I

GETTING STARTED IN ENERGY

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ENERGY BASICS

Switch on a light. Heat your home. Drive to work. Power on your computer. Unless you live your entire life in a handcrafted tent in the wilderness, you can't escape using some Energy sector by-product. Just living your everyday life benefits the firms who explore, find, extract, refine, and deliver energy in all its forms to homes and businesses. And naturally, you also benefit from consuming energy on demand. So how can your portfolio benefit too?

In the first part of this book, we hope to provide all the basics necessary to understand how the Energy sector operates, what types of firms make up the sector, and the driving forces behind the sector—oil and natural gas prices. Successfully investing in Energy companies does not require a PhD in geology. What is important is a firm grasp of the laws of supply and demand, and understanding what drives the earnings and stock prices of Energy companies.

This chapter covers the basics of the Energy sector, including a primer on how oil and natural gas are found and extracted, some basic definitions, and some commonly used (but esoteric nonetheless!) terms. Don't worry if some things appear murky to start. On its face, Energy seems like a highly intricate and complex sector. And make

no mistake: It can be! But the basics are really quite simple. It comes down to exploring for and extracting raw energy materials from the earth, transporting them around the world, refining them into usable petroleum or other products, and selling them for mass consumption. Some companies do just one or two of those things, while others do them all.

OIL & GAS INDUSTRY

The easiest way to think about the Energy sector is by breaking it into its two main industries: Oil, Gas & Consumable Fuels and Energy Equipment & Services. The former is what most people think of as Energy—the Exxons, Chevrons, and other megasize firms that explore for and produce oil and natural gas. The Equipment & Services industry assists the Oil & Gas industry with this process. Let's start with the Oil & Gas industry and its main function—the *integrated process*.

The Integrated Process

Companies engaging in the exploration, production, delivery, refining, and marketing of petroleum products to consumers are all part of the integrated process. Its three main segments are *upstream, midstream*, and *downstream*:

- **Upstream**: exploration—searching for hydrocarbons like oil and natural gas; and production—actually taking the resources out of the ground and selling them. Companies like Devon Energy, Anadarko Petroleum, and Apache search the globe for oil and gas reserves.
- **Midstream**: processing, storage, and transportation of hydrocarbons. This includes transporting raw energy materials around the globe via ships, pipes, and other methods. Companies like TransCanada, Williams Companies, and Enbridge own large networks of pipelines that ship a variety of petroleum products.

- **Downstream**: refining oil and natural gas into usable petroleum products for sale to consumers. Companies like Valero Energy, Sunoco, and Tesoro refine crude oil into gasoline and jet fuel.

Well-known giants like Exxon Mobil and Chevron, engaged in all three segments of the energy business, are known as *Integrated Oil & Gas* firms. However, for most integrated oil firms, the upstream part of the business dominates the company's focus and resources because it's typically the most profitable.

And though the *upstream* segment is where the vast majority of profits are made in the Energy sector, with big profits come bigger risks. Therefore, pure upstream firms (also known as *exploration and production*, or E&P) are among the most risk loving in the biz. They spend billions each year on risky explorations and speculative drilling, hoping to find new, big reservoirs of underground energy. More often than not, they come up empty-handed—an undeniable boom-or-bust mentality. E&Ps do business the world over, negotiating with unpredictable (and sometimes unstable) foreign governments. But the risks are worth it—it can mean big revenues for years to come if an E&P firm discovers and develops a huge new petroleum deposit.

The *midstream* segment concentrates on transporting and storing oil, natural gas, and petroleum products. Midstream firms seem boring but are a very necessary part of the integrated process. These firms spend their time moving raw energy materials to the regions of the world where they're needed. This is most often done via pipelines or ships.

The *downstream* segment (also known as *refining and marketing*, or R&M) focuses on the final stage of the integrated process. *Refining* is the process of converting crude oil into usable petroleum products—such as gasoline and diesel—while *marketing* is selling the products to the consumer. Companies operating exclusively in the downstream segment are called *independent refiners*. While most of the major Integrated Oil & Gas firms have branded retail gasoline

stations (e.g., Shell, Exxon, Chevron), downstream operations are often the least profitable part of the business. As we'll explain later, the profit margins for refining and selling petroleum products are usually much, much slimmer than the profit margins for the exploration and production of oil and natural gas.

Together, the upstream, midstream, and downstream segments make up the majority of the Oil & Gas industry, so it's worth exploring each in a bit more detail.

Upstream Basics

An oil rig pumps oil from the Montana ground.
Source: © Getty Images, Inc.

Upstream activities—or E&P—can be the most profitable, but are the most risky and capital-intensive part of the Energy sector. Huge investments can be lost entirely. Conversely, large discoveries of oil deposits can generate revenues for decades to come. Let's review some upstream basics.

Geology, History, and a Bit of Etymology The word *petroleum* is derived from the Latin *petra* (rock) and *oleum* (oil). It's generally

believed oil and natural gas formed from plants and animals that died millions of years ago. These remains were driven deep into the earth over time by layers of silt and sand. This process generated an enormous amount of heat and pressure, converting the organic matter (mainly carbon and hydrogen atoms) into hydrocarbons (oil and natural gas).

Oil is found in sedimentary rock, trapped between layers of nonporous rock. Oil and natural gas deposits are found in a variety of locations around the world—from the flattest, driest deserts to the roughest, coldest mountain terrain to the deepest oceans. In nearly all cases—whether land or sea—it's necessary to drill wells through hundreds or thousands of feet of sand and silt rock.

If a reservoir is found through traditional oil and gas drilling methods, it's considered a *conventional* source. Conventional oil is the least costly to obtain and requires the least effort. Currently, the world is estimated to contain 1.3 trillion barrels of conventional oil reserves and 6,182 trillion cubic feet of natural gas.[1] However, as will be covered more in Chapter 4, this is subject to interpretation.

The first commercial oil wells were drilled in North America in the mid-1800s.[2] The US was considered to have one of the world's largest oil reserves at the time and even exported oil to foreign lands.[3] As recently as the mid-1900s, conventional sources of oil and gas were found in abundance and required relatively little effort and cost to extract.

The main difference between *unconventional* and conventional reserves is the way oil and gas are extracted. Examples of unconventional hydrocarbons include oil shale, oil sands, tight gas, and coal bed methane. While conventional reserves are trapped *between* layers of rock and can be extracted using ground pressure, unconventional reserves like oil sands and shale are trapped *within* rock and sand and are extracted through a mining process requiring enormous amounts of heat and pressure.

Nowadays, many believe the largest, most easily accessible conventional oil and gas deposits in the world are already tapped. As a result, companies must search for oil and gas in increasingly harsh

environments like deep offshore or rugged, remote terrains. The advancement of technology has enabled firms to tap into increasingly remote areas and at greater depths. Moreover, technology and high oil and gas prices may also make it economically viable to tap unconventional hydrocarbons, which were previously too expensive to recover profitably.

Despite the difficult extraction process, unconventional reserves are tremendous: Canadian tar sands are estimated to contain 173 billion barrels of oil,[4] making Canada the second-largest holder of oil reserves behind Saudi Arabia. The oil shale in North America is estimated to contain over 2.6 trillion barrels of oil.[5]

Although tremendous reserves exist within unconventional sources, it remains extremely costly and technically difficult to get them. And while current high oil prices have made unconventional sources more economically viable to extract, it will still be years before they contribute meaningfully to world production. (This issue will be further explored in Chapter 4.)

Extracting Oil and Gas in Six Steps Extracting oil and gas from the ground doesn't happen overnight. Before oil and gas production begins, there are a number of required steps in the upstream process:

1. Acquire the rights to explore for and develop oil and gas from the reserve holder. (A reserve holder is typically the owner[s] of the land a company wants to drill on.)
2. Conduct geological, geophysical, and seismic surveys to find oil and gas deposits.
3. Perform exploration drilling to test for deposits.
4. Conduct appraisal and development drilling to determine if the field contains commercially viable deposits.
5. Begin oil and gas production (or abandon the well if no commercial deposits are found).
6. Ensure payment to compensate reserve holders via royalties and/or *production sharing agreements* (PSAs).

As with most things in life, the lawyers and regulators need their say before anything can happen. A company must first acquire rights to explore for and develop oil and gas reserves from the reserve holder before it can do anything else. This is usually accomplished through the execution of a lease with the landowner.

Leases may differ in terms of duration, royalty payments, and drilling commitments. In some cases, landowners are private individuals, like a farmer with many acres of land. But often, leases are acquired from governments through auctions. For example, the US regularly holds auctions for leases in the Gulf of Mexico—an area known to have tremendous reserves of oil and gas. The highest bidder gets the right to drill.

To find conventional and unconventional oil and gas deposits, geologists use data surveys like seismic imaging and gravitational and magnetic surveys. Seismic imaging technology uses sound waves that bounce off underground rock structures and reveal possible oil and gas formations. The waves locate structural traps where faults or folds in the underground rock have created zones where oil could be trapped. Keep in mind these tests calculate the *probability* of deposits only. An exploratory well is drilled to confirm.

Once a well is confirmed to contain deposits, additional appraisal and development wells are drilled to determine its commercial viability since not all oil and gas deposits will prove to have large enough reserves or sufficient pressure for effective extraction. If a company's analysis shows the deposit does not contain sufficient reserves and pressure, it will abandon the well and try again somewhere else. But if the analysis shows an adequate amount of reserves, the company will install production equipment and start extracting resources. At this point, the focus shifts to reservoir management to assure maximum production over the reservoir's life.

Once production begins, the company typically compensates reserve holders with a share of the revenues. Depending on the region the resources are extracted, this is done via royalties or PSAs.

Royalties and Production Sharing Agreements

Royalties are payments usually calculated as a percentage of revenue from the oil and gas produced on the property. Royalty agreements vary widely depending on the country and whether the property is privately or publicly owned, but they can range between 10 to 50 percent of revenues. Oil and gas royalties are a substantial revenue source for many host governments. For the US, royalty revenues as a percentage of the economy are small (only generating about $10 billion in 2006),* but resource-rich regions like Alberta, Canada, rely on oil and gas royalties for a significant portion of government income.

Production sharing agreements (PSAs) determine the share a private oil and gas company will receive of natural resources extracted from a particular country. An example of a PSA is one requiring a firm to share a portion of net profits after its startup costs have been recouped, but the physical oil and natural gas reserves remain the property of the host government. Others may require joint ventures between the company and the host government's national oil company. Often, the private firm will bear most or all of the risk and cost of exploration and development. This is why it's common for firms to form joint ventures when conducting E&P activities in other countries—it's a way to share the risk and high costs of exploration.

*Minerals Management Service, Minerals Revenue Management, "All Reported Royalty Revenues" (Fiscal Year 2006), (accessed April 9, 2008).

Midstream Basics

Once production begins, companies must somehow transport oil and gas from the field to refineries that process crude oil into petroleum products. This is where the midstream segment comes into play.

The midstream process involves storage and transportation of hydrocarbons. It's essentially the "middle man" between producers and end users. Midstream assets include pipelines and crude tankers delivering oil, natural gas, and petroleum products from their origins to refiners. They also include storage terminals, where natural gas and oil are held until they're ready to be consumed or transported.

The Trans-Alaskan pipeline.
Source: © Getty Images, Inc.

Transportation methods vary depending on hydrocarbon type. Crude oil and most other petroleum products are easily shipped through tankers, pipelines, rail, trucks, or even airplanes. Natural gas poses some transportation problems and is mainly shipped through pipelines. In order to transport it via ships, natural gas must be cooled into a liquid form called *liquefied natural gas* (LNG) and requires special terminals and ships.

Mainstream investors don't typically hear much about this part of the business because it's a relatively small component of the overall Energy sector. While many Integrated Oil & Gas firms own their own midstream assets, there are also many other companies that focus specifically on this part of the business.

Downstream Basics

An oil refinery in operation.
Source: © Getty Images, Inc.

The downstream process includes refining and processing crude oil into petroleum products and managing the retail sale of those products. Crude oil by itself has few direct uses and must be refined to be usable. Refining is the process of breaking crude oil down into its various components, which are then selectively reconfigured into new products like gasoline, diesel, heating oil, propane, and jet fuel. While the majority of petroleum products are for transportation use (cars, airplanes, etc.), other petroleum products are used for industrial activities and everyday items like ink, tires, and even deodorant.

Refineries produce petroleum products based on location and demand. For instance, in California and Texas—two states with high auto usage—refineries mostly make gasoline and diesel. In Hawaii, a chain of islands with a tourism-driven economy, the majority of refineries produce jet fuel. In some developing nations, refineries may produce mainly chemicals for use in industrial activities.

Refineries also vary in the degree of complexity and types of crude they can process and are typically built to process the crude most

What's in a Barrel?

Oil doesn't just fuel your car. Though 75 percent of a typical barrel of oil in the US is used for gasoline, diesel, and jet fuel, oil is refined into many different products.

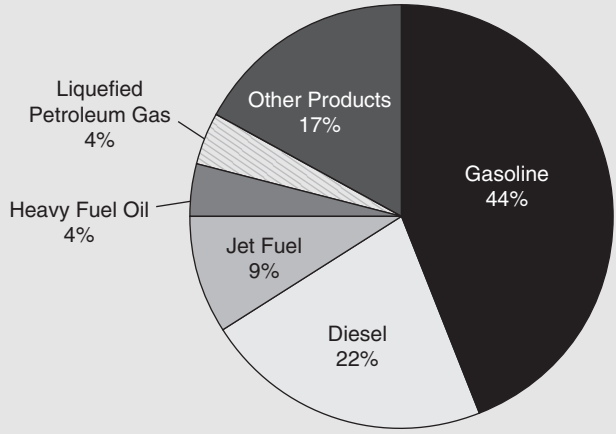

Figure 1.1 Products Made from a Barrel of Crude Oil
Source: Energy Information Administration.

readily available in the region. But since many countries are increasingly reliant on crude oil imports from foreign locations to meet demand, it's becoming vital for refineries to be versatile and process various types of crude.

Differences in Crude Oil Not all crude oil is created equal, and one barrel of crude can differ vastly from another. The differences determine how easily it can be refined. Differences in crude oil are based on density and sulfur content. Common terms used to describe oil include *light, heavy, sour*, and *sweet*.

- **Light versus heavy crude** refers to the density, or weight per volume, of oil, measured as American Petroleum Institute gravity (API gravity), expressed in degrees. The higher the API gravity, the greater the density. For example, the industry defines *light*

crude as having an API gravity higher than 38 degrees, while *heavy crude* has an API gravity below 22 degrees—medium oil is in between.[6] Light crude is more valuable than heavy because it's less expensive to refine and has higher energy content.

- **Sweet versus sour crude** refers to the sulfur content of oil. *Sweet crude* contains relatively little sulfur, while *sour crude* has substantial sulfur. Sweet crude is more valuable than sour because it's easier and less costly to refine.

Combining the two gives us the common descriptions of a barrel of oil: *light sweet* and *heavy sour*. An example of light sweet crude is the popular benchmark West Texas Intermediate (WTI) crude. By contrast, Arab Heavy oil from Saudi Arabia is heavy sour crude.

Marketing & Distribution *Marketing and distribution* refers to the selling of petroleum products to end users (i.e., consumers). The most common and recognizable examples are the thousands of retail gasoline stations across the US and the world selling gasoline and diesel fuel for cars. Many of these stations are independently owned and operated, oftentimes licensing the names of the major oil companies. Others are owned directly by the integrated oil companies or independent refiners.

Gas stations operate by purchasing gasoline from refineries and selling it at a markup to consumers. The retail price of gasoline reflects the entire integrated process: the refiners' cost of crude oil, refinery processing costs, marketing and distribution costs, and finally, the retail station's costs and taxes.

ENERGY EQUIPMENT & SERVICES INDUSTRY

We've covered the basics of the three major segments of the integrated process—the Oil & Gas side of the Energy sector. But Energy has another big component, so let's turn our attention to the firms that assist in getting oil out of the ground.

Energy Equipment & Services firms assist oil and gas firms with exploring, drilling, and producing reserves, but they generally don't

What Makes Up the Price of a US Gallon of Gas?

Ever wonder where your money goes when you fill up your gas tank? With gasoline prices rising steadily in recent years, all those gas station owners must be raking in huge profits, right? Wrong. Most people don't realize gas stations usually make more profit selling chips and sodas than gas to road trippers.

Figure 1.2 breaks down the price of an average gallon of gas in the US. For every dollar of gasoline sold, 71 cents covers crude oil costs, 13 cents goes to taxes, 8 cents covers refining costs, and the remaining 8 cents goes to distribution and marketing (i.e., the gas station). Suddenly, selling gas doesn't appear so profitable.

Think you have it bad? In Europe, taxes generally make up over 50 percent of gasoline costs. This is why Europeans pay so much more for gas than Americans—oftentimes, more than twice as much! Such high taxes leave little petty cash for cupcakes and candy at the mini-mart. What a shame.

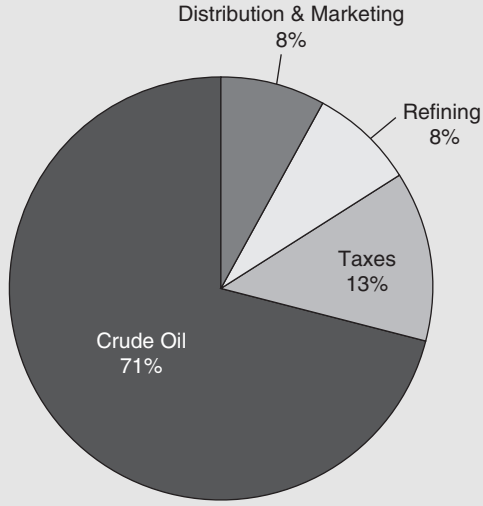

Figure 1.2 What We Pay For in a Gallon of Regular Gasoline

Source: Energy Information Administration.

own oil and gas deposits directly. These firms are hired by pure upstream oil and gas producers and integrated firms like Exxon Mobil to assist in getting hydrocarbons out of the ground. There are two main types: Oil & Gas Drilling and Energy Equipment & Services.

Oil & Gas Drilling

Drilling firms, like Transocean, Diamond Offshore Drilling, and Noble Corp., own the rigs used to explore for and produce hydrocarbon deposits. They rent their rigs to other firms, typically under a short- or long-term contract—usually charging by the day.

Why do upstream firms rent rigs? Due to the cyclical nature of the industry, owning rigs is great during up cycles—but they become extremely expensive pieces of equipment to sit idle during down cycles. Therefore, many producers find it more cost effective to contract drilling companies than to own rigs outright.

There are many different types of rigs, ranging from small service rigs mounted on trucks to enormous rigs installed on ships or offshore platforms. Rigs are mainly classified as either land or offshore rigs. (Drilling rigs are one of the most fascinating parts of the Energy sector and discussed further in Chapter 3.) As a general rule of thumb, the bigger the rig, the deeper it can drill. Rigs can also differ by:

- The commodity it drills for—oil or natural gas
- Its drilling trajectory— vertical, horizontal, or directional
- The type of well it drills—exploration, development, or infill

Oil & Gas Equipment & Services

Oil & Gas Equipment & Services firms like Schlumberger, Halliburton, and Baker Hughes provide all the equipment, services, and expertise required for oil field exploration, development, and production. They range from firms with specialized expertise in particular niches of the industry to total solution providers. While the products and services provided are too numerous to list, some key examples are:

- Drilling equipment: Equipment used for oil and gas drilling, such as drill bits, drilling fluids, mud pumps, drill pipes, and wellhead equipment.
- Pressure pumping services: Services include well cementing and stimulation, used to enhance production from wells.

- Wireline services: Data recording using electronic instruments lowered into wells.
- Directional drilling and measurement: Tools and services assisting in directional drilling and data recording.
- Seismic imaging and analysis: Data and analysis detecting the presence of oil and gas deposits using sound waves.
- Engineering and construction services: Designing, building, and operating massive oil and gas infrastructure such as refineries, LNG plants, rigs, and offshore platforms.
- Helicopters and boats: Transportation services like ferrying workers and equipment to and from offshore rigs.

In short, oil firms rely on Energy Equipment & Services companies in every aspect of the energy cycle.

Chapter Recap

Energy sector basics are fairly straightforward. The majority of firms engage in one (or more) of the three segments of the integrated process (upstream, midstream, or downstream), or they assist the companies in the integrated process. You don't need to be a geologist to understand what drives the earnings and stock prices of the Energy sector—you just need to know what those drivers are (covered in detail in Chapter 2) and have a firm grasp of the laws of supply and demand.

- The Energy Sector consists of the Oil & Gas industry and the Energy Equipment & Services industry.
- The Oil & Gas industry is broken down into upstream, midstream, and downstream segments. Together, they are known as the *integrated process*.
- Upstream is exploration and production, midstream is transportation and storage, and downstream is refining and marketing.
- The Energy Equipment & Services industry provides the Oil & Gas industry with the tools and services to explore for and produce hydrocarbons.
- The Energy Equipment & Services industry is broken down into Oil & Gas Drilling and Oil & Gas Equipment & Services.