PART I

Introduction and Financial Considerations

CHAPTER 1

Historical Perspectives

The energy industry is undergoing unprecedented change as it reacts to new challenges in safety, regulation, exploration, and alternative energy initiatives. One need only layer on the global political environment and the long-ranging repercussions of the 2010 Gulf of Mexico oil spill or the turmoil in the Middle East to realize that the energy sector is as complex as it has ever been. From this increasing complexity springs the need for this book. The following pages present a framework for understanding the basic elements of energy-industry economics. While not covering geology or defining from technical standpoints, this book provides a framework for analyzing the industry's basics and economics, and thereby helps prepare investors and other energy-industry professionals to more confidently venture forth into this vast and complex sector.

This book explores various opportunities available to investors in the energy arena and provides tools to better equip those new and not so new to investing in oil, gas, and alternatively generated energy. Time-tested analytic tools and investment criteria are utilized to provide the reader a better understanding of the economics behind the various energy sectors. Thoughtful and deliberate use of these analytic tools should enable deeper understandings of opportunities and more confident investment decisions. Also, long after the scent of fresh ink and paper have faded, we hope that this book will remain a trusted reference on many facets of commercial energy markets.

Chapter 1 explores some of the issues of the day in energy and places it in a historical context. We also review some of the key issues such as production and reserve growth for oil and gas producers. Cost structures continue to be a key consideration for alternative energy producers as project sponsors grapple with reducing electricity costs to become more competitive with that of fossil fuel producers. Next, we layer in the challenges in the regulatory environment that affect all energy producers. This chapter sets the foundation on which the next 21 chapters will build.

Oil and Gas Producers

A term that is used often in this book is *integrated major* (or major). This term refers to the industry business model of a large, vertically integrated oil and gas producer that has upstream, midstream, and downstream operations. Upstream refers to exploration and production, midstream consists of storage and transport, downstream refers to refining and retail operations. For integrated majors, the road ahead is one marked with significant challenges. In the wake of maturing basins, integrated majors are faced with stable to decreasing crude oil and natural gas production. The majors are also faced with the challenges associated with increasing crude oil and natural gas reserves in an environment where the preponderance of global reserves are controlled by national governments. The era of easy oil has indeed ended and the global oil industry is equally challenged by the development of new forms of alternative energies to meet future energy demand.

For national oil companies, the situation is different, but improving. National oil companies are challenged to extract hydrocarbons in an economical manner while supplying revenues to their governments. Therein lays the dichotomy and challenge. National oil companies are perennially faced with providing for the vast majority of their home country's economic resources. Many small national oil companies face a more precarious position of having to continually depend on high crude oil prices.

Are high crude oil prices a phenomenon of the past? While none of us has a crystal ball, the market consensus is that demand for crude and its refined products is going nowhere but up. Therefore, high crude oil prices have returned with a vengeance. How high is high? Over the near term, triple digit crude prices have returned but may not be sustainable over the longer term. The wild card is global economic recovery and returning crude oil demand from the 34-member Organization for Economic Co-operation and Development (OECD) countries. Currently, emerging market economies of China, India, Brazil, and Indonesia are contributing to the growth in crude and natural gas markets. Moreover, these emerging markets are stabilizing crude oil prices and preventing downward pricing pressure.

The natural gas market is currently in a pricing downturn. However, if we look beyond natural gas prices, we see a natural gas sector poised for future growth. Currently, natural gas inventories remain at relatively high levels contributing to the downward pressure on pricing. Natural gas is quickly becoming the fuel of choice as consumers and industries seek to move to greener solutions. Natural gas is becoming the fuel of choice because it is the *cleaner fuel*.

Moreover, unconventional natural gas shales (described more fully in Chapter 8) in the United States are in an unprecedented boom. Producers are seeking to acquire acreage in the U.S. basins of the Marcellus, Bakken, Eagle Ford, Haynesville, and Barnett Shale unconventional natural gas shale plays. According to the U.S. Department of Energy, growth in the U.S. natural gas market has the

propensity to increase proven U.S. natural gas reserves almost three-fold over the next decade as producers aggressively move to categorize unconventional shale gas deposits as proved reserves (see Chapter 6). At the same time, development of these unconventional natural gas shales will have a weakening effect on natural gas prices as new supply comes on-line. The U.S. Department of Energy and producers believe that demand for natural gas will continue to increase over the next decade because of its attractiveness as a clean-burning and attractively-priced fuel. While natural gas continues to grow in the United States, it is a much quieter story outside of the United States.

Production Perspectives

Integrated majors are looking beyond the once-prolific basins of the North Sea and Cantarell in the Gulf of Mexico, or shallower waters of the Gulf of Mexico. Today, the oil and gas industry is exploring in the Arctic Circle, off the west coast of Africa, and in the deep waters of the South Atlantic. The industry is exploring where the engineering and logistical challenges are significant. The engineering feats necessary to explore, develop, and transport fuels in −20°F (−29°C) are not insignificant.

This doesn't consider the costs associated with drilling in harsh environmental conditions. For novices to energy, exploration and production (E&P) represent the single biggest expense to oil and gas companies. Conversely, the E&P side of the business produces the largest portion of the revenues.

Today, most oil and gas production companies face significant production challenges. As basins mature, the integrated majors are not only left to explore in harsh environments but they are in the midst of stable to declining production profiles. Why is that? Independent oil companies do not own most of the oil and gas reserves on the planet. In most countries, governments own the mineral rights associated with oil or gas deposits. The oil and gas laws and regulations vary with each country.

Safety in Deepwater Drilling

Rig workers perform incredibly dangerous work, often in harsh working conditions. Included in the harsh environment is the practice of deepwater drilling. In April 2010, the Transocean-owned Deepwater Horizon platform exploded in the U.S. Gulf of Mexico killing 11 rig workers. Television news programs broadcast the challenges—reminiscent of NASA spacewalks and planetary rovers—of maneuvering heavy equipment in the 5,000 foot-deep waters of the Gulf of Mexico. The world watched as BP p.l.c. (BP) engineers finally capped and plugged the infamous runaway Macondo well in what became the worst oil spill in U.S. history.

The BP oil spill resulted in numerous countries reviewing safety standards and emergency response systems. There is no doubt that renewed or enhanced safety precautions, standards, and emergency response measures are necessary, particularly in deep water-drilling situations.

One of the oil and gas industry's responses to the BP spill was forming and implementing a collective effort to build a containment system to capture oil spilling in deepwater situations. An ExxonMobil-led consortium was formed to respond to such deep water-drilling emergencies. Consortium members, including Shell, Chevron, and Conoco Philips, each contributed US$250 million to form the joint-venture corporation. We believe that industry-led initiatives aimed at enhancing safety will continue to be put forth.

As authorities continue to sort through the details of this tragic accident, the industry and regulators must take steps to prevent these catastrophes, on behalf of employees, the environment, and regional economies. However, the collateral damage in the industry will be felt for years as sovereigns, municipalities, states, and provinces all over the globe assess deepwater drilling.

One of the most significant repercussions is that of increased regulation of deepwater drilling. Many sovereign nations are reassessing their current safety policies and those of the companies drilling in their waters. Included in this is a review of emergency response systems and the infrastructure necessary to manage a catastrophic drilling event.

Regulators around the globe also have tightened up the process of leasing and permitting new deepwater wells. The U.S. reaction to the oil spill has been to implement a moratorium, shutting down all new deepwater drilling projects. As of this writing, we still do not have an independent assessment of the accident. And while drilling officially reopened in the Gulf of Mexico, to date few drilling permits have been issued.

Many sovereign nations are pursuing deepwater drilling despite the risks. For many countries, deepwater drilling represents economic opportunity and badly needed revenues. By shutting down deepwater drilling, these countries would pay an unacceptable economic price. The best example of this is Brazil. There will be more on Brazil in Chapter 2, Investment Opportunities in Energy.

Importance of Reserves

One of the more significant challenges for an independent oil company (IOC) is growing its reserve base. In Chapter 6, we will review the industry standards for measuring and determining hydrocarbon reserves. Growing the reserve base becomes increasingly complex when one considers that virtually 80 percent of global reserves are owned by state-owned or national oil companies (NOCs). Therein lays the challenge. IOCs must work with NOCs to drill and extract hydrocarbons where sovereign nations own the mineral rights. Several Middle East NOCs are susceptible to geopolitical risk where oil or gas production may be

potentially at risk. In 2011, Middle East turmoil in Libya and Egypt are excellent cases of production disruption and increased geopolitical risk. In Chapter 13, Bidding and Production Rights, we will review some the various oil and gas regulatory structures that exist.

In the oil and gas industry, reserves are often thought of as one of the key metrics. It is, in one regard, the end game. As previously mentioned, integrated majors have the traditional upstream (exploration and production) and downstream (refining and retailing) business model. Depending on the company, there also may be a midstream sector that includes pipeline, transportation, or storage operations. Midstream typically refers to business operations of refined fuels transport and storage. Within the industry, there are companies that are exclusively dedicated to the midstream segment of oil and gas operations.

Reserve growth is increasingly elusive. IOCs seek to work with NOCs, often in geographically challenging areas. Exploration for hydrocarbons is taking place in the deep waters of the South Atlantic and the frigid waters of Greenland and the Arctic Circle. In addition, IOCs are working with NOCs in geopolitically challenging areas around the world. One can easily imagine the challenges associated with working in Nigeria, Iraq, Venezuela, and the South China Sea.

In Chapter 2, we will explore the investments opportunities and challenges associated with countries such as Iraq, Australia, and Brazil. Each of these three countries presents a significant unique opportunity and set of challenges. Drilling opportunities in all three countries are highly sought after by the industry with companies from around the globe participating in the numerous oil and gas concessions that have been established.

Regulatory Environment

Spurred by the disastrous BP oil spill, many countries implemented deepwater drilling regulatory reviews. The explosion resulted in a six-month oil drilling moratorium in the U.S. portion of the Gulf of Mexico and lasting implications for the industry. What will be the ultimate effects?

Regulation has become one of the single biggest risks to the oil and gas industry. Certainly the U.S. oilfield service sector was adversely impacted as (according to U.S. government estimates) 35 drill rigs and thousands of workers were idled in the U.S. Gulf of Mexico. A small number of drill rigs left the Gulf of Mexico for the west coast of Africa and the South Atlantic. While many drill rig operators chose to stay and wait out the moratorium, the ensuing regulatory changes require producers to disclose their emergency response initiatives and safety plans. These are all very necessary, even critical, to both regulators and investors alike who need to assess possible risks.

Countries all over the globe are reevaluating drilling safety procedures and drilling operations. In addition, Australia and many European countries including

Norway began initiatives aimed at reviewing new licenses for deepwater drilling. Norway, however, recently announced that it did not see any reason to impose a moratorium on deepwater drilling.

While many countries share in the concern for deepwater accidents, there are still others that are encouraging deepwater drilling. In addition, many of these countries see deepwater drilling as an economic opportunity and are not willing to unnecessarily curtail deepwater drilling. Brazil is a case in point, where deepwater drilling represents a significant economic boon to its oil and gas infrastructure and has become a decade-long initiative. Part of the Brazilian plan includes growth in its domestic drill rig and related oilfield service sector infrastructure.

Alternative Energy Forms

Alternative energy, in all of its forms, has a bright future. However, many energy analysts, including myself, conclude that the growth in alternative energy will not achieve the scale necessary to significantly reduce reliance on hydrocarbon-based fossil fuels. That said, alternative energy will play an important role in the future global energy matrix and offers investors significant opportunities over the next decade.

This book will explore advances and investment opportunities in wind, solar, nuclear, geothermal, and hydro power. We will also examine new advances in clean coal technology, biofuels, and the rise and fall of the carbon-trading arena. The birth of the carbon-trading arena partially resulted from efforts to reduce emissions among power producers and other major users of fossil fuels and to transfer wealth from developed countries to less industrial countries.

In the near future, progress will be made in solar photovoltaic panels and wind turbine technologies. Currently, solar photovoltaic panels are enjoying resurgence in markets around the globe. Developments of wind farms are slowing as prices for natural gas soften and power generators seek lower-cost alternatives. Both solar photovoltaic panels and wind power projects are susceptible to the loss of government incentives as many nations can no longer afford to sustain subsidies. This book shall assess markets for natural gas, solar energy, and wind farms to uncover opportunities and challenges associated with all energy forms.

Alternative Energy Growth

Green investing has taken on a new level of importance in today's energy matrix. Companies, both large and small, are developing technologies to better utilize natural resources. Some of the most appealing and early investment opportunities

TABLE 1.1 2010 Primary Fuel Source by Region (tonnes of oil equivalent)

Region	Oil	Natural Gas	Coal	Nuclear	Hydro	Total
North America	1025.5	736.6	531.3	212.7	158.3	2664.4
South & Central America	256.0	121.2	22.5	4.7	158.4	562.8
Europe/Eurasia	913.9	952.8	456.4	265.0	182.0	2770.1
Middle East	336.3	311.0	9.2	0	2.4	658.9
Africa	144.2	84.6	107.3	2.7	22.0	360.8
Asia Pacific	1206.2	446.9	2151.6	125.3	217.1	4147.1

Source: BP Statistical Review of World Energy June 2010.

lay with manufacturers of wind turbines and solar photovoltaic panels. In Chapters 18 and 19, we will examine the successes, challenges, and issues surrounding both wind and solar power.

In addition, in Chapters 16 and 17, we will explore new inroads and thinking into today's hydro power and nuclear energy. Nuclear energy, while still decreasing in use around the globe, is coming under increased scrutiny in the wake of the Japan nuclear disaster. Germany recently took steps to reassess use of nuclear energy while other alternative forms gain traction and scale as shown in Table 1.1. However, many countries are still discouraging its use.

Solar Energy

Use of solar photovoltaic cells to produce electricity is growing throughout North America and Europe driven by governmental incentives. Such incentives have been designed to encourage investment and development of solar energy initiatives. Many project organizers are quickly working to secure investment before governments begin to curtail subsidies for solar energy projects.

One of the bigger challenges associated with solar energy is its limited application—it is confined to regions with plentiful sunlight. In addition, lack of storage may be challenging for solar photovoltaic power generators. Concentrated solar-power generation does have storage capabilities, which we will discuss in Chapter 19. Solar is a useful supplemental power source to augment primary grid sources during peak-use hours.

Currently, Germany is making significant inroads into solar photovoltaic cell investments. The challenge in Germany and other countries becomes the relative cheapness of natural gas compared to using solar energy. The relative decline of natural gas costs compared to other energy forms has become a bit of a conundrum in the industry. Nevertheless, solar photovoltaic cell technology is growing and we'll look at opportunities in this venue.

Wind Power

In recent years, wind power has witnessed growth amid the increase in governmental subsidies made available to power generators. Wind farms were beginning to expand in countries like Spain and Germany, but recently are facing increased challenges with the end of subsidies. The advent of the economic slowdown in OECD countries has meant a decrease in governmental subsidies for wind farms. Many generators were relying on these subsidies and today find themselves in a cost structure pinch.

Wind, as an energy form, is not the least expensive energy form. As an energy form, wind power is still more expensive than natural gas on a per-kilowatt-hour basis. However, there should be continued demand for wind farms throughout OECD countries.

Wind farms are also under similar economic pressures that are befalling solar projects. Natural gas has become so inexpensive and U.S. supplies so plentiful that many generators are waiting for the economics to improve before further investing in wind farms. Wind farms are expected to see improved economics over the mid to longer term.

Nuclear Energy

Nuclear energy remains an enigma in the energy industry. After the Three Mile Island nuclear accident in central Pennsylvania, growth of nuclear energy as an energy form was virtually halted. Today, we know that nuclear energy for all of its ills is still very cost effective and one of the least expensive energy forms.

However, building a new nuclear power plant is very costly and taking place virtually nowhere in the world. The United States and France are the biggest users of the energy form. Both countries have decreased use of nuclear-generated electricity in 2009 versus 2008, likely due to the global economic downturn. Russia and Japan have increased usage of electricity generated by nuclear power during this same period. Unlike many OECD members, Russia's economy has been growing in recent years. Japan's increase in nuclear usage indicates that its commercial and industrial sector was in a modest growth mode prior to the March 2011 earthquake. Chapter 17 will address new advances that have been made to improve safety in nuclear energy and examine the economics of nuclear energy and its cost effectiveness.

Coal Energy

While coal supplies are in relative abundance, the coal industry is under tremendous pressure to develop and institutionalize clean-coal technologies. In order to reduce carbon emissions, OECD countries are aggressively taking steps to reduce usage of coal. The United States still remains a significant coal user. Coal usage is decreasing in the U.S. market, albeit in small increments.

However, non-OECD countries such as China and Russia are continuing to utilize coal as a significant part of their energy matrix. Australia is another significant user of coal, but is actively taking steps to decrease usage. Many of the challenges surrounding coal in countries such as China and India are due to lack of existing infrastructure to transport and store the cleaner fuel natural gas. Eventually, that will change and natural gas will become an appealing alternative energy form. Such changes may be a decade away as infrastructure is built.

In the meantime, profitability for coal producers in North America and Europe is beginning to drop as usage decreases. North American and European coal producers are the first to bear the brunt of a shift away from coal to cleaner-burning fuels. The environmental benefits are expected to be considerable as coal-generating emissions decrease.

Hydro Energy

Hydro energy is experiencing resurgence as generators increasingly build environmentally friendlier structures than in prior years. According to the *BP Statistical Review of World Energy June 2010*, China, Brazil and Canada are the biggest users of hydro power today. Hydro power does not work in every country or region. Like nuclear, the costs of building a hydro plant are exorbitant. Partnerships and joint ventures are a fiscal necessity. Municipalities and regulators are increasingly open to hydro power plants when the environmental footprint is smaller and steps taken to lessen the overall environmental impact.

Alternative Energy Incentives

Alternative energy has been given a boost by recent tax incentives in the United States and other OECD countries aimed at increasing investment in alternative forms of energy. Like its hydrocarbon brethren, alternative energies are subject to changing regulation around the globe. Nuclear power continues to be highly regulated for all of the obvious reasons. Since the Three Mile Island incident, appetite for nuclear energy has been lackluster at best. Other notable incidents include the nuclear accident at the Chernobyl Nuclear Power Plant in Ukraine on April 26, 1986 and the failure of four reactors at Japan's Tokyo Electric Power Company in March 2011. Since then, nuclear energy has seen better days. However, 25 years later, nuclear technology has improved despite continuing risks.

While incentives for alternative energy forms have proliferated in the United States and Europe, they are quickly going away. We caution investors to review the subsidy structure for power generators in wind and solar power in particular. The global economic slowdown has resulted in governments curtailing subsidies. This may be temporary, but prepare for a more enduring environment with less governmental support for power generators. Many generators are already in a very

vulnerable position, particularly in Spain where subsidies have already been cut as a consequence of governmental belt tightening.

Energy Investment Cost Considerations

The costs associated with building a nuclear power plant or hydro project have escalated. Today, there is virtually no energy company that would contemplate building or pursuing a major infrastructure project on its own. Consortiums are the order of the day and will continue to be over the long term. While large energy companies tend to have access to the capital markets and considerable financial resources, partnering has become an economic and, to some extent, financial and operational necessity for large-scale infrastructure energy projects.

Refinery upgrading, pipeline building, or alternative energy projects require such considerable financial resources that multiple companies will partner to manage risk and share costs. An example of such a project is the Petrobras's Abreu y Lima refinery in the Brazilian state of Pernambuco in collaboration with Petróleos de Venezuela, S.A. This project has been on the drawing board for years with the projected cost increasing each passing year. Current total project cost estimates are in the US$11 billion range. Would a major energy company contemplate such a project on a stand-alone basis? It's not likely.

Each project is evaluated on a return on investment, return on capital employed, and debt repayment basis by the project owners and investors. Their investment criteria are complex and unique to their own time horizon, due diligence, and risk appetite. We will look at a few project opportunities as examples of how investors may participate.

Concluding Thoughts

Energy is indeed a strategic and economic imperative that warrants the savviest investor's time and attention. Whether stocks, fixed income opportunities, exchange traded funds, or commodity-based funds, energy holds investment promise. In the chapters that follow, we hope to illustrate some of the varied opportunities and provide a basis for further due diligence by both investors and others who have an interest in this complex industry.

This is a technology intensive industry, which only reinforces the importance of private sector investment, and progress is indeed being made. For example, carbon capture and storage holds promise as coal producers have found ways to produce what we refer to as a *cleaner coal*. The carbon capture and storage process can extract contaminants from coal while helping to revitalize mature oil wells. We will review cleaner coal developments in later chapters.

We will also review renewable energy, nuclear energy, geothermal, and hydro forms of electricity production and their potential growth opportunities. There have been considerable technological advances in the nuclear, wind, and solar arenas. An exciting development is that of solar power generation which can now store heat energy for later use. Technological enhancements are taking this industry to places once thought unimaginable. While there have been advances in nuclear technology, we believe that its use as a power source will be set back on the heels of Japan's March 2011 nuclear accident at the Tokyo Electric Power Company's nuclear plant.