Figure 2 shows the volume of gas moved through the transportation corridors, as of 1997. Important to note is the "political geography" of the flows. In recent years, Canadian natural gas exports to the United States have become sizable—and soon will be significantly increased, with the opening this month of the new "Alliance Pipeline," a 1,200-mile line from British Columbia to Chicago. Though a welcome addition to infrastructure, the pipeline itself is controlled by the same cartel financial interests usurping natural resources and undercutting the economy. It is significant that no U.S.-Mexico mutual interest infrastructure has been built. In 1982, then-President José López Portillo proposed an oil-for-technology development program between the two nations, but the free-trade circles around then-Vice President George Bush rejected this outright, favoring instead their schemes to deregulate, dominate, and loot—i.e., schemes that went on to become NAFTA.

The Physical Economy of the Natural Gas Industry

by John Hoefle

While the oil and gas industry is dominated by an oligarchic oil cartel and is rife with price-fixing and speculation, beyond these unsavory elements lies a marvel of technology and engineering, able to move large volumes of natural gas from distant fields to the doorsteps of millions of American homes and businesses. Here we take a look at the physical-economic side of this essential infrastructure.

Exploration and Production

The search for natural gas begins with the identification of subterranean rock formations where gas is likely to be found. The gas migrates upward through pores in sedimentary rock; if it reaches the surface, it is dispersed into the atmosphere, but most often the gas is trapped when it hits a layer of impermeable rock. These impermeable layers, usually shaped into domes by folding and faults, are what the geologists look for in their search for oil. The search begins with determining broad areas where traps are likely to be found, then examining potential prospects via seismology. Seismology involves sending energy waves through the Earth, then recording the results when the waves are reflected back to the surface. Because different layers of rock reflect the waves in different manners, geologists can process these reflections through computers to get a fairly good map of the subsurface strata. Another method of mapping underground rock formations involves using magnetometers to measure small changes in the Earth's magnetic field at the surface, which can indicate what types of rock lie below. Magnetometers can be placed in helicopters, planes, and even satellites, allowing wide areas to be surveyed.

Still, the only way to determine if a trap-like formation actually contains gas and/or oil, is to drill a well. Most wells today are drilled by rotary rigs, which use hard-drill bits at the end of long chains of rotating pipe. While the basic principle is old, advances in technology have significantly improved the drilling process, including the monitoring of conditions inside the well and advances in horizontal drilling techniques. There have also been the technologies in offshore drilling, allowing for deeper wells and a greater number of wells per drilling platform.

Once a gas-bearing formation is located, it must be tested to see if it is viable for commercial production. How big is the field, and what is the most efficient production rate? Is there oil mixed with the gas, and if so, of what viscosity? Does the gas flow freely out of the well, or must it be pumped out? The answers to these questions help determine whether the field should be put into production.

Processing and Transmission

For gas to have commercial value, it must be transported from the production wellhead to the homes, businesses, and industrial plants where it will be burned. Nearly all of the natural gas produced in North America is transported by pipeline, and the gas must be processed to remove oil and other more valuable hydrocarbons, as well as diluents such as water and helium and contaminants such as hydrogen sulfide. From the wellhead, the gas is piped into a gathering system, which collects gas from many wells in a field and transports it to a central station. A typical large gathering system may involve thousands of miles of gathering lines connecting a hundred or more wells. Total U.S. gathering systems exceed 300,000 miles of pipeline, and there are more than 600 gas-processing plants in operation in the United States.

Once the gas has been gathered and processed, it is ready to be fed into the interstate gas transmission systems operated by the gas transmission companies. These pipelines are generally made of steel, with diameters ranging from 20 inches to 42 inches. The gas is moved through the pipeline at higher pressures, both to reduce the volume of the gas and to provide a pushing force to propel the gas through the pipe. In order to maintain the pressure in the line, compressor stations are inserted into the pipeline every 100 miles or so. As of 1998, there were 85 interstate pipeline companies in the United States, with more than 200,000 miles of pipeline; there were also more than 200 smaller intrastate pipeline systems. Many of the pipelines pass through hubs, the best-known of which is the Henry Hub in Louisiana. During the 1990s, the number of hubs expanded, as the hubs were transformed into "market centers" where gas could be sold, traded, and temporarily

stored. Today, there are 38 such market centers in operation in the United States and Canada.

Storage and Distribution

When natural gas reaches its destination from a pipeline, it is often stored before it is distributed to the end-user. Storage facilities allow the gas utilities to stockpile gas during warmer weather, in preparation for the surge in demand during the Winter. There are more than 400 underground storage sites in the United States and Canada. These storage sites are of three main types: depleted reservoirs in oil and/or gas fields, aquifers, and salt caverns. Each type of site has its own advantages and disadvantages, but all are able to retain injected gas, and allow that gas to be retrieved when needed.

The last phase of the natural gas system is the distribution of the gas to the end-user, be it a residence, a business, or an industrial facility. This gas is also delivered via pipeline networks, which run from the local gas companies to each customer.

In some cases, it is not feasible to move gas by pipeline. The cost of building a pipeline to move gas produced in Indonesia to market in Europe, for example, is prohibitive. In such cases, the gas is liquefied, which reduces its volume to about one-sixhundredth of its gaseous state. This is expensive, since the temperature must be reduced to below the gas's boiling point of –259°F, and maintained at that level during transport, but the cost is more than offset by the lowered volume per unit of gas.

The Major Natural Gas Transmission Companies

In 1997, fourteen companies controlled more than 85% of the interstate natural gas transmission activity, according to the Energy Information Agency of the U.S. Department of Energy. These 14 companies were: Coastal Corp.; Columbia Energy Group; Consolidated Natural Gas; Duke Energy Corp.; El Paso Energy; Enron Corp; KN Energy Corp.; MDU Resources Group; Northern States Power Co.; PG&E Corp.; Reliant Energy Corp.; Questar Corp.; Sonat Corp.; and the Williams Companies.

Since that time there has been a flurry of merger and acquisition activity in the sector: El Paso Energy bought Sonat, and is in the process of acquiring Coastal Corp.; Dominion Resources bought Consolidated Natural Gas; Duke Energy sold two of its pipeline systems to CMS Energy, which was then bought by NiSource; and Northern States Power and New Century Energy are merging to form Xcel Energy.

Below, we profile the larger of these interstate natural gas transporters.

Duke Energy
Charlotte, North Carolina

Duke Energy assumed its current form with the 1997 acquisition by Carolina electric utility Duke Power of Houston-based PanEnergy. Duke Power traces its roots back to the 1899 founding of the Catawba Power Co., which by 1905 had become the Southern Power Co. In 1910, James "Buck" Duke, of the Duke family which formed American Tobacco Co., the W. Duke and Sons tobacco empire and Duke University, became president; in 1913, Duke formed the Southern Public Utility Co. to buy various regional gas, water, and electric utilities. In 1917, Duke established Wateree Electric, which was renamed Duke Power Co. in 1924; by 1935, Duke Power owned all the properties formerly held by Southern. When Buck Duke died in 1925, some 85% of the company's stock was owned by the Duke family, the Doris Duke Trust and Duke Endowment; the family's interest was reduced to 15% after the company was listed on the New York Stock Exchange. In 1997, Duke Power acquired PanEnergy of Houston, and changed its name to Duke Energy.

PanEnergy began in 1929 as Interstate Pipeline Co., which was renamed Panhandle Eastern Pipeline Co. in 1930; in 1931, it completed its first pipeline, which by 1939 ran from the Texas Panhandle to eastern Illinois. In 1951, the company began its second major pipeline system, the Trunkline Gas Co., linking the Gulf Coast to the company's eastern Illinois system. In 1959, Panhandle Eastern bought Anadarko Production Co., an oil and gas exploration firm, and by the end of 1969 the combined Panhandle-Trunkline system supplied natural gas to 12 states and Canada. The company changed its name to Panhandle Eastern Corp. in 1981, and spun off Anadarko in 1986. In 1989, the company bought another Houston-based pipeline company, Texas Eastern Corp., for $3.2 billion. Texas Eastern was founded in 1947 to operate a pipeline from the Gulf Coast to the Eastern Seaboard.

Duke Energy's board includes, among others: chairman, president, and CEO Richard Priory; First Union director Robert J. Brown; Sprint Corp. chairman William T. Esrey, who is also a director of Exxon Mobil; retired American General insurance chairman Harold Hook, who is also a director of Chase Manhattan Corp.; and Duke Endowment trustee Russell M. Robinson, II.

El Paso Energy
Houston, Texas

El Paso traces its roots to 1928, when Houston attorney Paul Kayser started the company as El Paso Natural Gas and obtained the rights to sell gas to El Paso, Texas. The company built a pipeline from gas fields in New Mexico to El Paso, then expanded those pipelines westward to Arizona and eventually