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Energy Systems and Management

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Energy Systems and Management

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Preface

This book on *Energy Systems and Management* reports selected papers of the International Conference on Energy and Management held during 5–7 June 2014 at Istanbul Bilgi University, Turkey. It was organized by Istanbul Bilgi University Department of Energy Systems Engineering and PALMET Energy to share knowledge on the recent trends, scientific developments, innovations and management methods in energy. Academicians, scientists, researchers and industry specialists studying in the energy field from nine countries contributed through oral and poster presentations.

The book starts with the chapter "An Overview of Energy Technologies for a Sustainable Future", which examines the correlation between population, economy and energy consumption in the past, and reviews the conventional and renewable energy sources as well as the management of them to sustain the ever-growing energy demand in the future. The rest of the chapters are divided into three parts; the first part of the book, "Energy Sources, Technologies and Environment", consists of 12 chapters, which include research on new energy technologies and evaluation of their environmental effects. The second part "Advanced Energy Materials" includes seven chapters devoted to research on material science for new energy technologies. The third part "Energy Management, Economics and Policy" contains ten chapters on planning, controlling and monitoring energy-related processes together with the policies to satisfy the needs of increasing population and growing economy.

This book is designed to provide the reader with an understanding of the current status and the future of energy sources and technologies, as well as their interaction with the environment and the global energy policies. I hope you will find this book useful in energy studies.

I would like to mention that this conference was made possible to celebrate the 100th anniversary of the first Istanbul Electric Power station, the 30th anniversary of PALMET Energy and the first graduates of Energy System Engineering students. I would also like to thank the organizing committee and the scientific committee members for their valuable contributions to the conference. Finally, I express my sincere thanks to Mr. Doğanay Samuray, CEO of PALMET Energy, and his team for their cooperation and full support.

Istanbul, Turkey, November 2014 Prof. Ali Nezihi Bilge

Contents

Chapter 1
An Overview of Energy Technologies for a Sustainable Future

Ayse Nur Esen, Zehra Duzgit, A. Özgür Toy and M. Erdem Günay

Abstract Population and the economic growth are highly correlated with the energy demand. The world population was multiplied by a factor of 1.59 (reaching above 7 billion) from 1980 to 2013, while the total energy consumption of the world was multiplied by 1.84 (getting beyond 155,000 TWh) in the same time interval. Furthermore, the demand for energy is expected to increase even more with an average annual rate of 1.2 % in the near future. However, for the last 30 years, about 85–90 % of the energy demand is supplied by petroleum, natural gas, and coal, even though they are harmful for the environment and estimated to be depleted soon. Hence, building energy policies to satisfy the needs of increasing population and growing economy in a sustainable, reliable, and secure fashion has become quite important. This may involve optimizing the energy supplies, minimizing the environmental costs, promoting the utilization of clean and renewable energy resources and diversifying the type of energy sources. Thus, not only the conventional energy generation technologies must be developed more, but also environmentally friendly alternative energy sources (such as wind, solar, geothermal, hydro, and bio) must become more widespread to sustain the energy needs for the future. However, this requires a significant amount of research on energy technologies and an effective management of the energy sources.

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1.1 Introduction

Energy has become one of the main elements of economic and social development in the modern world, and access to reliable and affordable energy is essential for sustainable development. Energy sources including fossil fuels, renewables, and nuclear, technologies related to the production, conversion, and distribution of energy, and the use of energy such as lighting, heating/cooling, and transportation compose an overall energy system (International Energy Agency 2011a). However, the economic, social, environmental, and policy-related issues raised by unsustainable energy systems lead the search for cleaner and more efficient ways to supply, transform, deliver, and use energy. A well-designed energy system can make a significant contribution to sustainability.

The growth in population has always been one of the key drivers of energy demand: as the world population increases, the demand for energy rises. The world population was about 7.1 billion in 2013, while it was 4.5 billion in 1980, which means that the population was multiplied by 1.59 in such a small time interval (Fig. 1.1). Likewise, the total energy consumption of the world has increased continuously from about 83,000 TWh to almost 155,000 TWh (multiplied by 1.84) in the same years (Fig. 1.2), and it is projected to grow even more at an average annual rate of 1.2 % from 2012 to 2035 (International Energy Agency 2014a). The increase in the world energy consumption is also largely driven by rapid economic growth in the developing countries, which are expected to account for around 90 % of the net increase in the energy demand until the year 2035 (International Energy Agency 2013a).

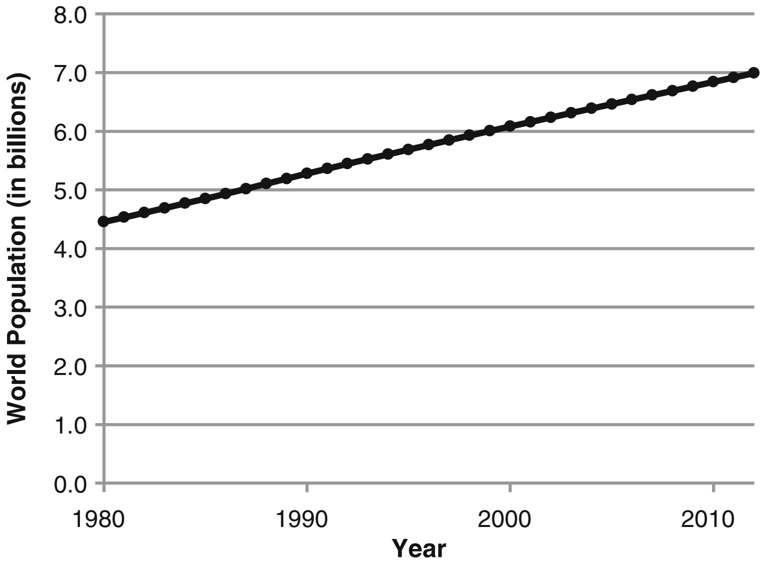

Fig. 1.1 Total world population through years

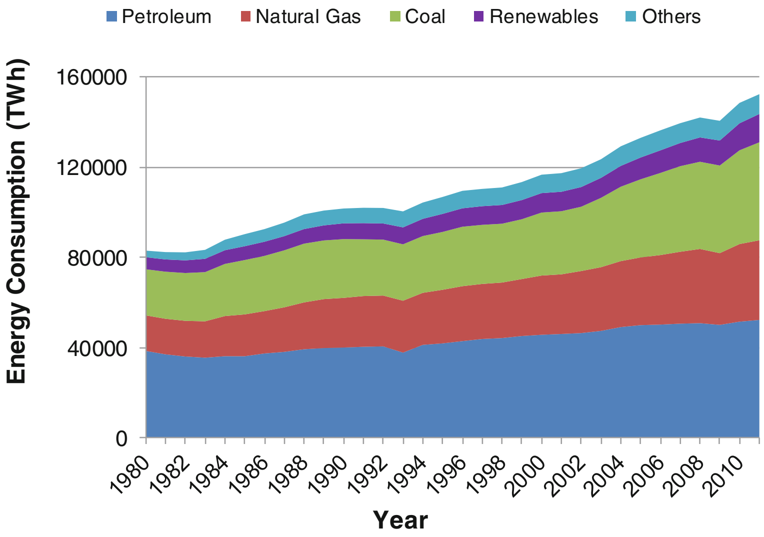

Fig. 1.2 World total energy consumption by different sources through years (US Energy Information Administration 2014)

The energy demand in the world increases year by year, but as indicated by Fig. 1.2, about 85–90 % of this demand is supplied by fossil fuels (petroleum, natural gas, and coal) for the last 30 years, even though they are harmful for the environment and estimated to be depleted soon. Contrary to fossil fuel sources, renewable energy sources, (such as: wind, solar, geothermal, hydro, and bio) employ environmentally friendly technologies, and they can be the alternatives to fossil fuel systems. However, there is only a slight increase in the total share of renewable energy sources in the last 30 years. For example, in the year 2011, the total share of renewable sources was 8.2 %, while it was 6.4 % in the year 1980 (Fig. 1.2), yet this is still not sufficient to substitute for the fossil fuel sources. Thus, not only the conventional energy generation technologies must be developed more, but also renewable energy technologies must become more widespread to sustain the ever-growing energy needs for the future. This requires a significant amount of research on energy technologies and an effective management of the energy sources.

1.2 Energy Sources and Technologies

Energy sources can be separated into three main categories: fossil fuels, nuclear, and renewables. In this section, these energy sources and the related technologies are reviewed briefly.

1.2.1 Fossil Fuels

Petroleum (oil) is the world's leading energy source with the highest share (Fig. 1.2) in the world total primary energy supply (International Energy Agency 2014b). It has a wide range of applications including transportation, industry, residential/ commercial and agricultural use, and electricity generation. The share of transportation was 57 % in global oil use in 2009 and is expected to rise to 60 % by 2035 (Organization of the Petroleum Exporting Countries 2012). Globally, little petroleum is used in electricity production and the use of oil in this sector is projected to decline to 5 % by 2035.

As the cleanest and the most efficient of all fossil fuels, natural gas is making significant contribution to the global energy mix. It is accounted for more than 20 % of world total primary energy supply in the recent years (International Energy Agency 2014b). There are two types of gas-fired power plants, open-cycle gas turbine (OCGT) plants and combined-cycle gas turbine (CCGT) plants. In comparison with coal-fired power plants, CCGT plants offer lower construction costs and emission. Hence, the share of CCGT plants in electricity has been increasing over the past decades.

Shale gas, which is classified as an unconventional source of natural gas, has effectively reshaped the gas industry, especially in the United States (US) (Armor 2013). The USA, China, Argentina, Algeria, Canada, and Mexico account for nearly two-thirds of the assessed, technically recoverable shale gas resources. In 2013, the US Energy Information Administration (EIA) estimated that shale gas resources in 42 countries represent 32 % of the global technically recoverable natural gas resources.

Despite its environmental challenges primarily associated with emissions, coal is still at the center of the global energy system. In 2012, its share in world total primary energy supply reached 29 % (International Energy Agency 2014b). The dominant position of coal in the global energy mix is largely due to its availability in almost every country and relatively low cost. The three types of coal power plants, pulverized coal combustion (PCC), fluidized bed combustion (FBC), and integrated gasification combined cycle (IGCC), are the most widely used ones today. Although PCC power plant causes significant emissions, it dominates the power industry. The efficiency of IGCC power plants is comparable with PCC power plants. They have lower emissions, but the investment costs are high.

The future of fossil fuels depends primarily on the new technologies for better efficiency and environmental performance particularly to eliminate CO_2 and other polluting emissions. In this respect, carbon capturing and sequestration (CCS), which is the process of injection of captured CO_2 to deep underground for permanent storage and sequestration, is a promising technology that could make a significant impact on the emissions from fossil fuels. Although CCS is technically feasible today, it has not been commercially proven on an integrated basis. The high cost of CCS is a major issue like all new low-emission technologies (Davies et al. 2013).

1.2.2 Nuclear

Nuclear energy is one of the alternative energy sources, which uses the heat produced by nuclear fission to generate power. After the first nuclear reactor was commissioned in 1954, today, 437 nuclear power reactors are in operation. The nuclear share in the global power generation in 2011 was estimated at 2,517 TWh, but it slightly decreased to 2,344 TWh at 2012 (U.S. Energy Information Administration 2014). The decline is mostly related to Fukushima Daichii nuclear accident. As explained by Rogner (2013), several nuclear power plants in Japan and in Germany were shut down due to safety concerns following the accident. Nevertheless, some other countries such as Canada, France, and the USA responded the accident with different nuclear policies by introducing safety improvements to their nuclear installations. France still produces 73.3 % of its electricity from nuclear energy. Russia is aiming to supply almost 50 % and India 25 % of their electricity from nuclear energy by 2050. Also, developing countries are continuing their plans to expand nuclear energy. Today, 72 nuclear power reactors are under construction (International Atomic Energy Agency 2014), which demonstrates the renewed global interest in nuclear energy mainly due to its important advantages. Nuclear energy, as a low-carbon and a price-stable energy source, is not subjected to unpredictable fuel costs and has a critical role to fight against climate change (Mari 2014). Most nuclear electricity is generated using the pressurized water reactor (PWR) and the boiling water reactor (BWR) designs, which were developed in the 1950s and improved since. Today, more sophisticated and more efficient types of nuclear power reactors are designed to fulfill the new demands.

1.2.3 Renewables

Renewable energy sources (such as wind, solar, geothermal, hydro, and bio) employ environmentally friendly technologies, and they can be the alternatives to fossil fuel systems. Although the use of renewable sources has become more widespread in electricity generation, heating/cooling, and transportation, there is only a slight increase in the total share of renewable energy sources in the last 30 years (Fig. 1.2). Nevertheless, the number of research studies on renewable energy technologies is increasing exponentially year by year. Some recent review publications together with their brief objectives on renewable energy sources are given in Table 1.1.

1.2.3.1 Bioenergy

Bioenergy refers to renewable energy produced from a variety of biomass to generate electricity, heat, and fuel. Today, it is the largest renewable energy source,

Table 1.1 Recent review publications on alternative energy sources and technologies

Author/Year	Energy source/ technology	Objective
Kralova and Sjöblöm (2010)	Biofuel	Reviews biodiesel sources, oil refining methods, current technologies in biodiesel production
Cheng and Timilsina (2011)	Biofuel	Summarizes the current status of advances in biofuel production technologies and key barriers to their commercial applications
Pereira et al. (2012)	Biomass	Surveys the current applications of biomass gasification technologies
Long et al. (2013)	Biomass	Investigates the biomass sources and estimates their bioenergy potential
Popp et al. (2014)	Biomass	Presents the risks related to availability of land for food crops, energy security, and environment
Raj et al. (2011)	Cogeneration technologies	Points out the present-day cogeneration technologies based on renewable energy sources and their various designs, numerical and simulation models, key development areas, economic and environmental considerations
Viral and Khatod (2012)	Distributed generation (DG) systems	Reviews basics of DG, current status of DG technologies, and their advantages and disadvantages, presents optimizations techniques/methodologies used in optimal planning of DG in distribution systems
Ruiz-Romero et al. (2014)	Distributed generation (DG) systems	Understands the difficulties of integration of DG in electricity distribution network, analyzes the effects of DG on power quality
Akinyele and Rayudu (2014)	Energy storage technologies	Presents current and new energy storage technologies for electrical power applications, discusses technological progress, performance and capital costs assessment of the systems
Mahlia et al. (2014)	Energy storage technologies	Discusses various types of energy storage, compares different types of energy storage, addresses barriers and issues in deploying energy storage system
Zarrouk and Moon (2014)	Geothermal energy	Provides a high-level assessment of the conversion efficiency of geothermal power plants
Bayer et al. (2013)	Geothermal energy	Reviews the potential environmental effects of geothermal power plants during their life cycle
Sternberg (2010)	Hydropower	Addresses hydropower's future, takes attention to environmental impacts of hydropower facilities, presents the technical, political and economic variables to identify the status of hydroprojects
Zimny et al. (2013)	Hydropower	Presents the development of hydropower in the world over the period 1995–2011 on the basis of available international statistical data
Basak et al. (2012)	Microgrid	Presents latest research and development in microgrids

(continued)

Table 1.1 (continued)

Author/Year	Energy source/ technology	Objective
Ellaban et al. (2014)	Renewable energy sources	Presents current status and future projection of major renewable energy sources, as well as their benefits, growth, investment, and deployment, presents the role of power electronics converters as enabling technology for using different renewable energy sources
Panwar et al. (2011)	Renewable energy sources	Overviews applications of major renewable energy gadgets in the scope of CO_2 mitigation for environmental protection
Armor (2013)	Shale gas	Highlights the growing importance and emergence of shale gas as an energy source
Aman et al. (2015)	Solar energy	Presents an overview of solar energy technologies, addresses safety, health, and environmental issues of solar energy systems
Devabhaktuni et al. (2013)	Solar energy	Reviews solar energy technologies, addresses costs of deployment, maintenance, and operation as well as economic policies that promote installation of solar energy systems
Yang and Sun (2013)	Wind energy	Surveys the testing, inspecting, and monitoring technologies for wind turbine blades, discusses development trends, and makes suggestions
Cheng and Zu (2014)	Wind energy	Reviews the wind energy conversion systems (WECS) and technologies, introduces the latest developments and future trends of WECS technologies
Rasuo et al. (2014)	Wind energy	Reviews development of new turbine rotor blades, presents test methods for blade of composite materials

providing 10 % of world total primary energy supply (International Energy Agency 2014b). According to Directive 2009/28/EC (2009), biomass resources are classified as the products, waste, and residues from agriculture, forestry, and related industries, as well as the biodegradable fraction of industrial and municipal waste. Heat production by the direct combustion of biomass is the leading application throughout the world. Numerous conversion technologies to convert biomass into heat and electricity already exist. Biomass can also be converted to liquid or gas biofuels. Bioethanol and biodiesel are the two alternative biofuels to replace petroleum and diesel fuels used in transport (Kralova and Sjöblom, 2010). Conventional biofuel technologies such as sugar-based ethanol and oil-crop-based biodiesel are in use on commercial scale. Advanced biofuel technologies such as bioethanol from lignocellulosic materials and biodiesel from microalgae are still in progress (Cheng and Timilsina 2011). Besides liquid biofuels, biomass gasification for heat and electricity generation as well as hydrogen and ethanol production has been applied widely (Perreira et al. 2012). The main challenge in commercialization of advanced biofuel is their high production costs. The further development of bioenergy can be estimated through studies done in global and in local scale. Long et al. (2013) and Popp et al. (2014) reviewed the existing researches about potential of bioenergy (Table 1.1). Both studies pointed out that there are differences among estimations due to methodologies, assumptions, and datasets. Estimates of global primary bioenergy potential are in the range of 30–1500 EJ/year by 2050.

1.2.3.2 Geothermal Energy

Geothermal energy, defined as the thermal energy generated and stored in the earth, can be used for electricity production, for direct heating purposes and for efficient home heating and cooling through geothermal heat pumps. The main geothermal power plant types are dry steam, flash steam, and binary cycle. They differ in the temperatures and pressures of reservoir. In addition to conventional technologies, projects to commercialize enhanced geothermal system (EGS) and man-made reservoir created where there is hot rock but insufficient or little natural permeability or fluid saturation are in development. Geothermal power plants release large quantities of waste heat due to the lower conversion efficiency than other conventional thermal power plants (Bayer et al. 2013). Zarrouk and Moon (2014) analyzed the conversion efficiency of geothermal power plants based on the data from 94 geothermal power plants worldwide and calculated the average conversion efficiency around 12 % (Table 1.1).

1.2.3.3 Hydropower

Hydropower harnesses the energy of moving water for electricity. There are three main hydropower technologies: run of river, reservoir, and pumped storage. Depending on the hydrology and topography of watershed, hydropower plants vary from small to large in terms of scale. Pumped-storage system, where pump turbines transfer water from bottom to upper reservoir during off-peak hours to be used later, is a practical approach to enhance the hydropower and currently accounts for 99 % of on-grid electricity storage. The vast majority of pumped-storage systems are currently found in Europe, Asia (Japan in particular), and the USA. Hydropower plants play a strategic role in regional geopolitics since water management is one of the greatest global challenges (Sternberg 2010). A detailed review on development of hydropower in the world was presented by Zimny et al. (2013) (Table 1.1).

1.2.3.4 Solar Energy

Solar energy is the most abundant energy source available; however, it represents a small share in the world's current energy mix. Solar photovoltaic (PV), solar thermal electricity (STE), and solar heating/cooling are well-established solar technologies (International Energy Agency 2011b). PV systems directly convert sunlight into electricity. Crystalline silicon and thin-film solar panels are current commercial PV technologies, the first of these dominate solar industry. Thin-film modules can be made flexible and produced in various sizes, shapes, and colors. The main thin films are made of amorphous silicon (a-Si), cadmium telluride (CdTe), copper indium diselenide (CIS), and copper indium gallium diselenide (CIGS), which receives considerable commercial attention among them. Today, STE exists only as concentrating solar power (CSP) plants in arid and semi-arid regions. CSP plants use mirrors to focus sunlight onto a receiver, which heats a transfer fluid to generate electricity through conventional steam turbines. The four types of CSP plants are parabolic trough, fresnel reflector, solar tower, and solar dish. The parabolic trough system is the most commercially available technology. Non-concentrating solar collectors, flat plate or evacuated tube, capture solar energy as heat for heating and cooling purposes. Devabhaktuni et al. (2013) evaluated the global situation and challenges of solar energy systems. It is emphasized that the solar electricity cost is higher than the other renewable technologies; however, it is expected to decline due to advances in technology.

1.2.3.5 Wind Energy

Wind energy is widely available throughout the world. Wind turbines can be located onshore or offshore. Today, the majority of wind power is still generated in onshore wind farms. Due to higher and more consistent wind speeds at sea, offshore wind turbines can harness more frequent and powerful winds than onshore wind turbines; however, the capital costs as well as the technical challenges are higher than onshore. The main parts of a wind turbine are base, tower, nacelle, and blades. Blades are the most critical component among them. The energy conversion efficiency increases with larger blades; therefore, today, blade diameter ranges from 20 m to 100 m. In order to extend life cycle of blades and minimize the operation risks, proper testing, inspecting, and monitoring must be applied (Yang and Sun 2013). Several wind energy conversion technologies have been developed to reduce cost, and to enhance efficiency and reliability. Cheng and Zhu (2014) presented a review on the common types and future trends of wind energy conversion systems (WECS) (Table 1.1). The variable-speed wind turbines with three blades are currently the most popular of WECS. As pointed out by Rašuo et al. (2014), wind turbine construction requires an extensive collaboration of materials and manufacturing techniques. Much development of existing composite material components is ongoing in respect of innovative wind turbines.

A wide range of renewable energy sources and technologies have been used for heat and electricity generation. The advantages and disadvantages as well as current status and future prospects of renewable energy sources and technologies were summarized by Ellaban et al. (2014). One of the most promising commercially available technologies is cogeneration, which produces electrical and thermal energy from the same primary energy source with a higher efficiency. Several renewable technologies can be operated in cogeneration mode, which can accelerate the integration of renewable energy technologies (Raj et al. 2011).

In the near future, a further increase in the renewable share of the global electricity mix is expected. Renewable sources generate power only intermittently and with variable output. Thus, electrical power systems face with difficulties when integrating renewable sources into the power grids. Grid systems require smart, efficient power transmission and distribution networks. In that respect energy storage, distributed generation and microgrid technologies have become important in the evolution of electricity markets to increase the smart grid development. Energy storage systems offer possible solutions to meet peak demands, to improve power reliability, and to reduce costs. Akinyele and Rayidu (2014) and Mahlia et al. (2014) presented a comprehensive review on available energy storage systems technologies such as capacitors, flywheel energy storage, superconducting magnetic energy storage, lead–acid batteries, lithium-ion batteries, nickel cadmium batteries, metal–air batteries, compressed-air energy storage, pumped-hydrostorage, thermal energy storage, and high-energy batteries (Table 1.1). Distributed generation (DG), also called on-site generation, is mostly demanded by solar and wind industry to reduce infrastructure costs. A review on DG systems was carried out by Viral and Khatod (2012) and Ruiz-Romero et al. (2014). Microgrids are small-scale power grids to meet local energy demand by ensuring supply control. Basak et al. (2012) presented a literature survey on operation and control techniques, power quality issues, and protection and stability features of microgrids (Table 1.1).

1.3 Energy and Environment

There is an intimate relation between energy and environment. The harvesting, generating, distribution, and use of energy sources have serious impacts on environment in many different ways. No form of energy source is completely “clean”; only some energy sources have smaller impact than others. Before any power plant construction begins, an environmental review may be required to categorize potential environmental effects. Power plants should be designed to minimize the potential effect upon ecological system. Environmental impacts associated with energy involve climate change, destruction of natural ecosystems, and pollution of air, soil, and water.

Over the years, the extensive use of fossil fuels cause the CO_2 emission into the atmosphere, which leads the beginning of global warming. According to “CO_2 Emissions from Fuel Combustion” (International Energy Agency 2013b), global CO_2 emissions were 31.3 $GtCO_2$ in 2011 and coal is accounted for 44 % of it. In recent years, researchers have focused on developing new methods, technologies, and tools to reduce CO_2 emissions. It is projected to reduce CO_2 emissions from coal to 5.7 $GtCO_2$ by 2035 through the use of more efficient power plants, CCS technologies, and other energy sources such as renewables and nuclear.

Renewables are considered as clean energy sources, and optimal use of these resources minimizes environmental impacts. A comprehensive review on the scope of CO_2 emission mitigation through use of solar energy, wind energy, and bioenergy was presented by Panwar et al. (2011). It was pointed out that renewable energy has great potential to reduce CO_2 emissions depending on the use and availability of sources. It is still important, however, to understand the environmental impacts associated with generating power from renewables.

Biomass power plants emit CO_2, NO_x, and small amount of SO_2, but cause less pollution than fossil fuel power plants. The solid waste produced, called ash, must be disposed properly as it contains varying levels of toxic metals depending on the source and area.

The environmental effects of geothermal power plants are related to land use, geological hazards, emissions, wastes, and water use. These effects depend on the type and size of the geothermal power plant. A comprehensive overview of environmental impacts of geothermal power plants was presented by Bayer et al. (2013). Geothermal power plants may cause geological hazards such as induced seismicity and ground deformations. They release larger quantities of waste heat because of lower conversion efficiencies in comparison with other power plant types.

While hydropower does not cause air pollutant emissions, environmental impacts of hydropower can be significant. The extent of the impact depends on the project size. The dam and reservoir may harm the aquatic habitat and the species present.

Environmental impacts of solar panels can be considered in three stages, manufacturing, operation, and decommissioning. The negative impacts of solar energy on environment were reviewed by Aman et al. (2015). During the operation of solar panels, no emissions are released; however, manufacturing process produces some toxic materials and chemicals such as cadmium, lead, and arsenic depending on the composition of panel. Consequently, if used solar panels are decommissioned improperly, they can be environmental threats due to the toxic materials in their compositions.

Wind energy produces no air or water pollution because no fuel is burned to generate electricity. However, improperly installed wind turbines may create soil erosion problems. Wind farms can also have noise impacts, depending on the number of wind turbines on the farm. The most serious environmental impact from wind energy may be bird mortality; several researches on bird mortality were conducted (Zimmerling et al. 2013; Everaert and Stienen 2007). Improvements in wind turbine design and siting helps to reduce these impacts.

Nuclear power plants do not emit greenhouse gases; therefore, nuclear energy can play an important role to reduce the impacts of global warming (van der Zwaan 2013). However, the production of radioactive wastes, spent fuels, and the risk of accidents are still the drawbacks of nuclear energy from environmental perspective.

1.4 Energy Management, Economics, and Policy

Energy is one of the trending topics being discussed by everyday citizens, journalists, academicians, business world, and politicians. Hence, in recent years, due to energy awareness, there has been a greater interest in the issue of energy management, economics, and policies.

Energy management is concerned with the planning, controlling, and monitoring energy-related processes so as to conserve energy resources, protect climate, and save energy-related costs. Energy management is an interdisciplinary approach that includes technical, economic, geopolitical, and political issues regarding the production and consumption of energy and investments, research, and development of energy systems.

Since fossil fuel sources cannot be replenished once depleted and they are the most widely used sources, the shift from non-renewable energy to renewable energy is critical from the viewpoint of energy management. New targets must be set for renewable energy, and these clean energy resources should be promoted both legally and commercially through supports such as discounts, privileges, and subventions.

Each non-renewable or renewable energy resource has its own advantages and disadvantages. In order to generalize, the downside of non-renewable energy resources is that their supply is limited and they cause the release of carbon dioxide and greenhouse gas emissions into atmosphere while burning, which in turn contributes to global warming. The advantage of renewable resources is their unlimited replenishment and cleanness. However, the major obstacle of renewable energy resources is the requirement of high initial investment.

According to Renewables (2014), Global Status Report, EU-wide target for renewable energy is 20 % and Chinese target is 20 % by 2020, where it was 8.5 and 9 % in 2011, respectively. On the other hand, Atiyas et al. (2012) stated that Turkey has introduced the 30 % target for renewables by 2023, the hundredth anniversary of the Republic of Turkey which is said to be an achievable target.

With respect to economics, due to increasing demand in spite of limited supply, market is faced with escalating energy prices. Based on BP Outlook 2035 (2014), industry will continue to remain the dominant source of growth for primary energy consumption and will account for more than half of the growth of energy consumption 2012–2035. Therefore, especially from the viewpoint of industry, cheap energy is necessary, which leads to lower production costs and higher profits.

Increasing population and economic development triggers new energy policies to regulate consumption and demand for energy. The consequences of energy policies affect individuals, companies in private and public sector, and society as a whole. Energy policies address legislation, regulations, incentives, and guidelines regarding energy production, distribution, consumption, conservation, and diversification.

The objective of energy policies is to satisfy needs of increasing population and growing economy in an economic, sustainable, reliable, and secure fashion. Recent energy policies may involve optimizing sustainability of energy supply and environmental costs, promoting the utilization of clean and renewable energy resources, diversifying energy sources, avoiding dependence on energy imports from a single source or country and encouraging investments in power industry.

According to European Environment Agency (2011), increasing energy utilization efficiency and increasing utilization of domestic renewable sources is seen as a key policy for Turkey due to current dependence on scarce sources. According to WWF (2013), for promoting renewable energy development, China sets its national objectives so as to improve energy structure, energy supply diversification, energy security, environmental protection, and sustainable development of the economy and society, whereas India tends to energy security, low-carbon planning, energy availability and access, energy affordability, and energy equity.

In terms of projections for energy demand in near future, based on (Energy Information Administration 2013), more than 85 % of the increase in global energy requirement from 2010 to 2040 is expected to occur among the developing countries outside the Organization for Economic Cooperation and Development (non-OECD), due to strong economic growth and increasing populations, whereas most of the OECD member countries are assumed to be more mature energy consumers, with slower anticipated economic growth and little or no anticipated population growth (Fig. 1.3).

In specific, according to Ernst & Young (2013), as a member of OECD countries, Turkey has seen the fastest growth in energy demand in the OECD in the past two years and demand is expected to double by 2023. This is interpreted as both a challenge and an opportunity such that the challenge is to ensure that supply keeps pace with such rapid future growth and the opportunity is to invest. Hence, anticipated growth in energy sector promises new opportunities locally and globally.

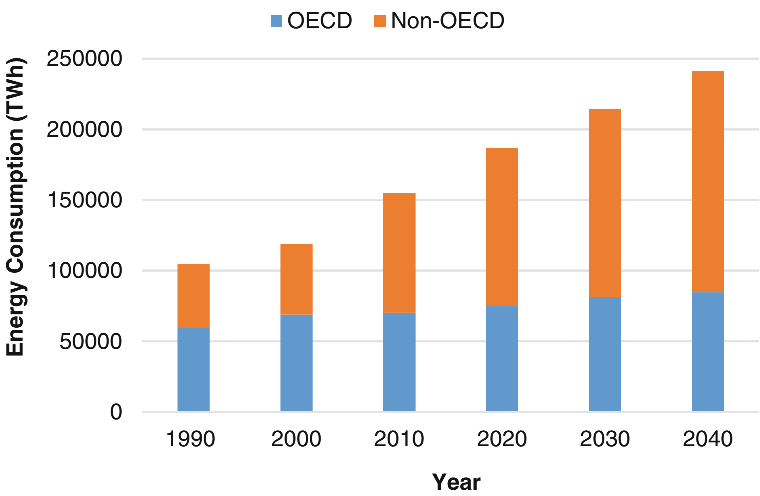

Fig. 1.3 Projection for world total energy consumption (Energy Information Administration 2013)

1.5 Conclusions

In this work, the correlation of the population and the economic growth with the energy demand was analyzed; almost all the energy generation technologies together with their environmental effects were reviewed; and finally, effective methods for the management of energy sources for a sustainable future were examined. It was reported that the population is now more than 7 billion, while the energy demand has reached over 155,000 TWh in the world, both of which are expected to increase even more in the near future. It was found that most of the energy demand is supplied by fossil fuel-related technologies depending on petroleum, natural gas, and coal, even though they are harmful for the environment and estimated to be depleted soon. Renewable energy sources employing environmentally friendly technologies were recommended as the alternatives to fossil fuel systems; however, the use of them was found to be still not sufficient to substitute the fossil fuel sources. To conclude, not only the conventional energy generation technologies must be developed more, but also renewable energy technologies must become more widespread to sustain the ever-growing energy needs for the future.

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Part I
Energy Sources, Technologies and Environment

Chapter 2
Thermal Pollution Caused by Hydropower Plants

Alaeddin Bobat

Abstract Thermal pollution is the change in the water temperatures of lakes, rivers, and oceans caused by man-made structures. These temperature changes may adversely affect aquatic ecosystems especially by contributing to the decline of wildlife populations and habitat destruction. Any practice that affects the equilibrium of an aquatic environment may alter the temperature of that environment and subsequently cause thermal pollution. There may be some positive effects, though, to thermal pollution, including the extension of fishing seasons and rebounding of some wildlife populations. Thermal pollution may come in the form of warm or cold water being dumped into a lake, river, or ocean. Increased sediment build-up in a body of water affects its turbidity or cloudiness and may decrease its depth, both of which may cause a rise in water temperature. Increased sun exposure may also raise water temperature. Dams may change a river habitat into a lake habitat by creating a reservoir (man-made lake) behind the dam. The reservoir water temperature is often colder than the original stream or river. The sources and causes of thermal pollution are varied, which makes it difficult to calculate the extent of the problem. Because the thermal pollution caused by Hydropower Plants (HPPs) may not directly affect human health, it is neglected in general. Therefore, sources and results of thermal pollution in HPPs are ignored in general. This paper aimed to reveal the causes and results of thermal pollution and measures to be taken in HPPs.

2.1 Introduction

Manufacturing is the activity of "**utility creation**" according to economists. Economic output is divided into physical (tangible) goods and intangible services. Consumption of goods and services is assumed to produce utility. Goods are items that can be seen

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and touched, such as a book, a pen, and a folder. Services are provided for consumers by other people, such as doctor, dentist, haircut, and eating out at a restaurant (Zwikael and Smyrk 2011). Services are something completely different from goods. Services are intangible commodities that cannot be touch, felt, tasted, etc. They are the opposite of goods, where goods are something that can be traded for money; services are when you hire a person or someone to do something for you in exchange of money. Services are usually hired or rented; they cannot be owned like goods can. Since it requires people and one cannot legally own a person in today's world, services can only be for hire (Humphreys et al. 2001). In this regard, electric production can be acknowledged as a service output.

All the manufacturing systems that produce utility (goods and services) perform in accordance with inputs-transformation-outputs (ITO) model (Fig. 2.1). The factors of production such as capital, manpower (labour), raw material (land or natural resources), and management (or entrepreneur) constitute the main inputs of this model. These factors are processed in a certain time, and goods and services are obtained as outputs at the end of process. However, efficiency of this production process is less than 100 % because of waste or deficiency (Ely and Wicker 2007). On the other hand, the waste or deficiency may involve significant social, economic, and environmental costs. For instance, the existing wastes can cause the environmental problems in ecosystem.

According to the first law of thermodynamics, energy and matter available in a system or an environment can be transformed (changed from one form to another), and they can disperse around but they can neither be created nor destroyed. The clean-up costs of hazardous waste, for example, may outweigh the benefits of a product that creates it. The same law is acceptable for energy production. Moreover, the hazardous waste, it can be waste heat or thermal pollution/alteration in the energy production, can cause the environmental problems in aquatic ecosystem. Therefore, natural resources or natural systems have been deteriorated or consumed/used ex parte by human in a way.

According to the second law of thermodynamics, every process emits some heat or waste to the environment at the end of process (Toossie 2008). One of the biggest sources of the thermal pollution in water comes from electric power plants where water passes through the condenser and returned to the environment as an altered

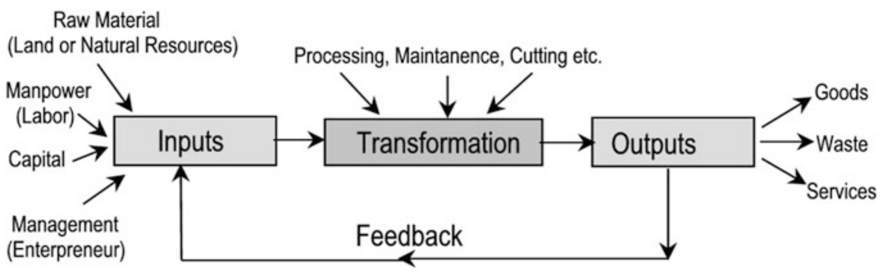

Fig. 2.1 General manufacturing model