Sustainability Takes Center Stage

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Sustainability is no longer an option—it's an imperative. Awareness and alarm about the impact of human activity on the environment has begun to shift buying and investment behavior around the world. Increasing energy use, resource depletion and waste generation are creating an urgency to rethink current consumer and business practices, and specifically to address priorities related to sustainability.

To remain profitable and relevant in the marketplace of tomorrow, companies must work to grow the "triple bottom line," which seeks to balance the impact of company operations on people, the planet and profits.

With this renewed focus, many energy and chemical companies are integrating sustainability metrics into their business goals, looking beyond the typical financial indicators to include the impact of global value chains on communities and natural resources. Energy companies are targeting the energy transition, investing in new technologies and alternative feedstocks. Chemical companies are preparing to meet the unique demands of the circular economy, where economic activity is decoupled from the consumption of finite resources and waste is re-integrated into processes. This is forcing a fundamental rethinking of current business models.

Sustainability topics, including climate change, regulatory compliance, the circular economy and energy consumption are being raised in shareholder meetings, by large institutional investors and by the media.

The liabilities associated with environmental damage—actual or perceived—can have a very real negative effect on shareholder value, while also raising concern about reduced growth in some end-use markets.

In Accenture's recent survey of CEOs, 99% of large-company CEOs agree that "sustainability issues are important to the future success of their businesses."[1] Pressure to reform business practices is coming from many sectors, but particularly from the consumers and communities associated with companies in oil and gas, chemicals and related segments.

Digital Solutions Are a Key Enabler for Sustainability Goals

Digital tools have targeted sustainability-related objectives for decades, mainly focusing on energy efficiency, pollution control and value chain optimization. Traditionally, cost savings drove much of the efficiency efforts, but now companies are moving toward the more specific process metrics that consider emissions and resource use.

Additionally, companies are increasingly focusing on waste and discharge reduction from production units, as well as efficiency enhancement through digital solutions. And they're exploring new energy sources with lower carbon footprints.

Digitalization is a crucial enabler for companies to meet both business and sustainability objectives. The International Energy Agency (IEA) has found that digital solutions can help boost energy efficiency as much as 30% for industrial operations.[2] In Europe, the Technology Platform for Sustainable Chemistry has highlighted digitalization as a key tool to meet sustainability objectives in the chemicals sector.[3]

These solutions provide the visibility, analysis and insight needed to address the challenges inherent in sustainability goals. Success begins by harnessing the voluminous data available from operations—applying new technologies, such as artificial intelligence (AI)—to control operations and empower

operators to make the decisions that will achieve their multiple objectives of customer satisfaction, societal sustainability and business profit.

Many digital solutions have been focused on efficiency gains for production processes, and technology projects often target a reduction in energy use, yield improvement and lower emissions.

And importantly, most solutions make it possible to chart progress on sustainability goals. Process simulation technology tracks and optimizes CO_2 and other pollutant emissions; the same tools, combined with other technologies such as planning solutions and enterprise visualization tools, provide the basis for emissions reporting for refineries, chemical plants and other energy assets.

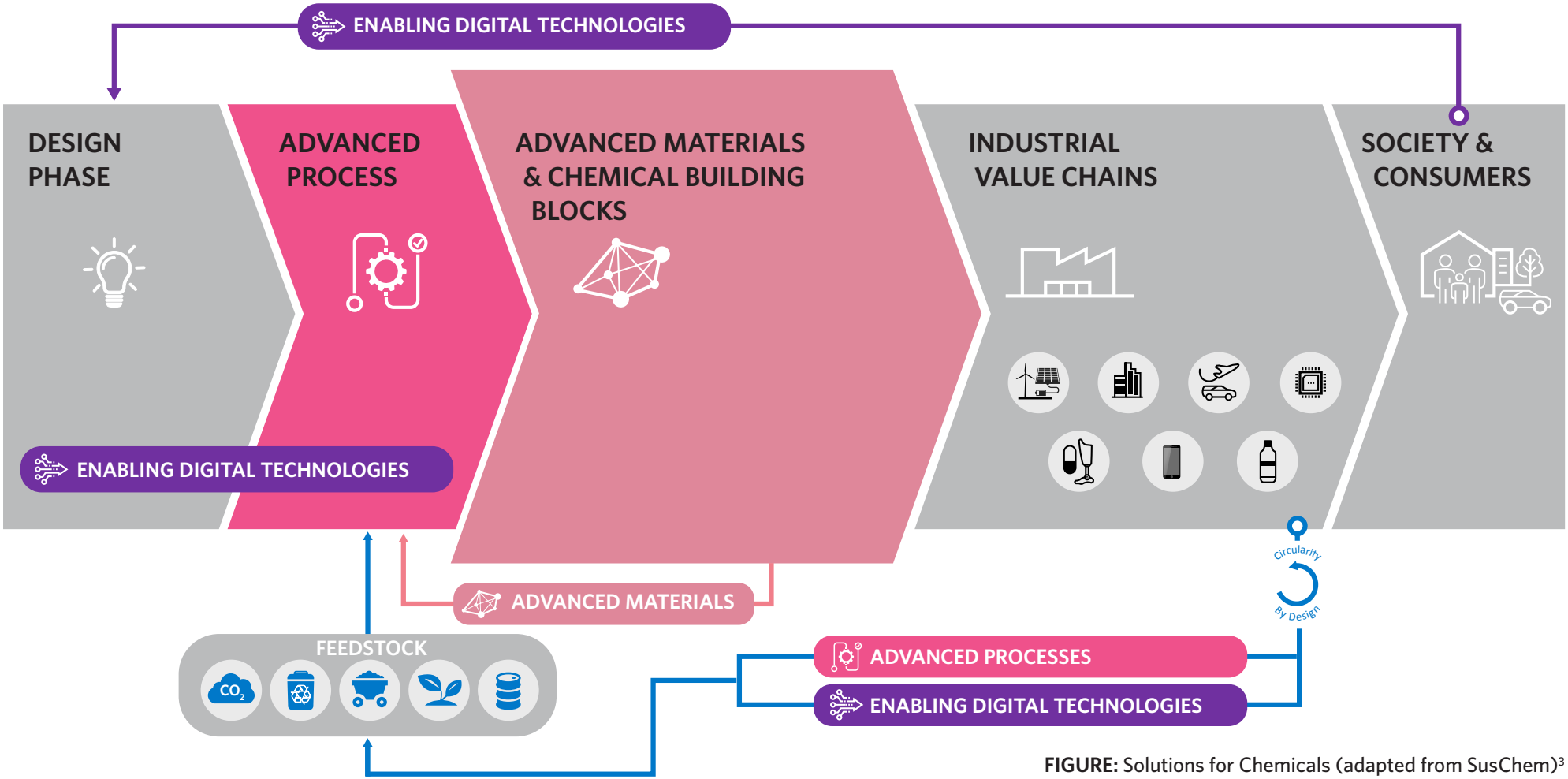


FIGURE: Solutions for Chemicals (adapted from SusChem)[3]

Integrated technological solutions can form the core of strategic sustainability initiatives. Sophisticated models and workflows enable companies to:

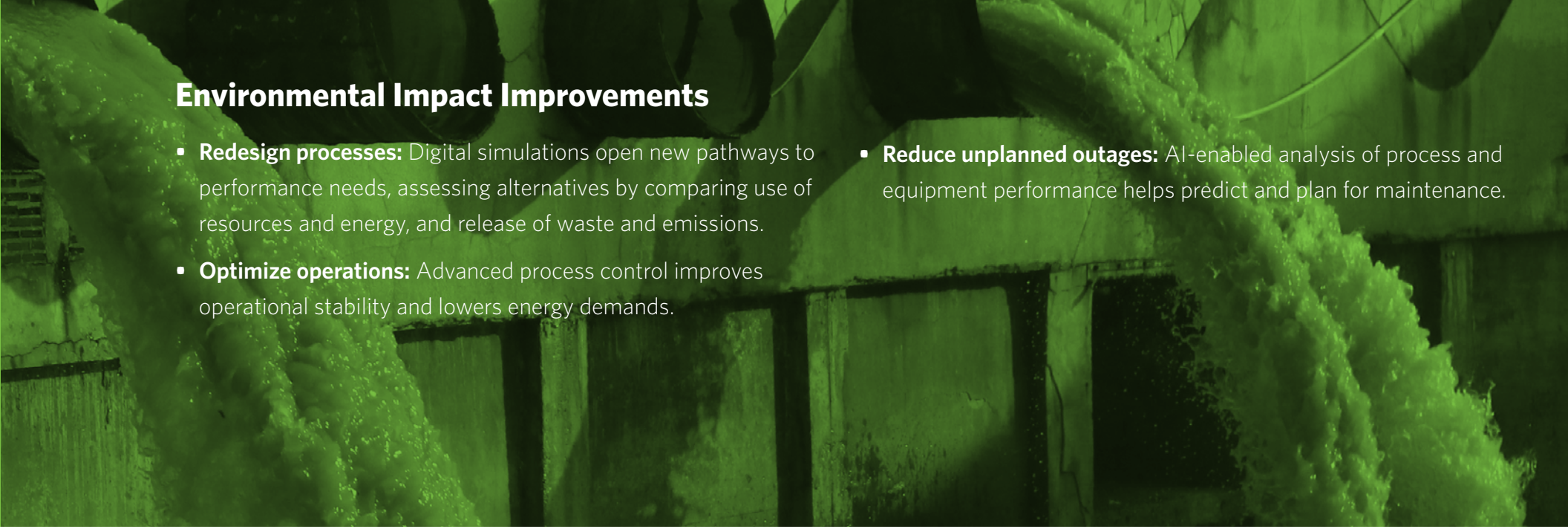
- Cut energy and water use
- Reduce or avoid emissions
- Improve process reliability and integrity
- Innovate for new processes, products and value chain integration
- Develop innovative solutions for the circular economy challenges, such as carbon capture, use and sequestration (CCUS) and plastics recycling

In addition, predictive and prescriptive maintenance solutions that use proprietary machine learning and AI capabilities can help reduce environmental emissions that often occur with unplanned outages.

Reducing Environmental Impact

Digital solutions can provide guidance on environmental impact throughout initial project planning and operating processes, and even give insight into maintenance activities to help avoid equipment breakdowns—and the emissions and dangerous conditions that come with them.

Using a digital simulation of production processes, often called a **digital twin**, companies are able to determine the best process and equipment selection for energy efficiency and reduced emissions of CO_2 and other pollutants and greenhouse gases. After construction, these same models are used to improve operations by adjusting to feedstock and operational variations to ensure efficient resource and energy use. Process control capabilities help stabilize operations to optimize energy use, extending this analysis across the entire supply chain.



Environmental Impact Improvements

- **Redesign processes:** Digital simulations open new pathways to performance needs, assessing alternatives by comparing use of resources and energy, and release of waste and emissions.
- **Optimize operations:** Advanced process control improves operational stability and lowers energy demands.
- **Reduce unplanned outages:** AI-enabled analysis of process and equipment performance helps predict and plan for maintenance.

And when processes do not run as expected, digital technologies can provide insight and avoidance measures. AI gives companies advance warning of potential breakdowns, so they can avoid the most dangerous conditions, reduce the amount of effluents released into the environment, and minimize maintenance costs. For complex processes, multivariate analytics takes a broad view of many process variables to identify those that are critical to reduce off-spec production and lower waste.

Advanced technology solutions have enabled many companies to deliver improved environmental performance for their businesses. These are some examples of real-world success:

- International oil companies are using the steam-assisted gravity drainage (SAGD) steam injection for production to lower CO_2 emissions by 4% and reduce water consumption by 20%, while increasing overall production.
- Kuwait National Petroleum Company (KNPC) has reduced energy demand and use in their refineries by $15M per year and optimized the sourcing of energy between available utilities to increase energy efficiency and reduce their carbon footprint.
- Petrochemical producer Braskem has used advanced process control to lower the energy consumption of an ethylene unit by 20%.

Achieving Safety and Reliability

With the use of digital technologies, project engineers are able to design for process safety from the start, delivering optimal designs that comply with industry safety standards. Integrated system analysis can generate comprehensive plans for critical systems such as pressure relief and flare systems across the plant and the entire complex. And new dynamic modeling capabilities enable upgrades of existing flare and pressure safety valves, as they integrate current operations to create a more accurate model of operations.

Monitoring and control technologies work to continuously optimize unit operations to stay within safety limits and alert for equipment failure and process degradation that can lead to unexpected incidents. The same models that have enabled better design and operations are also a very useful tool to prepare new operators to manage unexpected process upsets that often lead to safety incidents. Operator training systems using digital twins of current and future operations are becoming the standard training practice across the industry.

Safety & Reliability Opportunities

- **Predict potential incidents:** Use AI-enabled insight to recognize patterns in operating data and gain warning of possible breakdowns and associated emissions and hazards.
- **Optimize for asset integrity:** Simulate processes to avoid runaway reaction and build in safety with in-depth analysis and design of flare and pressure-relief systems.
- **Prepare operators:** Simulate operations to train for unexpected conditions and avoid possible hazards.

There have been a number of notable success stories from companies using digital solutions to **improve safety and reliability**:

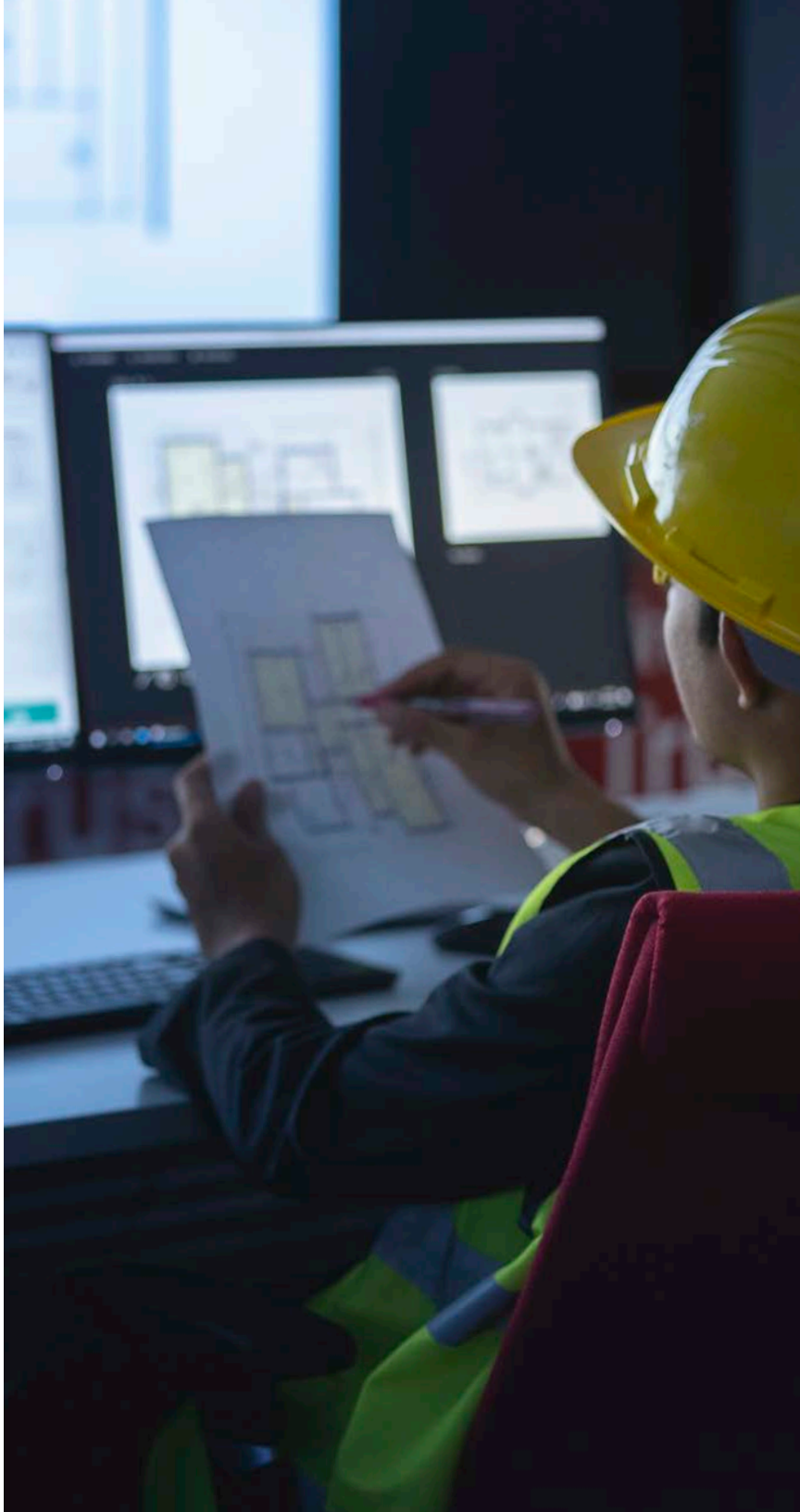
- Chiyoda Corporation has used dynamic modeling of LNG operations to enable faster startup while ensuring critical safety standards are met.
- Dow has successfully assessed potential sulfuric acid hazards with dynamic simulation.
- In an LDPE process, one producer received 27 days of warning for a central valve failure and avoided an unplanned shutdown and probable emissions release.

Driving Efficiency and Innovation

The desire to make significant strides toward sustainability targets will drive many companies to fundamentally change their energy sources and shift product portfolios. This transition will take time and will require substantial investment in new technologies. However, the potential payoff is significant, with an estimated $1 trillion in new business opportunities available, according to the Ellen Macarthur Foundation.[4]

Digital technologies are enabling companies to increase the efficiency of their operations and more quickly develop solutions to solve the challenges of the circular economy. The solutions focus primarily on emissions associated with energy use, such as CO_2 and NO_x, in addition to a move toward the use of alternative energy sources.

Digital twin capabilities give companies a comprehensive view of energy use across a unit or enterprise, and new visualization tools enable better analysis and reporting of the overall and discrete energy consumption. Specific modeling of process energy can also identify potential energy savings opportunities between units and throughout the complex. Additionally, utility analysis tools allow operators to better plan energy use, and sourcing across production sites and can be expanded to facilitate energy sharing with local consumers.

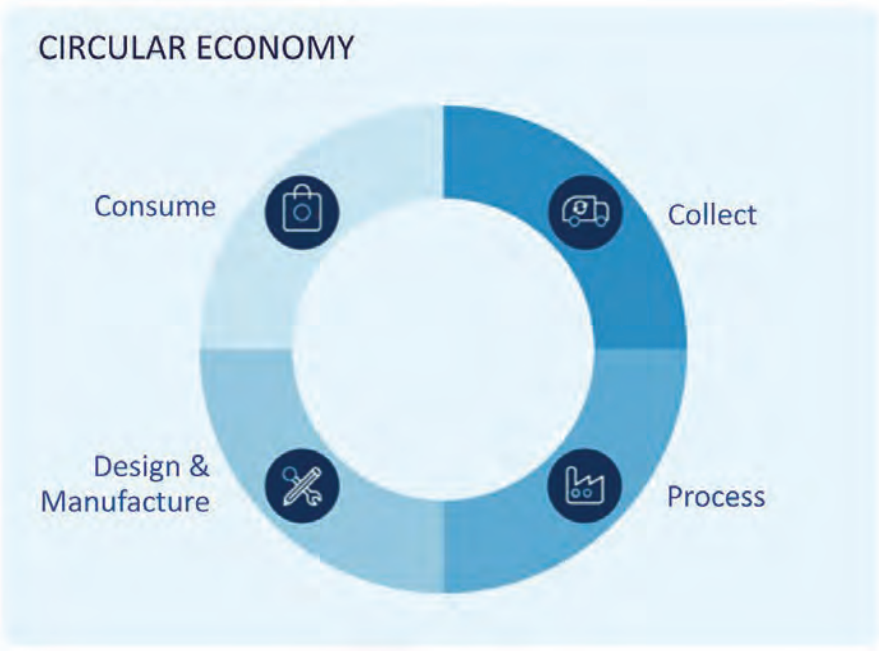


A new emphasis emerging in the industry is “decarbonization,” or the reduction of the carbon footprint of a process or energy source. These efforts target a reduction in carbon emissions associated with a process —for example, using a lower-carbon fuel like natural gas instead of coal, or substituting wind or solar energy or renewable biomass for a fossil fuel. Digital solutions aid these efforts by modeling and comparing alternative processes for various metrics, such as cost, emissions of CO_2 and other greenhouse gases for the energy delivery.

Simulations can efficiently screen alternative energy sources and new process routes, while accounting for associated emissions and resource demand for each. Early efforts are underway to apply modeling technology to improve the efficiency of processes based on new energy feedstocks, such as biomass and plastics waste.

Digital networks also enable better connectivity between energy demand systems, so that energy is used more efficiently across a plant, community or region. The research agency SusChem refers to this as “industrial symbiosis.”

Concern about growing volumes of plastic waste worldwide has raised the urgency of moving toward a circular economy, where materials are re-used after initial application so fewer natural resources are consumed overall. Some companies are pursuing depolymerization processes to deconstruct the plastics back to their base raw materials—an approach often referred to as molecular or chemical recycling—allowing for the same high-quality product to be produced again.



Digital solutions help companies move toward the circular economy

However, most of these processes are inefficient and can currently only be executed on a small scale. They will need further development to be competitive solutions for the global market, and modeling software is an important tool to boost the speed and efficiency of these experiments and to optimize commercial processes.

Water productivity is another important component of the circular economy, and can be improved using process optimization and improved control. Companies are currently using modeling to improve water efficiency in processing, along with the economic assessment of water treatment and desalination projects. In addition, process monitoring has enabled leak identification.

Efficiency & Innovation Upgrades

- **Energy and water efficiency:**
  Use a digital twin to design processes that are more efficient with energy, water and resource use than existing processes.
- **Decarbonize across the value chain:**
  Leverage process models to develop new bio-based materials that include technical and economic feasibility assessments.
- **Product and process innovation:**
  Design new scale-up strategies for high-performance materials that integrate into the circular economy.

Solutions for Success in Sustainability:

Aspen Energy Analyzer™ for Improved Energy Management

Digital technologies enable the modeling of processes to optimize energy demands and potential emissions. These simulations enable better heat integration to reduce steam use, utility planning for new plants, including purchase and sourcing options, and they enable potential symbiosis with nearby facilities to enable energy sharing with other local consumers. Companies have reduced energy consumption and CO_2 emissions from 5–20%.

Aspen Plus® and Aspen HYSYS® to Accelerate Development of New Processes and Products

Process modeling enables optimization of existing process and development of new routes that use less energy and generate fewer emissions and waste materials. Experimental design aids project planning so commercial implementation is faster and more cost-effective.

Aspen Mtell® to Avoid Emissions and Incidents due to Unplanned Outages

AI-enabled prescriptive maintenance gives advance warning of failures, so plant personnel have time to plan around predicted downtime with a holistic view of the operations. This enables them to run the plant efficiently and plan for downtime, avoiding potentially dangerous situations, energy waste and related emissions.

Aspen ProMV™ to Reduce Waste From Off-Spec Production

Multivariate analysis of batch production data enables deep analysis of process variability that leads to off-spec production, and significant waste of raw materials and energy. Insight on variable relationships enables dynamic alignment of batches and online optimization. Customers have seen up to 30% boost in output by utilizing the data they already have on hand.

There have been a number of industry success stories already, as companies ramp up their focus on efficiency and innovation:

- ADNOC has used a digital twin of existing oil and gas operations in the Middle East to capture efficiency opportunities and optimize implementation, cutting water use by 10% and energy use by 5%.
- Fluor Corporation has used modeling for carbon capture to develop its proprietary carbon capture process, helping them to establish a leading position in the emerging-market growth area of carbon capture in power and industrial facilities.
- The Malaysia Palm Oil Board has been able to quickly determine the feasibility of converting palm oil to high-performance polymers.

The integration of sustainability targets with business goals will be transformational for energy and chemical companies, as well as businesses across industries. Global efforts to move toward new energy sources and the circular economy will drive a strategic shift in business metrics and the practices that will enable success. Many forward-looking companies have already begun this process, investing to build new capabilities and developing innovative technologies and business models to achieve new targets.

Achieving the fragile balance of sustainability goals—equally considering people, planet and profit—is a considerable challenge, but one that must be addressed to be competitive in the energy and chemical markets of today and tomorrow. Digital technologies will take center stage during this transition, enabling the capabilities that will separate the winners from the losers.

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About Aspen Technology

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster. Visit **AspenTech.com** to find out more.

[1] CEO Study on Sustainability 2019, Accenture and UN Global Compact, Sept 2019

[2] Energy Efficiency 2019, International Energy Agency, Oct 2019

[3] Strategic Research and Innovation Agenda, SusChem, Nov 2019

[4] The Circular Design Guide, Ellen Macarthur Foundation