



# Energy Expansion: Chemicals Industry

Improving efficiency to prepare for an uncertain energy pricing and regulatory future

**SIEMENS**  
ENERGY

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## Executive summary

The global chemicals industry is a multi-trillion-dollar business responsible for supplying critical products to support food production, consumer and industrial products, along with our growing dependence on rapidly evolving technologies. The evolving political landscape will have significant impacts on global trade and put additional pressures on production in the US.

**Challenges are coming, and the chemicals industry must act now, while gas prices are low, and the political environment is favorable.**

The replacement of aging equipment to meet modern efficiency levels and new environmental standards and retaining expertise amidst the retirement of an aging workforce are also in focus. The chemicals industry is the world's largest industrial consumer of energy and is responsible for nearly 5% of global greenhouse gas emissions <sup>1</sup>. **In addition, with the modernization of the electrical grid and its power mix, stresses to the overall system's economics and reliability are inevitable.** There is an immediate need for affordable, reliable, sustainable, and secure energy systems for powering this industry into a future of uncertain gas and electrical rates and environmental regulations.

Siemens Energy is uniquely positioned to leverage its experience as a global technology leader to help chemicals customers overcome their most pressing energy challenges. This whitepaper discusses the current state of energy usage in the chemicals industry and introduces the specific technologies, solutions and services Siemens Energy can offer:

- [Energy System Design Studies](#)
- [Compression Solutions](#)
- [Steam Turbines & Heat Recovery Applications](#)
- [Electrification, Automation, Digitalization](#)
- [Grid Consulting and High Voltage Transmission](#)
- [Carbon Capture Support](#)
- [Combined Heat and Power](#)
- [Hydrogen, Power-to-X, and Energy Storage](#)
- [Wind Turbine Power Generation](#)

Chemical producers must respond to the industry's unprecedented energy and regulatory challenges **before they are left behind with carbon excessive operations, future regulatory penalties, unreliable and expensive power, and stranded assets.** A successful energy transition requires balancing affordability, reliability, sustainability, and security. Siemens Energy works with its industrial customers to maximize each of these in their current and future energy systems by identifying robust energy system strategies and designs and delivering the world's most efficient energy technologies.

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<sup>1</sup> Gabrielli et al. Net-zero emissions chemical industry in a world of limited resources One Earth, 2023

# Chemical Industry Overview

**More efficient, reliable, secure, affordable, and sustainable energy solutions are needed to keep plants competitive, maintain production and reduce environmental impact.**

Chemicals play a significant role in the environment and overall economy. **Hydrocarbons and their derivatives provide both a feedstock for chemicals as well as the energy to drive reactions yielding even more valuable commodities.** As demand for more synthetic and specialty materials grows, this sector will continue to expand, bringing about new processing methods which emphasize cost, efficiency, and environment.

The United States is experiencing a resurgence of investment and expansion in the industrial sector. **Within the chemical processing sector specifically, growth is forecasted at 3-4% per year.** Despite this growth, chemical producers will continue bearing the pressure of customers, investors, and regulators to decarbonize their own operations while reliably supplying low-cost products. Specifically, a range of factors must be balanced by chemical manufacturers in addition to simply producing products:

1. **Economics:** Replacing equipment that is costly to maintain and investing in new capital projects to modernize production units.
2. **Demographics:** Retaining expertise amidst an aging work force as well as regional variations in operating boundaries, for example high- and low-cost electricity markets.
3. **Technology:** Deployment of modern technologies and smart digital control and operations solutions required to maintain financial viability.
4. **Power:** Changing power supply landscape including renewable generation, and alternative fuels.
5. **Regulation:** Potential greenhouse gas emissions penalties or incentives to decarbonize.

A wide range of processes and technologies are employed to transform raw resources into marketable products: hydraulic fracturing for production, compression for transmission, distillation, catalytic hydrocracking, and polymerization, to name a few. **Each of these require incredible amounts of thermal, electrical, mechanical, and chemical energy.** Siemens Energy offers a broad portfolio of products and services to support the transformation of this industry into more efficient, reliable, secure, and environmentally sustainable energy operation with financial competitiveness at the forefront.

## A Transition from Old to New

At the beginning of the industrial revolution, coal was a source of energy and chemical feedstocks. Now the **demand for low-cost natural gas is soaring, being produced in volumes 50% greater than a decade ago.** Overall, the

power generation sector has been effectively transitioning away from high-carbon fuels, reducing coal usage by 50% over the last 10 years.

Within the chemicals sector, electricity, coal, petroleum, and natural gas have served as basic feedstocks. **With the industrial sector accounting for nearly a quarter of all reported CO<sub>2</sub> (and CO<sub>2</sub> equivalent) emissions.** Within this sector, electricity is both consumed and produced on-site. Electricity is often produced by recovering or reusing waste energy or by burning gasses directly. The cost of replacing low-cost coal power with renewable and modern gas power systems is expected to increase the cost of purchased grid electricity into the future. The cost of natural gas on the other hand is expected to be less impacted by these factors, offering a more stable price of energy and underscoring the importance of maximizing the efficiency of energy derived from this resource. For example, **combined heat and power (CHP) systems can serve as a buffer against rising electricity rates while supplying electricity and process heat at greater than 90% thermal efficiency and reducing the plant's overall CO<sub>2</sub> intensity.**

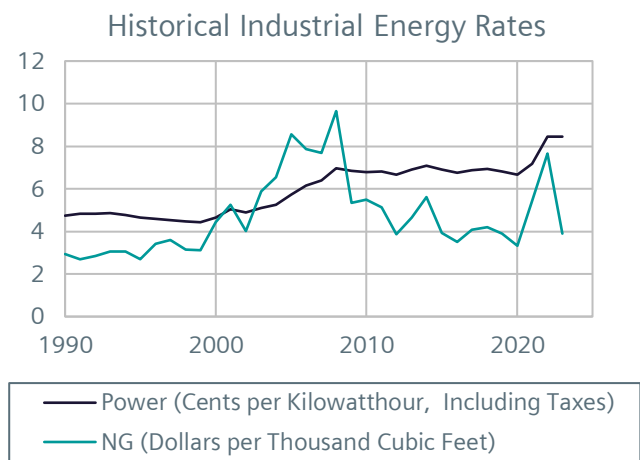


Figure 1. Energy rates for the U.S. industrial sector. <sup>3</sup>

Figure 1 shows the cost of delivered power in the industrial sector over the past 30 years. Initially, substantial coal and nuclear power generation provides relatively low and steady electricity rates. Natural gas rates steadily increased from 1990 to 2008 as traditional recovery methods become less financially effective. This changed around 2008 with the beginning of the "shale gas revolution" where hydraulic fracturing, horizontal drilling, and other technological breakthroughs began to reduce the price of and increase the volume of natural gas from large shale formations. Electricity rates trend positively with increasing natural gas prices and again flatten when prices drop. These rates are also impacted by the retirement of aging infrastructure and the introduction of modern systems, which independent of

the price of fuel, are expected to continue driving the price of electricity upwards. Compounding this, new electricity consuming entrants, for example data centers to support a boom in artificial intelligence, are expected to become a growing burden, competing for supply, and pushing prices up even further due to investments in infrastructure.

**Regional differences in electricity rates will significantly impact the potential for electrification.**

In high-cost electricity regions, self-generation boosts independence and reduces peak charges, while potentially creating a new value stream for export by industrial operators. Renewable generation can help but carries the geographic challenges of wind and solar resource potential as well as constraints to available land. **A low-risk, long-range solution to mitigate energy price spikes for industrial users in these regions is to more tightly**

**associate energy use with a well-established supply of natural gas and associated chemicals that are key feedstocks to the industry.** Fortunately, industrial operators can access natural gas at prices comparable to large utility users, and in some cases very useful feedstocks (e.g., ethane and propane) needed for high-end product streams may even be freely available <sup>2</sup>.

In lower-cost electricity regions, increasing use of electrification becomes more financially attractive. In some areas, renewable sources are helping to push down power prices. Switching to a renewable energy base, such as wind, solar, or hybrid systems containing energy storage can become a good alternative in this case. **It's important to also include transmission, behind-the-meter distribution and energy management, and interconnection costs in these cases.**

## Industrial Emissions

Much of the discussion on greenhouse gas (GHG) emissions has focused on carbon dioxide released through combustion of fossil fuels for electricity, heat, and transportation, which accounts for 90% of all anthropogenic carbon emissions <sup>3</sup>. In addition to these, non-combustion related emitted industrial GHGs can include:

1. Methane and similar light hydrocarbons including waste gas as process byproducts.
2. SF<sub>6</sub>, typically used in substation breakers, and high global warming potential (GWP) process gases.
3. N<sub>2</sub>O, with both industrial and agricultural sources.

Figure 2 shows direct GHG emissions by industrial sectors within the United States. **Significantly, the chemical industry, here consisting of petroleum and natural gas, chemical production, and refining is responsible for 26% of total direct industrial GHG emissions.** Also interesting, power plants, due to their reliance on fossil fuels, contribute an overwhelming 57% of all industrial GHG emissions. Some of this electrical power, and its embedded indirect GHG emissions, is consumed by chemical plants. A realistic view of GHG emissions therefore needs to consider direct and indirect sources, including Scope 1,2, and 3 emissions.

US Industrial Direct GHG Emissions

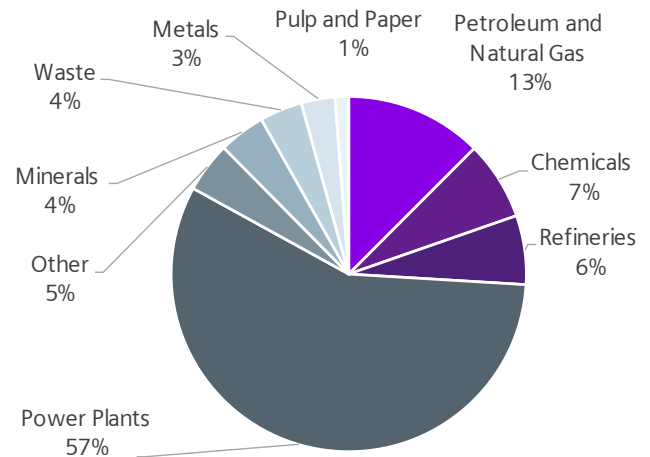


Figure 2. U.S. greenhouse gas emissions by key industrial sectors.<sup>4</sup>

<sup>2</sup> Data from US EIA October 2023 Monthly Energy Review. Web: <https://www.eia.gov/totalenergy/data/monthly/>

<sup>4</sup> Natural gas pipeline tariffs will limit the gas heating value to a specific range (e.g., the Algonquin Pipeline is from 1050 and 1110 Btu/scf) requiring excess ethane, propane, and butane to be removed from the gas.

<sup>5</sup> CSIRO. Web: <https://www.csiro.au/en/research/environmental-impacts/climate-change/Climate-change-QA/Sources-of-CO2>

<sup>6</sup> Data from US EPA 2023 Greenhouse Gas Emissions from large facilities. Web: <https://ghgdata.epa.gov/ghgp/main.do>

Siemens Energy considers four key pathways for chemical producers to reduce their overall direct and indirect GHG emissions while improving their competitiveness:

## Improving Energy Efficiency

Improving the energy efficiency of plant processes both reduces direct GHG emissions through better management of waste heat and the reduction of losses, and indirect emissions through a lower overall demand from the electrical grid. **Process and overall plant energy optimization, waste heat recovery, and combined heat and power systems are each proven options for improving plant and energy efficiency.**

Siemens Energy specializes in combined heat and power. Trigeneration, Cogeneration, or most commonly, combined heat and power (CHP) are the designations given to industrial-based energy conversion processes, which change chemical energy into useful thermal energy, and then into electrical energy. In the mid 1980's, there was significant growth of CHP stemming from the fact that equipment installed to generate electricity was also useful for economically producing heat and steam in an era of high fuel costs. CHP has since proven itself across industries as a critical enabler for reducing CO<sub>2</sub> emissions, increasing reliability and in many cases flexibility, and all the while remaining financially attractive. Today, as electricity rates are well outpacing natural gas prices, CHP solutions for self-generation provide chemical producers **a buffer against uncertain future electricity rates and co-locate a wealth of otherwise unusable waste heat which may be recovered and used for process heat.**

## Introducing Low-Carbon Fuels and Power

The largest contributor of GHG emissions in chemical production facilities is the combustion of fossil fuels for electricity and process heat. These emissions may be reduced by substituting traditional fuels with low-carbon or carbon-free alternatives for energy generation or feedstocks. Low-carbon fuels may be synthesized from captured or bio-genic carbon sources and produced hydrogen. Chemical producers can benefit from this GHG emissions reduction pathway by producing low- or zero-carbon fuels for sale or by relying on fuel flexible power systems. As the availability and affordability of novel low-carbon fuels will improve over time, specific investments in energy conversion systems, gas turbines, engines, boilers, etc., **need to ensure that these systems are capable of handling today's fuels and tomorrow's fuels without losing performance.**

Another alternative to replacing traditional fossil fuels with lower-carbon alternatives are renewable power systems which eliminate the operating-life GHG emissions associated with fossil generated electricity. Wind and solar power systems are becoming more efficient and affordable, and grid interconnection arrangements often include attractive market conditions for selling unused renewable energy. In

addition, battery energy storage systems create the opportunity to store and dispatch carbon-free energy during non-generating hours.

## Electrifying Processes

If carbon-free electricity is available on-site or if grid electricity is less carbon-intense than on-site gas power, **than plant GHG emissions reductions can be maximized by maximizing the plant's degree of electrification.** Specifically, converting existing heat driven processes to electrically driven processes, replacing conventional boilers with electrified heat solutions, and incorporating electrified waste heat recovery systems can shift the overall plant load from fossil fuel to electricity. Many electrified heat technologies enable waste heat from process exit streams to be upgraded into useful process heat streams, therefore reducing the plant's dependence on net steam generation from fossil resources.

## Capturing Carbon

The chemical industry relies heavily on carbon-based fuel as both energy and process feedstocks. As sweeping changes to the availability of low-carbon fuels and renewable energy, and project planning and execution for electrification efforts and energy efficiency overhauls will take time, an immediate solution to plant carbon emissions comes in the form of capturing the emitted carbon. These systems can recover large amounts of carbon from exhaust streams. **This recovered carbon may then be used as a feedstock to chemicals, plastics, products, processes, and fuels, or stored long-term to avoid release into the atmosphere.**

# Siemens Energy's Transformative Energy Solutions

Providing a holistic approach to address the Chemical industry's energy challenges.

Siemens Energy works with chemical producers to maximize the affordability, reliability, and sustainability of their energy systems by identifying robust energy system strategies and designs and delivering the world's most efficient energy technologies. Doing so, requires site-specific collections of solutions. Figure 3 exemplifies this concept, wherein three unique chemical plants undergo different degrees of decarbonization using different collections of technologies and solutions (illustrative only). In an existing plant, Plant 1, high tariff rates and carbon intensity of the local electrical grid result in self-generation using a CHP system as a significant solution. Conversely, for a new build plant, Plant 2, energy system optimization, compression sizing and operation optimization and waste heat recovery through a mechanical vapor recompression system produce the strongest result over a traditional baseline. Finally, in Plant 3, the optimization of the recovery steam turbine system coupled with automation of a few critical plant processes produces the lowest net steam demand, minimizing carbon emissions. The individual solutions in this section are helping industrial customers decarbonize operations and maximize their energy system's affordability, reliability, security, and sustainability.

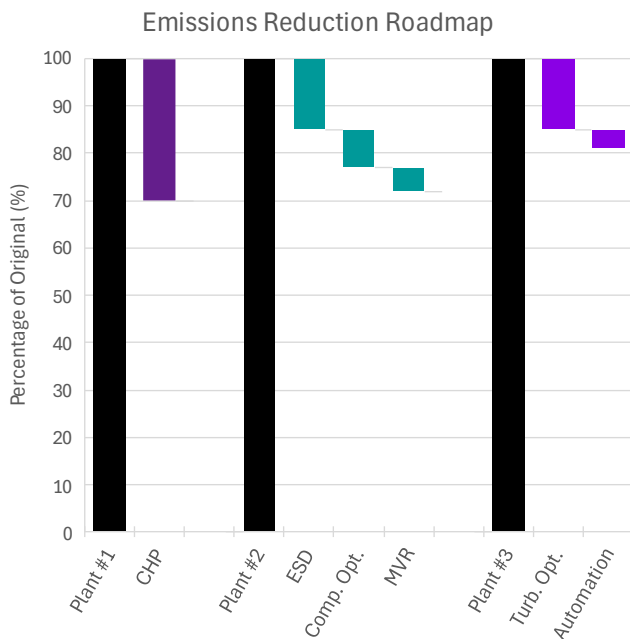


Figure 3. Illustration of combined solutions for plant decarbonization.

## Energy System Design Studies

*Developing optimized energy solutions*

Siemens Energy has introduced Energy System Design (ESD) to help chemical producers make the right decisions for energy system expansions, upgrades, and new system designs, considering the need for decarbonized and low-cost energy, the regulatory and incentive landscape, and the broad range of technologies available. **ESD is a model-based engineering optimization study that selects and sizes energy conversion and storage assets to supply thermal and electrical power to an individual chemical plant.**

*Example:* An ESD study helped a chemical customer minimize their leveled cost of renewable power-driven ammonia production.

## Compression Solutions

*Innovating for efficiency*

**Siemens Energy offers a comprehensive portfolio of turbo, reciprocating, and hybrid compression solutions for the petrochemical industry.** Siemens Energy's compressor portfolio incorporates over a dozen legacy brands coming from the acquisition of Dresser Rand and Rolls Royce, providing a technical foundation. Hydrogen, air, steam, carbon dioxide, and a wide array of hydrocarbon and other gas compression systems are available for powering ammonia, olefin, methanol, and other chemical production and refining processes. Compression solutions can also help plants to upgrade steam from heat pumps or low-grade process streams to be beneficially used or re-used across the plant, or as critical equipment for carbon capture, sequestration, and storage. Another innovation of Siemens Energy's compression solutions is its application to decarbonize olefin production processes.

**The Rotating Olefin Cracker (ROC) technology employs a dynamic reactor system that replaces conventional furnaces used for pyrolysis when manufacturing light olefins** – the building blocks for chemical products used in everyday materials, from packaging to polymers. The technology is a joint development with Technip Energies. Modernization and upgrades of existing compressors is another important decarbonization lever and valuable Siemens Energy offering as improved efficiencies can be attained and existing equipment can be re-used minimizing lifecycle environmental impacts.

*Example:* A Siemens Energy turbo compressor supplies H<sub>2</sub>-rich syngas compression for a diesel desulfurization hydrotreatment unit.

## Steam Turbines & Heat Recovery Applications

### Capitalizing on unused energy

Siemens Energy works with petrochemical production customers to recover valuable excess heat across the plant's processes for beneficial reuse elsewhere in the plant. Excess steam or upgraded low-grade steam may be used to produce additional plant power using one of Siemens Energy's leading industrial steam turbine systems. **Our steam turbine solutions set the standard for reliability, efficiency, uptime, and operational flexibility, while minimizing operation and maintenance costs, and specific steam consumption.**

Modernization and upgrades of existing steam turbines is another important decarbonization lever and valuable Siemens Energy offering as improved efficiencies can be attained and existing equipment can be re-used minimizing lifecycle environmental impacts. Here, Siemens Energy benefits from the incorporation of legacy steam turbine technologies, including Westinghouse, and many others.

Heat transfer systems may be deployed to redirect low-grade waste heat toward pre-heating other plant energy streams to improve plant-wide efficiency or toward nearby industrial operators and nearby residential areas as district heat. **Siemens Energy's mechanical vapor recompression (MVR) solutions help plants to upgrade low-grade waste heat to produce higher-grade heat or steam for processes and power extraction.** Finally, Organic Rankine Cycle (ORC), and supercritical CO<sub>2</sub> cycle systems are being developed by Siemens Energy to help customers directly generate power from low-temperature waste heat.

*Example: A chemical complex is using an SST-600 steam turbine to condition process steam and produce an additional 45% power from waste heat.*

## Electrification, Automation, Digitalization

### Future-proofing the industry

**Reducing operating costs and decarbonizing operations begins with improving the energy-efficiency of plant components, processes, and the overall plant system.** Siemens Energy offers a range of digital products and solutions designed to optimize industrial operations and enhance energy efficiency, including the Omnivise Portfolio for plant optimization and cybersecurity, Digital Twin Technology for real-time asset evaluation, Sensformer® Advanced for transformer monitoring, high-voltage systems with integrated edge computing, and Smart Asset Care for increased plant availability and safety. These solutions demonstrate Siemens Energy's commitment to driving sustainability and efficiency in the energy sector. In addition, **Siemens Energy's Electrification, Automation, and Digitalization (EAD) team** works with petrochemical customers to:

- Maximize plant return-on-investment through energy management systems (EMS) which improve demand-side flexibility, asset power generation, and steam management in-line with hourly price signals and other constraints.

- Replace conventional mechanical drives with highly efficient electric drive systems containing electric motors and variable frequency drives (VFDs).
- Maintain maximum boiler efficiency using soot-blowing optimization solutions.
- Develop concepts into reality through engineering studies, including Pre-FEED and FEED and decarbonization consulting.

*Example: Siemens Energy is supplying power distribution and drive systems, controls, and a complete digital twin for a new biorefinery*

## Combined Heat and Power (CHP)

### Reducing costs and carbon intensity

Petrochemical plants require large amounts of both electrical energy and steam. **Siemens Energy produces best-in-class gas turbines (GT), coupled with heat recovery steam generators (HRSGs) and steam turbines to provide electricity, thermal energy, and process steam.** Natural gas auxiliary burners may be used to provide supplemental process steam within the HRSG, or electric heat can supplement energy to meet the design needs. In addition, Siemens Energy produces industrial steam turbines which can improve process steam control and significantly increase plant efficiency by drawing additional electricity from the 100+ bar high-pressure (HP) steam generated by the HRSG. These systems can be sized to produce a range of steam pressures and flows for cracking, separating, and other plant heating applications. In addition, Siemens Energy is developing an integrated gas turbine driven furnace solution for olefin production to maximize plant efficiency and minimize power and steam cost. Moreover, modernization and upgrades of existing gas turbines improves their performance and GHG emission profile.

*Example: An upgraded SGT-800 gas turbine supplies power, process steam, and heat to a large chemical plant, improving efficiency by 10% with 16% lower GHG emissions.*

## Grid Consulting and High Voltage Transmission

### Ensuring stable power

Siemens Energy offers innovative solutions that enhance grid interconnection reliability, resilience, and flexibility. Siemens Energy's complete **air-insulated and gas-insulated substations, and large power transformers** help petrochemical customers purchase and sell electricity from and to the electrical grid at the highest efficiency, reliability, and safety performance available. **Siemens Energy's grid consulting experts can also help petrochemical customers to maintain the highest standards of stability in their exported power** voltage and frequency and ensure that load flows are well managed. Siemens Energy further improves emission reductions by implementing state-of-the-art Operations and Maintenance programs, services, and technologies to electrical infrastructure systems.

## Power-to-Heat

### Diversifying for reliable heat

Decarbonizing plant operations requires electrically driven options for producing process heat which outperform traditional fossil fuel combustion-based systems. These technologies are shown in Figure 4. Siemens Energy offers the turboheater, **an electrically driven turbomachine which can heat air and steam to very high temperatures (370 – 1000 °C)** which may be useful for superheated steam generation and other furnace or high temperature plant applications. Another solution which is currently being developed, induction heaters, efficiently and quickly produce heat by the process of electromagnetic induction. **Induction heaters may be used in the production of steam up to 1000°C, which can then be used across a plant's processes.**

**Example:** A heat pump and compression solution can help plants recover reactor stream waste heat to produce process steam.

Required Heat Temperature (°C)	50 - 80	80 - 150	150 - 270	270 - 370	370 - 1000
Petrochemical Plant Use Cases		Polymerization, Isomerization, Heating		Alkylation, Hydrocracking	Cracking, Reforming, Steam
CHP	Yes	Yes	Yes	Yes	No
Mechanical Vapor Recompression	No	Yes	Yes	No	No
Induction Heater	No	No	Yes	Yes	Yes
Turboheater	No	No	No	Yes	Yes

Figure 4 Power to Heat technology comparison.

## Carbon Capture Support

### Mitigating environmental impact

Petrochemical plants require a significant amount of power, often generated using fossil fuels on-site, and maintain various process specific sources of carbon dioxide emissions. This carbon dioxide may be captured using solvent-based carbon capture systems. **Siemens Energy can help petrochemical customers to engineer the right system for capturing, storing, and utilizing this carbon dioxide.** Siemens Energy's compression and heat pump systems may be included to significantly improve the efficiency of complete carbon capture packages.

**Example:** Siemens Energy provided integrally geared compressor systems as critical to the capture, storage, and transport of over a million metric tons of CO<sub>2</sub> annually for an industrial customer.

## Hydrogen, Power-to-X, and Energy Storage

### Pioneering low-carbon fuels

Conventional on-site power and steam generators rely on fossil fuels to produce heat. Low carbon fuels offer an alternative to fossil fuels by delivering the same thermal energy as conventional fuels when burned, but with significantly

lower net carbon emissions. These fuels are either carbon free, as in the case of hydrogen and ammonia, or are hydrocarbons synthesized from captured carbon dioxide, as in the case of e-methane, e-methanol, and other e-fuels. Siemens Energy's **industrial gas turbine systems may be operated using a range of conventional and low-carbon fuel, and even co-fired to incorporate mixes of each.** The same gas turbine systems may therefore be used to produce power and steam with readily available conventional fuel today and low-carbon fuels as these become financially and logistically more available in the future.

Hydrogen may be used as a carbon free fuel to produce on-site heat for steam and power generation or as a critical feedstock in the production of e-fuels. E-fuels, including the synthetic natural gas e-methane, and e-methanol, are low carbon fuels synthesized using green hydrogen and captured carbon dioxide. These may be produced and sold using the abundant carbon dioxide and water resources within a plant. Siemens Energy **offers expertise in advanced chemical processes and produces a world class hydrogen production technology, the PEM electrolyzer Elyzer P-300,** to help petrochemical customers maximize their opportunity to expand into the hydrogen and e-fuels production markets. Additionally, an important byproduct of water electrolysis is high quality oxygen, which may be sold or used for chemical processes, for example synthesizing methanol at a low carbon intensity.

Petrochemical plants, in operating processes across a highly dynamic load range, require rapidly dispatchable and reliable power to meet the process electricity, heat, and steam loads required to keep production on-line. Energy storage systems help customers to increase the availability of power from renewable generation and help them to avoid peak demand electricity tariffs by strategically discharging stored power (peak shaving). Siemens Energy offers **battery energy storage systems (BESS) for storing and supplying electrical energy.** Siemens Energy's BlueVolt energy storage solutions are designed to significantly reduce greenhouse gas emissions. Siemens Energy can also help customers evaluate or design alternative systems including thermal (pumped heat energy storage, electric thermal energy storage, and other latent and sensible energy approaches), mechanical, and chemical energy storage.

**Example:** An Elyzer P-300 will soon come online to supply an industrial district with 335 kg/hr of electrolyzed green hydrogen.

## Wind Power Generation

### Harnessing renewable energy

**Siemens Energy provides best-in-class wind turbine generation systems** for converting wind power into carbon-free electricity for driving processes or export to the grid. Individual turbine systems can provide between 2.9 and 7.0 MW of electricity for driving processes or use within Power-to-Heat systems for producing process steam.

## Summary

**Challenges are coming, and the chemicals industry must act now, while gas prices are low, and the political environment is favorable.**

Major shifts in technology, fuel resources, and regulatory policy are substantially influencing the trajectory of the chemical production industry. Electricity rates have been increasing and are expected to continue to increase as aging coal and nuclear plants are retired, new plants are brought online, and transmission and distribution infrastructure is modernized. Aging infrastructure will need to be replaced by modern systems and an aging workforce threatens to remove an exceptional wealth of accumulated knowledge from the field. These challenges, coupled with the industry's significant energy consumption and greenhouse gas

emissions, underscore the urgent need for affordable, reliable, and sustainable energy solutions. **Failure to act now threatens to leave chemical producers with carbon excessive operations, regulatory penalties, and stranded assets in the next five to ten years.**

**Siemens Energy stands ready** to join chemical production customers in navigating these challenges by offering a range of innovative and proven technologies and solutions. A successful energy transition requires balancing affordability, reliability, security, and sustainability. Siemens Energy partners with its industrial customers to maximize each of these in their current and future energy systems by identifying robust energy system strategies and delivering the world's most efficient energy technologies.

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