

1. Introduction

1.1 The Chemical Industry

The North American Industry Classification System (NAICS) groups businesses into categories based on their primary activities. NAICS has replaced the older Standard Industry Codes (SIC) to provide a common basis for economic data collection and analysis for the United States, Canada, and Mexico. The chemical industry, which includes all chemicals from commodities (e.g. ethylene and ammonia) to finished products like cosmetics and pharmaceuticals, is part of the manufacturing sector. Its NAICS classification code is 325xxx. The sub-sectors are:

- 3251xx Basic Industrial Chemicals (including ethanol)
- 3252xx Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments
- 3253xx Pesticides, Fertilizers, and Other Agricultural Chemicals
- 3254xx Pharmaceuticals and Medicine
- 3255xx Paints, Coatings, and Adhesives
- 3256xx Soaps, Cleaning Compounds, and Toilet Preparation Chemicals
- 3259xx Other Chemical Products and Preparation Chemicals

An integral part of the U.S. economy since the 17th century, the modern chemical industry produces more than 70,000 diverse products. Indeed, few goods today are manufactured without some involvement with the chemical industry. Nearly 24% of all chemicals produced are used as feedstock in other chemical manufacturing processes, and nearly 30% of the total production yield is purchased as raw materials by the rest of the manufacturing sector.¹

1.2 Economic Impact

Chemical manufacturing is one of the oldest and most important manufacturing sectors in the United States. The industry currently accounts for nearly 5% of the nation's gross domestic product (GDP). Chemical production rates have grown steadily over the previous two decades, setting record sales and shipment numbers in both the 1997 and 2002 economic censuses. Data provided by the federal government's *Advance Report of the 2002 Economic Census* shows that the chemical industry includes 13,098 individual companies with combined sales numbers equaling approximately \$427.3 billion, a workforce of more than 789,000 employees, and an annual payroll of more than \$40.7 billion. Comparison of the 1997 and 2002 economic censuses shows marked increases in several categories, indicating sustainable growth within the industry.

Chemical manufacturing is Iowa's second largest industry, trailing only food processing in total sales. It contributes \$2.88 billion to Iowa's Gross State Product (GSP), which is 10% of the manufacturing GSP. There are approximately 367 chemical manufacturing plants categorized by the NAICS code 325xxx within the state. Approximately 80% of these chemical companies are involved with agricultural fertilizers, pesticides, or other ag-related chemicals. The remaining

¹ U.S. Department of Energy: Office of Industrial Technologies, *Energy and Environmental Profile of the U.S. Chemical Industry*, May 2000.

companies are comprised of a vast segment of manufacturers ranging from paint to pharmaceuticals.

These plants employ over 9,800 people. Figure 1.1 gives a breakdown of chemical industry employment within the state by county.²

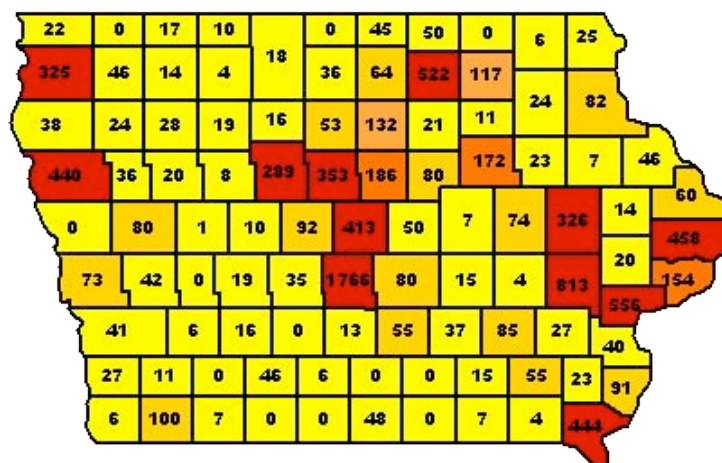


Figure 1.1 Breakdown of Employment by County²

1.3 Energy Consumption

The chemical industry is the second most energy-intensive enterprise in the United States, accounting for over 6500 trillion Btus (Tbtu) of energy use in 2002. This represents one-third of the total industrial energy used in America.³ Over half of the energy consumed by the industry is in the form of feedstock (Figure 1.2). The rest is primarily used to provide heat, cooling, and power to manufacturing processes with only a small amount contributing to building utilities.

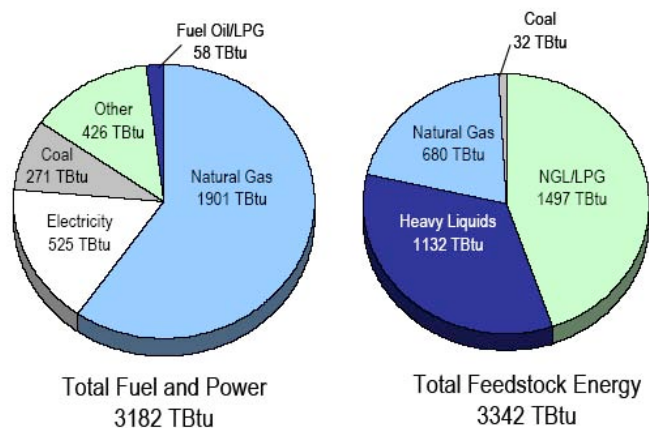


Figure 1.2 Energy Use in the U.S. Chemical Industry⁴

² Center for Industrial Research and Service, Iowa State University, *Chemicals Industry in Iowa*, <http://www.ciras.iastate.edu/industry.asp?i=325>.

³ American Chemistry Council, *Guide to the Business of Chemistry 2003*, Washington D.C., 2003.

⁴ American Chemistry Council, *Guide to the Business of Chemistry 2003*, Washington D.C., 2003.

Chemical processing requires large amounts of energy to convert raw materials into finished products, which makes the industry particularly vulnerable to fluctuations in energy prices. Chemical manufacturing is the largest consumer of natural gas in the United States, requiring more than 10% of the total amount used domestically.⁵ Recent spikes in natural gas pricing have created a hardship for many chemical manufacturing companies; causing temporary shut downs in some regions of the country. The cost of fossil fuel energy sources are projected to continue to increase in the near future, causing further uncertainties in the chemical manufacturing markets.⁶

Energy efficiency has been a focus of chemical manufacturers since the 1970s. However, as Fig. 1.3 illustrates, significant improvements in this area did not come until the early 1990s. It is expected that rising energy costs will motivate the industry to continue refining energy efficiency measures in an effort to control costs and maintain competitiveness. The challenge faced by chemical manufacturers is how best to identify possible sources of improvement and implement changes that can take place quickly, while providing the most benefit with the smallest capital investment.

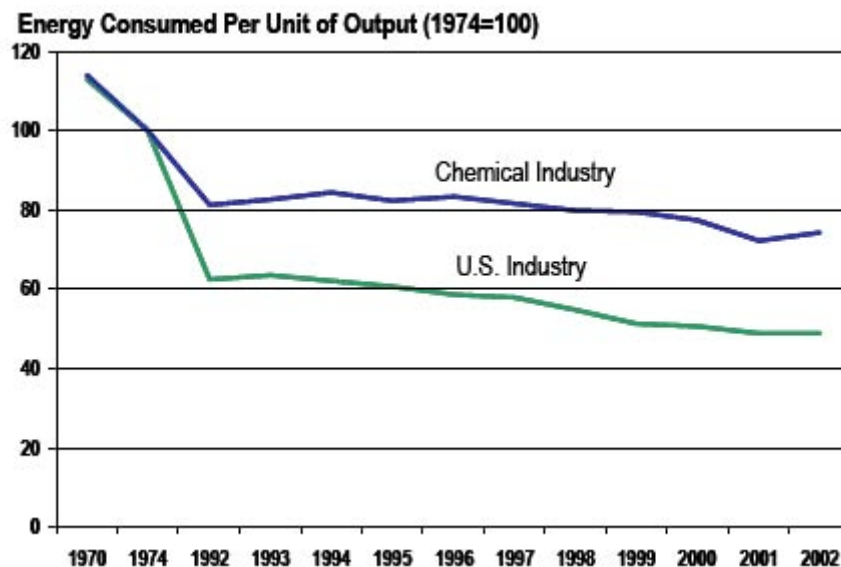


Figure 1.3 Energy Intensity in the U.S. Chemical Industry⁷

1.4 Purpose of Publication

This report serves two purposes: 1) to document the significance of energy management and efficiency to the chemical industry, and 2) to provide best practices for reducing energy consumption that are specific to Iowa's chemical industry. For purposes of this report, a best practice is defined as an activity or procedure that has been effective at conserving energy and

⁵ U.S. Department of Energy: Office of Industrial Technologies, *Energy and Environmental Profile of the U.S. Chemical Industry*, May 2000.

⁶ Brown, R., Chemical Marketing Reporter, *Energy Cost and Demand Issues are Key to Petrochemicals in 2004*, Vol. 265, No. 1, January 5, 2004.

⁷ American Chemistry Council, *Guide to the Business of Chemistry 2003*, Washington D.C., 2003.

could be adapted to improve energy efficiency in other similar situation. Sponsorship from the Iowa Energy Center (IEC) and the Center for Industrial Research and Service (CIRAS) at Iowa State University provided funds to hire consultants to help identify best practices in Iowa's chemical industry and to create this best practices document.

1.5 Best Practices

When analyzing systems for energy efficiency, it is often helpful to consider a systems approach, i.e., an analysis of the supply and demand side of a system and how each side interacts. An example of the supply side of a system would be replacing an oven burner with a more efficient design, thus reducing the natural gas consumed by the oven. An example of the demand side of a system would be improving the mechanical efficiency of a mixing process by changing the shape of the mixing device or by changing the motion of mixing. Thus, reducing the energy consumption per unit of product will save energy.

This publication will identify and discuss best practices from both supply and demand sides of the systems considered. While focusing on the two sides of a system is important, increasing efficiency on one side doesn't necessarily increase overall system efficiency, which is the ultimate goal of energy efficiency projects. The best practices discussed in this report are recommended to increase overall system efficiency, though it is important to understand how it will help a system as a whole.