

普通高等教育规划教材

能源英语 1

Energy English 1

赵明学 杨晓华 周英莉/ 编著



知识产权出版社

全国百佳图书出版单位

普通高等教育规划教材

本书受中国矿业大学（北京）“越崎”系列教材建设资助

能源英语 1

Energy English 1

赵明学 杨晓华 周英莉/编著



知识产权出版社

全国百佳图书出版单位

图书在版编目 (CIP) 数据

能源英语 1/赵明学, 杨晓华, 周英莉编著. —北京: 知识产权出版社, 2016. 8

ISBN 978 - 7 - 5130 - 3110 - 3

I. ①能… II. ①赵… ②杨… ③周… III. ①能源—英语 IV. ①H31

中国版本图书馆 CIP 数据核字 (2014) 第 248497 号

内容提要

本书分为传统能源和新能源两部分。传统能源部分介绍了煤、石油、天然气、水能和核能。传统能源的大规模工业化利用历史较长, 开采、加工、运输、储存和利用技术成熟。但传统能源中除水能外均是不可再生的, 其中煤和石油已带来严重的环境污染。新能源部分介绍了太阳能、风能、生物能、地热能、海洋能和氢能。传统能源带来的能源危机和环境破坏使新能源备受关注, 虽然在全球能源供给总量中的比例很小, 但发展迅速, 尤其是太阳能和风能。

编写此书是为了让学习者了解能源、关注能源、正确看待能源问题, 在建立能源知识构架、掌握相关英语表达的同时, 形成节能意识, 爱护我们赖以生存的地球。

责任编辑: 陈晶晶

责任出版: 孙婷婷

能源英语 1

赵明学 杨晓华 周英莉 编著

出版发行: 知识产权出版社 有限责任公司

社 址: 北京市海淀区西外太平庄 55 号

责编电话: 010 - 82000860 转 8391

发行电话: 010 - 82000860 转 8101/8102

印 刷: 北京中献拓方科技发展有限公司

开 本: 720mm × 960mm 1/16

版 次: 2016 年 8 月第 1 版

字 数: 240 千字

ISBN 978 - 7 - 5130 - 3110 - 3

网 址: <http://www.ipph.cn>

邮 编: 100081

责编邮箱: shiny-chjj@163.com

发行传真: 010 - 82000893/82005070/82000270

经 销: 各大网上书店、新华书店及相关专业书店

印 张: 15.5

印 次: 2016 年 8 月第 1 次印刷

定 价: 45.00 元

出版权专有 侵权必究

如有印装质量问题, 本社负责调换。

Contents

1	Energy Introduction	1
1.1	History of Energy Utilization	1
1.2	Energy Demand	2
1.3	Classification of Energy Sources	4
1.4	Energy and Environment	7
1.4.1	Global Warming	7
1.4.2	Acid Rain	10
1.4.3	Damage to the Ozone Layer	11
1.4.4	Thermal Pollution	11
1.5	Future of Conventional Energy Sources	12
2	Global Conventional Energy Scenario	17
2.1	Global Conventional Energy Reserves	17
2.2	Energy Production	19
2.3	Energy Consumption	21
2.3.1	Global Energy Consumption	21
2.3.2	Energy Consumption in China	23
2.4	China's Sustainable Development Strategy for Its Energy Sectors	25
3	Coal	30
3.1	Formation of Coal	30

3.2	Classification and Uses of Coal	31
3.3	Coal Mining	34
3.3.1	Surface Mining	35
3.3.2	Underground Mining	36
3.4	Delivery of Coal	38
3.5	Storage of Coal	39
3.6	Coal-fired Electricity Generation	39
3.6.1	Overview of Coal-fired Electricity Generation	39
3.6.2	Coal-fired Electricity Generation Technologies	40
3.7	Reserves of Coal	42
3.8	Output and Consumption of Coal	44
3.9	Environmental Impacts of Coal	46
3.9.1	Threats from Coal Mining	46
3.9.2	Threats from Coal Use	47
3.10	Clean Coal Technology to Tackle Environmental Challenges	47
3.10.1	Coal Cleaning	48
3.10.2	Combustion Technologies	48
4	Petroleum	57
4.1	Definition of Petroleum	57
4.2	Formation of Petroleum	58
4.3	Composition of Petroleum	59
4.4	Petroleum Extraction	60
4.5	Petroleum Refining and Its Products	61
4.6	Petroleum Delivery	63
4.7	Storage of Petroleum	64
4.8	Uses of Petroleum	64
4.9	Reserves of Petroleum	65
4.9.1	Global Petroleum Reserves	65
4.9.2	Distribution of Petroleum in China	67

4. 10	Output of Petroleum	67
4. 11	Consumption of Petroleum	68
4. 12	Environmental Impacts of Petroleum	69
5	Natural Gas	74
5. 1	Formation of Natural Gas	74
5. 2	Composition of Natural Gas	74
5. 3	Extraction of Natural Gas	75
5. 4	Processing of Natural Gas	75
5. 5	Delivery of Natural Gas	76
5. 6	Storage of Natural Gas	78
5. 7	Bottlenecks and Development in China's Natural Gas Industry	79
5. 8	Uses of Natural Gas	81
5. 9	Reserves of Natural Gas	83
5. 10	Output of Natural Gas	83
5. 11	Consumption of Natural Gas	83
5. 12	Environmental Impacts of Natural Gas	84
6	Hydro Energy	89
6. 1	Definition of Hydro Energy	89
6. 2	Classification of Hydropower Plants	89
6. 3	Site of Hydropower Plant	93
6. 4	Composition of Hydropower Plant	93
6. 5	Small Hydropower Project	95
6. 6	Reserves and Power Generation Capacity of Hydro Energy Resources	95
6. 6. 1	Global Hydro Energy Resources	95
6. 6. 2	Hydro Energy Resources in China	97
6. 6. 3	Hydropower Projects in China	97
6. 7	Multi-purpose of Hydropower Project	98
6. 8	Environmental Impacts of Hydro Energy	99

7 Nuclear Power	103
7.1 Definition of Nuclear Energy	103
7.2 Classification of Nuclear Energy	104
7.3 Nuclear Fuels	107
7.4 Nuclear Reactors	108
7.4.1 Components of Reactors	108
7.4.2 Types of Nuclear Reactors	110
7.5 Nuclear Power Generation Theory	111
7.6 Nuclear Power Application	112
7.7 Reserves of Nuclear Material	113
7.8 Nuclear Safety	115
7.8.1 Radioactive Effect and Nuclear leakage Accidents in History	115
7.8.2 Nuclear Power or Nuclear Weapon	116
7.8.3 Safety Measures	116
7.9 The Future of Nuclear Power	118
8 Renewable Energy	122
8.1 Overview	122
8.2 History	124
8.3 Renewable Energy Debate	125
9 Bioenergy	128
9.1 Wood Fuels	128
9.2 Biomass for Electricity Generation	131
9.3 Biofuels— Ethanol	134
9.4 Biomass Resources	138
9.5 Summary	143
10 Solar Energy	147
10.1 Solar Radiation Resources	149
10.2 Solar Collectors	151

Contents

10.3	Solar Energy Applications	153
10.4	Solar Photovoltaic Systems (PV)	157
10.5	Solar Thermal Power Plants	160
10.6	Solar Energy Storage Systems	162
10.7	Other Solar Energy Applications	163
10.8	Conclusion and Outlook	164
11	Wind Energy	169
11.1	Wind Energy—Resources and Potential	169
11.2	Types of Modern Wind Turbine	171
11.3	Energy Production	173
11.4	Wind Energy Costs	174
11.5	Wind Farms	175
11.6	Environmental Aspects	176
11.7	Future Developments	178
12	Geothermal Energy	182
12.1	Geothermal Resources	184
12.2	Utilisation	188
12.3	Technologies for Electricity Generation	189
12.4	Electricity Generation	190
12.5	Direct Utilisation	191
12.6	Heat Pump Applications	193
12.7	Environmental Issues	195
12.8	Enhanced Geothermal Systems	197
12.9	New Developments—Drilling for Higher Temperatures	198
13	Ocean Energy	204
13.1	The Tides	204
13.1.1	Harnessing the Energy in the Tides	206
13.1.2	The Future of Tidal Power	213
13.2	Wave	214

13. 2. 1	The Resource	215
13. 2. 2	Wave Energy Technologies	216
13. 2. 3	Environmental Aspects	221
13. 2. 4	The Prospects for Wave Energy	221
13. 2. 5	Conclusions	222
14	Hydrogen Energy	227
14. 1	Hydrogen	227
14. 2	Uses of Hydrogen Energy	228
14. 3	Production of Hydrogen	229
14. 4	Storage of Hydrogen	231
14. 5	Delivery of Hydrogen	233
14. 6	Chinese Policies on Hydrogen and Fuel Cell Technologies; Promoting R&D	234
14. 7	Hydrogen Economy	234
14. 8	Safety Issues of Hydrogen Energy	235
14. 9	Hydrogen and Environment	235

1 Energy Introduction

Any activity requires energy. Human's life will perish without energy to sustain. The amount of energy for a person's survival is 0.5lit. of oil equivalent^①, but the actual amount of individual energy consumption in daily life is 9.3lit. of oil equivalent, ensuring various needs, such as cooking, cooling and heating houses and commuting to work or school.

1.1 History of Energy Utilization

Human's utilization of energy involves three phases—manual and animal labor age, mechanical age and electric age. Initially, human and animals acquired energy through food intake. Manual and animal labor was the approach to accomplishing human beings' activities. Then in 1785 the industrial revolution occurred and a mechanical age started. The invention of the steam engine by James Watt of Scotland symbolized this revolution. Steam replaced manual and animal labor and was widely used in the industry. The appearance of internal combustion engine^② in the late 19th century further accelerated the trend. In 1888, the invention of the commercial induction motor^③ by Nicola Tesla and the commercial availability of electrical power started the new electrical age. Application of machines and electricity accelerated energy requirement. Now energy is so crucial to modern society and human civilization.

① oil equivalent n. phr. 油当量。按标准油的热值计算各种能源量的换算指标, 1 千克油当量的热值, 联合国按 42.62 兆焦 (MJ) 计算。

② internal combustion engine n. phr. 内燃机

③ induction motor n. phr. 感应电动机

In this process, coal started the industrial revolution in Britain and promoted the revolution worldwide. Petroleum laid the foundation for the world economy after the Second World War. It can be said that energy is the basis of economic growth and world development.

Here the importance of petroleum should be mentioned again because it contributed a lot to the development of new energy sources, such as solar energy, wind energy, biomass energy^①, etc. 1973 is a crucial year when the oil shock^② happened and influenced energy security. Before 1973, petroleum powered the world as a secure and cheap fuel and the world economy developed rapidly. In October of that year, Organization of Petrol Exportation Countries^③ (OPEC) put an embargo on oil production and started the oil-pricing control strategy. The oil prices surged four times, causing a severe energy crisis the world over and bringing an end to the era of ample and cheap oil. This energy crisis further incurred global inflation and became an economic crisis. For the first time, developing alternative energy sources became an urgent issue for governments of all countries. The second “oil shock” hit the world in 1979 because of sharp decline of output due to Iran revolution. By the end of 1980, the price of crude oil was 19 times what it had been just ten years earlier. The second oil shock again triggered the governments’ panic of energy crisis. Consequently, more allocation from the governments and research promoted further development of alternative energy sources.

1.2 Energy Demand

Energy is not always affordable or accessible to all. Energy poverty is found in developed and less developed countries, in cities and countryside.

Access to modern energy services is still low in developing countries and this lack of access disproportionately affects the least developed countries (LDCs).

① biomass energy n. phr. 生物质能

② oil shock n. phr. 石油震荡

③ Organization of Petrol Exportation Countries n. phr. 石油输出国组织，成立于1960年。

1 | Energy Introduction

Statistics from the UNDP/WHO^① Report 2009 revealed the large gap between energy demand and energy supply. Three billion people still rely on solid fuels, traditional biomass and coal. Two million deaths annually are associated with the indoor burning of solid fuels in unventilated kitchens. About 44% of these deaths are children; and among adult deaths, 60% are women. Nearly a third of humanity has no access to modern energy services. One and half billion people are still living in darkness. To achieve universal energy access, the global community must take specific and far-reaching measures to massively scale up initiatives to expand access to modern energy services for the poor and un-served. Meanwhile, energy poverty exists even in developed countries. In the cases of the United States and the UK, low income households and households on tenant basis are usually fuel-poor. They have, on average, less efficient houses and the elderly are more likely to be energy-poor.

According to the World Energy Outlook^② 2008, cities consumed two thirds of global energy in 2006. This proportion is expected to grow to almost three quarters by 2030. Substantial energy is required to meet types of energy consumption, such as transport energy consumption, water supply, increasing demand of electricity by high-rise buildings, and higher demand of air-conditioning due to heat island effects in compact cities. Population growth in cities also implies higher absolute energy demand. In rural areas, more people suffer energy poverty. Some energy-poor households find it difficult or impossible to get access to electricity. Others may have access but be unable to afford available energy service to heat their houses in winter to acceptable temperature.

In the report by the United Nations' secretary-general's adversary group in 2010 on Energy and Sustainable Future, two issues were identified as priorities—improving energy access and strengthening energy efficiency. Expanding access to affordable and clean energy is critical for enabling sustainable development across much of the globe. ^[1]

① UNDP/WHO n. abbr. United Nations Development Programme/World Health Organization, 联合国开发计划署/世界卫生组织。

② World Energy Outlook n. phr. 《世界能源展望》，是国际能源署（IEA）发布的年度报告。

1.3 Classification of Energy Sources

Energy sources can be classified in various aspects—origin, method of obtainment, usability^①, long-term availability, property, commercial application and pollution to environment. The contents of the classifications are overlapped to some extent.

1. Based on origin

- (a) Fossil fuel^② energy (from coal, petroleum and natural gas)
- (b) Nuclear energy
- (c) Hydro energy^③
- (d) Solar energy
- (e) Wind energy
- (f) Biomass energy
- (g) Geothermal energy^④
- (h) Ocean energy (from thermal, tide and wave, etc.)
- (i) Hydrogen energy^⑤

2. Based on method of energy obtainment

1) Primary energy sources^⑥ (PESs)

Primary energy is an energy form embodied in nature and still not being subjected to any conversion or transformation process. ^[2] Primary energy sources can be non-renewable or renewable. These energy sources include coal, crude oil, natural gas, solar energy, wind energy, hydro energy, biomass energy, nuclear fuels, etc. These sources are generally in raw forms and generally cannot be used directly. They need processing and conversion to meet the requirement of the users in a usable form.

① usability n. 可用性

② fossil fuel n. phr. 化石燃料

③ hydro energy n. phr. 水能

④ geothermal energy n. phr. 地热能

⑤ hydrogen energy n. phr. 氢能

⑥ primary energy source n. phr. 一次能源

1 | Energy Introduction

2) Secondary energy sources

Secondary energy sources are obtained from primary energy sources and become available to a consumer after processing or transformation. They are high-qualified and easily used. Thus, they are also known as usable energy sources. Secondary energy sources include electricity, steam, hot water, coke, coal gas, hydrogen energy, etc.

3. Based on usability

This kind of classification is based on technological maturity of an energy source.

1) Conventional energy sources^①

Conventional energy sources are traditionally utilized, technically matured, and are widely used in large-scale production, including fossil fuels, hydro energy and nuclear energy.

2) Non-conventional energy sources

Non-conventional energy sources are less developed than conventional energy sources or still in research. They are also known as new energy sources or alternative energy sources^②, including solar energy, wind energy, biomass energy, geothermal energy, ocean energy and hydrogen energy.

4. Based on long-term availability

1) Renewable energy sources

The supply of renewable energy sources is not reduced by human's consumption and renewed by nature. They are hydro energy, solar energy, wind energy, biomass energy, geothermal energy, ocean energy.

2) Non-renewable energy sources

Non-renewable energy sources are finite and their formation requires millions of years, which means they can not get supplement after being consumed and confront the risk of depletion. They are fossil fuels and uranium.

① conventional energy source n. phr. 传统能源, 常规能源

② alternative energy source n. phr. 替代能源

5. Based on properties

1) Energy containing sources^①

This form of energy sources are materials providing energy. They can be stored and transported directly, such as fossil fuels, wood, nuclear fuels, hydrogen, etc.

2) Process energy sources^②

They provide energy in the process of physical movement of materials, such as electricity, hydro energy, wind energy, tidal energy, wave energy, direct solar radiation, etc.

6. Based on commercial application

1) Commercial energy sources

The secondary usable energy sources are classified as commercial energy sources because they are essentially harnessed in commercial activities. Electricity, petrol^③, diesel^④, natural gas, etc. belong to this category.

2) Non-commercial energy sources

Non-commercial energy sources are those collected by individuals in nature and directly used without commercial operation. Wood, animal dung cake, crop residue, etc. are categorized as non-commercial and are typically used in rural areas.

7. Based on pollution to the environment

1) Clean energy sources^⑤

Clean energy sources are less or not contaminative to the environment. Solar energy, hydro energy, ocean energy, hydrogen energy, etc. belong to this form of energy sources.

2) Non-clean energy sources

Energy sources which are contaminative to the nature are known as non-clean energy sources. Coal and petroleum are the representatives of this form.

① energy containing sources n. phr. 含能体能源

② process energy sources n. phr. 过程性能源

③ petrol n. 汽油

④ diesel n. 柴油

⑤ clean energy source n. phr. 清洁能源, 洁净能源

1.4 Energy and Environment

Human's civilization is established on the generation and consumption of energy, while the two activities are accompanied by environmental degradation^①. Conventional energy sources are cheaper, and more convenient to be delivered and stored than non-conventional ones, so they are universally available at present. Such as heat, carbon dioxide, carbon monoxide, nitrogen oxides^②, sulfur oxides, ozone^③ (O_3), heavy metals, particulate matters^④, etc. These pollutants impair the self-cleaning capability of the environment, deteriorate its various recycles, such as water cycle, nitrogen cycle and carbon cycle, and disturb its ecological balance^[3]. In a word, human interference has exceeded natural limits.

1.4.1 Global Warming

Global warming is closely associated with the greenhouse effect^⑤, a physical property of the earth's atmosphere^[4]. Solar radiation at the frequencies of visible radiation (visible light, i. e. short wave) largely passes through the atmosphere to warm the earth's surface, which then emits this energy at the lower frequencies of infrared thermal radiation^⑥ (long wave)^[5] to the space. Greenhouse gases^⑦ (GHGs), including carbon dioxide (CO_2), methane^⑧ (CH_4), nitrous oxide (N_2O)^⑨, ozone, and water vapor, in the atmosphere make it absorb more infrared energy than it re-radiates to the space, resulting in a net warming of the

① environmental degradation n. phr. 环境退化

② nitrogen oxides n. phr. 氮氧化物, 包括 N_2O 、 NO 、 NO_2 、 N_2O_3 等, 造成大气污染的主要是一氧化氮 (NO) 和二氧化氮 (NO_2), 因此环境学中的氮氧化物一般是这二者的总称。

③ ozone n. 臭氧

④ particulate matter n. phr. 颗粒物

⑤ greenhouse effect n. phr. 温室效应

⑥ infrared thermal radiation n. phr. 红外热辐射

⑦ greenhouse gas n. phr. 温室气体

⑧ methane n. 甲烷

⑨ nitrous oxide 氧化亚氮

earth-atmosphere system and rise of surface temperature. This is the “natural greenhouse effect”. The earth’s atmosphere system balances absorption of solar radiation by emission of infrared radiation to the space.^[4] (Fig. 1.1) However, the increased anthropogenic^① energy activities lead to further increase in the concentration^② of greenhouse gases in the atmosphere. Excessively emitted CO₂ is the major contributor of global warming. CO₂ constitutes more than 50% of GHGs. The CO₂ emission from the developed countries accounts for more than 80% of the world total. Meanwhile, manmade matters like chlorofluorocarbons^③ (CFCs), sulfur hexafluoride^④, intensify the damage to the balance of absorption of solar radiation and emission of infrared radiation. As a result, those GHGs trap more infrared radiation in the earth’s surface, leading to the “enhanced greenhouse effect”^⑤.^[6]

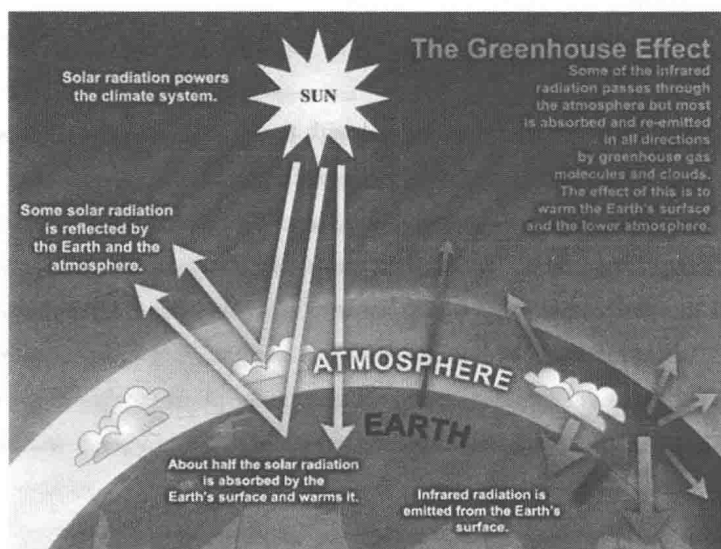


Fig 1.1^[7]

① anthropogenic a. 人为的

② concentration n. 浓度

③ chlorofluorocarbons n. 氟氯烃, 又称氯氟烃, 即氟利昂

④ sulfur hexafluoride n. phr. 六氟化硫, 简称 SF₆。其是法国两位化学家 Moissan 和 Lebeau 于 1900 年合成的人造惰性气体, 当前主要用于电力工业中。

⑤ enhanced greenhouse effect n. phr. 增强温室效应