



# Objectives and strategies for energy revolution in the context of tackling climate change

HE Jian-Kun

Research Center for Contemporary Management, Tsinghua University, Beijing 100084, China

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## Abstract

Global climate change mitigation and CO<sub>2</sub> emission reduction have promoted the revolutionary transformation in energy system. The core content of energy system revolutionary transformation is to replace the high-carbon energy system dominated by fossil energy with low-carbon energy system dominated by new and renewable energy and finally realize the near-zero emission of CO<sub>2</sub>. The new energy system transformation has also led to a reform in global economic and social development patterns. Developing low-carbon economy becomes the fundamental strategy of sustainable development under climate risk management and the only solution to getting on the road from industrial civilization to ecological civilization. China intends to achieve the peaking of CO<sub>2</sub> emissions around 2030 and increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. Guided by the targets, China directs its economy development to a low-carbon pattern. Therefore, new and renewable power capacity need to reach 1300 GW, and the electricity generated should be 4 times of that in 2013 with a continuous increase rate of 6%–8% around 2030. The pace of energy substitution need to be accelerated and efficient, safe, clean, and low-carbon energy supply and consumption systems should be established besides strengthened energy conservation and improved energy efficient. Therefore, reform need be deepened, favorable policy system and market mechanism for energy revolution and low-carbon development need be established, energy pricing mechanism should be reformed, and national carbon market should be formed to provide a favorable policy and market environment for low-carbon technology innovation and industry development.

**Keywords:** Climate change; Energy revolution; Low-carbon development; CO<sub>2</sub> emission reduction

## 1. Introduction

Climate change is the biggest threat to human today and will jeopardize the ecological security of the Earth and well-being of humans. Since the United Nations Framework Convention on Climate Change (UNFCCC) was established in the United Nations Conference on Environment and

Development in 1992, the world has begun to cooperate on combating climate change. The core of mitigating climate change is reducing greenhouse gas (GHG) emissions by anthropogenic activities, stabilizing the GHG concentration in the atmosphere, and controlling the temperature rise on the Earth's surface to protect the Earth's ecological security and the sustainable development of humans. This controlling and management of natural risks during the development of human society provide a path to realize the harmony of economic and social development and natural and ecological environment protection. The key to realize those objectives is promoting the revolutionary transformation in energy production and consumption, developing and establishing a new efficient and low-carbon energy system dominated by renewable energy, and finally realizing near-zero CO<sub>2</sub> emission so as to free the

E-mail address: [hejk@tsinghua.edu.cn](mailto:hejk@tsinghua.edu.cn).

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development of human society from the limited mineral resources, prevent pollution emission into the Earth's environment and coordinate economic and social development goals and protection of the Earth's ecological environment.

## 2. Energy system revolution driven by global climate change mitigation

The 2009 Copenhagen Climate Conference has reached a consensus to hold the increase in global temperature below 2 °C. The IPCC Fifth Assessment Report released in 2014 emphasized the emission reduction pathway of controlling global temperature rise within 2 °C on a basis of the scientific conclusion that anthropogenic GHG emissions are the main cause of climate change. It is emphasized that the global carbon emissions need to peak around 2020, to decrease by 40% by 2030 which equals the emission level of 2010, to cut by 40%–70% around 2050, and to realize near-zero emission at the end of the 21st century. On the other side according to the emission reduction commitments and development trends of the countries, there is still a 5–10 billion tons of CO<sub>2</sub> emission reduction gap by 2020, and the global emissions will be 30% more than the amount of 2010 by 2030. The temperature rise will then be 3.7–4.8 °C at the end of this century, and will lead to catastrophic consequences to nature and human society (IPCC, 2014). Therefore, it is necessary for all countries to reduce more emissions and the world's economic and social development will face serious challenges of limited emission spaces. The ongoing Durban platform negotiations will reach a new agreement on the post-2020 climate convention framework regarding all countries in the end of 2015. As the situation of climate change mitigation becomes more serious globally, all countries will have to take more ambitious actions on emission reduction.

The core content of climate change mitigation is to reduce GHG emissions, mostly CO<sub>2</sub> emissions in energy consumption. Fossil energy consumption is the main source of GHG emissions and the field of emission reduction which is closely related to economic and social development. Realizing CO<sub>2</sub> emissions control goals while maintaining sustainable economic and social development needs the revolutionary transformation of the energy system, which is two-fold. First, strengthening energy conservation and improving the efficiency and economic benefits of energy utilization technologies to slow down the energy demand growth rate while maintaining economic development. Second, developing new and renewable energies such as hydro, wind, solar, biomass, and nuclear powers, upgrading energy mix and cutting the share of fossil energy such as coal and oil to reduce CO<sub>2</sub> emissions while ensuring energy supply. The two aspects above constitute the goals and the main paths of energy transformation. Finally the sustainable and low-carbon energy system dominated by new and renewable energy will replace the high-carbon energy system dominated by fossil energy, and near-zero CO<sub>2</sub> emission will be achieved.

The urgency of combating climate change globally has accelerated the pace of global energy revolution. Big nations

have implemented new energy strategies and set advanced energy efficiency standards, energy conservation objectives as well as renewable energy development goals. For example, the European Union targets at a 20% increase in the energy efficiency by 2020 compared with 1990 levels. Germany plans to reduce primary energy consumption by 20% and 50% respectively against 1990 levels by 2020 and 2050, and with the continuing economic development, the share of renewable energy would reach 30% and 60% respectively by 2030 and 2050. Therefore the energy consumption related CO<sub>2</sub> emissions would reduce by more than 80%. The U.S. also sets the technology standards for light passenger vehicle to increase the fuel economy by 80% and reduce the CO<sub>2</sub> emissions by more than 40% by 2020 compared with those at present; moreover, commercial and industrial buildings will have a 20% energy efficiency increase by 2020. By 2030, the CO<sub>2</sub> emissions in the present electricity stations in the U.S. would be 30% less than the 2005 level. Currently the GDP growth of developed countries is relatively slow, which enable them to support the continuous economic growth by improving energy efficiency. Besides, their CO<sub>2</sub> emissions tend to decrease continuously due to stable total energy demand and adjustment in energy structure. As for developed countries in Annex II of the UNFCCC, GDP has increased by 5.3% while primary energy consumption decreased by 6.6% and renewable energy supply increased by 20% from 2005 to 2011, resulting in a CO<sub>2</sub> emission reduction by 8.2% (IEA, 2014; BP, 2014). Future economic recovery would possibly accelerate the GDP growth in developed countries, but their total energy consumption will be stable and the CO<sub>2</sub> emissions will keep decreasing. On the other hand, due to rapid industrialization and urbanization, developing countries' total energy demand would continue to increase, leading to the increasing fossil energy consumption and related CO<sub>2</sub> emissions for a long time in spite of rapid renewable energy development. Therefore, it is more difficult for developing countries to decarbonize energy mix compared with developed countries.

Global energy transformation has promoted the innovation and development of low-carbon energy technologies, and advanced energy technologies are now becoming a hot field of international technology competition as well as a reflection of a nation's core competitiveness. Developed countries actively promote energy transformation and reduce CO<sub>2</sub> emissions to increase their industrial low-carbon competitiveness, enhance the diversity of energy mix and decrease dependence on fossil energy as well as secure energy supply. Moreover, taking advantage of the globally low-carbon development trend and their advanced technologies in renewable energy and energy efficiency promotion, developed countries actively enlarge their market in developing countries, seeking new economic growth points and opportunities of benefit, and gaining competition advantage in the world economic and technological competition. Under such a situation, China has to actively take part in the competition, strengthen the R&D (research and development) and accelerate the industrialization of advanced energy technologies, and take control of the core technologies to win the market by utilizing the advantage

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