks indicate “top issues.” The score is based on the frequency of relevant keywords in documents (i.e., 10-Ks, 20-Fs, shareholder resolutions, legal news, news articles, and corporate sustainability reports) that are available on the Bloomberg terminal for the industry’s publicly listed companies. Issues for which keyword frequency is in the top quartile are “top issues.”

**IWGs:** SASB Industry Working Groups

**%:** The percentage of IWG participants that found the disclosure topic to likely constitute material information for companies in the industry. (-) denotes that the issue was added after the IWG was convened.

**Priority:** Average ranking of the issue in terms of importance. One denotes the most important issue. (-) denotes that the issue was added after the IWG was convened.

**Ei:** Evidence of Interest, a subjective assessment based on quantitative and qualitative findings.

**EFI:** Evidence of Financial Impact, a subjective assessment based on quantitative and qualitative findings.

**FLI:** Forward Looking Impact, a subjective assessment on the presence of a material forward-looking impact.

T: During the IWG phase the issue was called “Product Lifecycle Management & Innovation” and its scope included angles covered in this Brief’s “Safety & Environmental Stewardship of Chemicals & GMOs” and “Product Design for Use-phase Efficiency” disclosure topics.
APPENDIX IIA:
Evidence for Sustainability Disclosure Topics Continued

<table>
<thead>
<tr>
<th>Sustainability Disclosure Topics</th>
<th>EVIDENCE OF INTEREST</th>
<th>EVIDENCE OF FINANCIAL IMPACT</th>
<th>FORWARD-LOOKING IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HM (1-100)</td>
<td>IWGs</td>
<td>EI</td>
</tr>
<tr>
<td>Political Spending</td>
<td>15</td>
<td>83</td>
<td>7</td>
</tr>
<tr>
<td>Health, Safety, and Emergency Management</td>
<td>63*</td>
<td>88²</td>
<td>1</td>
</tr>
</tbody>
</table>

**HM:** Heat Map, a score out of 100 indicating the relative importance of the topic among SASB’s initial list of 43 generic sustainability issues. Asterisks indicate “top issues.” The score is based on the frequency of relevant keywords in documents (i.e., 10-Ks, 20-Fs, shareholder resolutions, legal news, news articles, and corporate sustainability reports) that are available on the Bloomberg terminal for the industry’s publicly listed companies. Issues for which keyword frequency is in the top quartile are “top issues.”

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²: During the IWG phase two issues — “Employee Health & Safety” and “Process Safety, Emergency Preparedness & Response” — were analyzed separately. This Brief’s “Health, Safety, & Emergency Management” disclosure topic now covers both issues. The percentages for both issues were averaged.
## APPENDIX IIB:
Evidence of Financial Impact for Sustainability Disclosure Topics

| Evidence of Financial Impact | REVENUE & EXPENSES | | | | ASSETS & LIABILITIES | | | | RISK PROFILE | | |
|-----------------------------|---------------------|-----------------|-----------------|---------------------|---------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                            | Revenue             | Operating Expenses | Non-operating Expenses | Assets | Liabilities | Cost of Capital | Industry Divestment Risk |
| Market Share                | New Markets         | Pricing Power    | Cost of Revenue | R&D | CapEx | Extra-ordinary Expenses | Tangible Assets | Intangible Assets | Contingent Liabilities & Provisions | Pension & Other Liabilities |
| Greenhouse Gas Emissions    | •                   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Air Quality                 | •                   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Energy & Feedstock Management | •                 | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Water Management            | •                   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Hazardous Waste Management  | •                   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Safety & Environmental Stewardship of Chemicals & Genetically Modified Organisms | •     | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Product Design for Use-phase Efficiency | •   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Political Spending          | •                   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
| Health, Safety, and Emergency Management | •   | •                | •               | •       | •       | •                         | •                         | •                         | •                         |
## APPENDIX III: Sustainability Accounting Metrics | Chemicals

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>ACCOUNTING METRIC</th>
<th>CATEGORY</th>
<th>UNIT OF MEASURE</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gas Emissions</td>
<td>Gross global Scope 1 emissions, percentage covered under a regulatory program</td>
<td>Quantitative</td>
<td>Metric tons CO2-e, Percentage (%)</td>
<td>RT0101-01</td>
</tr>
<tr>
<td></td>
<td>Description of long-term and short-term strategy or plan to manage Scope 1 emissions, emission-reduction targets and an analysis of performance against those targets</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RT0101-02</td>
</tr>
<tr>
<td>Air Quality</td>
<td>Air emissions for the following pollutants: NOx (excluding N2O), SOx, volatile organic compounds (VOCs), and hazardous air pollutants (HAPs)</td>
<td>Quantitative</td>
<td>Metric tons (t)</td>
<td>RT0101-03</td>
</tr>
<tr>
<td></td>
<td>Number of production facilities in or near areas of dense population</td>
<td>Quantitative</td>
<td>Number</td>
<td>RT0101-04</td>
</tr>
<tr>
<td>Energy &amp; Feedstock Management</td>
<td>Total energy consumed, percentage grid electricity, percentage renewable*</td>
<td>Quantitative</td>
<td>Gigajoules (GJ), Percentage (%)</td>
<td>RT0101-05</td>
</tr>
<tr>
<td></td>
<td>Percentage of raw materials from renewable resources</td>
<td>Quantitative</td>
<td>Percentage (%) by weight</td>
<td>RT0101-06</td>
</tr>
<tr>
<td>Water Management</td>
<td>(1) Total water withdrawn, percentage in regions with High or Extremely High Baseline Water Stress, (2) percentage recycled water usage</td>
<td>Quantitative</td>
<td>Cubic Meters (m³), Percentage (%)</td>
<td>RT0101-07</td>
</tr>
<tr>
<td></td>
<td>Number of incidents of non-compliance with water quality permits, standards, and regulations</td>
<td>Quantitative</td>
<td>Number</td>
<td>RT0101-08</td>
</tr>
<tr>
<td>Hazardous Waste Management</td>
<td>Amount of hazardous waste, percentage recycled</td>
<td>Quantitative</td>
<td>Metric tons (t), Percentage (%)</td>
<td>RT0101-09</td>
</tr>
<tr>
<td>Safety &amp; Environmental Stewardship of Chemicals &amp; Genetically Modified Organisms</td>
<td>Percentage of products that contain Registration, Evaluation, Authorisation and Restriction of Chemical (REACH) substances of very high concern (SVHC)</td>
<td>Quantitative</td>
<td>Percentage (%) by revenue</td>
<td>RT0101-10</td>
</tr>
<tr>
<td></td>
<td>Percentage of products that contain Class I World Health Organization (WHO) Acute Toxicity Hazard Categories pesticides</td>
<td>Quantitative</td>
<td>Percentage (%) by revenue</td>
<td>RT0101-11</td>
</tr>
<tr>
<td></td>
<td>Discussion of strategy to (a) manage chemicals of concern and (b) develop alternatives with reduced human and/or environmental impact</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RT0101-12</td>
</tr>
<tr>
<td></td>
<td>Percentage of products by revenue that contain genetically modified organisms (GMOs)</td>
<td>Quantitative</td>
<td>Percentage (%) by revenue</td>
<td>RT0101-13</td>
</tr>
</tbody>
</table>

*Note to RT0101-05—The registrant shall discuss its efforts to reduce energy consumption and/or improve energy efficiency throughout the production processes.
## APPENDIX III:
### Sustainability Accounting Metrics | Chemicals Continued

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>ACCOUNTING METRIC</th>
<th>CATEGORY</th>
<th>UNIT OF MEASURE</th>
<th>CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Design for Use-phase Efficiency</strong></td>
<td>Revenue from products designed for use-phase resource efficiency</td>
<td>Quantitative</td>
<td>U.S. Dollars ($)</td>
<td>RT0101-14</td>
</tr>
<tr>
<td><strong>Political Spending</strong></td>
<td>Amount of political campaign spending, lobbying expenditures, and contributions to tax-exempt groups, including trade associations</td>
<td>Quantitative</td>
<td>U.S. Dollars ($)</td>
<td>RT0101-15</td>
</tr>
<tr>
<td></td>
<td>Five largest political, lobbying, or tax-exempt group expenditures</td>
<td>Quantitative</td>
<td>U.S. Dollars ($), by recipient</td>
<td>RT0101-16</td>
</tr>
<tr>
<td><strong>Health, Safety, and Emergency Management</strong></td>
<td>Process Safety Incidents Count (PSIC), Process Safety Total Incident Rate (PSTIR), and Process Safety Incident Severity Rate (PSISR)**</td>
<td>Quantitative</td>
<td>Number, Rate</td>
<td>RT0101-17</td>
</tr>
<tr>
<td></td>
<td>Number of transport incidents***</td>
<td>Quantitative</td>
<td>Number</td>
<td>RT0101-18</td>
</tr>
<tr>
<td></td>
<td>Challenges to the Safety Systems indicator rate (Tier 3)</td>
<td>Quantitative</td>
<td>Rate</td>
<td>RT0101-19</td>
</tr>
<tr>
<td></td>
<td>(1) Total recordable injury rate (TRIR) and (2) fatality rate for (a) direct employees and (b) contract employees</td>
<td>Quantitative</td>
<td>Rate</td>
<td>RT0101-20</td>
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<tr>
<td></td>
<td>Discussion of efforts to assess, monitor, and reduce exposure of employees and contract workers to long-term (chronic) health risks</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RT0101-21</td>
</tr>
</tbody>
</table>

** Note to RT0101-17—The registrant shall describe incidents with a severity rating of 1 or 2, including their root cause, outcomes, and corrective actions implemented in response.

*** Note to RT0101-18—The registrant shall describe significant transport incidents, including their root cause, outcomes, and corrective actions implemented in response.
APPENDIX IV: Analysis of SEC Disclosures | CHEMICALS

The following graph demonstrates an aggregate assessment of how representative U.S.-listed Chemicals companies are currently reporting on sustainability topics in their annual SEC filings.

**TYPE OF DISCLOSURE ON SUSTAINABILITY TOPICS**

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gas Emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>86%</td>
</tr>
<tr>
<td>Air Quality</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>88%</td>
</tr>
<tr>
<td>Energy &amp; Feedstock Management</td>
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<tr>
<td>Water Management</td>
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<td></td>
<td></td>
<td></td>
<td>88%</td>
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<tr>
<td>Hazardous Waste Management</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88%</td>
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<tr>
<td>Safety &amp; Environmental Stewardship of Chemicals &amp; Genetically Modified Organisms</td>
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<td></td>
<td></td>
<td></td>
<td>83%</td>
</tr>
<tr>
<td>Product Design for Use-phase Efficiency</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>83%</td>
</tr>
<tr>
<td>Political Spending</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>83%</td>
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<tr>
<td>Health, Safety, and Emergency Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88%</td>
</tr>
</tbody>
</table>

*IWG Feedback*

*Percentage of IWG participants that agreed topic was likely to constitute material information for companies in the industry.

1/ During the IWG phase the issue was called “Product Lifecycle Management & Innovation” and its scope included angles covered in this Brief’s “Safety & Environmental Stewardship of Chemicals & GMOs” and “Product Design for Use-phase Efficiency” disclosure topics.

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