Abstract  First-mover advantage and solid foundation of oil and gas cooperation is very important to the Belt and Road Initiative. Deeply studied opportunities and challenges of oil and gas cooperation have far-reaching significance to the cooperation in other industries in the Belt and Road. In this article, based on the systematic analysis of the oil and gas supply security, investment environment, regional win-win situation in oil and gas cooperation, new opportunities and challenges about upstream, pipeline, refining, trade, warehousing, engineering technology and equipment are studied. Enhancing capacities in four areas and implementing the 16 measures are given for deepening oil and gas cooperation in the future. Meanwhile, this article also gives suggestions and cooperation directions for countries and companies.

Keywords:  the Belt and Road, oil & gas cooperation, new challenges, new opportunities, new measures

1 Introduction

In September and October 2013 the “Silk Road Economic Belt” and the “21st-century Maritime Silk Road” initiatives (abbreviated as the BR Initiative) were proposed successively by Chinese President Xi Jinping that focuses on international cooperation. Many countries in the world have paid great attention to the BR Initiative. At present, the BR Initiative has entered a stage of overall execution. Connecting the Asian-Pacific Economic Circle in the east and the developed economic regions of Europe in the west, the Belt and Road is “the longest and the most potential economic corridor in the world”. With the construction of the Belt and Road, connectivity among countries along this route will be realized, which is beneficial to the multi-dimensional, multi-directional and multi-level cooperation among these countries. As the power and foundation for social and economic development of all these countries, oil & gas has the most solid foundation for bilateral cooperation, the most likely possibility for future deepened cooperation, the most obvious complementary advantages and the most operable development opportunities. Moreover, oil & gas cooperation can drive the connectivity in the fields of commerce, trade, science and technology, amplify the economic integration and cultural reference between China and other countries, and lay foundation and provide support for constructing a community of common interests and common destiny. This article mainly discusses new challenges, new opportunities and corresponding new measures for oil & gas cooperation under the BR Initiative.

2 New situation and new risks faced by oil and gas cooperation

Oil & gas is the power and foundation for the social and economic development of countries along the Belt and Road, affecting national economy and people’s livelihood. In terms of China’s oil and gas supply security, resource rich countries’ social and economic security and regional win-win oil and gas management, oil and gas cooperation are still faced with certain challenges.

2.1 Longstanding oil and gas supply risk in China

Coal, petroleum and natural gas are three main types of fossil energy, which have long been the main supply and consumption bodies of world energy. In the world consumption structure of primary energy in 2014, fossil energy accounted for 85.9%. According to IEA forecasts, in the new policy background, the share of fossil energy in the world energy consumption structure by 2030 will remain as high as 74.5%, despite of a drop of 7.2 percentage point compared with that in 2014. The percentage of coal, petroleum and natural gas in the fossil
energy consumption is 26%, 28% and 23% respectively. The percentage of petroleum and coal supply has been decreasing continually, while the percentage of natural gas supply has been increasing stably (IEA, 2016).

Meanwhile, oil and gas are also the main body of energy consumption in China. With the rapid growth of economy, the fast promotion of industrialization and urbanization process, and the sharp increase of car ownership, China’s petroleum consumption in 2014 was as high as 520 million tons, and the petroleum demand in the coming 30 years will still increase rapidly. It is predicted that China’s petroleum consumption will hit a peak of 750 million tons in 2030-2040, and then drop down to about 700 million tons in 2050 (Zhai, Hu, & He, 2015). Nevertheless, the development and utilization scale of natural gas in China has long been restricted by such factors as coal-centered energy structure, economic development level, energy policy and unbalanced supply and marketing. Since 2000 when the west-east gas pipeline was commissioned, China’s natural gas consumption has been increasing rapidly. The natural gas consumption in 2014 was about 181.6 billion cubic meters, with an average annual increase rate of 15.7%, which is much higher than 7.2%. The increase of natural gas consumption is the fastest among all types of primary energy (BP, 2015). Driven by the multiple factors of atmospheric pollution control, energy conservation, emission reduction and industrial structure optimization and upgrading, China’s natural gas consumption will continue to increase rapidly in the future. The share of natural gas will become larger in the consumption structure of primary energy. China is expected to become the natural gas consumption center of the world. It is predicted that the natural gas consumption will reach 500 billion cubic meters in 2030, and 650 billion cubic meters in 2050 (Zhai, Hu, & He, 2015).

Oil & gas are the social and economic development foundation in China. The total oil and gas consumption in the future will keep on increasing. Increasingly high dependence on external supply and longstanding risk concerning import source will be the two challenges facing China in ensuring the oil and gas supply security.

First, affected by China’s rapid economic development, the unbalance between the supply and demand of oil and gas in China becomes increasingly prominent, and the risk of the increasing dependence on external supply will be longstanding. After 1993, China became a net crude oil importer from the original crude oil exporter. Since 2000, China’s crude oil consumption has been increasing rapidly. The total crude oil consumption in 2000 was doubled compared with that in 2014, with an average annual increase rate of 6.6%. In the same year, China’s net crude oil import was 310 million tons, and the external dependence degree reached 59.5%. It is predicted that China’s petroleum import by 2030 will be 450 million tons, and the external dependence degree will exceed 66%. Although it was not until 2007 that China became a net natural gas importer, China’s natural gas import in 2014 was as high as 58.3 billion cubic meters. At present, the external dependence degree is 32.1%. It is expected that China’s natural gas import by 2030 will be 200 billion cubic meters, and the external dependence degree will reach 40%.

Second, in terms of oil and gas import channel, China’s north-western, north-eastern, south-western and sea passages to import oil and gas are taking shape, but there are still two challenges. In the first place, the capacity of land passages is far too low. Now, the annual crude oil import capacity of the four passages totals 658 million tons, and the annual capacity of three land passages is 58 million tons, accounting for only 9%. Among the 310 million tons of crude oil imported in 2014, only 25 million tons of oil was transported to China by onshore pipelines. Secondly, geographic areas of the export countries are relatively centralized. Each year, China imports crude oil from nearly 40 resource producing countries in the world, and more than 70% of them are Middle East and West African countries. Besides, most of the crude oil is imported by sea, and the sea passage is closely related to geopolitics, which is highly risky.

2.2 Oversea environment for oil and gas cooperation is faced with severe crisis

2.2.1 Social and economic security of main cooperative resource producing countries is faced with enormous challenges

Most of the key resources producing countries along the Belt and Road have implemented a resource-based development strategy. In some countries, the production value of their oil and gas industry accounts for 30%–60% of their GDP, and the revenue from oil and gas export accounts for 70%–90% of the total national export revenue (Table 1). Since July 2014 when the international oil price dropped sharply, economy of these resources producing countries has suffered heavy losses. First, revenues from petroleum export have decreased dramatically. According to rough estimate, the net revenue from oil and gas export of OPEC countries in 2015 dropped by nearly 50%; the revenue from oil and gas export of Russia dropped by more than 40%; on the basis of an 8% decrease in 2014, the export revenue of Kazakhstan in 2015 continue to decline by about 50%. Second, financial markets experience turbulence. Currencies of these resource producing countries depreciate severely. Since Kazakhstan adopted the free floating exchange rate system, Tenge’s value has fallen by more than 30%. The stock markets have dropped sharply. The stock markets in Kazakhstan, Iran and Saudi Arabia have gone into bear-market stages in succession since the second half of 2014, with the accumulative stock decline exceeding 30%. Third, foreign exchange reserves shrink greatly. The drop of Russia’s foreign exchange reserve
since 2014 has been nearly 25%. The foreign exchange reserve of Saudi Arabia has dropped from its highest point of 800 billion dollars in 2014 to the present 650 billion dollars.

It was because of the combined action of these factors that the resource producing countries along the Belt and Road are exposed to the risks of economic downturn and further currency depreciation. Major resource producing countries have had financial deficits of different degrees. Impacted by the decelerated economic growth, petroleum industry development in some resource producing countries is slowing down. In Russia, unconventional oil and gas projects and the commissioning of circum-Caspian large oil and gas development projects are postponed. The increase in pipeline replacement cost makes Kashagan Oil & Gas Field delayed to 2017, and Tengiz production increase project delayed to 2019.

2.2.2 Economic downturn may lead to social turmoil in resource producing countries

For a long time, most of the resources producing countries along the Belt and Road have implemented high welfare policies to secure social stability. Under the economic pressures brought by low oil prices, resource producing countries have to reduce substantial expenditures on people’s livelihood because the government finances have lost balance. Gulf countries such as Saudi Arabia, the UAE, Oman and Bahrain have all cut down fuel allowances (Figure 1).

With the continuation of low oil price crisis, social turmoil is likely to occur in one or more countries. In April 2016, Kuwait scheduled to adopt a new salary framework for all of its civil servants, impacted by the drastic drop of global oil prices. In Kuwait, the salaries and bonuses of about 20,000 petroleum workers will be cut down automatically. Influenced by this plan, about 6,000 petroleum workers, almost half of the trade union members (13,000) in Kuwait went on strike. This strike made the oil and gas production of Kuwait decreased sharply. The crude oil output has been reduced from 3 million barrels to 1.1 million barrels, and the natural gas output has been reduced from 1.3 billion cubic feet per day to 620 million cubic feet per day. Oil received by refineries has dropped from 930,000 barrels per day to 520,000 barrels.

2.3 The win-win demand of regional oil and gas management cannot be satisfied

The demand for win-win joint management of regional oil and gas has become increasingly urgent, which is also the premise and challenge for deepening oil and gas cooperation in the future. The dominant global energy management frameworks were formed in the 1970s, and have developed for half a century. At present, a global energy management platform consisting of such major organizations as International Energy Agency (IEA), Organization of Petroleum Exporting Countries (OPEC) and Energy Charter has been established. The global energy supply and demand pattern, however, has experienced gigantic changes. The global shale oil and gas has displayed great development potential. The external energy dependence of North America has been decreased gigantically. The energy consumption growth in developed European countries is limited, while the energy consumption growth in developing countries is notable. The center for global energy trade has shifted to Asian-Pacific region. The defects (Table 2) of current major energy management frameworks have caused resistance to win-win regional oil and gas cooperation in the following respects:

(1) Inability to represent emerging countries and developing countries. Existing management frameworks are led by the US or other developed countries, not including nor representing emerging countries or developing countries. Emerging countries do not have equal access to energy development and technology transfer. Instead, they can only make energy development at high costs in remote areas with political unrest.

(2) Lack of effective dialog mechanism between energy-producing countries and energy-consuming countries. At present, international energy market is becoming increasingly globalized. Instead of being antagonistic, producing countries and consuming countries require more cooperation and dialogs. However, international organization

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Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage of industrial output value in GDP</th>
<th>Percentage of oil &amp; gas export revenue</th>
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<tbody>
<tr>
<td>Iraq</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>Russia</td>
<td>17%</td>
<td>60%</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>31%</td>
<td>80%</td>
</tr>
<tr>
<td>UAE</td>
<td>30%–40%</td>
<td>–</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>–</td>
<td>&gt;70%</td>
</tr>
<tr>
<td>Oman</td>
<td>41%</td>
<td>75%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>45%</td>
<td>92%</td>
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which can take into account the common benefits of both producing countries and consuming countries is needed.

(3) Inability to cope with the new risks brought about by the multi-polarization of energy supply. The existing management mechanism designed for energy security is mainly oriented to petroleum supply security. However, with the further development of international energy market and the emergence of an increasing number of producing countries and consuming countries, the global energy market is presenting a multi-polarization feature, and its main risks have shifted from supply interruption to price fluctuations. In addition, the upgrade of global management mechanism did not realize in time the harmonization and unification of benefit fluctuations.

3 Cooperation opportunities are available throughout the whole oil and gas industrial chain

The development of oil and gas industries in countries along the Belt and Road is extremely unbalanced but highly complementary. First, the oil and gas producing countries are endowed with rich oil and gas resources, but are lack of stable consumption markets, oil and gas exploration and development technologies, and equipment manufacturing and engineering construction capabilities. Secondly, the oil and gas consuming countries have strong market demands, apparent capital advantages and relative technological advantages. Thirdly, oil and gas transit countries possess natural geographical advantages, and need stable transit income and oil and gas supply. Based on a systematic evaluation for these countries, it is believed that there exist tremendous cooperation demands and opportunities (Figure 2) in the future for these countries throughout the whole oil and gas industrial chain consisting of oil and gas exploration and development, pipeline construction, refining and petrochemical, LNG and storage, oil and gas trade, engineering technical service and equipment manufacture.

3.1 Exploration and development is the foundation for oil and gas cooperation

It is predicted that the annual crude oil production of major resource producing countries in the Belt and Road region
by 2030 will attain 2.88 billion, and their annual natural gas production will be 2.9 trillion cubic meters. It is estimated that one trillion dollars of accumulative upstream investment will be needed, but it is hard for most of these countries’ economy to support independently their enormous investment plans due to low oil prices, which provides a lot of opportunities for foreign companies to take part in the upstream cooperation. Opportunities for upstream oil and gas cooperation in the region mainly cover the areas of risk exploration, oil and gas field development and brown oil field production improvement, and most of these opportunities are concentrated in countries and regions with relatively rich oil and gas such as Russia, Central Asia, Middle East and countries surrounding the South China Sea.

3.1.1 Risk exploration

Oil & gas exploration degrees of countries along the Belt and Road are relatively low, with tremendous oil and gas resource to be discovered. According to statistics, there are 53.4 billion tons of petroleum and 83 trillion cubic meters of natural gas to be discovered in these countries (Tong, Zhang, & Tian, 2011). The five countries of Saudi Arabia, Russia, Iran, Iraq and Turkmenistan, especially the circum-Caspian area, Russia’s East Siberia, middle and small basins in the Far East and Arctic Shelf, Turkmenistan’s organic reef belt and Kazakhstan’s deep strata, are important potential areas for discovery of large oil-gas fields. Even such countries endowed with relatively small oil and gas reserves as Uzbekistan, Tajikistan, Kyrgyzstan, Mongolia, Vietnam, India, Pakistan, and Bangladesh have the demands for enhancing exploration and verifying their oil and gas distributions. The countries and regions mentioned above are potential cooperative partners for carrying out risk exploration in the future.

3.1.2 Oil-gas field development

In respect of oil-gas field development cooperation, there exist a lot of large oil-gas fields with tremendous reserves and slow development progress under production or construction in Russia, Kazakhstan, Turkmenistan, Iran and Iraq, which are all key areas for future cooperation. Particularly some of Russia’s strategic assets opened recently. Central Asia’s large oil-gas fields whose commissioning has been postponed for many times due to various reasons and Iran’s and Iraq’s large oil-gas fields which are urgently in need of foreign funds and technologies because of insufficient investment and equipment aging deserve special concern.

Meanwhile, a lot of oil-gas fields in the Belt and Road region remain undeveloped, including over 600 oil fields and 500 gas fields lacking productivity construction. These oil fields are mainly located in Russia, Azerbaijan, Saudi Arabia, the UAE, Iran and Iraq, and their proved and probable oil reserves exceed 7.9 billion tons (IHS, 2015). In addition, these gas fields are mainly located in Russia,
Turkmenistan, Saudi Arabia, Iran, Iraq and Qatar, and their proved and probable gas reserves amount to 19.4 trillion cubic meters. The peak productivity is expected to be 410 million tons for oil fields and 1.59 trillion cubic meters for gas fields, requiring 1.3 trillion dollars of investment (Table 3).

3.1.3 Exploitation of brown oil fields

Most of the brown oil fields in oil and gas producing countries along the Belt and Road have long production history, fast declined production and urgent demands for foreign investment and technical cooperation. By utilizing the technical advantages in EOR, foreign companies may take part in actively Russia’s West Siberia and Ural-Volga brown oil field projects. Russia’s marginal oil field production increase project taken over from TNK-BP by Rosneft Oil, and Kazakhstan’s EOR project for western onshore brown oil fields. Most of the oil fields in Saudi Arabia, the UAE, Iran and Qatar under production now belong to brown ones with declining productivity. Many countries have developed EOR plans for brown oil fields, offering favorable opportunities for future cooperation. Production of the brown oil fields in Indonesia and Malaysia is fast declining. Their EOR projects deserve proactive concern.

3.2 Pipelines are the channels for intra-regional oil and gas circulation

Currently, the oil and gas pipeline network construction in countries along the Belt and Road tend to regionalize and fragmentize. Great efforts are needed to connect these regional pipeline networks. Oil & gas producing countries need market security, whereas oil and gas consuming countries need supply security. As a result, most countries along the Belt and Road have strong demands for constructing transnational pipelines and domestic pipelines, but many of them are lack of funds and technologies for pipeline construction. It is roughly estimated that nearly 20,000 km of new oil and gas pipelines need to be constructed by 2030 in the region, and therefore 100 billion dollars of investment will be required. Meanwhile, some pipelines run through highly risky areas, and require all parties involved to share the risks. The joint demand for oil and gas security, funds, technologies and risk sharing has provided plenty of opportunities for cooperation in pipeline construction in the region.

3.2.1 Transnational pipelines

Most of the onshore transnational oil and gas pipelines in the region are distributed in Russia-Central Asia area unreasonable. So far, the oil and gas export capability in the region has been insufficient in the east and blank in the south (Figure 3). The crude oil export capabilities of land passages total 390 million tons. 87% of the crude oil is exported to European and CIS countries, while only 13% of the oil is exported to Asia-Pacific region. The export capabilities of natural gas passages total 364 billion cubic meters. Gas exported to European and CIS countries accounts for more than 70%, while gas exported to Asia-Pacific region accounts for less than 30%. Consequently, based on the classification of oil and gas export countries, transit countries and consuming countries, there are three types of cooperation opportunities for constructing transnational oil and gas pipelines in the Belt and Road region in the future, so as to secure oil and gas supply and market security.

Firstly, oil and gas exporting countries such as Russia, Turkmenistan, Iran and Iraq need to construct transnational oil and gas passages to realize the diversification of oil and gas export directions. Russia’s ESPO pipeline is a trunk mainly to export oil and gas from Far East region of Russian to North-east Asian markets, demanding for further expansion of transportation capacity. Turkmenistan is seeking for export diversification, and moving forward actively the construction of Turkmenistan-Afghanistan-Pakistan-India gas pipeline and trans-Caspian oil and gas pipeline. Iran has abundant oil and gas resource, and several gas export pipelines (such as Iran-India and Iran-Turkey pipelines) planned before are expected to start

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<th>Table 3</th>
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<td><strong>Oil/Gas Reserve and Peak Production Forecast for Oil-Gas Fields Lacking Productivity Construction in Main Countries/Regions along the Belt and Road</strong></td>
</tr>
<tr>
<td><strong>Region</strong></td>
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<td>Russia</td>
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<td>Central Asia</td>
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<tr>
<td>Asia-Pacific</td>
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<td>Total</td>
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construction after the sanctions against Iran are lifted gradually. Iraq’s export pipelines are severely damaged, demanding repair or rebuilt.

Secondly, transit countries such as Mongolia, Afghanistan and Pakistan with important geographical locations hope to obtain greater and more stable economic benefits, and to construct transit oil and gas passages. Having no import pipelines, Mongolia hopes to construct China-Mongolia-Russia oil pipeline to realize pipeline transportation. Afghanistan and Pakistan are important passages connecting the oil and gas rich areas in the Middle East and the Central Asia to the oil and gas consuming areas in China, East Asia and South Asia. However, there are no transnational oil and gas pipelines in the two countries. Both of these two countries desire to become the transit countries of oil and gas pipelines, and hope to promote the construction of Iran-Pakistan oil and gas pipeline, China-Pakistan oil and gas pipeline and Turkmenistan-Afghanistan-Pakistan-India gas pipeline.

Thirdly, consuming countries in the ASEAN and Northeast Asia have not been connected to each other to secure energy supply jointly. The ASEAN gas pipeline network has been proposed for many years. Malaysia, Indonesia and Singapore all intend to carry out this plan, but the implementation progress is so slow due to their different interest demands and lack of solutions to securing resource. Shangdong (China) - Inchon (Korea) - Kyushu (Japan) pipeline has been discussed for a long time. All the three countries, especially Korea, have strong desires to construct the transnational pipeline. However, this pipeline still remains in the conceptual phase due to various reasons.

3.2.2 Domestic pipelines

Domestic oil and gas pipeline construction in most of the countries (with the exception of a few countries) along the Belt and Road such as Iraq, Iran, Kazakhstan, Tajikistan, Kyrgyzstan, Pakistan and Bangladesh is immature, and so enormous investment is needed to realize interconnectivity. In Tajikistan, the domestic pipeline network coverage degree is low, and the new refinery projects (such as Dangghara Refinery) require associated oil pipelines. The southern area of Kyrgyzstan lacks pipelines, and has insufficient gas supply. And therefore, it demands new domestic pipelines. Pakistan is making great efforts to carry forward the upgrading and expansion of existing gas pipeline network (such as Gwadar-Nawabshah gas pipeline), and so requires tremendous investment. Bangladesh is planning to reinforce its domestic gas pipeline network construction, and is in urgent need of foreign funds and technology support. It allows foreign investors to take part in the oil and gas pipeline construction by the means of BOO, BOT, BOOT and PPP. Besides, it also offers national treatment to foreign investors. The same is true for the Middle East area with rich resources. In the case of Iraq, its pipelines were damaged severely in the war, and the pipeline transportation capacity is far too low, which has impacted oil and gas production and export.

Moreover, restricted by the Strait of Hormuz, some countries including Iran, Saudi Arabia and the UAE are looking for opportunities to construct or expand strategic export pipelines bypassing the Strait of Hormuz, and have demands for constructing strategic pipelines. Iran is
planning to build a pipeline running from the south northwards to reach the Indian Ocean. Saudi Arabia has built a strategic pipeline running from the east westwards to reach the Red Sea. The UAE has built a strategic oil pipeline stretching from Abu Dhabi to Al Fujayrah Port, but it is still looking for opportunities to expand its transportation capacity.

In addition to oil and gas pipelines, product oil pipelines in this region are even more needed. Particularly the countries with a large population, vast territory and huge petroleum consumption such as India, Indonesia and Bangladesh, have strong demands for the construction of product oil pipelines.

### 3.3 Oil refining and chemical engineering is a necessary step for oil and gas application

The east end and the west end of the Belt and Road connect respectively the two biggest oil and gas consuming markets in the world. Oil refining and chemical engineering are significant for oil and gas application, and so the refining industry in the region has great development potential and absorptive capacity. According to rough estimate, more than 200 million tons of newly increased refining capacity will be needed by countries (not including China) in the region by 2020, and therefore more than 100 billion dollars of investment will be needed. At the same time, the requirements of green and low carbon development, equipment upgrading and rebuilding, and product structure optimization also provide cooperation opportunities for refining and chemical industry in the Belt and Road region.

#### 3.3.1 Oil refining demand

Although the total refining capacity of countries along the Belt and Road is in excess, individual country’s desire for development is still strong because their refining capacities and levels vary from each other. Three factors, which are productivity construction, technical transformation and product quality upgrading, bring about extensive cooperation opportunities in refining industry for countries along the Belt and Road. First, from the perspective of productivity construction, refinery construction, upgrading, productivity expansion and transformation in many countries are underway. It is predicted that by 2020 the number of refineries in the region will increase to 454 from 433 at the end of 2014, and the total refining capacity will increase by 400 million tons to reach 2.45 billion tons. Except for China, the nine countries, including Saudi Arabia, Iraq, Kuwait, Qatar, Oman, Egypt, India, Vietnam and Malaysia, have all planned to expand their productivity by more than 10 million tons. Secondly, from the view of refinery technical transformation, refineries of more than half of the countries in the region have old facilities, low technological level, insufficient deep processing capacity, weak comprehensive processing capacity and relatively single product structure, and so it is urgent to upgrade and transform the refineries. Besides, refinery capacities in the region are generally far too limited. In 2014, the average refinery capacity in the region is about 5.7 million t/a, which is lower than the world average level of 7 million t/a. Many countries have the intention to transform their old refineries. Thirdly, from the view of product quality standard upgrading, the general quality standard of oil products produced by refineries in the region is much lower than that of developed countries such as European countries, America and Japan. So far, there is no country in the region that can achieve Europe IV standard for gasoline and diesel, and only a quarter of the countries in the region can achieve Europe IV standard or higher. With the implementation of increasingly strict environmental standard, a lot of product upgrading work will be required.

#### 3.3.2 Petrochemical demand

The development level of petrochemical industry varied in the countries along the Belt and Road. Structural problems, such as relatively single product structure, incomplete product categories, more low-and-medium-end bulk products, less high-end products with additional value, weak comprehensive processing capacity, short industrial chain and insufficient deep and advanced processing capacity, exist even in countries with petrochemical industry. Cooperation opportunities for petrochemical productivity almost cover the whole region.

Concerns of countries along the Belt and Road for petrochemical cooperation also vary. First of all, in Russia, the development of ethylene industry is relatively lagged. The productivity of synthetic resin and synthetic rubber is great, but the product structure is relatively single. The future direction for petrochemical productivity cooperation with Russia is to take part in its construction and technical transformation by the means of joint venture cooperation. Secondly, the five traditional countries of Central Asia, including Kazakhstan and Turkmenistan, all have low productivity for ethylene and three major synthetic materials, and so they have the demand for attracting foreign investment to construct plants. The CIS countries such as Ukraine, Azerbaijan and Belarus have certain productivity foundation, but their product structures are relatively single. They have the demand for improving product structures and producing petrochemical products with high value-added. Third, petrochemical industries in the Middle East countries develop rapidly by relying on their abundance in raw materials, and their general capabilities are relatively strong. However, their key equipment relies on import from developed western countries. They produce more low-and-medium-end bulk products than high-end products. The future cooperation direction is to take part in actively the regional new
productivity construction and the high-end oriented development plan, especially the productivity construction of ethylene and synthetic resin. Fourth, except for India, other South Asian countries basically have no petrochemical industry. These countries have great demands for expanding the productivity of petrochemical products (such as ethylene and three major synthetic materials) as well as strong desires to attract foreign investment to develop cooperation in downstream industries (such as light textile, plastic processing, tire manufacturing, rubber product processing and clothing). Fifth, development level of petrochemical industry in South-east Asian countries varies. Countries with relatively lagged petrochemical industry such as Burma, the Philippines and Vietnam need to improve the productivity of basic petrochemical materials such as ethylene. The main demands of Thailand, Malaysia and Indonesia are to complete industrial chain, improve product structure and develop high-end products. Countries with developed petrochemical industry such as Singapore need to seek export markets.

3.4 Oil & gas trade is the focus of intra-regional oil and gas cooperation

The Belt and Road is an important oil and gas producing and consuming region in the world as well as active oil and gas trade region in the world. In 2014, crude oil and natural gas trade volume of countries along this route accounted for 48.5% and 51.8% (BP, 2015; IHS 2015) respectively of the total trade volume of the world. With the further advancement of oil and gas cooperation in this region, there will be more opportunities available for China (as the biggest oil and gas consuming country in the region) to cooperate with resource producing countries for oil and gas import trade and with consuming countries for product oil and chemical product export trade.

3.4.1 Crude oil trade

The Middle East-Central Asia-Russia will be the main export region of crude oil in the world for a long time. In Middle East, the six countries, including Saudi Arabia, Oman, Iraq, Iran, the UAE and Kuwait, will remain to be the most important petroleum export countries in the world in the future. It is predicted that by 2020 the petroleum export volume of the Middle East will amount to 1.23 billion tons with a 12% increase over that of 2014 (EIA, 2015). With the stable growth of petroleum production in North America and the decrease of petroleum consumption in Europe, the former’s petroleum export volume to Asian-Pacific region will increase continually.

Russia-Central Asia and the Middle East are the main cooperative partners of China for crude oil trade. In 2014, China imported 40 million tons of petroleum from Russia-Central Asia and 150 million tons from the Middle East, accounting for 13% and 52% (China’s General Administration of Customs, 2015) respectively of China’s total import volume of crude oil. In the future, Russia, Kazakhstan and the Middle East will remain to be the key cooperative partners of China for crude oil trade. It is predicted that by 2020, Russia’s petroleum exported to China will amount to 56 million tons, Kazakhstan’s petroleum exported to China via China-Kazakhstan oil pipeline will increase to 20 million tons, and the Middle East will have the capacity to export 290 million tons of oil to China.

3.4.2 Natural gas trade

The Belt and Road is an important natural gas production and supply region in the world as well as China’s important source region for natural gas import. The resource producing countries in Russia-Central Asia, Middle East and South-east Asia are the main cooperative partners of China for natural gas trade. In 2014, China imported 58.4 billion cubic meters of natural gas (China’s General Administration of Customs, 2015), and Qatar, Australia, Malaysia, Indonesia, Burma and Uzbekistan are the first six major source countries of export, accounting for 90% of China’s total import volume.

In the future, there is great potential for the natural gas trade between China and major resource producing countries. It is predicted that by 2020 Russia’s export volume of natural gas will approximately 350 billion cubic meters with a 40% increase over that in 2014, and it could export about 20 billion cubic meters to China. Turkmenistan and Uzbekistan could export 50 billion cubic meters and 5 billion cubic meters of natural gas respectively to China. The export volume of natural gas in the Middle East can reach 205 billion cubic meters with a 28% increase over that in 2014, and it can export 40 billion cubic meters to China. The export volume of natural gas in South-east Asia can reach 80 billion cubic meters, and it can export 20 billion cubic meters to China.

3.4.3 Product oil trade

China’s supply of product oil exceeding its demand and the urgent demand for importing product oil by other countries in the region provide important opportunities for China to conduct product oil trade with them. Among them, countries in South Asia and South-east Asia will become the major cooperative partners. It is predicted that by 2020, the total import volume of product oil in the region will amount to 290 million tons, and the import volume of South Asian and South-east Asian countries will total 180 million tons, accounting for 62% of the region. It is anticipated that China’s product oil can be exported to the seven countries, including Pakistan, Burma, Indonesia, Vietnam, Mongolia, Singapore and the Philippines in the future. However, it has to be pointed out that currently the
overall refining capacity in Asian-Pacific region is in excess. Many countries both inside and outside the region, such as Korea, Japan, India, Singapore and Russia, are competing with China for the export market of product oil in the region, and this competition is expected to be very intense. To secure more market shares, China has to reduce further the refining cost, and improve the international competitiveness.

3.4.4 Petrochemical product trade

Sinopec has relatively developed industry and a full range of products. Its productivity for petrochemical products such as ethylene and three major synthetic materials is top-ranked worldwide. The development of petrochemical industry in most of the countries in the Belt and Road region is apparently lagged. In addition, it is common for these countries to have unbalanced product structure and the need to largely import some products. All these countries have the desires and potentials to develop petrochemical product trade. In the future, South Asia with poorly developed petrochemical industry and Russia-Central Asia and South-east Asia with structural problem will be the key cooperative regions for petrochemical product trade. The products of concern are synthetic resin in Russia-Central Asia, ethylene, synthetic resin, synthetic rubber and synthetic fiber in South Asia, and synthetic resin and synthetic fiber in South-east Asia. Similar to the cooperation in product oil trade, petrochemical trade likewise is faced with fierce competition from the US, Western Europe, Japan, Korea and the Middle East.

3.5 Construction of LNG and storage infrastructures is effective supplement to oil and gas trade

With the fast promotion of oil and gas trade, the construction of LNG and storage infrastructures has also seen a rapid development, and has become one of the key development areas for oil and gas cooperation. It will play an active role in promoting oil and gas trade.

3.5.1 LNG facilities

LNG facilities include a resource producing country’s LNG production line and export terminal, and a consuming country’s LNG import terminal and re-gasification facilities. Based on the current situation of infrastructure construction in the areas of LNG production, utilization and consumption and the cooperation demands of relevant countries, the cooperative partners for LNG facility construction fall into three groups: Russia with developed LNG industry but insufficient fund; Iran and Iraq with abundant natural gas resource but low LNG utilization degree; and Ukraine, India, Pakistan, Bangladesh and Thailand with scanty natural gas resource and import facilities.

3.5.2 Storage cooperation

Storage cooperation covers both oil and gas storage construction and operation. Countries along the maritime Silk Road are the main cooperative partners. Complete storage facilities cannot only ensure the petroleum supply stability for countries along the maritime Silk Road economic belt, but also enhance their flexibility in trade. At present, Pakistan, Burma, Sri Lanka and Djibouti have cooperated with China for port development. The construction of oil and gas facilities at Gwadar Port and Kyaukpyu Port are underway. Colombo Port and Djibouti Port are also key target areas for the construction of oil and gas storage facilities. In the future, countries along the maritime Silk Road such as India, Bangladesh, Thailand, Malaysia, Indonesia, Vietnam, Brunei and the Philippines will also have demands for port development and oil and gas storage facility construction.

3.6 Engineering technologies and equipment manufacture are the extended focuses of oil and gas cooperation

3.6.1 Oil & gas engineering technologies

General oil and gas engineering technical service capacity of countries along the Belt and Road is far too low. With the fast development of exploration, development, oil refining, petrochemical and pipeline construction in the region in the future, demands for international engineering technical service teams will increase greatly. It is also favorable for China’s engineering technical service teams to carry out international cooperation based on the ‘Going Global’ strategy. There exist huge potential demands to conduct cooperation in building alpine region exploration and development technology R & D center in the Far East jointly with Russia, promoting the exploration technologies of carbonatite, deep water and deep oil and gas seismic exploration, high precision acquisition and processing and high density 3D acquisition, and the development technologies of extended-reach horizontal wells, multilateral wells, extra-deep wells and ultra-high temperature drilling in the circum-Caspian region, expanding the desert exploration and development technologies and high sour oil and gas field development technologies in the Middle East, and providing comprehensive research and conceptual design of oil and gas geology, oil and gas development and production in the South-east Asia.

3.6.2 Oil & gas equipment manufacture

It is roughly estimated that more than 30 billion dollars’ worth of petroleum equipment are needed annually by countries along the Belt and Road. Products required by these countries cover all business areas of petroleum upstream, midstream and downstream. There exists great
potential and space for cooperation in specific equipment manufacturing business. The future cooperation in oil and gas manufacturing includes equipment and relevant accessory systems demanded in large quantities, such as the arctic exploration equipment, offshore drilling platforms, polar low temperature track-mounted drilling rigs, large LNG equipment and large compressor packages required by Russia. The demands of Central Asian countries for corrosion resistant gathering and transportation pipelines and collapse resistant line pipes are great. The demands of Caspian Sea littoral countries and Malaysia and Indonesia in the South-east Asia for offshore engineering equipment and relevant accessory systems (such as large offshore drilling platforms and offshore drilling and work over equipment) are great. The demands of Middle East countries for desert engineering equipment (such as marine-origin gas field development equipment, desert quick-moving drilling rigs, sulfur resistant and sand control producing equipment, water seepage producing equipment, airtight joint tubings and casings and corrosion resistant and acid resistant line pipes) as well as the development equipment for brown oil fields with high water cut are great. After the sanctions against Iran are lifted gradually, its demand for oil field equipment replacement will be great.

To improve the oil and gas supply capacity, the implementation of four measures should be sped up. The first is deepening existing projects. Enhance the operation of existing projects such as Kashagan in Kazakhstan, Yamal in Russia, Rumaila in Iraq, and MIS in Iran to optimize continually asset structure and portfolio. The second is expanding risk exploration. Integrate China’s advantages in the theories and technologies of subtle reservoir exploration and ultra-deep exploration to promote the joint risk exploration in Russia, Kazakhstan, Turkmenistan, Iraq, Iran and Indonesia. The third is improving development level. Expedite the cooperation in developing large oil and gas fields not developed, brown oil field EOR, and low grade oil and gas fields. The fourth is developing sea areas. Speed up resource investigation, exploration and development of undisputed areas in the South China Sea to promote the joint efforts in developing with independent development, to drive multilateral efforts with bilateral actions, and to push forward the cooperation in less sensitive areas, as well as construction of large gas areas in the East China Sea to promote the exploration and development of disputable areas.

### 4 Capacities to deepen future oil and gas cooperation in four areas

Oil & gas cooperation in the Belt and Road region lay foundation for the specific implementation of the BR Initiative. In the future, however, in order to deepen the oil and gas cooperation in the region, comply with new circumstances, mitigate potential risks, and grasp comprehensive cooperation opportunities in the areas of upstream, passages, trade, refining, petrochemical, storage and engineering technical equipment, the capacities in four areas should be improved continually, and the implementation of 16 measures should be sped up.

#### 4.1 Improve oil and gas resource supply capacity of the Belt and Road

Countries along the Belt and Road have abundant oil and gas resources, and have great potential for production increase. Based on the optimization and integration of existing projects, it is proposed strongly that an overall resource investigation covering the whole region should be carried out, and the construction of risk exploration cooperation areas, brown oil field EOR demonstration areas and 10-million-ton and above oil and gas resource cooperation bases should be highlighted. In this way, the oil and gas production and supply capability can be improved worldwide.

#### 4.2 Improve oil and gas market impacting capacity of the Belt and Road

Only by improving the Belt and Road region’s influence on the global oil and gas market, can China’s discourse power over the regional oil and gas trade be improved, can China take the initiative in oil and gas cooperation, and can mutual benefits and win-win situation be realized. To improve the influence of the Belt and Road region’s oil and gas market, construction in four areas should be sped up. The first is the construction of trading center. Make Shanghai the central market of Asia-Pacific oil and gas trade by uniting resource producing and consuming countries and using China Yuan as the major vehicle currency to radiate the North-east Asia, Central Asia and South-east Asia, to form a global oil and gas trade market involving the joint efforts of many countries, and to improve the discourse power over market. The second is the construction of an e-commerce platform. Satisfy the demands of countries along the Belt and Road for product oil and three major synthetic materials, and promote the cooperation and sharing of China’s advantageous productivity for product oil and petrochemicals with surrounding countries. The third is the construction of shared oil and gas reserves. Promote the construction of shared strategic reserve system with major oil producing countries such as Saudi Arabia, Iran, Iraq and Russia and major oil consuming countries such as Japan, Korea, India and Pakistan to realize the share of facilities and reserves, and to ensure the oil and gas supply security in the region. The fourth is the construction of logistics center. Build free
economic ports or zones in Shanghai, Qingdao and Yangpu to carry out policy innovation, to realize convenient investment and trade, free currency exchange, efficient and easy regulation, and normative legal environment, and to speed up the circulation of oil and gas.

4.3 Improve oil and gas transportation capacity of the Belt and Road

Only by planning regional oil and gas resource production and demand market on the whole, deepening bilateral and multilateral cooperation related to oil and gas passages, and promoting continually the construction of oil and gas passage system, can interconnected intra-regional oil and gas transportation capacity be improved.

To improve the oil and gas transportation capacity, development in four areas should be accomplished. First, improving four major passages. Make efforts to expand the north-west passage, the north-east passage, the south-west passage, and the sea passage. Plan the feasibility research comprehensively on oil and gas transportation projects related to the six major economic corridors of China-Mongolia-Russia, New Eurasian Land Bridge, China-Central Asia-West Asia, China-IndoChina Peninsula, China-Pakistan and Bangladesh-China-India-Burma. Promote the construction of Shandong-Inchon (Korea) subsea pipeline, and construct the East China Sea and South China Sea oil and gas pipeline network. Second, participating in the construction projects of oversea passages. Support the construction of oil and gas pipeline network bypassing the Strait of Hormuz, which connects to the Indian Ocean by Saudi Arabia and Iran. Take part in actively the construction of oil and gas passages such as East Siberia-Pacific Ocean oil pipeline, Iran-Pakistan-India gas pipeline, Iraq-Jordan-Red Sea oil-gas pipeline, TAGP, the Arctic passage and Kra Canal project. Third, value key ports, which include Hambantota Port of Sri Lanka, Gwadar Port of Pakistan, Kyaukpyu Port of Burma, Djibouti Port of Djibouti, and Dar-es-Salaam Port and Bagamoyo Port of Tanzania on the ‘chain of pearls’. Fourth, boosting green shipping. Strive to build LNG powered vessels and supporting facilities.

4.4 Improve oil and gas industry development capacity of the Belt and Road

Cultivate and develop various characteristic industrial clusters, which are regional oil and gas production and demand oriented, and industrial park or R & D center/base construction based, to improve integrally the comprehensive competitiveness and sustainable development capacity of local oil and gas industries.

To improve the development capacity of oil and gas industries, joint construction in four areas should be carried forward. First, joint construction of refining and petrochemical parks. Construct export-oriented refining and petrochemical projects in countries with apparent resource advantages such as Saudi Arabia, Russia, Qatar, the UAE, Kazakhstan and Turkmenistan, as well as construct domestic demand-oriented refining and petrochemical projects in countries with great market potential such as Indonesia, Vietnam, Turkey and Malaysia. Construct industrial parks with three major materials as the main products in Pakistan, Saudi Arabia, Indonesia and the UAE to integrate the R & D, design, construction, equipment, and operation capabilities of refining and petrochemical industry. Second, joint construction of engineering service capacities. Give full play to China’s advantages in drilling EPC contracting and seismic technologies to carry forward the EPC contracting of oil-gas field development, to provide packaged solution to hard-to-produce resource, and to support the resource producing countries’ development of oil and gas at low cost and high efficiency. Third, joint construction of equipment bases. Set up equipment manufacturing bases specifically for developing marine-origin gas fields of the Central Asia-Middle East, oil-gas fields of alpine region, and high water cut brown oil fields in the Central Asia, Russia and the Middle East. Pay high attention to Iran’s enormous demand for oil field equipment transformation and replacement after the sanctions against it are lifted. Fourth, joint construction of R & D bases. Construct in China key R & D laboratories and engineering technical centers of intelligent oil and gas equipment to develop digital oil field systems, domestically made oil/gas pipeline control systems, intelligent equipment, intelligent refineries and the comprehensive utilization technologies of gas power generation and distributed energy.

References


