FUEL CELLS & INDUSTRIAL BATTERIES
Research Brief

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FUEL CELLS & INDUSTRIAL BATTERIES

Research Brief

SASB’s Industry Brief provides evidence for the disclosure topics in the Fuel Cells & Industrial Batteries 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 disclosure topic (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 disclosure topics likely to constitute material information for companies within a given industry. However, the final determination of materiality is the onus of the company.

Related Documents

- Fuel Cells & Industrial Batteries Sustainability Accounting Standards
- Industry Working Group Participants
- SASB Conceptual Framework

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INTRODUCTION

As one of the industries in the Renewable Resources & Alternative Energy sector, the Fuel Cells & Industrial Batteries industry plays an important role in the global shift toward cleaner energy and reducing environmental and social impacts. While the industry is relatively new and therefore small, it is growing at double-digit rates. Its long-term viability and success depend on its ability to compete with conventional sources of energy in various applications and, first and foremost, on a cost basis.

While renewable energy is more sustainable than fossil fuel-based and nuclear energy, companies in the Fuel Cells & Industrial Batteries industry are not inherently sustainable. To ensure long-term sustainable growth, companies in the industry need to manage several issues. The heavy reliance on certain materials may hinder the industry’s ability to scale if a supplier is at risk. By minimizing the reliance on critical materials, as well as securing their supply, companies can become cost-competitive. On the other side of the equation, technological advancements in products’ energy efficiency could propel the utilization of fuel cells and industrial batteries, significantly contributing to the total mix of clean energy.

Management (or mismanagement) of certain sustainability issues, therefore, has the potential to affect company valuation through impacts on profits, assets, liabilities, and cost of capital. Investors obtain a more holistic and comparable view of performance when fuel cells and industrial batteries companies report metrics on the material sustainability risks and opportunities that could affect value in the near and long term in their regulatory filings. This would include both positive and negative externalities and the non-financial forms of capital that the industry relies on for value creation.

NOTE ON INDUSTRY STRUCTURE

In developing this brief and determining disclosure topics and accounting metrics for the Fuel Cells & Industrial Batteries industry, SASB used a “pure play” definition of the industry, covering the manufacturing of fuel cells and batteries used in light automotive vehicle applications, as well as non-industrial batteries for personal consumer use in separate standards: Auto Parts and Household & Personal Products.

Therefore, depending on the specific activities and operations of fuel cells and industrial batteries manufacturers, sustainability topics and accounting metrics associated with Auto Parts and Household & Personal Products industries also may be relevant to consider.

SUSTAINABILITY DISCLOSURE TOPICS

ENVIRONMENT

- Energy Management

HUMAN CAPITAL

- Workforce Health & Safety

BUSINESS MODEL AND INNOVATION

- Product Efficiency
- Product End-of-life Management

LEADERSHIP AND GOVERNANCE

- Materials Sourcing
Specifically, performance on the following sustainability issues will drive competitiveness within the Fuel Cells & Industrial Batteries industry:

- Reducing the amount of energy consumed in manufacturing and testing;
- Ensuring worker health and safety, particularly from exposure to toxic materials;
- Advancing the efficiency and performance characteristics of products;
- Minimizing product lifecycle impacts through innovation in product design and business practices; and
- Managing the supply chain, including managing risks associated with the sourcing of sensitive or critical materials.

**INDUSTRY SUMMARY**

The Fuel Cells & Industrial Batteries industry is composed of companies that manufacture fuel cells for energy production and energy storage equipment such as batteries for primarily industrial or utility-scale purposes. Industry players design, build, and sell fuel cells and industrial batteries that have a range of different material inputs, including natural gas, lead, lithium, and other rare earth and critical materials. For the purposes of this brief, the industry does not include fuel cells or batteries used in light automotive vehicle applications or non-industrial batteries for personal consumer use. Manufacturers in this industry primarily sell business-to-business products to companies for varied energy-generation and -storage applications and intensities, from commercial business applications to large-scale energy projects for utilities.

Fuel cells include a range of technologies that produce electricity through electrochemical processes combining hydrogen and oxygen. Fuel cells can often operate on multiple fuel types, such as hydrogen, natural gas, propane, and methanol. Some of the main fuel cell technologies are alkaline fuel cell (AFC), proton exchange membrane (PEM), direct methanol fuel cell (DMFC), molten carbonate fuel cell (MCFC), phosphoric acid fuel cell (PAFC), and solid oxide fuel cell (SOFC). Each type of fuel cell has a unique chemistry and operating characteristics that define the application it is best suited for. For example, fuel cells such as PEM and DMFC, which operate at low temperatures and are lightweight, are used for mobile and small-scale applications, such as powering forklifts and defense vehicles.

In contrast, MCFC and PAFC fuel cells operate at higher temperatures and are better suited for stationary power generation, such as primary and backup power sources for commercial applications with higher energy needs, including utilities and universities.

The industrial batteries segment is slightly more mature than the fuel cells segment. However, new types of technologies and niche applications continue to emerge. Among the major industrial-scale battery chemistry types are lithium-, lead-, and nickel-based systems. As with fuel cells, each battery's various characteristics (such as power output and runtime) determine its application. Lithium-based batteries typically have higher specific energy in watt-hours per kilogram (Wh/kg) and higher specific power in watts per kilogram (W/kg), thereby providing longer runtimes and better power delivery than do lead and nickel batteries.

Lithium batteries are ideally suited for smaller applications such as defense vehicles and industrial machinery. In contrast, lead acid batteries have much lower levels of specific...
energy and specific power. However, the price point of lead acid batteries often gives them a competitive advantage. As of 2013, approximately 80 percent of the total installed capacity of industrial batteries (for stationary and motive applications) was based on lead-acid technology.

Industrial batteries can be used in military and defense applications, medical applications, and security metering, transportation, telematics, and other industrial segments. Industrial batteries for stationary use typically operate at low, steady power over a longer period of time than do smaller consumer batteries and are often configured to meet large backup power demands.

The Fuel Cells & Industrial Batteries industry is relatively small, with only four publicly traded companies in the United States. Companies listed on U.S. exchanges or traded over the counter are primarily headquartered in the U.S. (though some are domiciled in France and China) but have global operations and sell products to a global marketplace. The largest companies listed on U.S. exchanges are EnerSys, FuelCell Energy, Plug Power, and Ultralife Corporation. In 2014 EnerSys generated 51 percent of its revenue from the Americas, 39 percent from Europe, and 10 percent from Asia. In fiscal year (FY) 2015, sales outside the U.S. grew to about 60 percent of its revenue. Similarly, almost 70 percent of FuelCell Energy’s 2014 revenue came from South Korea, where the Renewable Portfolio Standards (RPS) that took effect in 2012 require an increase of renewable power generation from 2 to 10 percent by 2022. The U.S. market accounted for just under 30 percent of revenue. Plug Power generated all its revenue from the U.S. in 2014.

The global fuel cell and industrial batteries manufacturing market is valued at approximately $27 billion. Companies listed on U.S. exchanges generate approximately $2.8 billion from the industry. Even though countries such as China have increased their battery manufacturing capabilities, U.S. battery manufacturers still benefit from cutting-edge technologies, and exports are predicted to continue to increase. Considering the growing demand in European and Asian markets, several U.S. companies opened manufacturing facilities abroad to be closer to their customers.

The industrial batteries segment is the largest in the industry, based on reported segment revenues, followed by fuel cell manufacturing. While the fuel cell and lithium-based battery segments are still in the early stages of growth, consolidation in the industrial batteries segment indicates that the segment is in a mature lifecycle stage. EnerSys is the top company in this industry and has acquired multiple foreign companies over the past five years to expand its reach. Larger operations and vertically integrated production allow companies like EnerSys to benefit from a lower per-unit production cost. This makes them less susceptible to fluctuating input prices and gives them a competitive advantage over smaller companies and new entrants to the industry.

While the 2014 operating margin for the dominant company, EnerSys, was 7.9 percent, the three other public companies—FuelCell Energy, Plug Power, and Ultralife—had negative margins. The net income margin for EnerSys was 6.1 percent, whereas the industry median was negative 3.2 percent. Although the industry has seen steady growth in both segments over the past few years, the industry-wide margins show that companies are not yet profitable across the board. Low profitability could be due in part to high operating costs and high capital expenditures toward continued research and development (R&D).
The industrial batteries segment of this industry is expected to experience relatively slow growth over the next few years, given the rising prices of raw material inputs, including lead, zinc, and other nonferrous metal products. However, the level of technological change is considered to be high, as companies compete to create more efficient, safer, and more environmentally friendly alternatives. Capital-intensive and niche sub-segments such as backup batteries for photovoltaic applications and batteries for medical applications will likely continue to grow at a more rapid pace as the technology further evolves to suit market needs for specialized and high-value products.

The fuel cell segment is expected to continue to grow across all sub-segments, with especially strong growth in the stationary use category to meet continued demands for backup and remote power. Specifically, there has been a recent increase in demand for fuel cells in international markets (South Korea, Latin America, the Caribbean, Indonesia, India, the Middle East, Africa, Japan, and China). This is driven in part by government policy. In South Korea, for example, the RPS mandate that clean and renewable power generation must increase to 10 percent of total power generation by 2022 (up from 2 percent in 2012). The fuel cell segment of the industry grew by 30 percent in 2013, with shipments of nearly 200 megawatts of systems. Fuel Cell Today predicts that the size of the industry will be measured in gigawatts within the next five years.

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**LEGISLATIVE AND REGULATORY TRENDS IN THE FUEL CELLS & INDUSTRIAL BATTERIES 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.

The Fuel Cells & Industrial Batteries industry is subject to heavy regulation by multiple federal, state, local, and foreign regulatory standards, including those related to human and environmental health and safety laws, the management and disposal of hazardous substances, and the use of key materials.

As mentioned in the Industry Summary, national and foreign regulations aimed at curbing greenhouse gas (GHG) and other emissions and increasing the amount of clean of renewable power generation play an important role in demand for fuel cells and industrial batteries. The Clean Air Act (CAA) of the U.S. Environmental Protection Agency (EPA) regulates air emissions from stationary and mobile sources, while government-instituted cap-and-trade systems governing emissions of nitrogen oxides (NOₓ), sulfur oxides (SOₓ), and carbon dioxide (CO₂) exist in a growing number of regions. The E.U.

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8 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.
emissions trading system is the largest international system for trading emissions allowances, and its goal is to reduce emissions of covered sectors by 21 percent by 2020 from 2005 levels. The cap-and-trade program of the California Air Resources Board (ARB) targets the reduction of GHG emissions from major state facilities. The California program has also officially linked with the Quebec Ministry of Sustainable Development to co-host a joint cap-and-trade auction and is also working with the Western Climate Initiative to integrate this program into other regions. Furthermore, the Regional Greenhouse Gas Initiative is a nine-state program within the U.S Northeast to reduce CO₂ emissions from the power sector. China has already launched seven regional pilot cap-and-trade programs and also recently confirmed that a nationwide cap-and-trade program will be introduced in 2016.

Fuel cell and industrial battery customers are under increasing pressure to reduce their environmental footprints through improvements that range from corporate to utility-scale modifications. This pressure may come from emissions-related regulations, such as the cap-and-trade programs noted above, or from increasing pressure by peers and reporting schemes, including the Global Reporting Initiative and the Carbon Disclosure Project, to set transparent corporate standards and reductions for GHG emissions. This trend could help give products in the Fuel Cells & Industrial Batteries industry a competitive advantage if end users can employ them to lower their total GHG footprint.

Several tax incentive programs at both federal and state levels, in addition to stimulus funds, are already in place to help promote the development and expansion of energy generation and storage projects. The federal investment tax credit provides corporate tax credits for a wide range of renewable technologies, including fuel cells and combined heat and power (CHP) systems. California’s Self-Generation Incentive Program is one of the longest-running and most successful examples of a statewide initiative to promote distributed energy generation. Moreover, the American Recovery and Reinvestment Act (ARRA) of 2009 stimulates investment into a range of clean energy projects, including smart grid, carbon capture and storage technologies, and other energy efficiency and renewable energy projects. More than $31 billion has been invested through ARRA.

The EPA’s Resource Conservation and Recovery Act (RCRA) regulates the industry’s management of hazardous waste. RCRA regulations affect the generation, transport, treatment, storage, and disposal of such waste. In addition, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly referred to as Superfund, establishes legal responsibility for the environmental remediation of contaminated sites.

The Emergency Planning and Community Right-to-Know Act of 1986 requires that U.S. industrial facilities, including those that produce fuel cells and batteries, report toxics released into the air, land, and water annually to the EPA in the Toxics Release Inventory (TRI). TRI substances represent possible chronic and acute human health risks and adverse environmental impacts.

The industry is also required to adhere to specific health and safety standards for its employees. In the U.S., these standards are enforced by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor. The department currently regulates exposure to approximately 500 hazardous substances. In some instances, companies must additionally establish their own exposure criteria for the
thousands of other hazardous substances not addressed by OSHA.

Furthermore, companies in this industry are specifically impacted by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 and subsequent rules adopted by the U.S. Securities and Exchange Commission (SEC). Under the Dodd-Frank Act, companies are required to publicly disclose their use of conflict minerals if those materials are “necessary to the functionality or production of a product” that the company manufactures or contracts to be manufactured. These minerals include tantalum, tin, gold, and tungsten originating in the Democratic Republic of the Congo (DRC) or neighboring countries.36

The industry is facing increasing concern over the end-of-life management of products. Fuel cell and battery producers need to comply with region-specific producer manufacturing and take-back laws such as the E.U. Directive on Waste Batteries and Accumulators. The directive is aimed at reducing the amount of mercury, cadmium, lead, and other metals in the environment by minimizing their use and treating and reusing old batteries. Under this regulation, producers have a duty to take back discarded industrial batteries from any end-user free of charge and to tell end-users how they can return these batteries.37

Other such regulations include the E.U.’s Directive on End-of-life Vehicles, Japan’s 2002 End-of-life Recycling Law, South Korea’s 2007 Act for Resources Recycling of Electrical and Electronic Equipment and Vehicles, and the upcoming implementation of China’s Restriction of Hazardous Substances program. With an increasing demand for product transparency in the U.S. and other regions, similar regulations could expand to new jurisdictions in the future.

Broadly speaking, environmental and human health regulations are becoming increasingly strict in most markets, and regulations may impact the industry across operations, supply chains, and end markets.

**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 the 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 Fuel Cells & Industrial Batteries industry:

- **Environmental and social externalities:** The production of, and end-of-life for, fuel cells and industrial batteries can create negative environmental and social externalities. This includes improper disposal of hazardous materials at the end-of-life of fuel cells and batteries, the use of rare earth metals and conflict minerals as inputs to production, and health and safety hazards for workers. As a result, regulations could lower the demand for, or constrain the supply of, critical inputs for fuel cells and industrial batteries. Regulations could also increase costs associated with worker health and safety and product end-of-life management.

- **Resource scarcity:** Fuel cell and industrial battery manufacturing is a materials-intensive process that is impacted by the growing resource scarcity and increasing prices of critical materials.
As described above, the regulatory and legislative environment surrounding the Fuel Cell & Industrial Batteries industry emphasizes the importance of sustainability management and performance. Specifically, recent trends suggest a regulatory emphasis on reducing environmental impacts and improving health and 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 financial implications for companies in the Fuel Cells & Industrial Batteries 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 yearlong 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 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.

The Fuel Cells & Industrial Batteries industry utilizes energy as a key input for manufacturing and testing products. This energy consumption contributes to the indirect release of GHG emissions, which can lead to climate change. At the same time, energy expenditures can represent a large portion of a company’s cost of operations, making energy consumption an important issue to manage.

Energy Management

Most of the energy consumption in the Fuel Cells & Industrial Batteries industry takes place during the manufacturing and testing processes. As detailed in the Evidence section below, purchased electricity can represent a major share of the energy in the industry. Major uses of electricity in this industry vary depending on the type of component being manufactured and tested for efficiency in labs. The automated and manual processes involved all require energy.
Fossil fuel–based energy production and consumption contribute to significant environmental impacts, including climate change and pollution, which have the potential to indirectly yet significantly impact the operations of fuel cell and industrial battery companies. Factors related to sustainability, such as GHG emissions pricing, incentives for energy efficiency and renewable energy, and risks associated with nuclear energy and its increasingly limited license to operate, are leading to a rise in the cost of conventional energy sources while making alternative sources cost-competitive. Therefore, it is becoming increasingly important for companies in energy-intensive industries to manage their overall energy efficiency, their reliance on different types of energy and the associated risks, and their access to alternative energy sources.

By improving the efficiency of the manufacturing process and exploring alternative energy sources, including using their own products to power their facilities, fuel cell and industrial battery companies can reduce both their indirect environmental impacts and their operating expenses. These reductions can improve profit margins and, in turn, can help improve the commercial viability of this industry’s products.

Company performance in this area can be analyzed in a cost-beneficial way 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.

**Evidence**

Manufacturing and R&D require significant energy consumption to power cooling, ventilation, lighting, and product testing systems. The majority of the companies traded in the U.S., including over the counter, have negative net operating margins. Therefore, it will be particularly important for fuel cell and industrial battery manufacturers to control energy costs while the industry proves the commercial viability of large-scale projects at competitive price points.

According to data from the 2011 Annual Survey of Manufacturers, conducted by the U.S. Census Bureau, for the “storage battery manufacturing” segment (2007 NAICS code 335911), purchased electricity constituted 3.5 percent of value added and 3.3 percent of the total cost of materials. This was greater than the average for all U.S. manufacturing facilities included in the survey, where purchased electricity was 2.3 percent of value added and 1.6 percent of the total cost of materials. This indicates that the industry is more exposed to rising or volatile energy costs and grid disturbances, particularly given the low and negative profit margins (a negative 3.2 percent median net income margins for the industry).

Overall, storage battery manufacturing facilities in the U.S. purchased 2.3 billion kilowatt-hours (kWh) of electricity for heat and power, which accounted for $112 million of operating expenses. The relative cost of purchased fuels is lower than that of purchased electricity for this segment.

One of the main challenges for the industry (particularly the fuel cell segment) is to prove the commercial viability of large-scale projects. Initiatives aimed at reducing energy consumption can have a positive impact on operational efficiency and margins. This could help companies pass through cost savings and lower the price of fuel cells and batteries, improving their commercial viability.

A number of the top companies in the industry, including EnerSys, FuelCell Energy, Plug Power, and Ultralife, cite concerns about increasing energy costs in their annual SEC filings. Ultralife reported the following concerns in its FY2013
Form 10-K: “We use various utilities to provide heat, light and power to our facilities. As energy costs rise, we continue to seek ways to reduce these costs and will initiate energy-saving projects at times to assist in this effort. It is possible, however, that rising energy costs may have an adverse effect on our financial results.”

With electricity costs increasing, companies in the industry are trying to reduce their reliance on grid electricity by taking steps to decrease or offset their energy expenses. Furthermore, many are implementing or piloting their own energy-generation and storage technologies to reduce overall grid dependence and associated emissions. For example, Highway Holdings is trying to minimize high electricity expenses at its manufacturing facilities in China by installing more meters and shifting its production schedule to lower-cost periods. Highway Holdings claims it has experienced electricity shortages, as well as increased energy prices, because of the rapid growth of China’s economy, which has adversely affected the cost of operations.

FuelCell Energy’s FY2014 Form 10-K described the following strategies aimed at improving its energy efficiency in manufacturing: “We have a tri-generation fuel cell power plant at our North American manufacturing plant, efficiently generating power and heat for the facility and hydrogen for the manufacturing process. From a sustainability standpoint, on-site tri-generation avoids the use of a combustion-based boiler for heat and its associated emissions and reduces pollutants from the diesel truck needed for hydrogen delivery, reducing our carbon footprint and benefiting the surrounding community.”

Furthermore, companies such as Plug Power have chosen to use their own fuel cell technology for primary and backup power generation at their manufacturing facilities to reduce their corporate footprint. Plug Power has also opted to purchase Green-e certified renewable energy credits as a means of offsetting its own environmental footprint while supporting the development of new renewable generation capacity.

**Value Impact**

Energy management is likely to have a chronic impact on value though operational costs. Fuel cell and industrial battery manufacturers that invest in process innovation aimed at reducing electricity consumption and that implement alternative sources of energy are likely to improve their operational efficiency in the medium to long term.

Furthermore, a reduced reliance on traditional sources of energy and a greater share of purchased or self-generated electricity from renewable or alternative energy sources indicate a company’s ability to mitigate its environmental footprint and its exposure to energy cost increases or volatility driven by sustainability impacts. This could help lower companies’ cost of capital as well as improve the commercial viability of their products, contributing to revenue growth.

The probability and magnitude of these impacts could increase in the future as emerging governmental regulations on environmental impacts continue to drive energy cost increases.

**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.

Fuel cell and industrial battery manufacturing poses inherent dangers to employees. Exposure to hazardous chemicals, electrical hazards, explosive materials, heavy machinery, and pressurized equipment poses physical risks. Implementing a safety culture is critical to proactively guard against accidents or other incidents with negative environmental and social impacts. A company's ability to protect employee health and safety and to create a culture of safety for employees at all levels of the organization can directly influence the results of its operations.

Workforce Health & Safety

Fuel cell and industrial battery manufacturing workers may be exposed to hazardous substances or accidents that can have chronic or acute health impacts, sometimes resulting in fatalities. While injury rates are generally low in the industry, relative to others, companies have faced regulatory action from violations of health and safety standards, some of which have been repeat violations. Companies can also face litigation as a result of fatalities or chronic health impacts from working in fuel cell and battery manufacturing facilities.

Chronic health impacts can develop as a result of repeated or prolonged exposure to hazardous substances. Since lead is a key component in many traditional batteries and is absorbed into the body by ingestion or inhalation, battery plant workers can be subject to lead toxicity, which can have a variety of physical and mental health impacts. Beyond exposure to hazardous substances, acute incidents might also include fires and explosions, freeze burns, and electrical hazards.

Companies that employ best practices, such as providing health and safety training, protective gear, improved ventilation, and regular monitoring, can increase workforce health and safety performance. Business practices that emphasize a strong safety culture are also important to achieving sustained, improved performance on this issue. Through these efforts, companies can minimize regulatory and litigation risks that could affect long-term value.

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

- Total recordable injury and fatality rates; and
- Discussion of efforts to assess, monitor, and reduce exposure of workforce to human health hazards.

Evidence

In the manufacture of industrial batteries, companies process, store, and dispose of large amounts of hazardous materials, such as lead and acid. As a result, employees' health and safety may be at risk, and therefore companies in the industry are subject to stricter laws governing this issue.

Some companies in the industry may have operational facilities in countries where local employee safety laws may be less strict. For example, according to the EnerSys FY2015 Form 10-K, more than half the company's manufacturing capacity is located outside the U.S. FuelCell Energy has manufacturing facilities...
in the U.S., South Korea, and Germany. Multinational operations require companies to comply with local regulations, although U.S. investors may expect companies to perform to higher standards of employee health and safety. To reduce the risk of incidents, companies including EnerSys, Exide Industries, and Saft Groupe certify their global facilities to health and safety standards such as Occupational Health and Safety Assessment Series (OHSAS) 18001.

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 limits for exposure to concentrations of hazardous substances in the air or in contact with skin.

However, OSHA has largely focused on acute health impacts from accidents and immediate process safety, while risks from long-term exposure to hazardous substances have received less attention. Existing OSHA standards allow workers to have blood lead levels up to 60 μ grams per deciliter (g/dL) before they have to be removed from work areas because of significant lead exposure. However, the California Department of Public Health (CDPH), among others, has suggested that these regulations are not stringent enough because they were based on scientific information that is more than 35 years old. The CDPH has proposed an alternative exposure limit of 20 μg/dL, which is still under consideration. New regulatory initiatives such as these, in both developed and developing countries, could increase future regulatory risks for fuel cell and battery companies, particularly with a greater understanding of health impacts for industry workers.

The EPA research indicates a causal relationship between low-level lead exposure and high blood pressure, heart disease, and male reproductive issues. A study also determined that there is likely a causal relationship between low-level lead exposure and a decrease in brain functions such as learning and memory, as well as psychological effects. More severe cases of lead poisoning can cause anemia, nerve and kidney damage, convulsions, or even death.

EnerSys is one example of a company that was found to be in serious violation of regulations and was repeatedly fined by OSHA for exposing workers who recycle lead batteries to concentrations of lead beyond the permissible limits. A serious violation occurs when there is “substantial probability that death or serious physical harm could result from a hazard about which the employer knew or should have known.” In 2011, EnerSys received a fine of $77,000 at its Frisco, Texas, battery recycling facility for not implementing engineering and work practice controls to prevent worker exposure to hazardous concentrations of lead. EnerSys also repeatedly exceeded lead-exposure limits at its Fort Smith, Arkansas, facility in 2008, with penalties of $36,600, and at its Laurelvale, Pennsylvania, facility in 2009, with penalties of $52,400. While individual penalties are small, fines for repeated violations could have a chronic impact on company value, not only by directly eroding already weak profit margins but also by lowering worker morale and productivity and increasing long-term employee health care expenses.

EnerSys highlighted the costs of associated compliance risks in its FY2013 Form 10-K: “Our ongoing compliance with environmental, health and safety laws, regulations and permits could require us to incur significant expenses, limit our ability to modify or expand our facilities or continue production and require us to install additional pollution control equipment and make
other capital improvements. In addition, private parties, including current or former employees, could bring personal injury or other claims against us due to the presence of, or exposure to, hazardous substances used, stored or disposed of by us or contained in our products."  

Exide Technologies, a battery maker that had been in business for 125 years, filed for bankruptcy in 2013 after California environmental regulators shut down one of its lead-recycling plants. The California Department of Toxic Substances and Control ordered Exide to suspend operations at the recycling plant because of noncompliance with state health standards. Specifically, there were allegations of hazardous wastes such as arsenic and lead being released into the soil and air in amounts that exceeded public health regulations, posing potential health risks to workers and the neighboring community. While this incident was not the only reason Exide filed for bankruptcy, the company estimates that the closure of the California recycling plant cost it $24 million in earnings before taxes, interest, depreciation, and amortization.

In addition to costs associated with violations, companies are also at risk of litigation and additional health costs for employees. Forty-three workers recently sued a Saft battery factory for prolonged exposure to cadmium, and at least twice that number of workers may have been affected.

Value Impact

Performance on worker health and safety can affect the operational efficiency and cost structure of fuel cell and industrial battery companies. In particular, violations of health and safety standards could result in monetary and nonmonetary penalties and additional costs of corrective actions, with an impact on net profits.

Adverse legal rulings against a company as a result of employee lawsuits related to both regulated and unregulated but known hazardous substances and/or workplace accidents could create contingent liabilities. In instances where casualty liability coverage may not be sufficient, a company may take losses that could reduce operating expenses.

Performance on health and safety is also important in foreign operations, regardless 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 operations in the long term. Negative reputational effects can be particularly damaging for nascent segments of the industry, such as fuel cells, especially as they attempt to provide “clean” sources of energy. Generally, poor safety records can have a chronic negative impact on reputation and can lower the value of intangible assets.

The impact of this issue is likely to become more significant over the medium to long term, as the quality and availability of data on health hazards improve and companies face new regulations or the inclusion of new chemicals in existing regulations. Therefore, the probability and magnitude of these impacts are likely to increase in the future.

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 and efficiency and responsibility in the design, use-phase, and disposal of products. 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.

In the Fuel Cells & Industrial Batteries industry, business model and innovation issues focus on the responsibility of producers to reduce the lifecycle impacts of a product (particularly through reuse and recycling at the end-of-life stage) and improve the energy efficiency in the use phase. Emerging environmental and social trends, along with increased regulatory requirements and scrutiny, are creating new innovation and business opportunities for companies in the industry. Such innovation directly impacts the total cost of owning, disposing of, and (potentially) manufacturing fuel cells and industrial batteries. Companies’ intellectual capital can be used to create innovative products that address the material environmental and social impacts discussed above, which are otherwise created by this industry over the product lifecycle.

Product Efficiency

As the global regulatory environment continues to evolve and to mandate lower emission and increased use of renewable energy, companies in the industry may play an important role in helping their clients comply with these regulations. While fuel cells and batteries may be inherently cleaner and more efficient than traditional sources of energy, firms may still improve characteristics of their products through design decisions and win a competitive advantage in capturing a larger share of this growing market. Both customer demand and regulatory requirements are increasing for energy-efficient products with lower environmental impacts and lower total cost of ownership. The widespread adoption of fuel cell technologies, in particular, may be limited because of their high costs relative to competing energy sources. Therefore, design decisions in the Fuel Cells & Industrial Batteries industry that drive energy and thermal efficiency and enhance storage capacities can lower barriers to adoption.

Together, these factors are driving fuel cell and industrial battery manufacturers to improve their products’ use-phase charging and thermal efficiency. Improved efficiencies could help lower total costs of ownership for customers. As the rate of adoption of fuel cells and industrial batteries increases, it will become even more important to ensure that product design is maximized for efficient energy production or storage. As noted in the Industry Summary, different types of fuel cells and batteries are more suitable for different applications, such as stationary versus motive. However, companies can continue to innovate to improve the efficiency of these products in order to meet demand and capture additional market share.

In particular, advances in battery technology to increase storage capabilities and improve charging efficiencies, while lowering costs, are critical for the integration of renewable energy technologies into the grid. Market demand for such battery types is expected to increase dramatically in the next few years. Fuel cell and industrial battery manufacturers that are able to improve efficiency in the use phase will be able to satisfy growing demand, pressured by stricter environmental regulations, high energy costs, and customer preferences.

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

- Average storage capacity of batteries, by product application and technology type;
- Average energy efficiency of fuel cells as electrical efficiency and thermal efficiency,
by product application and technology type;
• Average battery efficiency as coulombic efficiency, by product application and technology type;
• Average operating lifetime of fuel cells, by product application and technology type; and
• Average operating lifetime of batteries, by product application and technology type.

Evidence

According to industry analysts, one of the major barriers to greater fuel cell adoption is their high cost relative to that of incumbent energy generation sources. Companies that innovate to improve product energy efficiencies to lower the cost of their product, as well as decrease their customer’s cost of ownership, will likely increase their market share.

Companies can lower a product’s cost of ownership through thermal efficiencies within product offerings. A typical high-temperature fuel cell system consumes only 70 to 80 percent of its fuel. FuelCell Energy is researching a CHP system that will better utilize excess heat to increase overall system efficiency by more than 75 percent. This will reduce its customers’ utility costs by an estimated 25 percent. General Electric’s research organization is working on a utility-scale fuel cell that currently turns 65 percent of the usable energy from natural gas into electricity. The company expects to increase the energy efficiency to 95 percent using waste heat from the process.

By configuring its power plants for CHP, FuelCell Energy can deliver up to 90 percent system efficiency, depending on the application. This is a significant improvement over the efficiency of the company’s Direct FuelCell power plants and the hybrid applications and advanced configurations, which deliver electrical efficiency of 47 and 60 percent, respectively. The company also provides a High Efficiency Fuel Cell configuration, which utilizes heat energy to generate additional electricity from each unit of fuel, with an electrical efficiency of approximately 60 percent.

According to EnerSys, upgrading propane-powered lift trucks to electric-powered ones can lower annual fuel costs by $6,300 per vehicle as well as reduce truck maintenance and increase productivity (lift and travel speeds) by 20 percent. Electric-powered trucks not only reduce operating expenses for customers but also eliminate a significant amount of CO₂ emissions, which are likely to be important determinants of demand.

These types of innovations require significant capital investments for companies. For example, FuelCell Energy spent $35 million on research and development in 2014, roughly 19 percent of its total revenue that year.

Battery technology is projected to undergo major innovations and price reductions over the next decade. Navigant Research predicts that the market for next-generation batteries will grow from $164 million in 2014 to more than $2.5 billion in 2023. Those companies manufacturing products that can deliver the most energy efficiency to their clients are likely to capture a larger share of this market and obtain a pricing power through competitive advantage.

Much of the industry growth will come from tackling grid-integration issues for renewable energy sources such as wind and solar. Currently, much of the needed technology is not economically viable. For example, battery technology needs to find a cost-effective method to address intermittency. Wind and solar resources are not always available, so for these technologies to scale up, energy needs to be
stored so that it can be deployed at peak times. Batteries will need to cost-effectively store utility-scale electricity for hours, not just the minutes currently economically viable for smoothing out small-scale demand fluctuations.\(^79\)

There also needs to be significant price decreases to accompany the innovation in energy storage densities and efficiencies. Battery storage will have to cost around $100/kWh to make storing utility-scale energy viable. Currently, costs for this type of technology are hovering around $700/kWh.\(^80\) However, industry researchers project that these necessary advances will take place: Navigant Research forecasts 21.8 GW of energy storage systems will be installed globally between 2013 and 2023, representing a significant market opportunity.\(^81\) Greentech Media, a renewable energy research group, projects that 720 MW of distributed energy storage will be deployed in the U.S. alone between 2014 and 2020. This would represent a 34 percent compound annual growth rate.\(^82\)

China BAK Battery, in its FY2013 Form 10-K, disclosed the inherent risks associated with rapid technological shifts and the importance of remaining competitive through product innovation: “Accordingly, our significant investment in our R&D infrastructure may not bear fruit. On the other hand, our competitors may improve their technologies or even achieve technological breakthroughs that would render our products obsolete or less marketable.”\(^83\) Companies in this segment of the industry must invest heavily in R&D to remain competitive. Ultralife spent $7.2 million in 2012 and $5.9 million in 2013 on R&D.\(^84\) This represents 7 percent and 7.5 percent, respectively, of their revenue in those years.\(^85\)

Innovations are also occurring in small-scale battery storage. In 2014, Flux Power developed a lithium-ion battery for forklifts, which it claims significantly outperforms the industry standard lead-acid battery. The company claims the battery is capable of more than 2,000 charge cycles, as opposed to the standard 500 charge cycles for lead-acid batteries, and can last up to 25 percent longer between charges.\(^86\) These types of innovations significantly decrease a customer’s cost of ownership. Companies that are successful in offering these innovative types of products will gain market share.

Innovation may be related not only to improving performance characteristics of products but also to inventing new applications for fuel cells and industrial batteries. For example, FuelCell Energy developed a new battery that utilizes emissions from coal- or gas-fired power plants instead of ambient air. The technology can destroy approximately 70 percent of smog-producing pollutants, such as NO\(_x\), and capture up to 90 percent of carbon emissions. At the same time, the new battery’s power output has been increased by 80 percent, for only about a 30 percent increase in costs, which is less than the DOE’s target of $40/ton.\(^87\) In 2015 the DOE selected FuelCell Energy for a cost-sharing carbon capture project, sponsored by the National Energy Technology Laboratory, with an outlay of $23.7 million. In the second phase of the project, 700 tons of CO\(_2\) per day is expected to be captured and 648,000 kWh of “ultra-clean” power per day to be generated.\(^88\)

According to FuelCell Energy’s statement on its 2015 third quarter earnings call, both utility and energy companies have expressed broad interest in this technology. Plant operators may capitalize on their investment by selling generated electricity. Another advantage is the ability to install it incrementally, which helps to cost-efficiently reduce emissions. FuelCell Energy is currently in discussions regarding carbon capture
with “several of the top U.S. utilities,” which may help the company to expand its market share in this segment. 89

Value Impact
With rising energy costs and attention focused on reducing global GHG emissions, there is increasing market demand for energy storage and supply technologies that reduce the total cost of ownership for customers, help customers reduce their environmental footprint, and enable greater integration of renewable energy technologies into the grid.

Companies that invest their R&D resources in improving their products’ storage capabilities and energy efficiencies will both contribute to lowering environmental impacts as well as enjoy a competitive advantage by lowering customers’ total cost of ownership and enabling them to meet their GHG reduction targets. This can drive greater market share and revenue growth for innovative companies that improve their products’ environmental attributes. Breakthrough technologies in this regard could dramatically lower companies’ risk profile and cost of capital.

The probability and magnitude of impacts from this issue are likely to increase over time as alternative energy technologies become more cost-competitive and GHG emissions reduction increases in urgency.

Product End-of-life Management
As the rate of adoption for fuel cells and industrial batteries increases and more products reach the end of life, it will become increasingly important to ensure that product design is maximized for end-of-life management and materials efficiency. Fuel cells and batteries contain hazardous materials, which, at the end of life of these products, can leach into the environment if products are improperly disposed of. This can pose significant human health and environmental risks, with possible regulatory impacts for companies in some regions. While recycling or reuse of batteries and fuel cells is critical to minimizing these impacts, such processes themselves pose hazards to workers at recycling plants and neighboring communities, as mentioned above in the topic on Workforce Health & Safety.

Effective design for disassembly and reuse or recycling will be a key element for ramping up these recovery rates in order to reduce the lifecycle impacts of fuel cells and batteries and mitigate the strain of new production on natural resources. The role of fuel cell and industrial battery manufacturers is therefore critical in the process of designing products for reuse, modularity, and/or recycling. Companies can also create take-back programs and/or work with trusted third-party recycling companies to ensure safe disposal and reuse of their products.

Proper management of the issue can reduce negative environmental impacts from the industry value chain. The emergence of several laws regarding the end-of-life phase of batteries has recently heightened the importance of the issue, creating potential added costs of managing risks as well as opportunities through regulatory incentives. Furthermore, given input price volatility and resource constraints, fuel cell and industrial battery companies that are able to develop take-back and recycling systems and reuse some of the recovered materials in manufacturing are likely to improve their long-term operational efficiency and improve their risk profile.

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

- Percentage of products sold that are recyclable or reusable;
- Weight of end-of-life material recovered, percentage of recovered materials that are recycled; and
- Discussion of approach to manage use, reclamation, and disposal of hazardous materials.

**Evidence**

According to industry analysts, the major barrier for fuel cell adoption is “high capital costs and the low costs of incumbents.” The relatively high cost of fuel cells is due, in part, to the expensive material inputs for manufacturing fuel cell products. Companies that can reduce input costs through innovative design and supply chain efficiency for the reuse and recycling of their products could therefore gain a competitive advantage by passing through lower costs to their customers.

Recycling rates and amounts of materials recovered from this industry vary by country. Europe currently recycles 1,000 to 2,000 metric tons of lithium-ion batteries every year. However, the European Association for Advanced Rechargeable Batteries estimates that recycling rates could reach 10,000 metric tons a year within the next decade.

Companies that work to recycle and reuse products and develop cleaner energy-generating and storage processes can take advantage of stimulus incentives such as 2009’s ARRA. East Penn Manufacturing Company is an example of a battery company with fully integrated recycling facilities that received a $32.5 million grant from the U.S. Department of Energy, as part of ARRA, to expand its production facilities. Through the use of vertically integrated recycling facilities, East Penn Manufacturing is able to provide a full-service product take-back offering to its customers while also securing key inputs for future products. The company’s lead smelter and refinery recycles virtually 100 percent of every lead-acid battery component brought to the facility, avoiding hazardous acid disposal and risks through reuse.

Platinum is considered to be a key material whose costs and limited availability are reducing the widespread development of fuel cells (particularly PEM cells). It is estimated that approximately 46 grams of platinum are needed to power a 50 kW fuel cell. This would cost approximately $2,200, according to recent price estimates, as platinum is a precious metal that is considered to be a limited resource and is found only in South Africa and Russia. Fuel cells and other demands for platinum are expected to raise these prices even higher as the market continues to expand. Given the price and resource constraints of platinum, some estimate that a fuel cell–leasing scenario could help reduce the up-front price of platinum by as much as 40 percent because of improved recovery processes.

In addition to cost savings and improved competitiveness, having an effective product design and programs for recycling and take-back can help companies proactively mitigate risks from expanding regulations related to product end of life. As discussed earlier in the Legislative and Regulatory Trends section, under the E.U. Directive for Waste Batteries and Accumulators, producers have a duty to take back discarded industrial batteries from any end-user free of charge. In assessing the economic impacts of this directive, the E.U. Commission estimated that collection and recycling costs represented 1.5 to 25 percent of a battery’s sale price, depending on the type of battery and on specific collection targets. The E.U. Commission also estimated that
in a scenario of shared responsibility, where costs would be distributed between producers, public authorities, and retailers, costs paid by producers would vary between 1.5 and 5.5 euro cents per unit sold.98

Fuel cell power plants may create various environmental externalities at the end of their lifecycle if not decommissioned properly. In its FY2014 Form 10-K, FuelCell Energy stated that the company refurbishes and reuses certain parts of its power plants at the end of their useful lives, supporting the “cradle-to-cradle” concept: “The balance of plant has an operating life of twenty to twenty-five years, at which time metals such as steel and copper can be reclaimed for scrap value.”99 These practices may reduce not only regulatory risks associated with environmental and social externalities but also the cost of production and the exposure to volatile metal prices.

With the increasing focus on lifecycle environmental impacts of products within the U.S. and other regions, similar regulations, like the New York State Rechargeable Battery Recycling law, could expand to new jurisdictions in the future, creating additional regulatory risks for companies. Some companies in the industry have started providing investors with disclosure around this issue in their annual SEC filings. For example, in its FY2013 Form 10-K, Ultralife stated that it is committed to responsible product stewardship and ongoing compliance with domestic and international battery recycling laws. The company also mentioned that it continued “to evaluate the impact of these regulations, and actual costs could differ from [their] current estimates and additional laws could be enacted by these and other states which entail greater costs of compliance.”100 Specifically, Ultralife is subject to compliance with the E.U. Directive for Waste Batteries and Accumulators and is required to meet mandated targets for collection and recycling of batteries. The directive also sets rules on the labeling of batteries and their removability from equipment to facilitate their reuse and safe disposal.101

**Value Impact**

Product end-of-life issues can affect the cost structure and revenue expansion of companies over time. They can also potentially lead to acute impacts on cash flows through regulatory penalties or the introduction of new regulations on end-of-life management.

While product and business model innovations to improve the recyclability, recycling or reuse of products can lead to additional R&D expenses in the short term, such innovations can drive competitiveness and revenue growth in the medium term. In addition, recovery and recycling of critical materials can help manufacturers of fuel cells and industrial batteries achieve significant cost savings and insulate themselves from the risk of rising prices or the unavailability of key materials. Companies with effective end-of-life management and recycling programs could face lower costs of capital given their lower supply risks.

Stricter regulations around end-of-life management require higher recyclability and recycling rates of fuel cells and batteries. These regulations can affect demand and increase compliance costs for companies in this industry. Noncompliance with regulations may lead to civil penalties and extraordinary expenses.

The percentage of recyclable products indicates how well companies are positioned to respond to increased demand for these products. The usage by weight of recycled or remanufactured materials in products indicates a company’s performance in operational and resource efficiency.
The probability and magnitude of impacts from this issue are likely to increase in the medium term with more stringent and new end-of-life regulations being introduced and with increasing supply constraints and higher prices of key input materials.

**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.

Fuel cell and industrial battery companies rely on increasingly complex and geographically diverse supply chains for critical material inputs, magnifying the risks of supply disruptions. Rapid industry growth and, therefore, increasing demand for critical materials is likely to create additional environmental and social externalities that could pose additional supply risks to companies. Effective materials sourcing practices that mitigate supply risks will play an increasingly important role in creating shareholder value in the industry, as the supply chain and regulatory environments are constantly shifting.

**Materials Sourcing**

Manufacturing certain types of industrial batteries and fuel cells requires an available supply of materials such as lithium, cobalt, nickel, and platinum. In some applications, gold, tantalum, and tin may be necessary to their functionality or production. Access to these materials is critical for the continuous development and scaling of clean energy technologies like fuel cells and industrial batteries.

Limited global resources of these materials, as well as their concentration within particular countries that may have poor governance structures or are the subject of geopolitical tensions, expose fuel cell and industrial battery companies to the risk of supply chain disruptions and input price increases or volatility. Moreover, a company’s reputation can be damaged if it uses gold, tantalum, tin, or other minerals originating from conflict zones.

The use of such minerals from certain conflict zones also exposes fuel cell and industrial battery companies to regulatory risks associated with the Dodd-Frank Act (see the Legislative and Regulatory Trends section above for details). To the extent that a fuel cell or industrial battery manufacturer, foreign or domestic, files reports with the SEC and considers tin, tantalum, tungsten, or gold (3TG) as “necessary to the functionality or production” of its products, the company is required to provide disclosures around the origin of the minerals in accordance with act’s conflict minerals provision. This requires active monitoring of the supply chain.

Companies face pressure from legislators, nongovernmental organizations, and peers to track and eliminate the use of tin, tantalum, tungsten, and gold responsible for conflict in the DRC. The limited availability of suppliers that can provide certified conflict-free minerals presents supply constraint risks to companies in the industry, as well as puts upward pressure on material prices.
While lithium battery manufacturing is likely to currently account for the industry's largest volume, as well as variety, of critical materials—including lithium, nickel, and cobalt—used in manufacturing, the innovation and growth in fuel cell technology could contribute to the rising demand for platinum. Although platinum is usually used in much lower quantities, it is a significantly more expensive metal than lithium, cobalt, and nickel per unit of weight.

As the market for fuel cells and industrial batteries expands, there will likely be an increase in demand for critical and conflict-free minerals. Moreover, competition from other industries that utilize the same critical materials and/or employ fuel cell and battery technologies is likely to exacerbate supply risks. Fuel cell and industrial battery companies with strong supply chain standards and the ability to adapt to increasing resource scarcity will be better positioned to protect shareholder value. Innovations at the design phase to reduce dependence on some of these materials will help lower risk. Companies that are able to limit the use of critical and conflict materials, as well as secure their supply of the materials they do use, will not only minimize environmental and social externalities related to extraction but also protect themselves from supply disruptions, volatile input prices, and reputational and regulatory risks.

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

- Percentage of materials costs for critical materials;
- Percentage of tungsten, tin, tantalum, and gold smelters within the supply chain that are verified conflict-free; and
- Discussion of the management of risks associated with the use of critical materials and conflict minerals.

Evidence

According to the RAND National Defense Research Institute, a high percentage of material resources critical to U.S. manufacturing is imported. In a 2013 RAND report focusing on materials for which the dominant producer is outside the U.S., the U.S. has appreciable net imports, and dominant producers have shortfalls in quality of governance, the materials identified as critical include lithium, nickel, cobalt, tungsten, and tantalum, all of which are used in certain types of fuel cells or batteries. The report notes that almost 53 percent of cobalt reserves are located in the DRC; 37.4 percent of lithium is produced in Chile, and more than 50 percent of global lithium reserves are located in Bolivia. Russia, Indonesia, and Philippines control 42.4 percent of nickel reserves; Brazil, Mozambique, and Rwanda account for more 60 percent of tantalum production; and China alone has 85.8 percent of global tungsten reserves. Some of these countries impose production controls and export restrictions such as quotas and tariffs, which, in light of increasing demand for these materials, have had a significant impact on price and availability. For example, between 2010 and 2011 the price of rare earth metals doubled. In extreme cases (as with lanthanum and cerium, for example) the price of materials rose by up to 900 percent. Platinum is another metal for which reserves and production are concentrated within a few geographic locations. It is a key resource that is used in the production of fuel cells and can pose sourcing risks. According to the British Geological Survey, the Bushveld Complex in South Africa accounts for approximately 90 percent of global platinum resources and 80 percent of global
production of the metal. The British Geological Survey expects demand for platinum, and possibly palladium, which is a platinum group metal (PGM), to be driven primarily by growth in the fuel cell sector, where PGMs are used as catalysts. As demand for platinum increases, such a high concentration of production could represent serious risks to companies in the industry. In the late 2000s, South African platinum production declined as a result of unscheduled maintenance shutdowns, geological problems, and labor disputes. Undersupply caused a deficit of 375,000 ounces of platinum in 2008 and resulted in a significant increase in the price of the material.  

Plug Power has identified platinum as a key resource in its PEM fuel cell, noting, “Platinum is a scarce natural resource and we are dependent upon a sufficient supply of this commodity. Any shortages could adversely affect our ability to produce commercially viable fuel cell systems and significantly raise our cost of producing our fuel cell systems.”

In the Fuel Cells & Industrial Batteries industry, lithium and lithium-ion battery manufacturing account for the largest amount by volume of critical materials used. Lithium, nickel, and cobalt are the primary metals utilized by these companies. The segment has been growing at double-digit rates, and this growth is expected to continue. Automotive applications account for approximately 70 percent of the lithium-ion batteries segment by revenue. Ramping up the production of electric vehicles (as well as other clean energy technologies) is likely to present a risk to manufacturers of fuel cells and industrial batteries, as it significantly increases the competition for critical materials.

In 2014, electric car manufacturer Tesla revealed its plans for developing a gigafactory that would manufacture lithium-ion batteries to power its vehicles. The company estimates that it will produce enough batteries to power 500,000 Tesla vehicles by 2020. Goldman Sachs estimates that Tesla’s gigafactory would use up to 17 percent of the existing lithium supply.

Although lithium reserves are geographically concentrated, with 70 percent of the economically accessible supply coming from Argentina, Bolivia, and Chile, experts see a lower risk of supply constraints compared with those for nickel and cobalt, as these countries have “differing political agendas” and are not expected to impose export restrictions. But the political situation could change in the future, posing a risk to the lithium supply. Several years ago, President Evo Morales of Bolivia (a country that has 73 million metric tons of lithium reserves), claimed that the reserves were going to be nationalized as a permanent reserve of the state. With increasing demand for lithium and only a few key producers dominating the market, the price of lithium increased almost tenfold, rising from $350 per ton to nearly $3,000 between 2005 and 2010. Demand from companies like Tesla continues to put upward pressure on the price of lithium. In 2015, one ton of lithium carbonate sells from anywhere between $6,500 and $7,000.

A 2011 study by PricewaterhouseCoopers demonstrates the importance of managing critical materials constraints for companies in renewable energy and automobile industries, among others. In the report, platinum and lithium are included as “energy critical” elements, as identified by the American Physical Society, because of their importance for fuel cells and batteries manufacturing.

While nickel reserves are not as concentrated in a single county, some producing countries may impose restrictions affecting the market for the
metal. For example, in 2014, a ban on nickel exports from Indonesia resulted in a price increase from $13,000 a ton to $21,000.115

As mentioned earlier, the DRC controls significant reserves of cobalt. According to the CIA World Factbook, the DRC is characterized by “an uncertain legal framework, corruption and a lack of transparency.”116

In the DRC and certain other regions of the world, the mining and sale of conflict minerals such as tantalum, tin, tungsten, and gold, in addition to cobalt and other minerals, provides funding for armed conflicts, and the mining is carried out under conditions that violate human rights. Some electronic components in fuel cells and industrial batteries use such minerals, thus exposing the companies in this industry not only to regulatory risk associated with the conflict minerals rule of the Dodd-Frank Act but also to input price volatility and reputational risks.117 Besides control over a significant share of cobalt supply, the DRC accounts for 6 to 8 percent of global tin production, 15 to 20 percent (or 8.6 percent in 2009, according to the U.S. Geological Survey) of tantalum, and 2 to 4 percent of the global tungsten supply. Global input prices of 3TG have shown high volatility, sometimes related to the conflict in the DRC. A 31 percent increase in tin prices in 2008 coincided with a rebel offensive against the DRC’s primary tin-trading center. The price of tantalum, a mineral used in electronics that are a part of various fuel cell and battery components, rose from $110 per kilogram in 2011 to nearly $300 in 2012 because of supply constraints and rising demand.118

To mitigate the risks of potential supply disruption and eliminate the use of materials produced in war zones, Tesla sources its cobalt from the Philippines and is looking into developing cobalt mining in the U.S.119

There is mounting evidence of interest from companies and investors in the use of conflict minerals. Major players in the industry, such as EnerSys, Ultralife, and Arotech Corporation, already provide disclosure on this issue to investors in their Forms 10-K and SD.120 For example, Arotech Corp stated, “These new requirements [disclosure requirements under the Dodd-Frank Act] could affect the pricing, sourcing and availability of minerals used in the manufacture of our products. There will be additional costs associated with complying with the disclosure requirements, such as costs related to determining the source of any conflict minerals used in our products.”121

EnerSys’s Conflict Minerals Report states that metals tin, tantalum, and gold are commonly used in circuit boards, resistors, capacitors, and transformers that are needed to manufacture battery chargers.122 In its FY2014 Form 10-K, EnerSys stated that compliance with the Dodd-Frank Act disclosure requirements may have an impact on the sourcing and availability of minerals used in manufacturing its products. According to the company, only a limited number of suppliers may be able to provide conflict-free metals, which presents availability and price risks. Compliance costs may also increase as regulations become more stringent.123

The SEC estimates that it will cost the companies subject to filing reports with the agency a total of $3 billion to $4 billion in the first year of reporting and at least $200 million each year afterward to comply.124 This cost will be spread across roughly 6,000 companies from multiple industries.125

As mentioned in the Industry Summary, to ensure its long-term feasibility, the Fuel Cells & Industrial Batteries industry needs to reduce costs of goods sold and develop more efficient and cost-competitive products. In the past decade, fuel cell
manufacturers have had some success in these efforts. According to the DOE’s Office of Energy Efficiency and Renewable Energy, the cost of automotive fuel cell technology has fallen by more than 50 percent since 2006 and by more than 30 percent since 2008. Some of this cost reduction can be attributed to minimizing the amount of platinum used. The platinum content of fuel cell catalysts was reduced by five times.126

Despite these successes, fuel cell manufacturers face continuing challenges regarding their use of platinum, as discussed earlier. According to the chief engineer for General Electric’s Power Conversion division, the low availability and high cost of platinum are the main obstacles preventing fuel cells from expanding as a mass-market technology.127

Fuel cell companies may protect themselves from price volatility and potential supply shortages by recovering and recycling platinum. Up to 90 percent of platinum can be recycled at a fuel cell’s end of life.128 The importance and financial benefits of platinum recovery and recycling are discussed in the Product End-of-life Management topic above. Evolution in technology could further reduce the amount of platinum needed to provide catalytic activity in fuel cells. A recent research paper from the Georgia Institute of Technology discusses a new fabrication technique that could increase platinum’s utilization efficiency by a factor of seven, substantially reducing the amount of metal required.129 Materials efficiency strategies (such as those discussed in the previous topic), as well as developing technologies that minimize the amount of platinum used or that substitute it with less expensive and more abundant materials, could help fuel cells manufacturers gain a competitive advantage.

Value Impact

Failure to effectively manage the sourcing of key materials and to efficiently use them can result in higher input costs or insufficient supply. This could lead to lost revenue due to production disruptions and affect operational efficiency. Companies that do not verify sourcing or avoid the use of conflict minerals may also face regulatory compliance costs and reputational risks, which could damage intangible assets and long-term growth.

The increasing scarcity or unavailability of certain key materials used by fuel cell and industrial battery companies, as well as the price volatility of such materials, can increase the risk profile and cost of capital of those companies that rely heavily on such materials and are unable to source them effectively. Using critical materials and conflict minerals more efficiently and investing in R&D and capital expenditures to find alternatives to them can mitigate the impacts of such price increases and supply constraints.

As the Fuel Cells & Industrial Batteries industry scales in size and the use of these key materials becomes more prevalent, the industry is likely to become more exposed to risks related to critical and conflict minerals. Together with increasing supply-demand gaps for such materials, this is likely to increase the probability and magnitude of impacts on company value in the medium term.
APPENDIX I
FIVE REPRESENTATIVE FUEL CELLS & INDUSTRIAL BATTERIES COMPANIES

<table>
<thead>
<tr>
<th>COMPANY NAME (TICKER SYMBOL)</th>
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<tr>
<td>EnerSys (ENS)</td>
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<td>Exide Industries—ADR (EXQDY)</td>
</tr>
<tr>
<td>FuelCell Energy (FCEL)</td>
</tr>
<tr>
<td>Plug Power (PLUG)</td>
</tr>
<tr>
<td>Ultralife Corporation (ULBI)</td>
</tr>
</tbody>
</table>

This list includes five companies representative of the Fuel Cells & Industrial Batteries industry and its activities. This includes only companies for which the Fuel Cells & Industrial Batteries industry is the primary industry, that are listed on U.S. exchanges or 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 November 17, 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</td>
<td>IWGs</td>
<td>EI</td>
</tr>
<tr>
<td></td>
<td>(1-100)</td>
<td>%</td>
<td>Priority</td>
</tr>
<tr>
<td>Energy Management</td>
<td>75*</td>
<td>88</td>
<td>2</td>
</tr>
<tr>
<td>Workforce Health &amp; Safety</td>
<td>25</td>
<td>82</td>
<td>4t</td>
</tr>
<tr>
<td>Product Efficiency</td>
<td>88*</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Product End-of-life Management</td>
<td>50</td>
<td>94</td>
<td>3</td>
</tr>
<tr>
<td>Materials Sourcing</td>
<td>38</td>
<td>76</td>
<td>4t</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 likely to 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. 1 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.
## APPENDIX IIB:
Evidence of Financial Impact for Sustainability Disclosure Topics

<table>
<thead>
<tr>
<th>Evidence of Financial Impact</th>
<th>REVENUE &amp; EXPENSES</th>
<th>ASSETS &amp; LIABILITIES</th>
<th>RISK PROFILE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revenue</td>
<td>Operating Expenses</td>
<td>Non-operating Expenses</td>
</tr>
<tr>
<td></td>
<td>Market Share</td>
<td>New Markets</td>
<td>Pricing Power</td>
</tr>
<tr>
<td>Energy Management</td>
<td>•</td>
<td></td>
<td>•</td>
</tr>
<tr>
<td>Workforce Health &amp; Safety</td>
<td></td>
<td></td>
<td>•</td>
</tr>
<tr>
<td>Product Efficiency</td>
<td>• • •</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>Product End-of-life Management</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Materials Sourcing</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
</tbody>
</table>

MEDIUM IMPACT □ HIGH IMPACT □
# APPENDIX III

## SUSTAINABILITY ACCOUNTING METRICS—FUEL CELLS & INDUSTRIAL BATTERIES

<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>Energy Management</strong></td>
<td>Total energy consumed, percentage grid electricity, percentage renewable</td>
<td>Quantitative</td>
<td>Gigajoules (GJ), Percentage (%)</td>
<td>RR0104-01</td>
</tr>
<tr>
<td><strong>Workforce Health &amp; Safety</strong></td>
<td>(1) Total recordable injury rate (TRIR) and (2) fatality rate</td>
<td>Quantitative</td>
<td>Rate</td>
<td>RR0104-02</td>
</tr>
<tr>
<td></td>
<td>Discussion of efforts to assess, monitor, and reduce exposure of workforce to human health hazards</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RR0104-03</td>
</tr>
<tr>
<td><strong>Product Efficiency</strong></td>
<td>Average storage capacity of batteries, by product application and technology type</td>
<td>Quantitative</td>
<td>Specific energy (Wh/kg)</td>
<td>RR0104-04</td>
</tr>
<tr>
<td></td>
<td>Average energy efficiency of fuel cells as (1) electrical efficiency and (2) thermal efficiency, by product application and technology type</td>
<td>Quantitative</td>
<td>Percentage (%)</td>
<td>RR0104-05</td>
</tr>
<tr>
<td></td>
<td>Average battery efficiency as coulombic efficiency, by product application and technology type</td>
<td>Quantitative</td>
<td>Percentage (%)</td>
<td>RR0104-06</td>
</tr>
<tr>
<td></td>
<td>Average operating lifetime of fuel cells, by product application and technology type</td>
<td>Quantitative</td>
<td>Hours (h)</td>
<td>RR0104-07</td>
</tr>
<tr>
<td></td>
<td>Average operating lifetime of batteries, by product application and technology type</td>
<td>Quantitative</td>
<td>Number of cycles</td>
<td>RR0104-08</td>
</tr>
<tr>
<td><strong>Product End-of-life Management</strong></td>
<td>Percentage of products sold that are recyclable or reusable</td>
<td>Quantitative</td>
<td>Percentage (%) by weight</td>
<td>RR0104-09</td>
</tr>
<tr>
<td></td>
<td>Weight of end-of-life material recovered, percentage of recovered materials that are recycled</td>
<td>Quantitative</td>
<td>Metric tons (t), Percentage (%)</td>
<td>RR0104-10</td>
</tr>
<tr>
<td></td>
<td>Discussion of approach to manage use, reclamation, and disposal of hazardous materials</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RR0104-11</td>
</tr>
<tr>
<td><strong>Materials Sourcing</strong></td>
<td>Percentage of materials costs for items containing critical materials</td>
<td>Quantitative</td>
<td>Percentage (%)</td>
<td>RR0104-12</td>
</tr>
<tr>
<td></td>
<td>Percentage of tungsten, tin, tantalum, and gold smelters within the supply chain that are verified conflict-free</td>
<td>Quantitative</td>
<td>Percentage (%)</td>
<td>RR0104-13</td>
</tr>
<tr>
<td></td>
<td>Discussion of the management of risks associated with the use of critical materials and conflict minerals</td>
<td>Discussion and Analysis</td>
<td>n/a</td>
<td>RR0104-14</td>
</tr>
</tbody>
</table>
APPENDIX IV: Analysis of SEC Disclosures | Fuel Cells & Industrial Batteries

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

**TYPE OF DISCLOSURE ON SUSTAINABILITY TOPICS**

<table>
<thead>
<tr>
<th>Fuel Cells &amp; Industrial Batteries</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>Energy 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>
<tr>
<td>Workforce Health &amp; Safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82%</td>
</tr>
<tr>
<td>Product Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Product End-of-life Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>94%</td>
</tr>
<tr>
<td>Materials Sourcing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76%</td>
</tr>
</tbody>
</table>

IWG Feedback*

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

2 Ibid.
3 Ibid.
5 Ibid.
6 Ibid.
7 Ibid.
11 Author’s calculation based on data from Bloomberg Professional service, accessed September 24, 2015, using Equity Screen (EQS) for companies listed on U.S. exchanges that generate at least 20 percent of revenue from their Fuel Cells & Industrial Batteries segment and for which Fuel Cells & Industrial Batteries is a primary SICS industry.
16 Author’s calculation based on data from Bloomberg Professional service, accessed September 24, 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 Fuel Cells & Industrial Batteries industry, using Levels 4 and 5 of the Bloomberg Industry Classification System.
17 Author’s calculation based on data from Bloomberg Professional service, accessed September 24, 2015, using Equity Screen (EQS) for U.S.-listed companies and those traded primarily over the counter (OTC) that generate at least 20 percent of revenue from their Fuel Cells & Industrial Batteries segment and for which Fuel Cells & Industrial Batteries is a primary SICS industry.
20 Author’s calculation based on data from Bloomberg Professional service, accessed September 24, 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 Fuel Cells & Industrial Batteries industry, using Levels 4 and 5 of the Bloomberg Industry Classification System.
21 Carter, “Battery Manufacturing in the US.”
22 Author’s calculation based on data from Bloomberg Professional service, accessed September 24, 2015 using Equity Screen (EQS) for U.S.-listed companies and those traded primarily over the counter (OTC) that generate at least 20 percent of revenue from their Fuel Cells & Industrial Batteries segment and for which Fuel Cells & Industrial Batteries is a primary SICS industry.
23 Carter, “Battery Manufacturing in the US.”


39 Ibid.

40 Author’s calculation based on data from Bloomberg Professional service, accessed December 16, 2014, using Equity Screen (EQS) for U.S.-listed companies and those traded primarily over the counter (OTC) that generate at least 20 percent of revenue from their Fuel Cells & Industrial Batteries segment and for which Fuel Cells & Industrial Batteries is a primary SICs industry.


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48 Ibid.

49 Carter, “Battery Manufacturing in the US.”


52 Ibid., p. 22.


54 Data from internal review of filings of companies in the Fuel Cells & Industrial Batteries industry.

57 Ibid.
59 Ibid.
60 Ibid.
61 Ibid.
64 Ibid.
68 Church, “Exide Files for Bankruptcy after Losing Wal-Mart Business.”
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80 Ibid.


EnerSys, FY2013 Form 10-K for the Period Ending December 31, 2014 (filed June 1, 2015).


Ibid.


Ibid.
