

World Energy China Outlook 2013-2014

I. World Energy Trends: A Chinese Perspective

World Energy China Outlook 2013-2014 offers an insightful review and a unique preview of world energy trends through comparing China with the rest of the world.

The year 2013 has witnessed a continuous grand shift in energy demand towards the Eastern Hemisphere amidst an economic slowdown in such emerging economies as China, India, the Middle East and African countries. New energy sources of supply have reshaped the energy production landscape in the past eight years, presenting a terrain differing from what was seen in 1960s through 1990s. Existing supplies mainly from the Middle East have been jeopardized and diluted as new energy sources come on-stream in the US, the rest of North America and beyond.

A possible advent of the *New Middle East* in the wake of the *Energy Independence* in the U.S. is repositioning the growing importance of supply from North America, which seemingly indicates the western bound shift of supply worldwide. Piecing all types of energy sources together, be it conventional or unconventional, onshore or offshore, it is obvious that the shift of supply is not limited to western bound one as a matter of fact. Instead, multiple sources from multiple supplying centers gain polycentric momentums of developments in the energy world, e.g., oil renaissance in Iraq, oil and gas exports from the Caspian Sea/Central Asia, gas discovery in East Africa, and upward production in the deep waters around the world in addition to the advent of the New Middle East described above. The landscape of world energy is featured by multiple supplies against eastern bound demand. Such a trend will continue for years to come.

Concurrently, supply lags behind demand in world energy. Short of investments and infrastructure backup required, and supply constraints pushed oil price highly positioned between \$100-110/bbl in 2013. There is no existence of global gas pricing because of regional gas network and separate pricing systems. With intensified interactions between regional markets, however, it is observed that differentials in regional gas pricing could be narrowed down as we see gas price at Henry Hub in the recovering process while LNG price in Asia Pacific rim will be re-justified. Also, it is unavoidable that the gas prices in the form of LNG remain high until the year 2018 when sellers competition is intensified.

2. Neo-energy revolution is on the horizon. This observation is resulted from our broader review of changes in energy mix starting from the *Industrial Revolution* in 1870s to reorganization and substitution of main energy sources from coal to oil thereafter, which is closely tied up with waves of industrial revolution and advancement of human civilization. We believe that the upcoming *Neo-Energy Revolution* would lead to unprecedented innovations and transformations in thoughts, technology, and management and trigger a new round of de-carbonization on the ground.

Therefore, we have to tackle a number of challenges and hardships facing us today. We believe such an energy transformation is in sight in selected developing countries. However, the new round of energy revolution has revealed brand new prospects: (1) traditional patterns of energy utilization are about to be terminated; (2) hydrocarbon fuels (coal, oil, gas) could co-exist instead of being replaced by one another continuously, being developed in favor of ecological and environmental protection and utilized in cleaner, more efficient, globally competitive manners; (3) natural gas and renewable energy sources will be joining these forces to grow on the stage reflecting higher human expectations and environmental requirements around the world.

Hence,, every country has to live with the new expectations and explore a new development pattern through all types of innovation and systematic reforms in order to fit new realities. China is to restructure its current energy strategy, policy and management system under its new leadership, launching a new round of industrialization, urbanization, informationization and agricultural modernization with wider and deeper implications and in keeping with global trends and realities.

3. After revisiting energy policies executed in mainland China in the past six decades, we concluded that although China's current energy policies and regulations prioritize security of supply, domestic and international production, energy savings, structural change, green and low carbon growth, and technological and systematic innovation, they fail to satisfy ecological and human expectations because they are designed to serve the state interests of keeping higher economic growth, which is, in our view, one of the reasons behind its failure.

To remedy the problem, we have made the following recommendations in this report:

- (1) Energy constraints on economic growth have to be taken into account in economic and social developments featured by new drives to industrialization, urbanization, informationization and agricultural modernization;
- (2) Ecosystem and human environmental costs have to be factored into economic and social developments when pursuing economic benefits;
- (3) Participation in global energy governance and coordination with the rest of the world have to be outlined responsibly when planning its short term and longer term development at home.

As a result, an Eco-friendly Energy Strategy (EES) is envisaged to optimize energy mix by reducing coal consumption, stabilize oil demand, accelerate developments of natural gas and renewable energy sources and stimulate energy saving and efficiency sector to serve public interests. With these campaigns in place, China will be in a better position to meet both ecological and human expectations at home and globally. The EES is therefore used as the central scenario approach in this report, comparing with new policy scenario, current policy scenario and 450 scenario prepared by the Paris-based International Energy Agency.

4. Natural gas sector in China will step into its Golden Age in the years after 2020, especially in the period of 2025 through 2035 featured by rapid increase in output, sound policy in place and public interests secured. The key evidences behind the gas boom are: unconventional gas will be an engine of the increase in gas production into 2035 while conventional gas has reached its peak output in 2015-2020 and will witness its decline thereafter in our outlook period. It is expected in our report that unconventional gas could reach 67 percent of total gas output in China instead of the IEA's prediction of 45 percent in 2020 from current 39 percent instead of the IEA's 12 percent and continue to increase up to 72 percent in 2035 instead of the IEA's 83 percent indicating the country is stepping into its full age of unconventional gas. Obviously, how to stimulate the sub-sector in China is a central point for the country to renew its hydrocarbon industry policy and the green driven economy and could be an issue for its upcoming industrial reform, accordingly.

There are a number of uncertainties, however. For instance, shale gas production remains at its nascent time, although it has larger resources potential than that in the U.S. in statistical term. It is less possible to reach its said output targets for shale gas (as reported, 6.5 billion cubic meters for 2015 and 60-100 bcm in 2020) in China. There is no way for China to copy the success of shale gas in the U.S. And no fast development could result any time soon. By contrast, tight gas and coal bed methane would take lead based on their sizable production combined (currently calculated into conventional gas output statistically) and ever-enhanced technologies employed. There is a set of questions to be answered in terms of development pattern for the sub-sector, policy issues and environmental concerns over the possible unconventional gas boom. In addition, coal-to-gas (CTG) projects are under experiment due to debates on their high costs and pricing.

5. Renewable energy is taking a bigger pie in the energy mix in developed world. Western experiences are recognized in terms of energy saving and market orientation in conjunction with technology and investment innovation by the sector and stimulated by their authorities. Comparatively, in China, state policy took over market orientation to propel new renewable energy (especially solar panel and wind farms) to grow. Solar energy, currently under restructuring, was over invested and expanded being short of domestic consumption backup, which is a good case in point.

In this report, we predict that non-fossil fuel energy demand in China will increase up to 15 percent in 2020 and 24.5 percent (higher than that of oil) in 2035. We believe that hydro-energy will be stable while nuclear energy will resume its fast track under stricter regulations and safety circumstances. Notably, new renewables (solar, wind and bio-energy combined) will gain their fastest growth momentum above 100 percent, as their current capacity at home remains small in its entirety. Evidently, energy policies for these sources have to be soundly designed and balanced to deal with market force and the state hands. Eventually, home consumption and market competition have to be fostered to lead these energy developments under the guidance of a sound policy. Consequently, market potential and growth can be tapped and stimulated.

II. Energy Development in China and Repercussions on the World

6. Energy consumption in China will grow at rate of 2.23 percent in the outlook period (2011-2035), higher than the IEA's growth rate of 1.9 percent under its new policy scenario (CPS) while energy production will grow at 1.97 percent, higher than the IEA's growth rate of 1.4 percent. Consequently, China will be in a higher position leading the world energy growth, both in demand and supply at large. A greater impact on the world energy industry, world economy, and geopolitics will be widely felt onward in the course of its new four drives mentioned above. The world energy system and landscape have been re-drawn, accordingly. The EES is envisaged to conduct readjustment, reform and enhancement in policy innovation campaign in order to reduce high CO² emission (mainly from coal consumption), mitigate environmental concerns and social costs, and coordinate with the rest of the world.

7. It is a fact that different types of energy mix lead to different impacts of carbon emission on the eco-system and global warming. The IEA's 450 scenario aims to curb global warming with temperature increase within 2 °C while its NPS and CPS will come with results 3.6 °C and 5.3 °C temperature increase. The EES is designed as a better scenario than the IEA's NPS but worse one than the 450 scenario. CO² emission growth from coal consumption in our outlook period will be negative 0.4 percent, at much lower rate than IEA NPS in both 2030 and 2035. As a result, Chinese contribution under the EES will obviously improve the environment and global warming concern within 2-4 °C by 2050.

8. Energy demand is subject to demographic evolution and economic growth in the past but will be curbed through energy saving and energy efficiency partially today, plus new economic pattern and innovative management system being effective. Energy consumption per GDP unit in China was reduced steadily in the past two decades thanks to an enhancement of energy efficiency as many scientific authorities recognized. We believe that policy makers in Beijing will continue to exert greater pressure on increases in both energy efficiency and technology innovation in order to tap its great potential in the rest of its 12th Five-Year Plan (i.e., 2014-2015).

9. According to our outlook, China's foreign energy dependency will increase to 11 percent in 2015 and 26 percent in 2020 from current 9 percent, but become stabilized thereafter and possibly decline to 15 percent in 2035. Foreign oil dependency will increase to 60 percent in 2015, 65 percent in 2030 and 68 percent in 2035 from the 55 percent in 2011 while foreign natural gas dependency will be 35 percent in 2015, 40 percent in 2020 before declining to 24 percent in 2035. All above-mentioned dependencies are lower than those envisaged by the IEA. However, these dependencies resulted from looming bigger gaps between demand and supply will push the country to enlarge its oil and gas imports globally. Neighboring oil and gas imports will then be emphasized as its cross border trunk lines and related facilities were built when pursuing its diversification of energy sources from abroad. Energy trade and investments will be globally expanded, both bilaterally and multilaterally. To take an active attitude towards cooperation security being a part of global energy governance is not only a vision but an action as well.

10. Energy security is a special focus under closer scrutiny in our report. An evolving concept on the energy security was discussed, covering security of demand, supply and cooperation at both regional level and global one. Such an energy security was furthermore explored at a bilateral level by taking Sino-Russian hydrocarbon ties as an example. And multilateral level review was done by examining Chinese practices towards the regional and global energy governance.

In our report, we reviewed the history of Sino-Russian cooperation in the energy sector and identified the multi-faceted nature of the bilateral cooperation based on common interests for long-term development. In addition to their commonly identified interests, however, there exist interest differentials and even conflicts of preferences between the two powers. Consequently, strategic game exercises were executed for their own best benefits on sensitive issues including gas pricing. The game will continue under the strategic partnership as long as their commitments are alive. The tipping point of transformation, however, may emerge around 2020.

Multilateral cooperation is a combination of bilateral cooperation regionally and globally. China is actively participating in such cooperative activities including its contribution to re-building up the Energy Club under the framework of Shanghai Cooperation Organization in 2012 and its involvements in the G20 activities in 2013. In 2014, China will play its bigger role in APEC Meeting in the outskirts of Beijing where the country will be well examined in terms of its cooperation with other countries in the EES strategic framework.

11. Crude price in China is tied with the world market, while oil product prices remain subject to adjustment by its national planner NDRC from time to time at present. Gas price inside the country is far below the level of its import pricing. Gas market is immature, although some regional gas markets are developed where infrastructure, trading activities and competition are being expanded and witnessed both in form of liquefaction natural gas (LNG) and in form of pipeline natural gas (PNG). Gas-to-gas competition and free access

by the third parties have been recognized but not developed until 2014-2015 in favor of market based pricing. Given multiple gas supplies on-stream as observed for the years in 2018-2020, we believe that gas prices (for LNG, PNG, and CTG) across China could be justified and set at some benchmark level similar to those in Europe by then.

12. Uncertainties remain, however, in addition to those mentioned concerning shale gas, CTG issues. Some factors instituted by our IWEPC Energy Database remain to be identified such as energy demand growth into 2035, carbon emission factors, nuclear energy, solar, wind and nuclear utilization, plus CCS effectiveness. Carbon taxes remain uncertain whether they are executed in 2020.

III. Policy Recommendations

13. Our review on energy policy and findings suggests that energy policy in line with the EES has to constitute a set of constraints on economic development while satisfying economic and social requirements and dealing with repercussions of energy dependency and carbon emission. Policy makers have to face new challenges and uncertainties with care.

Above all, China has to continue to stress home supply and home market development given greater potential and less touched potentials and areas in deeper onshore exploration, deep waters, unconventional hydrocarbon, as well as some new renewables. The country calls for cleaner coal and intensive investments on gas activities while stabilizing oil supplies. It is imperative at present for China to explore home-based consumption and market development pattern for renewable energy sources.

In addition, technology advancements in energy saving and efficiency have to be factored into the energy policy, while management innovation and market competition being key elements to energy policy making.

14. We believe that energy issues in China are those of the world, vice versa. For security reason, China has to make its energy policies ready to deal with its interactions with relevant countries and parties involved on energy security, energy governance, and the global warming. Active engagements and open dialogues with all stakeholders are required in order to be a responsible party. A set of logistic settings including required institutions, staffing, rules, education, and information sharing are necessary and should be in place beforehand to enhance China's cooperation capabilities.

15. Energy policy set by the government is by no means dominated by the state. Those national interests have to be in line with the public requirements, especially those growing expectations for clean and green energy, safety and health. Hence, transparency, accountability and social acceptance are required in the policy-making process and policy execution. Therefore, a type of "social license" is badly needed to all energy projects.

Appendix

Table of Contents

Foreword

Executive Summary

Introduction

1. Report nature, elements and frameworks
2. Approaches, Methodology and Modeling
3. Scenario Analysis and Assumptions
4. Limitations

Part One: World Energy Trends: A Chinese Perspective

Chapter One: Global Energy Trends and Impacts of U.S. and China

1. Global Energy Trends
2. U.S. and China Repercussions

Chapter Two: *Neo-Energy Revolution* and Its Implications

1. Energy substitution and Characteristics
2. Energy shifting in the wake of the industrial revolution
3. Neo-Energy Revolution and implications

Chapter Three: China's *Eco-Friendly Energy Strategic Approach*

1. World energy development and strategic orientation
2. Chinese current energy strategy and policy review
3. Eco-friendly Energy Strategy
4. Scenarios analysis

Chapter Four: Regional Natural Gas Trends and China's Role

1. Global natural gas market trends
2. Regional natural gas market analysis
3. Asia Pacific market
4. Golden age of unconventional gas
5. Natural gas outlook and implications

Chapter Five: Non-Fossil Fuels and China Options

1. Non-fossil fuels and investment evaluation
2. Technology and investment
3. Scenarios analyses
4. Non-fossil fuels in China

Part Two: Energy Security: A Multidimensional Investigation

Chapter Six: Neo-Energy Security: Perspectives and Situations

1. Energy security: from conventional wisdom to contemporary one
2. Scenario approach at global level
3. Scenario approach at China/country level

Chapter Seven: Bilateral Energy Security: The Case of Sino-Russian Hydrocarbon Nexus

1. The nature and process of Sino-Russia oil and gas cooperation
2. Scenario analysis and outlook
3. Strategic game and policy demand

Chapter Eight: Multilateral Mechanisms and Capability Building

1. Significance of multilateral cooperation
2. Shifting from bilateral requests to multilateral frameworks
3. Scenario analysis
4. Infrastructure settings

Appendix One: IWEF Energy Database Framework

Appendix Two: Acronyms, Statistical Units and Formulas

References

Acknowledgements

Tables, Figures and Boxes

Table 0-1 Eco-Energy Strategy Scenario and IEA New Policy Scenario

Table 0-2 GDP and Urbanization Assumptions in China and the World
Table 0-3 World Oil and Gas Prices
Table 0-4 Technology Advancement Categories
Table 0-5 Energy Industry, Policy, and Public Interests in China
Table 1-1 World Primary Energy Demand under IEA New Policy Scenario
Table 1-2 Regional Energy Demands under New Policy Scenario
Table 1-3 Fossil Fuels Reserves and Recoverable Resources
Table 1-4 New Middle East Oil Production
Table 1-5 Regional Natural Gas Prices
Table 1-6 Global Energy Infrastructure Investment Requirements in 2012-2035
Table 2-1 Industrial Revolution and Evolving Energy and Industries
Table 3-1 World Energy Demand Outlook
Table 3-2 World Energy Demand Mix and Compound Growth into 2035
Table 3-3 World CO ₂ Emissions Outlook
Table 3-4 World CO ₂ Mix and Compound Growth into 2035
Table 3-5 Green Growth Index Comparison in China
Table 3-6 Chinese Energy Demand Outlook
Table 3-7 Chinese Energy Demand Mix and Compound Growth into 2035
Table 3-8 CO ₂ Emissions Outlook in China
Table 3-9 CO ₂ Mix and Compound Growth in China into 2035
Table 4-1 Natural Gas Demand Outlook by IEA
Table 4-2 Natural Gas Supply Outlook by IEA
Table 4-3 Natural Gas Trade under IEA New Policy Scenario
Table 4-4 Natural Gas Supply and Demand Outlook in North America by IEA
Table 4-5 Pipeline Gas Ex/Imports in North America in 2012
Table 4-6 LNG Ex/Imports in North America in 2012
Table 4-7 Natural Gas Supply and Demand Outlook in Europe by IEA
Table 4-8 Natural Gas Production in Europe in 2012
Table 4-9 Natural Gas Demand in Japan, South Korea and Chinese Taiwan
Table 4-10 Russian Gas Outlook under IEA New Policy Scenario
Table 4-11 Unconventional Gas ratios into 2035 by IEA
Table 4-12 Scenarios Approach towards Gas Supply and Demand in China
Table 4-13 Unconventional Gas Ratio and Production Assumptions in China
Table 4-14 Natural Gas Imports Planning around 2020
Table 5-1 Global Renewable Energy Investment Trends
Table 5-2 World Renewable Energy Demand by region and Scenario
Table 5-3 World Renewable Energy Consumption by Sector
Table 5-4 World Renewable Generation Comparison
Table 5-5 Relevant New Energy Policy and Regulations
Table 5-6 Renewable Energy Generation Comparison
Table 5-7 Typical Wind Farm Investment Costs and Electric Pricing in China
Table 5-8 Wind Power Investment Estimated in China
Table 5-9 House Land, Solar Power Utilization and Market Potential
Table 6-1 Scenario Approach toward Energy Security
Table 7-1 China's Oil and Gas Ex/Imports
Table 7-2 Russian Oil and Gas Ex/Imports
Table 7-3 Sino-Russian Oil and Gas Cooperation Outlook

Figure 1-1 U.S. Primary Energy Dependency
Figure 3-1 Energy Intensity by GDP Unit in Leading Countries 1990-2009
Figure 3-2 Carbon Emission Trends under Eco-Energy Strategy Scenario
Figure 4-1 Natural Gas Consumption in Europe in 2012
Figure 4-2 Littoral Natural Gas Production in North Sea
Figure 4-3 Natural Gas Demand Outlook in Asia Pacific Region under IEA New Policy Scenario
Figure 4-4 Natural Gas Production and Demand Trend in China
Figure 5-1 Technological Contribution to Global Warming
Figure 5-2 Annual Average Generation Investments against Global Warming below 2 Degree
Figure 8-1 Chinese Participation in Non-Western dominated Multilateral Cooperation Frameworks, A Comparative Approach
Figure 8-2 Chinese Participation in Non-Western dominated Multilateral Cooperation Frameworks, An Interactive Approach

Box 1-1 Chinese New Industrialization Targets
Box 3-1 Chinese Energy Orientation
Box 4-1 Natural Gas Market Evolution in Asia Pacific Region
Box 4-2 Japanese JCC Pricing Formulas
Box 4-3 IEA Golden Rules for Unconventional Gas
Box 5-1 Non-Fossil Fuels Definition
Box 5-2 New Energy Technology Planning
Box 6-1 Chinese New Security Concepts

Appendix Table 1 Assumptions for Energy Demand Growth
Appendix Table 2 Assumptions for Energy Supply Growth
Appendix Table 3 Carbon Emission Factor
Appendix Table 4 New Energy Generation Growth Rate
Appendix Table 5 Energy Demand Growth Comparison 2011-2035
Appendix Table 6 Chinese Energy Demand Mix 2011-2035
Appendix Table 7 Chinese Energy Production and Growth 2011-2035
Appendix Table 8 Power Generation Structure
Appendix Table 9 Fossil Fuels Carbon Emission Trends 2011-2035
Appendix Table 10 Carbon Emission under Eco-Energy Strategy Scenario

Appendix Figure 1 IWEPC Chinese Energy Demand and Supply Outlook Database Framework
Appendix Figure 2 IWEPC Chinese Energy Demand Constraints
Appendix Figure 3 IWEPC Chinese Energy Supply Constraints