

THE SUSTAINABILITY FUTURE FOR ENERGY AND CHEMICALS

**ARC Strategies
September 2020**

Recent ARC Advisory Group research indicates that improving operational safety stands out as an important objective for corporate sustainability initiatives, with digitalization playing a key role in ensuring progress in meeting objectives. ARC's survey revealed that while 90 percent of global energy and chemical companies have sustainability initiatives, chemical companies ranked sustainability somewhat higher in importance. Access to capital, resources and aging assets are top barriers to meeting sustainability objectives.

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Executive Overview

During the first half of 2020, ARC Advisory Group conducted research to gain a better understanding of the current state of sustainability and “green initiatives” in the chemical and energy industries. Specifically, we wanted to learn where companies are focusing their efforts, what challenges they face, and - ultimately - how they believe digitalization and other technologies can advance their sustainability initiatives.

Recent ARC research shows that 90 percent of global energy and chemical companies have sustainability initiatives in place. In general, the sustainability initiatives at energy companies focus on the transition to a lower carbon future. In contrast, chemical companies are focusing these initiatives on producing more sustainable products that meet the increasing customer demand for a more circular economy, with increased recycling and reuse of products and materials.

The research findings show that 90 percent of global energy and chemical companies have sustainability initiatives in place. In general, the sustainability initiatives at energy companies focus on the transition to a lower carbon future, while chemical companies focus these initiatives on producing more sustainable products. In other words, products that meet the increasing customer demand for a more circular economy, with increased recycling

and reuse of products and materials. For both industry segments, improving operational safety also plays a vital role, since - for many companies - this is part of the license to operate.

Government regulation and mounting consumer pressure are driving the investment in sustainable products and lower-carbon energy through carbon taxes, fuel standards, and a ban on single-use plastics. In addition, one of the world's largest investment firms, BlackRock, with nearly \$7 trillion under management (including huge stakes in leading industrial manufacturing and energy companies), recently announced that sustainability issues would be at the center of its investment strategies moving forward.

Key findings include:

- Lack of capital and resources and aging assets are top barriers to meeting sustainability objectives
- Customer buying preference drives company sustainability programs and access to capital
- Improving operational safety is a key element of most sustainability initiatives

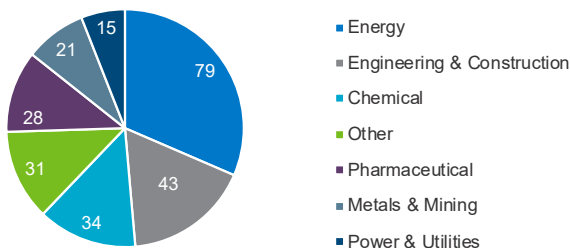
- Digitalization plays a key role in ensuring progress in meeting sustainability objectives.

Benchmarking Research Methodology

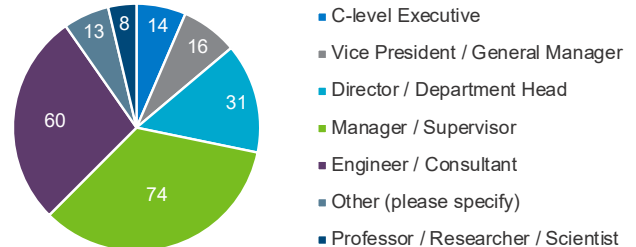
Beginning in March and through April 2020, ARC Advisory Group conducted research to analyze and benchmark the current state of sustainability initiatives among industrial asset owners. More than 200 industry professionals from North America, Europe, Latin America, Middle East, Africa, and Asia-Pacific participated in the survey. ARC then followed up with in-depth discussions with subject matter experts (SMEs) at energy and chemical companies. The research identified some compelling reasons for industrial organizations to rethink their current approaches to sustainability.

ARC analyzed and compared the responses from the engineering SMEs, executive or business managers, operations leaders, and supply chain managers. Thirteen percent of respondents were at the C and VP levels and 34 percent were management. Industries represented include energy, engineering & construction, chemicals, metals & mining, pharmaceutical, and several other industry segments.

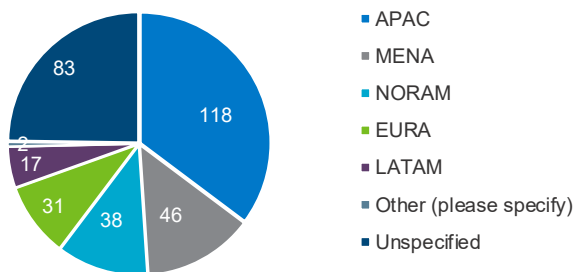
31% Energy, 17% Engineering, 14% Chemicals



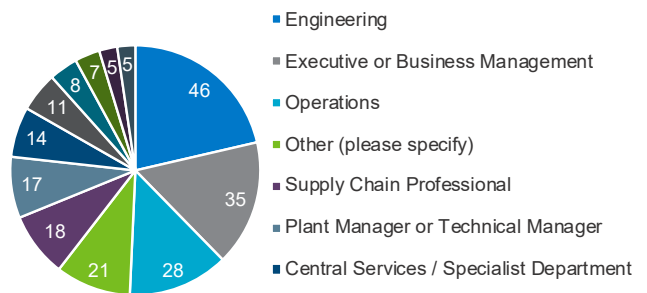
6% C-Level, 7% VP/GM, 34% Manager/Supervisor



46% APAC, 19% MENA, 15% NORAM, 11% EURA



21% Engineering, 16% Exec/Mgt, 13% Ops.



What “Sustainability” Means for Energy and Chemical Companies



Introduced in 2015, the UN Sustainable Development Goals (SDGs) represented an agenda for sustainable development. While very general, the goals outlined aim to achieve a better and more sustainable future for all. With UN Resolution 70/1, the UN General Assembly established 2030 as the target year for achieving the following sustainable development goals:

No poverty	Reducing inequality
Zero hunger	Sustainable cities and communities
Good Health and Well-being	Responsible consumption and production
Quality Education	Climate action
Gender Equality	Life below water
Clean Water and Sanitation	Life on Land
Affordable and Clean Energy	Peace, justice, and Strong Institutions
Decent Work and Economic Growth	Responsible Consumption and Production
Industry, Innovation, and Infrastructure	Climate Action

United Nations Sustainable Development Goals

Across industry, sustainability is now front and center for customers and investors alike. Several international energy and chemical companies have aligned their corporate sustainability goals with the UN’s SDGs. Many are making progress toward formulating and executing well-thought-out strategies to improve and manage sustainability proactively. Leading industrial companies such as ExxonMobil, Dow, Saudi Aramco, and Shell have publicly announced somewhat different sustainability approaches.

ExxonMobil, for example, has articulated a commitment to producing the energy and chemical products that are essential to modern life, economic development, and improved standards of living and for protecting people, the environment, and the well-being of communities near its operations; and to employ advanced technologies to improve the sustainability of its current businesses.

Dow is collaborating with like-minded partners to advance the well-being of humanity by helping lead the transition to a sustainable planet and society. Dow, one of the world's leading materials science companies, has expressed a commitment to using science-based solutions and acting collaboratively to help lead the transition to a more sustainable society, employing a circular economy paradigm.

Shell's sustainability approach is built on a foundation of safe, efficient, responsible, and profitable operations. According to Shell, it will strive to produce and deliver energy responsibly and in a way that respects people, their safety and their environment. At the simplest level, this means "doing no harm," and involves a portfolio shift toward renewables.

Saudi Aramco's approach involves pushing the limits of creativity and technology to drive down the carbon intensity of energy products. To this end, the company is increasing research into new, carbon-neutral feedstocks to provide meaningful solutions to the energy and climate challenges.

Sustainability Goes Beyond Environmental, Social, and Governance

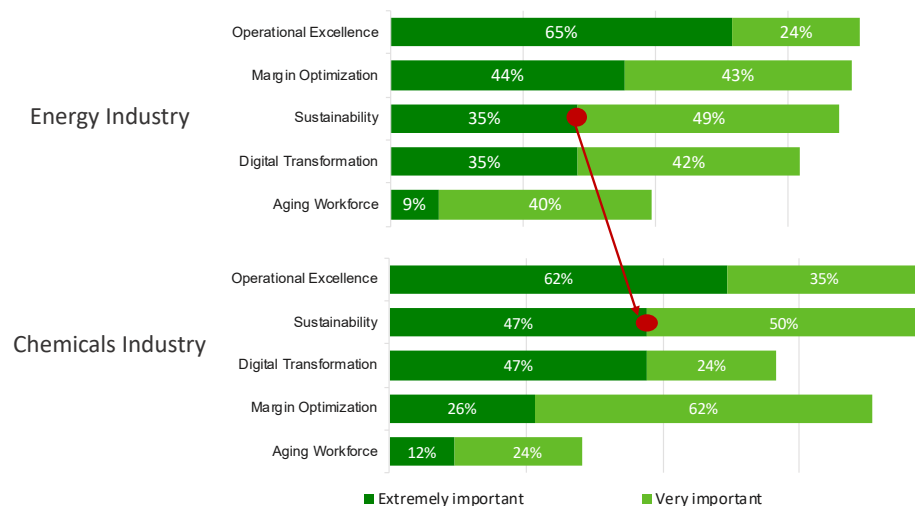
People and organizations outside the industry want to better understand how the energy and chemicals sectors are evolving. This includes the impact of these sectors' activities on people and the environment and the associated risks, opportunities, and trade-offs. One of the ways companies respond to these requests is through corporate reporting, specifically non-financial, environmental, social, and governance (ESG) reporting. ESG criteria provide a set of standards for a company's operations that socially conscious investors use to screen potential investments.

The environmental criteria consider how a company performs as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers, and the communities in which it operates. Governance criteria considers factors such as transparency of reporting on sustainability progress, embedding sustainability culture throughout an organization, reporting on how investor dollars are applied, and how an organization manages its data to protect customers and minimize cyber risk. Sustainability, however, is broader than ESG and extends to meeting the business and other needs of the present, but without compromising the ability to meet the needs of future generations.

Parties in the supply chain – suppliers as well as customers - are also refining their expectations of transparency. Purchasing tenders now often integrate sustainability as a pre-qualification item. High-quality reporting can make the difference in gaining valuable contracts from companies that have similar values. Companies can also mitigate supply chain risks of poor social and environment practices by encouraging transparency throughout their procurement processes.

Relative Importance of Sustainability Objectives Varies Between Industries

We asked survey respondents to rank common programs or directives related to operational excellence, margin optimization, sustainability, digital transformation, and aging workforce. As shown, operational excellence remains quite high in priority for both energy and chemicals, but with a sharp difference in how the two sectors rank sustainability. Companies that exhibit operational excellence are distinguished by two characteristics: they manage their business and operational processes systematically and invest in developing the right culture.



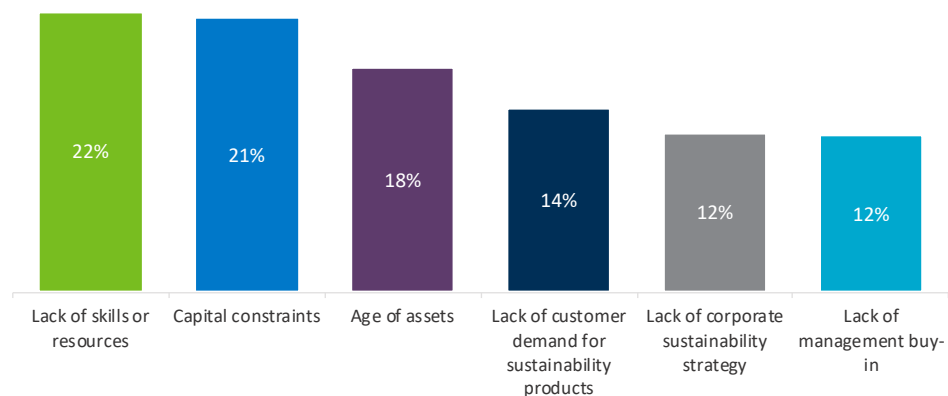
How Would Your Company Rate the Above in Terms of Importance?

Key priorities for all industrial companies include doing what's right for customers, shareholders, employees, and the public, while maintaining its social license to operate. For energy companies, the primary objective is to deliver energy competitively to the nine billion people on the planet, while figuring

out how to do this with a changing global energy mix to help meet carbon reduction targets. Chemical manufacturers, on the other hand, tend to be more aligned with customer needs for sustainable products; products containing more recycled material and with biodegradable properties. Thus, chemical companies tend to rank sustainability higher than do energy companies. Sustainability is a strategy for the overall business plan and the products engineered.

Barriers to Meeting Sustainability Objectives

The majority of survey respondents identified the lack of capital or resources and aging assets as top barriers to meeting their sustainability objectives. However, when we spoke with industry leaders about these apparent barriers, some other important considerations emerged. For example, we learned that while most companies have a chief financial officer, chief legal officer, and other traditional leadership roles; there is not usually a chief sustainability officer. Since sustainability decisions are made by whoever controls the asset, those decisions are often made without considering the secondary effects of climate emissions. Furthermore, even at those companies with sustainability leadership, there is often a disconnect between the sustainability leadership and operational roles such as plant operations, engineering, or supply chain.



What Are the Barriers to Meeting Your Sustainability Objectives?

In general, the larger the company, the better its capability to pursue sustainability objectives aggressively. Because – hypothetically at least – they have more resources to devote to those objectives. However, several people we spoke with indicated that funding decisions are made at the board level at

larger companies, and many board members might not have clear insights and visibility to properly address sustainability. This is especially true given the age of much of the asset base in the energy and chemicals industry.

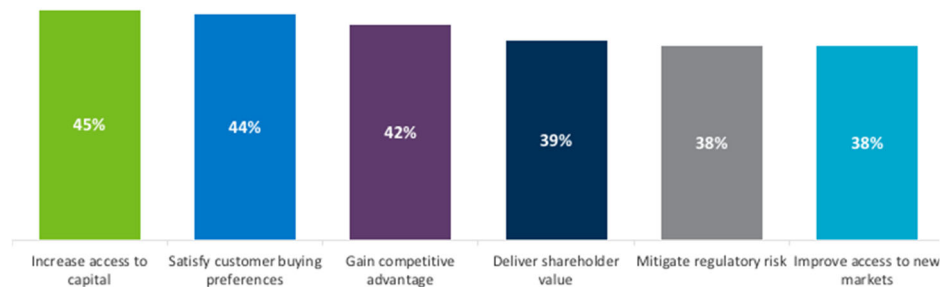
The majority of infrastructure for heavy industry was designed and built without sensitivity to sustainability goals or the development of more recent business models. In fact, most facilities were built prior to digital technology and are designed principally around operational philosophies that date back to the 1980s. Unfortunately, it is not reasonable to think that industry will somehow change overnight or be supple enough to react to even the simplest of outside pressures for sustainability concerns. Older plants or facilities typically lack the base of sensors, instrumentation, and digital systems needed to optimize efficiency. The justification for modernization can be difficult, and the conversion and installation process usually must be completed during a turnaround or shutdown.

The economics of driving complex change into highly energized and potentially dangerous assets that need to run at high levels of reliability are challenging. Owner-operators in general, and field operations in particular, are often very resistant to change, whether upgrading manufacturing assets or introducing digitalization, because when they introduce change, they also need to go through a rigorous engineering design process to ensure integrity.

Management of change (MOC) processes tend to stifle innovation for sustainability, creating a huge gap between what the head office people think is possible and desirable versus what field operations people think is possible and desirable. Head office staff such as IT, central engineering, or other centralized project or improvement type roles are constantly exposed to vendor conferences and information sources that form their perspective about what is possible. Workers in the field, however, often do not receive that same exposure to information. This gap between what field personnel understands about digital innovation versus what the home office understands creates an additional barrier to improving sustainability.

Sustainability Program Drivers

Not surprisingly, the majority of survey respondents believe sustainability programs will increase access to capital or help gain competitive advantage, but also satisfy customer buying preferences. Industrial manufacturers and producers believe sustainability, or the management of environmental, social, and governance to be important. However, recent developments in the investor community have sparked new interest in this area. Some of the largest investment firms have recently announced that sustainability issues will be at the center of investment strategy and the strongest foundation for client portfolios.



Please Rank the Importance of the Above Drivers for Your Sustainability Program

Firms such as BlackRock, are investors in many leading industrial manufacturing companies. According to the company, climate change is almost invariably the top issue raised by customers around the world. BlackRock, with nearly \$7 trillion under management (including huge stakes in leading industrial manufacturing and energy companies), recently announced that sustainability issues would be at the center of its investment strategies moving forward. The company anticipates that this will create a strong foundation for client portfolios. According to BlackRock's CEO, climate change is almost invariably the top issue raised by clients (and customers) around the world. This will result in a significant reallocation of capital that will occur "sooner than most anticipate." Furthermore, BlackRock recently identified 244 companies during the 2020 annual proxy season that weren't doing enough to either prepare their businesses for a warming planet or inform their investors about the possible risks of climate change to their operations.

The business leaders we interviewed mentioned two key questions asked by investors: "What is your digitalization strategy?" and "What is your action plan to improve sustainability?" While industrial organizations must

certainly run a profitable business, BlackRock believes progress on sustainability programs is important for their long-term portfolio risk. The message was clear: the investment community is worried about the future of the manufacturing business.

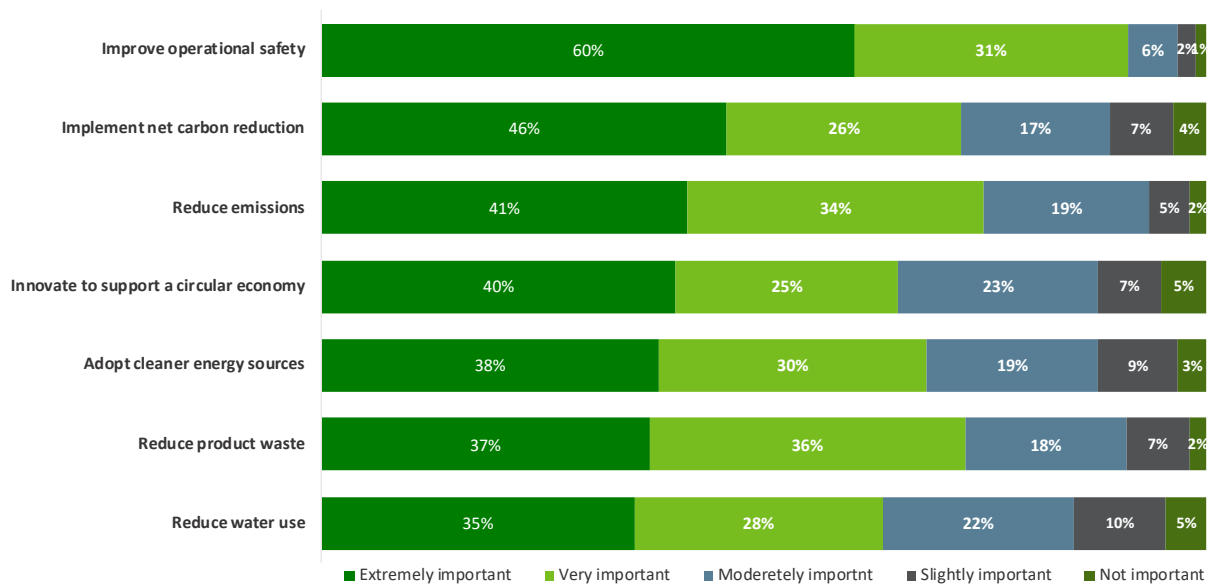
Chemical companies are preparing for a customer-driven trend for stronger and more sustainable materials for the auto industry. This changes market strategy with differentiating products. The physical properties of what is sold is of greater importance now; specifically, how physical properties satisfy the need for re-usable products and products which are “circular” in their ability to be re-used in a supply chain. The increased use of recycled resins can create a dilemma for automotive designers. There is a growing initiative to increase recycled materials content in products globally, and traditional methods of recycling polymeric materials in both thermoplastics and thermosets can lead to degradation of engineering, mechanical, processing, and/or aesthetic properties of the resin. In an era where product quality rules, this situation forces designers to accept a much lower percentage of recycle than they might otherwise wish to use or risk unacceptable property loss in molded parts. This is something no automaker can afford. Hence, a valuable feed stream of materials (polymers) often ends up destined for a landfill once many consumer products are broken down and more easily re-usable or recyclable materials are repurposed.

To help address the increasing pressure they face from the investment community and energy consumers, energy companies, in turn, are focusing on how they can continue to meet the world’s energy demands, while transitioning to wind, solar, geothermal, hydro, and other renewable and non-polluting energy sources.

Relative Importance of Sustainability Objectives

When comparing sustainability goals, improving operational safety is most important, according to 60 percent of survey respondents. Process safety incidents impact environment, personnel, brand, profitability, and the ability to grow a company. An industrial manufacturer knows very well that one major safety incident can negate its license to operate. While other objectives

of reducing emissions or adopting clean energy or innovating in the circular economy are important, these are all behind safety in operations.



How Important Are the Following Initiatives in Supporting Your Company's Sustainability Goals?

Many energy and chemicals facilities are undercapitalized. The lack of capital to maintain, inspect, upgrade or modernize assets at some companies can eventually lead to process safety events or environmental releases. As one knowledgeable industry participant indicated, “Many sites just cannot afford one more accident or incident,” and “on the other hand, it is easy to overspend.” Ultimately, as with safety, environmental compliance is a risk-management issue and the associated spending must be balanced against how much risk an organization can afford to assume.

Many companies equate sustainability with business sustainability and the ability to constantly attract capital and talent. Sustainability of business operations may be hampered the minute there is a safety or environmental problem, whereas the community at hand will simply curtail future expansion and impede the ability of the industry to grow, which ties back to shareholders’ access to capital.

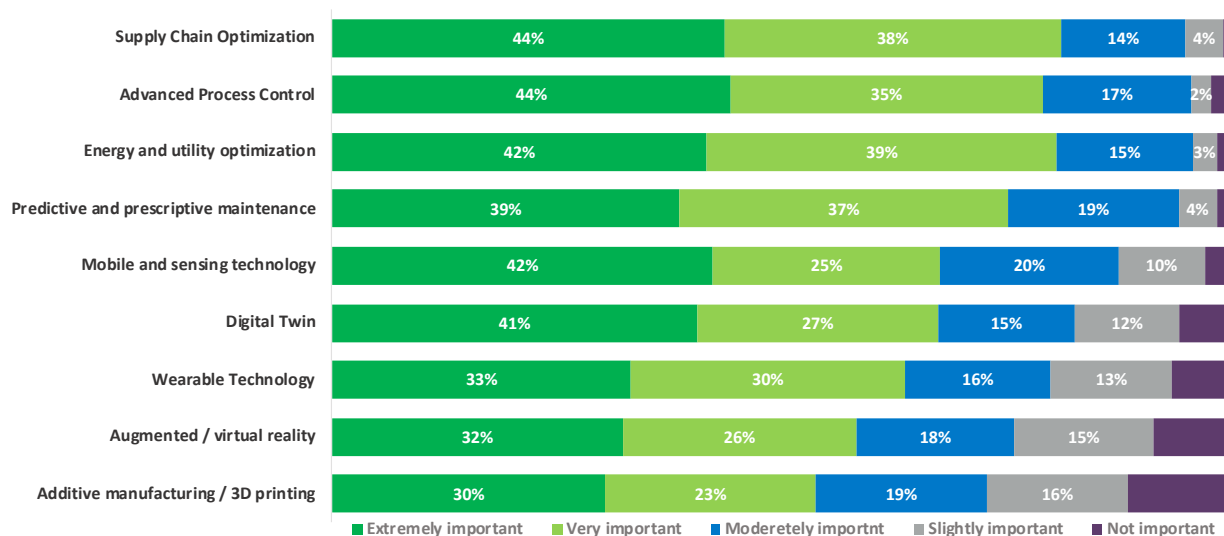
Industrial sites suffer from unplanned events more frequently partially due to staff churn. Often, knowledge and documentation are not adequate to overcome this. The average experience level is dropping over time, leaving a skills gap and inability to properly recognize the hazards. Relying on inherent knowledge that people develop over time is not sustainable and many

companies are turning to digitalization to improve operational safety and making the facilities more autonomous.

But unplanned events are not the only culprits. For example, in upstream shale oil production, natural gas is a byproduct, and – currently – there is no practical way to capture this gas and get it to market. In these cases, the shale gas must be flared off to the atmosphere during normal operations. This unfortunate practice is wasteful, environmentally harmful, and can create “negative optics.”

Importance of Digital Transformation to Achieving Sustainability Goals

ARC believes digital transformation spans industrial products, operations, value chains, and aftermarket services. It augments people and knowledge through expanded use of sensors, data, and analytics. Most industrial process companies globally will undergo a digital transformation to some degree or other, with many already actively using technology to improve both business and environmental performance and sustainability. Digital enablement of new business models and finding new ways to bring products or services to market is a key capability in sustainable manufacturing.



How Valuable Are These Digital Capabilities for Improving Sustainability?

Seventy-five percent of survey respondents believe digital transformation is extremely important or very important for achieving sustainability goals. The following digital capabilities were ranked in order of their importance to improve sustainability:

- Supply chain optimization to coordinate, manage, and improve the transparency of connected processes across different organizational silos; and coordinate processes to improve supply chain demands or product customization and satisfy customer needs for sustainable products.
- Advanced process control (APC) to reduce process variability, minimize costly product giveaway, optimize processes against constraints, and support autonomous operations (where appropriate). APC-based optimization can also coordinate multi-unit dynamic process optimization to help close the gap between plan versus actual production.
- Energy and utility optimization using process modeling and simulation technology to improve the process design, optimize energy efficiency and processing, and improve maintenance.
- Predictive and prescriptive maintenance to improve asset utilization and return on capital by use of machine learning and advanced analytics to shift maintenance operations to predict failures and avoid process disturbances and equipment downtime.

ARC's interviews with industry leaders revealed that operations management systems are a high priority. Human reliability and knowledge management through state-based control and other approaches have greater importance in the context of sustainability objectives. Product waste and energy losses often occur when workers do not have a good grasp on procedures and operational competency. For example, performing process startups, shutdowns, or other critical activities require established procedures that tie back to the experience level of workers and the operations management systems in place.

Case Study: Digitalization Improves Sustainability at BPCL

Bharat Petroleum Company Ltd (BPCL) currently operates four refineries in India, where sustainability is a major concern. BPCL has identified sustainability as one of the key corporate goals to be targeted by its digitalization initiative and team.



Kochi Refinery at Night
(Source: BPCL)

One of the highest impact digital technology projects BPCL has completed to date is a digital twin air emissions model at the company's state-of-the-art Kochi refinery. Air quality has become a growing and urgent quality of life issue in India. Regulators there have been looking at dynamic air quality rules, where allowable emissions levels will change based on the weather and ambient air quality in the region.

Anticipating those rules, the Kochi refinery implemented an Aspen HYSYS digital twin model of the refinery's crude conversion units. The model is calibrated continuously using operating data to provide an accurate picture of the operation of the process.

Using digital twin-enabled virtual sensors, the model calculates NO_x, CO_x, and other emissions at many more points across the process units than would be possible with physical sensors. Regulators in India have agreed that the digital twin-calculated values are acceptable to demonstrate regulatory compliance.

The information is presented to operators, technicians, and plant management as an easy-to-interpret dashboard. According to the company, this digital twin-based solution enables it to ensure compliance with air quality regulations and target and track its sustainability progress. From an economic perspective, since the operators have a high level of confidence in the model, they can now run the plant closer to limits. This has already resulted in measurable improvement in yields.

In addition to the sustainability- and yield-related benefits, the solution helps improve worker job satisfaction, since the transparency it provides lets employees know they are working in a sustainability-conscious organization that is doing its part to address the global climate change threat and improving air quality in India.

Conclusions and Recommendations

Clearly, “sustainability” within the global energy and chemical industries is a multi-faceted concept that encompasses more than just environment, safety, and governance. Overall business sustainability through operational excellence and margin optimization remain important objectives. In addition, due to the differing challenges each of those industries face, each has a somewhat different objective and focus for its sustainability initiatives.

While the vast majority of global energy and chemical companies have sustainability initiatives in place, based on ARC research, it appears that the sustainability initiatives at energy companies focus largely on the transition to a lower carbon future via increased use of wind, solar, hydro, geothermal, and other renewable energy sources; while chemical companies tend to focus their sustainability initiatives on developing and producing more sustainable, circular products characterized by low-carbon footprint and extensive use of renewable and/or recycled raw materials that can support reusable and/or recyclable end products for customers. For both industry segments, improving operational safety also plays a vital role, since – for many companies – this is part of the license to operate. And for both industry segments, digital transformation is seen as an important enabler for business and ESG sustainability.

A combination of regulatory pressures, customer pressures, and pressures from the investment community are forcing energy and chemical companies to move forward with their respective sustainability initiatives. While much can be accomplished via transparent and sincere management directives, education, and internal cultural changes, for most sustainability initiatives to succeed, the companies must allocate adequate capital. And with the reduced demand for energy and chemical products alike, imbalance between supply and demand, and disrupted supply chains – all brought on by the current COVID-19 pandemic – capital is becoming an increasingly scarce commodity. This is likely to emerge as a stress test, to see how committed those companies really are to their sustainability objectives in the new normal of the post-COVID-19 world.

Based on what we know about our end user clients in these industries, ARC remains optimistic about this.

ARC recommends the following actions for owner-operators:

- While it may be necessary to rethink your short-term business objectives brought on by the new normal imposed by the COVID-19 pandemic, don't let this distract you from your long-term business and sustainability objectives.
- Digitalization often plays a key role in ensuring progress in meeting sustainability objectives. In particular, companies should consider targeted investments in supply chain and process optimization technologies and predictive and prescriptive analytics.
- Invest in people to develop a culture of waste elimination and efficient use of production materials, while energy companies focus on delivering lowest cost products safely.

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Acronym Reference:

APC	Advanced Process Control	IoT	Internet of Things
BPCL	Bharat Petroleum Company Ltd.	IT	Information Technology
CEO	Chief Executive Officer	MOC	Management of Change
COx	Carbon Oxides	NOx	Nitrogen Oxides
ESG	Environmental, Social, & Governance	OT	Operational Technology
IIoT	Industrial Internet of Things	SDE	Sustainable Development Goals
		SME	Subject Matter Expert

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