New challenges faced by the world's energy development and the energy strategy of China

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I. New challenges faced by the world's energy development:

uncertainty and perplexity

1. Slowdown of nuclear power and consequent challenges to the transition of the global energy and economy

The orientation of the world's energy supply structure and its adjustment seemed clear before the Fukushima nuclear accident in Japan. For instance, IEA has taken nuclear power and renewable energy as the direction for energy development in order to realize the low carbon transformation of the global energy economy. Especially, emerging economies should accelerate the development of nuclear power.

Currently, 442 nuclear power units are in service around the world and the generating capacity of nuclear power accounted for around 16% of the total power generation. In 16 countries and regions, more than 20% of total electricity supply is completed by nuclear power. Especially, France has 77% of its total accomplished by nuclear power. The average percentage in European Union is 35%. The number for Japan is 34% while about 20% for the US. China and India are the major pillars for the resurgence of nuclear power among which China has the largest number of nuclear power programs both newly built and being constructed. India takes the second place.

However, the Fukushima nuclear accident initiated the worry on the safety of nuclear power among the general public. So far, the attitudes of the major nuclear power countries can be divided into three groups as described as follows:

The first group is the radical countries including Germany, Switzerland and Italy that intend to give up nuclear power. Germany announced that all of its nuclear reactors will be closed before 2022 and the 7 duration extended nuclear power units (Germany has totally 17 nuclear reactors) will be closed immediately. The 9% decrease in electric power will be filled up with electric power import. Switzerland announced that all the 5 nuclear power plants which produce 40% of the total electric power

supply will be closed before the year 2034. Italy decided to terminate the nuclear power restart plan after the referendum. Domestic political struggle is also one reason. For example, the Green Party in the Germany has consistently advocated to give up nuclear power and ruling Christian Democratic Party gave up nuclear power under huge pressure in order to win more voters.

The second group includes France, USA, India, the Republic of Korea and Canada that hold an opinion to stick to the established guideline to develop nuclear power based on the safety assessment on nuclear power plans. These countries also regard nuclear power as a safe energy source. US President Obama once declared clearly that the application of nuclear power plants in the US had passed detailed investigation and demonstration and they were safe on any account. The Republic of Korea planned to double the installed capacity of nuclear power by the year 2035 and then the capacity would be 35 GW.

The third group includes countries such as China, Russia, Australia, Brazil and South Africa that declared that they will draw lessons carefully from the nuclear crisis in Japan and estimate the site selection and safety of nuclear power plants by referring to more strict criteria. They will also slow down the development of nuclear power appropriately. Russia is going to increase the proportion of nuclear power from the current 16% to 25% by the year 2030 according to the original plan. Meanwhile, Russia also planned to carry out pressure test on nuclear power plant according to the methods adopted in Europe in order to enhance the safety of nuclear power.
At present, the slowdown of the development of nuclear power across the globe is inevitable. The 6-8% increase in the proportion of nuclear power by the year 2035 once estimated by the international energy agency (IEA, 2010) cannot be realized. The problem aroused by the facts mentioned above would be if the transformation of the global energy economy to non-fossil energy and low carbon energy will be slowed down or even if the direction will be reversed? It is foreseeable that on one hand renewable energy sources like wind energy, solar energy and biomass energy will develop further but there is uncertainty on the issue that if these energy sources can replace the fossil energy in a way that the economy can bear and then make up the supply gap caused by the development slowdown of nuclear power. On the other hand, the exploitation of fossil energy sources such as coal, petroleum and natural gas may extend further and that will result in the direction reversion of the transformation of global energy economy within a short term. Thus, the competition for energy will aggravate across the world.

2. Progress in renewable energy but trade dispute may aggravate

Responding to climate change and energy security, major countries substantially support the development of renewable energy although the economic cost of renewable energy is still higher than traditional fossil energy. Dramatic progress occurs in renewable energy with the substantial government support, encouraging

global energy. In the past 5 years, wind power grows by 27% annually. In 2010, the global new installed capacity of wind power increased by 39.40 GW while the accumulative installed capacity was 0.1995 billion KW 199.5GW doubling the number of the year 2007. It is estimated that the number will double again and reach 400GW by the year 2014. Faster application of photovoltaic power generation is also obvious. The capacity of photovoltaic power generation increased by 16 GW while the accumulative installed capacity was 37.90GW in the year 2010 with an average annual increase rate of 38.8% in the past decade. The IEA forecasted that the photovoltaic power generation will satisfy 11% of the total demand for electric power by the year 2050.

The cost of wind power and solar power decreased significantly along with technological progress and scale economies effect. Further, the decrease rate has exceeded the expectation and the prospect of grid parity is becoming clearer and clearer. In the year 2010, the average global contract price for wind power was 980 thousand Euros per unit capacity (1 MW), 19% lower than the peak value of 1.21 million Euros in the year 2007. The on-grid price for wind power in resource abundant countries like US and Sweden was 68 US dollars/MW (equals to 0.44 RMB /Kwh) which was very close to the cost of the power generation in coal-fired power plants which was 67 US dollars/MW (equals to 0.43RMB/Kwh). In China, the price of unit wind power decreased by 10% annually in the past 5 years while the accumulative decrease rate has exceeded 40%. The price of wind power system has fallen below 4000/Kwh. At present, the cost for wind power generation is lower than 0.5RMB/Kwh in some resource regions. The average on-grid price for thermal power is 0.44RMB/kwh which means the gap between the prices of wind power and thermal power is very small.

The conversion efficiency of solar photovoltaic power generation has increased significantly. At present, the highest conversion efficiency of commercial crystalline silicon photovoltaic cell is 20%. Some key breakthroughs have been made in the technology related to polycrystalline silicon preparation. The power consumption of polycrystalline silicon preparation has decreased by a wide margin because of the introduction of new techniques. The comprehensive power consumption for polycrystalline silicon preparation has decreased from 240Kwh/kg in the year 2000 to 120Kwh/kg internationally. Thus, the cost of polycrystalline silicon preparation and photovoltaic power generation has also decreased substantially. The international price of polycrystalline silicon reached the peak value of 470US dollars/kg in April of 2008 and then the price decreased continuously. The price decreased to 40-50 US dollars/kg in the year 2009. Currently, the price recovered to 50-80 US dollars/kg because of the booming demand. Judging from the current cost level, the cost of photovoltaic power generation can decrease to 0.9RMB/Kwh with reasonable margin for all stakeholders. It is also predicted that the cost of photovoltaic power generation will be comparable to thermal power around the year 2015.

Encouraged by the great achievements in renewable energy, we also note that some issues will be exposed especially with intensifying global trade disputes. Wind power has undergone some trade disputes and solar photovoltaic power generation could be a greater battle field. The global trade dispute in low carbon harms both the international trade rules and orders but also application of the low carbon technology which should bring benefit to all mankind. A pragmatic attitude of certain countries is needed to cope with this issue properly and all these countries should commit themselves to maintaining a free and fair international trade order.

3. The international climate talk has come to a deadlock

During the international climate talks after the Post-Kyoto Protocol, it is difficult to make breakthrough progress on the new topic of global governance on climate change currently although some interim achievements have been made in the Copenhagen Conference and Cancun conference. It is worth noting that some worrying new changes occurred in the driving mechanism to cope with climate change. Deeply affected by the financial crisis, the economy of developed countries such as the US and European Union are not recovering enough. Additionally, problems such as sovereign debt crisis is spreading. The primary goal of government policies should focus on economic recovery and job creation before the comprehensive countermeasures to tackle climate change and economic recovery are found. The importance of climate change declined on the priority setting in some countries even out of the core list. In addition, climate change is not the topic for discussion in the presidential election.

It is the consensus for major countries to realize green recovery and green growth after the financial crisis. These countries try to combine economic recovery and green transformation to solve both the short-term financial crisis and the long-term climate crisis at the same time. However, the influence of the financial crisis has exceeded the expectation. Thus, the effective and comprehensive countermeasures and implementation are far more complicated than the suggested concepts. In this context, lack of a new global agreement on climate change will result in insufficient external mechanism to drive the green transformation of the global low carbon energy development although the domestic policies may work somehow.

II. Sustainable energy development in China: a long-term important task

The *Twelfth Five-Year Plan* proposed that the establishment of a resource-conserving and environmentally friendly society should be the focus to accelerate the transformation of economic development mode. Such basic state policies are

suggested in the plan as resource conservation, environmental protection, energy conservation, lower emission intensity of greenhouse gas, circular economy, low carbon technology, responding to global climate change, coordination between economic & social development and population, resource and environment, and sustainable development. Three constrained indexes were also put forward. The first index was to increase the proportion of non-fossil energy in primary energy consumption from 8.3% at the end of 2010 to 11.4% by the year 2015. The second one was to decrease the energy consumption per unit GDP by 16% and to decrease the CO2 emission per unit GDP by 17%.

In addition, there are still several noticeable new concepts and measures described as follows:

Firstly, the total energy consumption should be controlled reasonably and explicit control goal on total consumption should be made. The fact foundation is that the energy consumption per unit GDP decreased by 19.1% during the *Twelfth Five-Year Plan* period and great achievements have been made. However, the total energy consumption still grows rapidly and the rapid growth of the total energy consumption cannot be suppressed only by reducing the energy consumption per unit GDP. Instead, cooperative control on the total energy consumption should be carried out to suppress the excessive growth of energy-intensive industries and to promote the transformation of economic development mode. It is a challenging issue to figure out how to control the total energy consumption in terms of policy making.

Secondly, the realization of sustainable energy development and the promotion of economic restructuring should be combined together. Especially, attentions should be paid to the development of the 7 strategic emerging industries including new energy (nuclear power, wind power, solar power and biomass energy), energy saving and environmental protection industry and new energy vehicles in order to increase the proportion of the added value attributed to the strategic emerging industries in GDP from 4% in the year 2010 to 8% and then further to 20% by the year 2020.

China has long engaged in the adjustment and optimization of energy mix. However, some changes were observed in rapid growth of energy consumption although the development of renewable energy and nuclear energy was also rapid. Currently, coal consumption in China accounts for 70% of the total energy consumption and that is 40 percentage points higher than the global average level. The percentage of petroleum is 17%. The percentage of natural gas is only 0.4% which is nearly 20 percentage points lower than the global average level.

Great efforts should be made to realize significant changes in energy structure during the *Twelfth Five-Year Plan* period. It is clear that energy mix can be optimized by greater proportion of non-fossil energy and smaller proportion of fossil energy especially coal. At present, the number of nuclear power units under construction in

China accounts for 43% of the total number of nuclear power units under construction across the globe and it is estimated that the installed capacity of nuclear power will be increased from 10GW to 40 GW by the year 2015. The scale of nuclear power under construction is huge and it is challenging to figure out how to develop nuclear power effectively after ensuring the safety of nuclear power although the proportion of installed capacity of nuclear power is still far lower than the global average. The capacity of wind power generation in China was nearly 40 GW in the year 2010. The new capacity was 18.93 GW with an accumulative installed capacity of 44.73 GW. All these statistics ranked the first place around the world. The capacity of photovoltaic cell was 8 GW in China, as half of the world total. In China, the installed capacity of wind power might exceed100GW while the installed capacity of solar power will exceed 10 million KW by the year 2015.

On the other hand, the proportion of high quality fossil energy such as natural gas should be increased. Meanwhile, the energy safety should be guaranteed and the relationship between the application of domestic energy and imported energy should be handled appropriately. The development of natural gas should be accelerated. The development and exploitation of unconventional natural gases such as shale gas and coal bed gas should be carried out in order to increase the proportion of natural gas in energy consumption significantly.

In terms of energy saving, the objective for the *Twelfth Five-Year Plan* seems lower than the objective for the *Eleventh Five-Year Plan* which was 20% decrease in energy consumption per unit GDP, but it is more difficult to realize. Theoretically, there are three channels to realize energy saving including energy saving through restructuring, technology and management. Prominent energy saving achievements have been made during the *Eleventh Five-Year Plan* period mainly through eliminating outdated production capacity and applying advanced and appropriate energy-saving technology. However, the room for eliminating outdated production capacity is shrinking. The energy-saving objective can only be realized through new methods while the economic restructuring (for example, the development of high-tech industries and service industries with low energy consumption) should contribute to energy saving and advanced energy-saving technology should be applied simultaneously. Nevertheless, the difficulty and complexity to realize the goal is considerable and comprehensive and effective policies should be made.

In a word, a series of challenges is facing global transformation of energy and economy as well as the sustainable development. Similar challenges confront different countries and great opportunities exist at the same time. We have to seize the opportunities and cope with the challenges through strengthening and carrying out pragmatic international cooperation to sustain energy development.