NATURAL GAS IN THE INDUSTRIAL SECTOR

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

Discussion Questions

1. **How should we balance the use of natural gas for zero-emitting feedstock purposes against other uses?**
2. **Are concerns about the availability of natural gas usage for feedstock still valid given increases in U.S. natural gas production? If so, what are ways to ensure industry and other sectors access to a fair share of gas?**
3. **How would exports of liquefied natural gas impact prices of natural gas liquids?**
4. **How can utilities and industrial consumers become more comfortable with CHP systems?**
5. **How can replacement of coal boilers with natural gas be incentivized beyond current regulatory requirements?**

HIGHLIGHTS:

- The industrial sector directly consumed 27 percent of natural gas in the United States in 2010.
- Newly abundant and low-cost domestic sources provide economic benefits to industry using the fuel for power, heat, and as a feedstock.
- The Energy Information Agency projects total natural gas consumption for industrial heat and power to rise by 6.25 percent between 2012 and 2021 before declining to lower but steady levels through 2035, and it projects natural gas feedstock us to rise by 25 percent between 2012 and 2035.
- Boiler upgrades and replacements can offer measurable reductions in greenhouse gas emissions through efficiency improvements as well as displacing coal with gas.
- Combined heat and power systems offer the potential to efficiently use natural gas while reducing greenhouse gas emissions.
- Many industrial activities are energy- and emissions-intensive, but some uses of natural gas as a feedstock emit very few greenhouse gases.

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INTRODUCTION

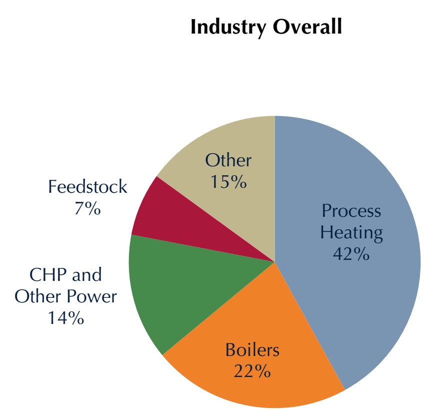
The industrial sector is very diverse and includes industries such as chemicals, metals, minerals, oil refining, paper, and food. Natural gas uses among these industries vary significantly. It is used for heating and cooling, process heating for glass melting, food processing, metals preheating, and drying; on-site electricity generation (fueling boilers and turbines); and it is used as a feedstock to make chemical products, fertilizers, plastics, and other materials.[1] The breakdown of natural gas use within the sector is shown in Figure 1. In total the U.S. industrial sector used natural gas for 30.4 percent of its direct energy use (for combustion and non-combustion) in 2010.[2] This usage amounted to 8.14 quadrillion Btus of natural gas in 2010 (27 percent of natural gas consumed in the United States), which emitted 408 million metric tons of carbon dioxide equivalent (CO2e). More than 82 percent of this natural gas use was for manufacturing (excluding refining and mining).[3]

Overall, the largest direct use of energy by the industrial sector is for process heating, which is the production of heat directly from fuel sources, electricity, or steam to heat raw material inputs during manufacturing. In 2010 process heating using all fuel sources produced 315.4 million metric tons of $C0_2e$, which was 40 percent of the total emissions for the industrial sector.[4] Natural gas is the dominant fuel used to generate heat, and process heating accounts for 42 percent of the natural gas use in the industrial sector (see Figure 1).[5]

Industrial boilers for heat and steam are another significant user of natural gas, and, while some are fueled by coal or other fuel, the dominant fuel source is natural gas. Boilers are commonly used for a variety of purposes by chemical manufactures, food processors, pulp and paper manufactures, and the petroleum and coal derivatives industries (including chemicals, coke, and coal tar).[6] Twenty-two percent of the natural gas used in manufacturing is consumed in boilers.[7] As with process heating, industrial boilers are dependent on natural gas, with 83 percent of boilers running on the fuel (Figure 2).

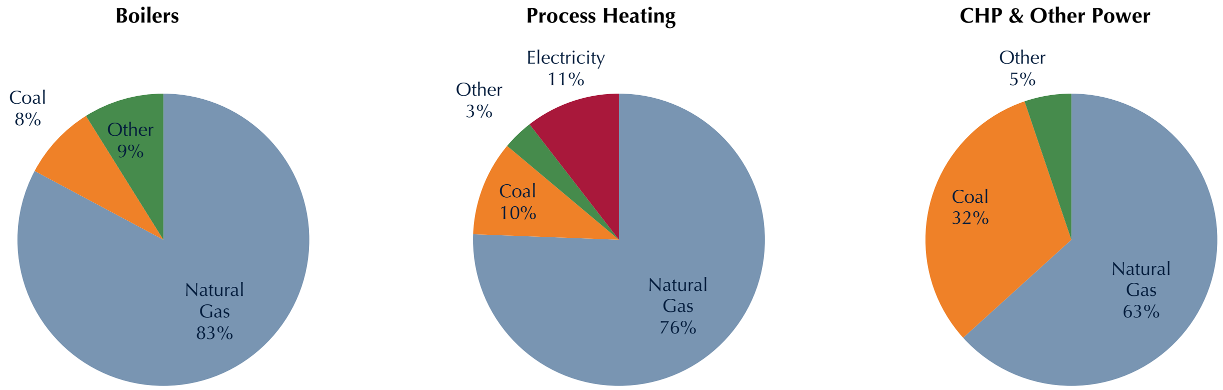
Often, power generation and process heating can be more efficiently accomplished by coproducing heat and power from a single unit with technology commonly called combined heat and power (CHP).[8] Additional efficiencies and emission reductions are also achieved through the generation of electricity onsite, because it avoids transmission loss.[9] In 2010, 14 percent of natural gas used in manufacturing was consumed by CHP and other power systems. As illustrated in Figure 2, natural gas dominates the fuel used for CHP. Nationwide, the added efficiencies of CHP systems avoid the annual emission of 35 million metric tons of CO_2e.[10]

FIGURE 1: Natural Gas Use in the Industrial Sector



Source: EIA Manufacturing Energy Consumption Survey (MECS), 2010[11]

FIGURE 2: Direct Consumption of Fuels in the Industrial Sector



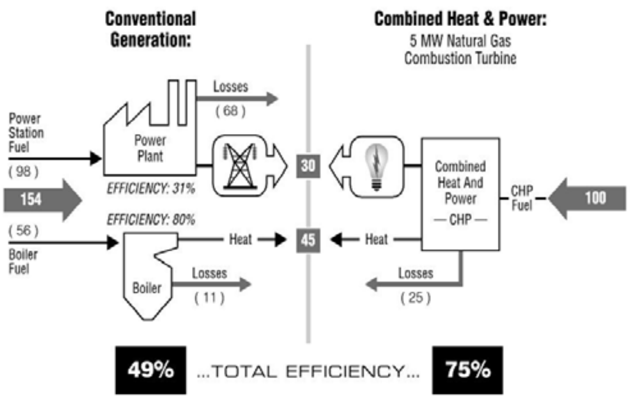
Source: EIA Manufacturing Energy Consumption Survey (MECS), 2010[12]

For the chemicals industry, natural gas also serves a unique function, providing a chemical feedstock in the form of methane and liquids found in the natural gas, including ethane, propane, and butane. These liquids, especially ethane, are processed and transformed to become additional intermediate and final products.[13] Chemical companies are particularly heavy users of natural gas as a feedstock and may consume up to two-thirds of their delivered natural gas for this purpose.[14] While U.S. companies are reliant on low-cost natural gas liquids as a feedstock, European competitors use more expensive, oil-based naphtha.[15] In 2010, for example, domestic ethane sold at half the price of imported naphtha in Europe, and, consequently, U.S. chemical manufactures have reaped a competitive advantage in international markets for intermediate and final goods.[16] The emissions implications of using natural gas as a feedstock are very different from its other uses because feedstock use transforms hydrocarbon molecules into other products, rather than combusting them. Consequently, when natural gas is used as a feedstock, very few greenhouse gases are emitted. [17]

POTENTIAL FOR EXPANDED USE IN THE INDUSTRIAL SECTOR

Increased availability and low prices of natural gas have significant implications for domestic manufacturing, which has historically been concerned about supply availability and price volatility. Recently, abundant supply and low prices have led to an increase in domestic manufacturing, creating new jobs and economic value. Numerous companies have cited natural gas supply and price in announcing plans to open new facilities in the chemicals, plastics, steel, and other industries in the United States.[18] In the past few years, the number of firms disclosing the positive impact of new gas resources for facility power generation and feedstock use to the Securities and Exchange Commission has increased substantially.[19] In 2010, exports of basic chemicals and plastics increased 28 percent from the previous year, yielding a trade surplus of $16.4 billion.[20] If the expectation that low prices will continue is correct, these economic benefits would be significant over the long term. A study by the American Chemistry Council, for instance, estimates that a 25 percent increase in ethane supplies would yield a $32.8 billion increase in U.S. chemical production.[21] Industry, however, needs more than just abundance and low prices to maintain use of natural gas. Price stability is necessary to encourage long-term investments in industry, and increased natural gas supplies also have the potential to stabilize prices.[22]

FIGURE 3: CHP versus Conventional Production



Source: EIA Manufacturing Energy Consumption Survey (MECS), 2010[23]

The Energy Information Agency's Annual Energy Outlook 2012 Early Release of projections for 2010 to 2035 reflects the expected increase in industrial natural gas demand. As seen in Figure 4, heat and power consumption is projected to rise by 6 percent between 2012 and 2021 before declining to lower but steady levels for the rest of the projection period. Figure 6 shows projections for natural gas use as feedstock to rise by 25 percent between 2012 and 2035. Growth will be tempered by long-term changes in the natural gas market and energy efficiency measures that offset increased demand, as illustrated in Figure 5 for heat and power and Figure 7 for feedstock. CHP generation is projected to rapidly increase by 235 percent over the period, as shown in Figure 8.[24] Increases in on-site CHP use are projected to be partially offset by increases in the use of grid-supplied electricity,[25] as the efficiencies and cost advantages of CHP are less pronounced when input prices are relatively low, as is currently the case with natural gas.

POTENTIAL FOR INDUSTRIAL SECTOR EMISSION REDUCTIONS

If supply remains robust and prices low and stable, the U.S. industrial sector is likely to reap substantial economic benefits from the increased availability of low-cost natural gas.[26] Even as the sector expands, there are opportunities to reduce its emission intensity. Improving the efficiency of industrial boilers is one such opportunity. Boilers tend to have a low turnover rate, and very often older units are less efficient than newer ones. The pre-1985 fleet of boilers has an efficiency rate of between 65 percent and 70 percent; while new boilers have efficiency rates of between 77 percent and 82 percent and new, super–high-efficiency units can reach efficiency rates of up to 95 percent.[27]

A Massachusetts Institute of Technology (MIT) analysis found that replacing older natural gas boilers with high-efficiency or super-high-efficiency units would decrease CO_2 emissions by 4,500 to 9,000 tons or more per year per boiler. The analysis also found a strong economic incentive to make these replacements, highlighting annualized monetary savings of 20 percent (given certain assumptions, including 2010 natural gas prices) with a payback period of 1.8 to 3.6 years for the new equipment.[28]

FIGURE 4: Projected Natural Gas Consumption (2009-2035) in…

Source: EIA AEO 2012 Early Release, 2012

While natural gas is the most commonly used fuel source for industrial boilers, 17 percent of boilers use coal or other fuels, as shown in Figure 2. Because of the air pollutants from these coal-fired boilers, these boilers are now subject to the Environmental Protection Agency's (EPA) 2012 Mercury and Air Toxics Standards.[29] MIT conducted a separate analysis to determine the results of replacing the affected coal boilers with efficient or super-high-efficiency natural gas boilers (these natural gas boilers are not regulated under the new EPA rule). This analysis found that replacement with natural gas boilers would reduce annual CO_2 emissions by about 52,000 to 72,000 tons per year per boiler.[30]

Increasing the use of CHP also has potential to reduce emissions. A 2008 Oak Ridge National Laboratory (ORNL) study analyzed the total U.S. energy system and calculated that increasing CHP's share of total U.S. electricity generation capacity from 9 percent in 2008 to 20 percent by 2030 would lower U.S. GHG emissions by 600 million metric tons of CO_2 compared to business as usual.[31] Another study, by McKinsey & Company in 2009, sought to estimate the potential for expanding CHP by 2020 through net present value-positive investments. McKinsey estimated that the potential exists in the United States for an additional 50.4 GW of CHP capacity by 2020, which would avoid an estimated 100 million metric tons of CO_2 emissions per year compared to business as usual. McKinsey found that 70 percent of the potential cost-effective incremental CHP capacity was through large-scale industrial cogeneration systems greater than 50MW.[32]

While CHP results in few GHG emissions, barriers currently limit its application. Utilities often cite safety concerns as a barrier to deployment, particularly a fear of miscommunication between CHP operators and utilities in the event of an emergency, which utilities say could lead to dangerous situations where line workers are not certain whether lines are energized or not. Utilities may also have concerns about liability and risk associated with the interconnection between CHP operations and the grid, as utility employees may be affected by safety and technical decisions of CHP operators made independent of utilities.[33] Like issues of safety, many utilities are concerned about the need to provide backup power to industrial facilities in case CHP systems are taken offline or are otherwise unavailable. For utilities, the ability to provide backup power to these facilities requires investments in capacity, and to pay for this capacity, utilities often charge higher, discriminatory rates and interconnection fees to CHP operators to compensate for these necessary investments.

In addition to these concerns, regulatory and corporate policies have inhibited the growth of CHP capacity. Power sector regulation in many states leads many utilities to view CHP as unprofitable and, accordingly, discourages its use.[34] However, some innovative policy approaches can overcome this problem. One approach is decoupling, which eliminates the connection between utility sales volume and profitability. By doing so, decoupling makes CHP measures profitable to utilities, and, therefore, more likely to gain their support.[35] Another potential policy solution is the implementation of lost-revenue adjustment policy, which compensates utilities for revenues lost because of efficiency measures. It allows utilities to collect a charge from customers to account for efficiency-related revenue losses.[36] Lost-revenue adjustment policies also have the potential to encourage CHP.[37] Other policy options include state incentives designed to encourage the use of CHP. State-level policies include standardizing interconnection guidelines, tax incentives, and inclusion of CHP as a compliance mechanism for clean energy standards.[38] Some states have enacted these policies, but, as with many state-led policies, there is a diversity of approaches to, and success with, implementation.[39]

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