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# ENERGY RISK MANAGEMENT

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AN OVERVIEW OF THE  
ENERGY SECTOR  
AND ITS  
PHYSICAL AND FINANCIAL MARKETS



Supported by *energy* **API**



John Wiley & Sons, Inc.



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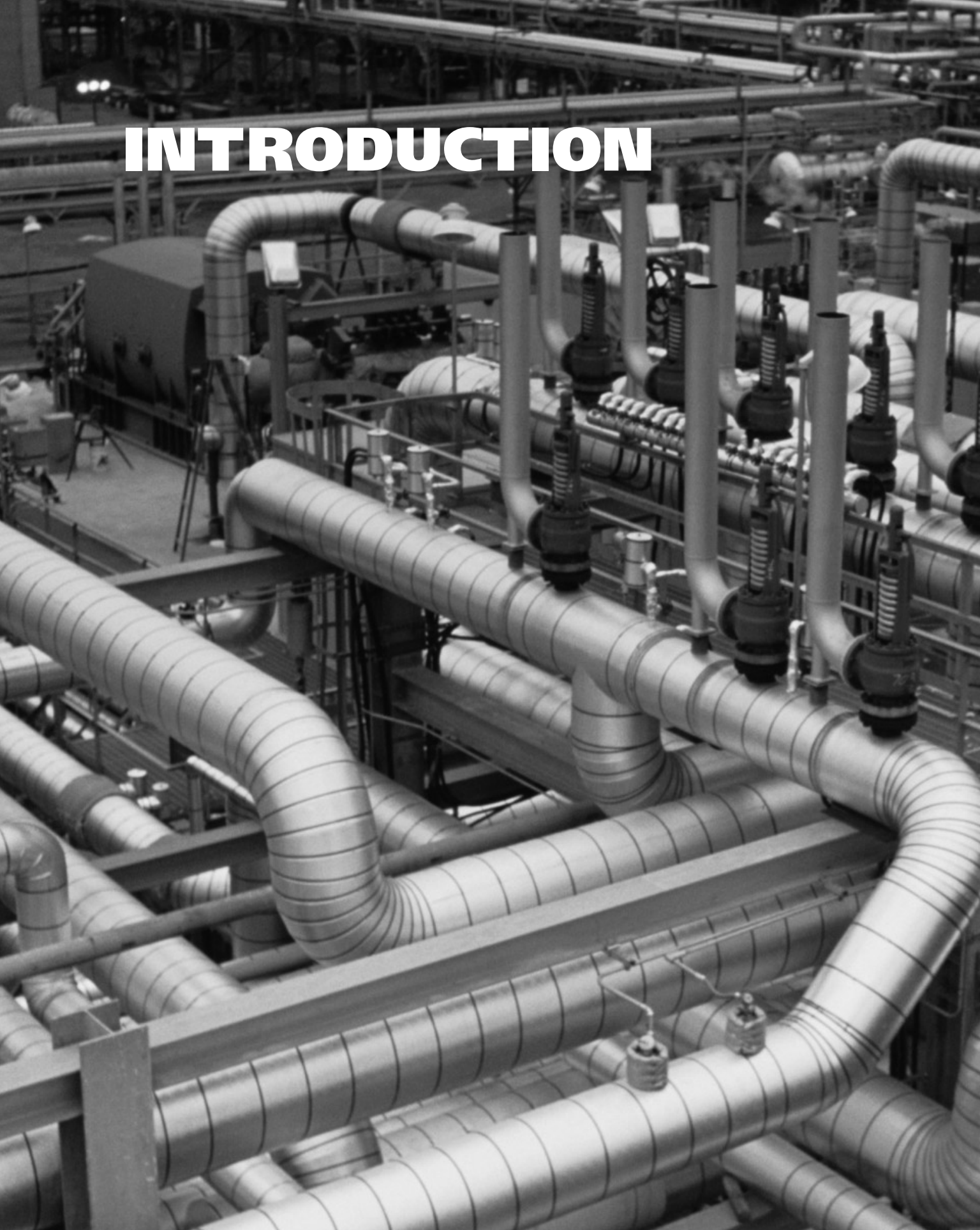
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All statistical data reflect the most up-to-date and available information as of June 2008.

# INTRODUCTION





*In 2006, daily global energy use exceeded 212 million barrels of oil, an increase of 6 million barrels per day compared to 2004. Energy demand is projected to remain very strong well into the future.*

During the period from 2008 to 2030 energy demand is projected to reach 702 QBtus (Quadrillion British Thermal Unit<sup>1</sup>), a 1.8 percent average annual growth rate, based on global economic growth averaging 4.1 percent per year over the same period.<sup>2</sup>

While growth estimates will differ depending on who is making the forecast and the assumptions used, there is unanimous agreement that energy usage will increase dramatically over the coming years. Large-scale investments will be required, and the use of technology will be vital to meet future energy demands.

One result of this growing energy demand is an increasing interdependence among countries driven by their demand for energy. For example, Russia is now a major global supplier of natural gas. Yet until fairly recently, if there had been a disruption in its natural gas supplies, only Russian consumers would have been affected because trading was restricted to within its own borders. However, Russia is now a super-regional supplier of natural gas. Its recently built pipeline allows it to export gas to several European countries, and as a result there is a growing dependence on Russian gas supplies well beyond its borders. While a disruption in Russian natural gas supplies a few years ago would have had only a “local” impact, today it would be felt throughout a large part of Europe.

In the mid to longer term, developing countries such as China and India are expected to drive enormous increases in energy demand and consumption. Demand for energy in non-OECD<sup>3</sup> (Organization for Economic Cooperation and Development) countries is expected to increase an average of 3 percent through 2030, compared with an estimated 1 percent in industrialized countries.

Oil price increases have also had a direct effect both on the demand and production of natural gas and coal. Worldwide natural gas demand is expected to increase by an average of 2 percent per year through 2030, with natural gas consumption rising to 163 trillion cubic feet per year in 2030 from 105 trillion cubic feet in 2006.<sup>4</sup>

Power consumption is expected to more than double by 2030 to 30,364 billion kilowatt hours from 16,424 billion kilowatt hours in 2004. Again, non-OECD countries are expected to drive that growth, averaging 3.9 percent per year.<sup>5</sup>

1. One British thermal unit (Btu) is defined as the amount of energy necessary to raise the temperature of one pound of liquid water by one degree Fahrenheit when the temperature of the water is at 39.1 degrees Fahrenheit (its greatest density). The Btu is the English system of units. The International System of Units uses joules to refer to units of energy. One Btu is equivalent to 1,055 joules, 251.9 calories or 0.0002928 kilowatt-hours. A pound of propane has about 15,000 Btus, a pound of charcoal about 9,000 Btus, and a pound of dry wood about 7,000 Btus.
2. International Energy Outlook 2007, Energy Information Administration, June 2008.
3. OECD Countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States.
4. International Energy Outlook 2007, Energy Information Administration, June 2008.
5. International Energy Outlook 2007, Energy Information Administration, June 2008.

## INTRODUCTION

Although these expectations are estimates, based on a number of varied underlying assumptions, it is clear that the ongoing development of global energy resources will be a key factor in meeting global growth demands. The energy industry is global, rapidly expanding and becoming increasingly interdependent. Energy use is behind virtually everything a person does or touches. In developed countries, the increase in energy consumption indicates a reliance on energy and its related products for continued economic growth and development. At the same time, developing countries are reliant on the development of energy resources to drive their growth.

A global energy trading marketplace has also developed along with the growing worldwide demand for energy. Exchanges around the world are adding new energy trading products at a record pace. Many of these newly launched products help energy companies to offset various risks with each other. Individual energy firms are expanding their energy trading and risk management activities not only to help ensure continued and uninterrupted supplies of energy products for their consumers, but also to protect against economic shocks and political unease in some parts of the world.

Historically, there has been minimal interaction between energy commodities, physically or geographically. While it is natural to consider that the production of oil or natural gas would include certain common business processes, ranging from extracting the commodity from the ground to distributing it to the ultimate customer, the relationships between the various energy products as they moved downstream<sup>6</sup> were not necessarily linked. That has changed with the advent of the Internet, which increased price availability and transparency. Instantaneous global communication, and the ever-increasing demand for energy also contributed to the development of the global commodity trading marketplace.

Because of these changes, a common trading and marketing language to facilitate transactions around the world has become necessary. This requires a comprehensive understanding of the upstream and downstream segments of the industry, the individual energy commodities that make up the energy industry, how they relate to each other and how the industry's participants operate.

In addition, increasingly active shareholders of energy companies are driving the need to focus more stringently on asset valuations, cash flows, earnings measurements and sound control environments to maximize shareholder value.

GARP's Fundamentals in Energy Risk Management is an integral part of GARP's *Certificate in Energy Risk Management* program. This program was developed in response to the needs of the expanding, and increasingly interdependent, global energy marketplace.

6. The terms "downstream" and "upstream" are commonly used in the energy industry. *Upstream* refers to the exploration and production functions in energy as the commodity is extracted from the ground, in the case of crude oil or natural gas. It moves *downstream* to the refineries, distributors, and retail outlets.

## CERTIFICATE IN ENERGY RISK MANAGEMENT

The ability to meet rapidly expanding global energy needs and more vocal shareholder demands will increasingly depend on quality decision making from properly trained employees of energy companies. GARP's *Certificate in Energy Risk Management* is designed to provide these employees—candidates—with a practical understanding of the energy industry and the risks associated with its various products to create a culture of risk awareness among all employees within an energy organization.

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GARP's *Certificate in Energy Risk Management* program has been designed to cover the following commodities:

- crude oil and products
  - natural gas
  - liquefied natural gas
  - power / electricity<sup>7</sup>
  - coal
- 

While other sources of energy such as wind, nuclear and biodiesel are also considered a part of the energy chain, this program focuses on the current primary energy markets. The program may be expanded in the future to include one or more of these other energy sources.

GARP's *Certificate in Energy Risk Management* is intended to familiarize students with the two broad segments of the energy markets, the physical marketplace and the financial or "paper" marketplace. The **physical marketplace** refers to the physical product, such as the crude oil or natural gas taken directly from the ground, or the power generated by utilities around the world. The **financial marketplace** includes the processes and procedures used by firms that trade and hedge commodities as well as the financial instruments—financial derivatives—that are used to trade them. The term "financial derivatives" is commonly used to describe many of the financial products developed for trading or hedging in the energy financial marketplace.

**GARP's Foundations of Energy Risk Management** introduces candidates to the basic components and some of the basic terminology used in the energy industry. This would include the energy cycle, energy use and sources and various risk types. It will also provide an overview of the physical energy products and the financial markets where energy is traded. Further, it will introduce certain risk management fundamentals and real option thinking. After having gained a basic understanding of the energy industry, the candidate will take an assessment exam to ensure he or she has attained a basic understanding of the energy markets.

7. Power and electricity are used interchangeably.

## CERTIFICATE IN ENERGY RISK MANAGEMENT

**Module 1 of GARP's Certificate in Energy Risk Management – The Physical Energy Market**, covers the basics of exploration and production, transportation and storage, and refining and distribution for each of the commodities noted above. The module focuses on the types of companies that deal in these commodities, their business activities and the associated risks they may face. After having gained an understanding of these risks, the candidate will then turn to Module 2 to learn about the instruments used to mitigate these risk exposures.

**Module 2 of GARP's Certificate in Energy Risk Management – Managing Energy Risk**, covers the financial marketplace as well as processes and procedures to mitigate exposures. Energy companies use the financial markets to "hedge," in other words, to reduce or transfer their risk when dealing in a certain commodity. These markets would include the use of such financial derivatives as commodity futures contracts, swaps, options, forward contracts and other structured financial products.

For anyone working in the energy field, it is essential to have an understanding of the physical and financial markets, how they interrelate and what financial risks are involved in the energy business. An inability to identify and address risk-related issues will leave a firm widely exposed, impacting not only its operations and use of capital, but also how it is regarded by shareholders and, increasingly, regulators.

GARP's *Certificate in Energy Risk Management* is not designed to make a person an expert in either the physical energy market or financial energy market. Its purpose is to provide the student with sufficient knowledge so that he or she will be able to, at a minimum, recognize the risks in dealing in either the physical or financial markets, and in some instances be able to proactively address or mitigate those risks. Being able to identify risks at an earlier stage will help prevent issues from arising or possibly lessen the impact they have on a company and its shareholders.

## GARP'S FOUNDATIONS OF ENERGY RISK MANAGEMENT COURSE SPECIFICATION

1. **Title:** Overview of the energy sector and its physical and financial markets
2. **Program of study to which this course contributes:** GARP's Certificate in Energy Risk Management
3. **Intended subject-specific learning outcomes**  
Upon completion of this course, the candidate will be able—at an introductory level—to:
  - (a) Demonstrate an understanding of the components of the energy cycle, how they are connected throughout the energy cycle, and the difference between integrated and specialty energy companies.
  - (b) Demonstrate an understanding of the core risks impacting the different components of the commodity cycle, how these risks relate to each other, and what common risk management tools are available for integrated and specialty companies.
  - (c) Demonstrate knowledge of global energy production and consumption, including geographical and developmental differences.
  - (d) Demonstrate an understanding of the major sources of energy, primary and secondary sources of energy, main geographical production and consumption areas, and main factors driving prices as well as the basic technical fundamentals of power / electricity, including power generation and transmission.
  - (e) Demonstrate an understanding of the physical and financial markets for energy products, the organization of these markets, the difference between spot and futures/forward markets, financial derivatives—forwards, futures, options, and swaps, the difference between speculation, arbitrage and hedging, the risks reduced by hedging as well as risks not impacted by hedging, basis risk, the relationship between physical spot prices and financial futures prices.
  - (f) Demonstrate an understanding of how real options can help decision making throughout the entire energy chain.

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### SYLLABUS AND LEARNING OUTCOMES

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Upon completion of this course, candidates will be expected to demonstrate an understanding of:

|                   |  | Level         |
|-------------------|--|---------------|
| <b>Chapter 1:</b> | The components of the energy cycle                             | Comprehension |
| <b>Chapter 2:</b> | The risks inherent to the energy business and the energy cycle | Comprehension |
| <b>Chapter 3:</b> | The global production and use of different sources of energy   | Comprehension |
| <b>Chapter 4:</b> | The major sources of energy and their markets                  | Comprehension |
| <b>Chapter 5:</b> | The physical and financial energy markets                      | Comprehension |
| <b>Chapter 6:</b> | The use of real options in the energy cycle                    | Comprehension |

## USER GUIDE

This study text has been designed to assist students in preparing for the GARP's *Certificate in Energy Risk Management* program.

The study text contains many technical terms used in the energy industry and energy risk management. Where appropriate, these terms are defined. However, candidates are required to have both a reasonable understanding and some experience in energy commodities. As such, they are expected to know terms commonly used in the energy industry, although it is recognized that some of the terms that may be considered common in one commodity may not necessarily be common in another commodity.

Throughout each chapter you will find examples of actual energy-related events, diagrams or tables aimed at explaining the "science" underlying the production of an energy commodity, the route it takes to reach the ultimate end-user, the risks of dealing in physical energy commodities, and the financial commodity markets. Methodologies used to mitigate or diversify these risks forms a material part of the study text.

At the end of each chapter you will be provided multiple-choice questions to help you prepare for the self-assessment test. The questions test your understanding of the contents in each chapter. It is important that you take the time to answer the questions and compare your answers with those provided in the Appendix. It is also important that you feel comfortable with the material covered in each chapter before proceeding to the next.

**To help highlight important information, we have developed two icons that will appear in the left margin:**



**Definitions of important terms**



**Important points to understand**

This study text also contains a detailed Glossary. We recommend that you refer to it to help you understand the key terms and concepts used throughout the course.

This study text has adopted the standard codes used by international commerce, including exchanges, throughout the world to identify currencies for the purposes of trading, settlement and market prices information. The codes, set by the International Organization for Standardization (ISO), avoid the confusion that could result as many currencies have similar names. For example, the text uses USD for the US dollar, GBP for the British pound, EUR for the euro and JPY for the Japanese yen.

