

## Oil Supply Crucially Related to Energy Security

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**ABSTRACT:** Taiwan lacks traditional indigenous energy resources and each year imports more than 97% energy demand from the politically unstable countries in the Middle East or South America; plus, coupled with Taiwan's economic model of energy-intensive industry relationships, how to implement the highest guiding principles of energy security policy is an important issue in terms of Taiwan's energy supply. Because closely related to economic development and social stability, energy policy in terms of secure supply is especially focused by the countries in the world that currently adopt the relevant measures no more than such as, distributed imports; supply diversification; and full safety stock. The so-called "not put the all eggs in the same basket" means that energy imports do not focus on a particular region or country, in order to achieve the decentralized political purpose; secondary, the supply diversification benefits except from avoiding an energy crash brought from the outside disaster, but also timely avoiding from the certain high energy prices; in other words, establishing the most costive energy supply mix can facilitate the development of a country's livelihood. Finally, the adequately secure stock is defined by a certain number of energy storage mechanisms in response to international or domestic major accidents caused by paralysis of energy supply to ensure the sustainable management of national economy.

**Keywords:** Energy security; Policy; Petroleum.

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### I. INTRODUCTION

The definition of "energy security" generally refers to the supply of energy at a reasonable price, and in a reliable and appropriate manner [1]. Here, reliable and appropriate supply means an uninterrupted supply that meets the needs of the global economy. The definition of a reasonable price may be obscured by the evolution of time, and its interpretation will vary with the identity of the energy producers and users. However, in general, energy prices are determined by the production costs and the supply and demand markets [2].

When the market supply and demand are imbalanced, energy prices will change. Energy security is "Two Sides of One" of the supply and demand markets [3]. When the supply side is greater than the demand side, the market price, of course, falls, therefore a sense of security goes to the energy users, but there is a sense of crisis to the producers, and vice versa. Here we focus on the need for energy imports of countries, rather than energy-producing or exporting countries, as the general public's energy security is only the national energy security scaled down [4]. On the economic level, when the energy crisis occurs, generally refers to the abnormal rise in the international energy market prices, so that the people's livelihood economy of the energy-importing countries will be hit, or even the normal operation of the country will be shaken.

In addition, the occurrence periods of energy crisis can be categorized into the short term and the long term. A short-term energy crisis includes the natural disasters, the abnormal weathers and other factors. The long-term energy crisis comes from the fact that energy supplies do not catch up with rapidly rising energy demand, for economic, financial or political reasons. In recent years, energy supply and demand situations should belong to the latter, especially many emerging economies, such as China, India, Russia, Brazil and South Korea, which have emerged rapidly, making the globally temporarily shortage of energy and resources supply shortage, so the energy resources prices are always high [5, 6].

Current energy security issues are still dominated by the oil security issues [7]. Because according to the latest BP statistics, so far, oil is still the most important use of energy projects. Second, the oil trade is the world's largest energy transaction, accounting for two-thirds, with reference to Fig. 1 and Table 1. Third, compared with coal and natural gas, oil reserves are less and unevenly distributed. More importantly, oil demand is concentrated in a few industrialized countries, but oil production is concentrated in a few developing countries. Compared with most other commodities, the international oil market is more easily manipulated. Indeed, the Organization of Petroleum Exporting Countries (OPECs) has the substantial ownership in the global oil market, with an absolute advantage of 41.4 per cent of global production and 71.4 per cent of reserves [8, 9]. The focus of this paper is therefore on oil security issues.

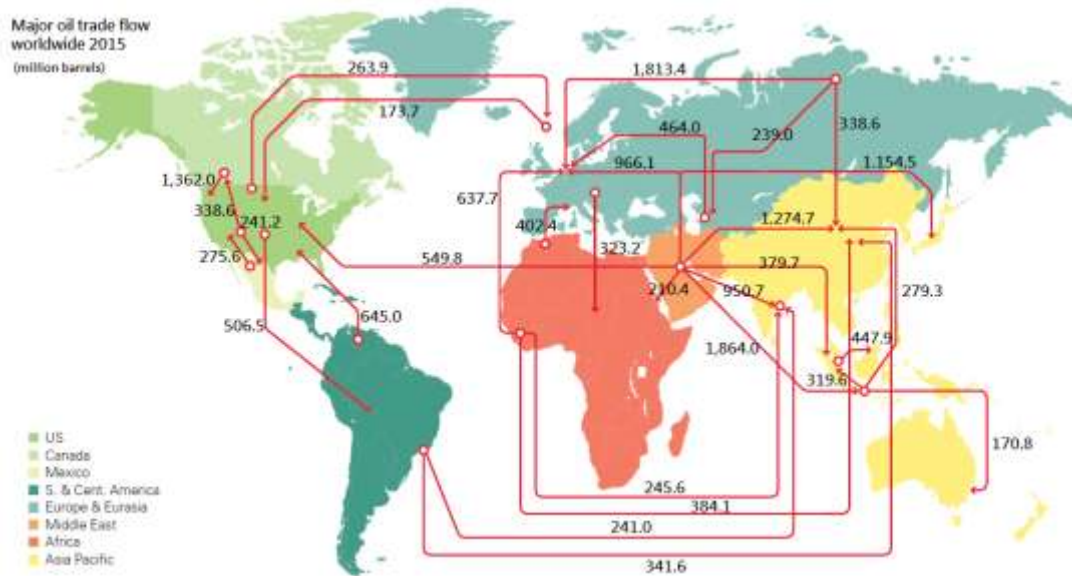


Fig. 1 Major oil trade worldwide flow in 2015 (unit: million barrels)

Table 1 Major oil trade in 2015 (unit: thousand barrels daily)

	Crude imports	Crude exports	Product imports	Product exports
US	7,351	491	2,050	4,145
Canada	657	3,200	613	627
Mexico	-	1,201	774	171
S. & Cent. America	404	3,462	1,908	605
Europe	9,801	204	3,847	2,701
Russia	57	5,115	41	3,139
Other CIS	465	1,626	269	249
Middle East	158	17,665	776	2,954
North Africa	162	1,235	683	397
West Africa	9	4,327	588	130
East & S. Africa	134	170	467	32
Australasia	491	184	540	63
China	6,743	57	1,453	767
India	3,919	3	488	1,150
Japan	3,370	6	976	363
Singapore	918	1	2,628	1,855
Other Asia Pacific	5,067	759	3,415	2,166
<b>Total World</b>	<b>39,707</b>	<b>39,707</b>	<b>21,516</b>	<b>21,516</b>

Data source: BP Statistical Review of World Energy June 2016.

## II. THE EVOLUTION OF THE GLOBAL OIL MARKET

In terms of global business and consumer behavior, oil is the most important commodity. Moreover, oil is still the largest single energy commodity in most regions, with proportion of about 36% of the world's total energy demand, up to 50% in the 1970s. The exception was the former Soviet Union, where natural gas was the primary source of energy, and the Asia-Pacific region, where coal was the main fuel. Total global primary energy consumption in 2015 is 13.15 billion metric tons of oil equivalent (toe), of which oil accounts for 4.33 billion metric tons of oil equivalent. On the purpose to better understand the changing nature of the oil security issue further, it is necessary to understand the evolution of the oil market over the past decades. Basically, the history of modern global oil market can be divided into the following five periods.

### 2.1 1960-73 period

The first period was from 1960 to 1973 (the first oil crisis), that is, the period of low and stable oil prices [10]. The strong economic growth contributed to the surge in oil demand. The supply of oil was dominated by a small number of multinational companies. The world paid not too much attentions to the oil supply security issues. In this period, the demand for oil and chemical products rose from 20mb/day to 60mb/day. Among them, the demand from the Organization for Economic Cooperation and Development (OECD) accounted for two-thirds [11]. Since most OECD countries were not involved in oil production and North American oil production was stagnant at the time, the OECD relied heavily on OPEC oil exports in the Middle East. Organization of Petroleum Exporting Countries (OPEC) was established in Baghdad in September 1960, then the members were: Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. OPEC was established on the objectives: through the control of the global balance between supply and demand of crude oil to maintain the price of crude oil in a certain range. Production quota - proportion of production ceiling through aggregate agreement, adjusted at any time - allocated to Member States. Currently, except above-mentioned five founder members, OPEC Member States include: Qatar, Libya, Algeria, Nigeria, the United Arab Emirates, Indonesia, Gabon, and Angola [12]. OPEC produced about 41.4% of the world's crude oil and had proven reserves of the world's 71.4% at end of 2015 [13]. OPEC today has been able to successfully dominate the global oil market [14]. The main credit is attributed to Saudi Arabia, who sometimes is even willing to sacrifice its own production and profits to achieve the global oil price adjustment function and role [15].

### 2.2 1973-86 period

The impact of the second oil crisis in 1973-86 on the global economy was very big, not only ended the early rapid economic growth, but also triggered a chaotic global economic market and structural adjustment [16]. This second period lasted until the mid-1980s; the global oil market and economic and social characteristics were: (1) the nationalization of oil industry in the main oil-producing countries in the Middle East; (2) the rapid rise in oil prices [17]; and, (3) the ensuing recession. The development of these scenarios not only deepened the concern of oil security, but also led to the depletion of natural resources that may be the human vigilance [18].

In response to this dilemma, the OECD developed countries set up the International Energy Agency (IEA) in Paris, France in November 1974 [19]. Through their own oil production, the development of alternative energy sources and the improvement of energy efficiency, the OECD Member States had greatly reduced the reliance on imported oil [20]. Specific examples included the addition of fuel supply chains from the new oil fields in Alaska, the introduction of nuclear energy and coal to replace most of the oil-based power generation, and the introduction and establishment of energy-saving measures or mechanisms [21]. With this effort, OECD net oil imports fell from 27mb/day peak in the mid-1970s to 16mb/day in the mid-1980s. In addition, the establishment of safe stock, restraint on the demand side and other contingency measures, making the OECD Member States improve the security of supply [22].

### 2.3 1986-2000 period

The collapse of oil prices in 1986 ended the first ten years of decline in oil supply and demand. Since then, oil prices had been hovering in the low-end region, the economy had grown steadily, OECD crude oil consumption had risen again to 48mb/day, and net oil imports had even surpassed 1973 levels [23]. With the discovery of new oil sources, ample supplies and severe disagreements within the OPEC, concerns about the security of oil supplies had gradually eroded. On the contrary, when faced with the international market downturn in oil prices and sluggish demand, OPEC Member States worried the crude oil demand safety instead [24]. At that time, the energy sector turned its attention to climate change and other environmental issues [25].

During this period, the oil market also produced a fundamental structural change, making the impact of oil security more global, more cross-regional and more cross-sectoral, so a number of producers with domestic oil

refineries allowed upstream and downstream sectors to accept international investment. For making the market supply more open and competitive, the oil governments deregulated the state ownership, allowing private enterprises to join operation, such that the originally simple bilateral transactions became more complex and multilateral relations.

Developed countries understood that the nature of the economy as a whole should be changed. Their industrial forms had successively been switched from energy-intensive manufacturing to high value-added services. In addition, through technological progress, increased capacity, economic liberalization, etc., energy consumption reduced and energy efficiency improved [26]. Finally, most countries (especially in Europe) had sharply increased the tax rate on petroleum products, while two-thirds of tax revenue came from petroleum products in Europe, and one-half in the OECD [27].

Since 1986, West Texas Intermediate (WTI), Brent Blend (UK) and Dubai Fateh (Dubai) have become the three major indicators of global oil prices. WTI is the United States local indicator, while Brent is the main oil price indicator outside the United States [28].

#### **2.4 2000-2007 period**

These changes in the global economic system, for a certain degree of reductions in oil demand, can be discerned by several digital changes [29]. First, the share of developed countries in oil consumption in energy mix had fallen from 55% in 1980 to 40% today, as natural gas and coal become the important alternative fuels in household heating, petrochemical industry and electricity sector. Second, the proportion of oil imports in OECD in 1981 was 13%, but only 4% in today. Finally, in terms of GDP contribution, developed countries now require only a half of the oil in the early 1970s. However, due to the emergence of emerging countries, such as China, India, Brazil and Russia, the so-called BRIC countries, with rapid economic growth, the demand for oil increase rather than reduce, especially in three major oil consumption sectors, namely, energy, transportation and petrochemistry [30, 31].

Although both the supply and demand sides in global economy can barely maintain in balance, but the situation may be changed or worsened by multiple factors from major oil-producing countries, for example, the Iraq war, Iran nuclear weapons, Venezuela and Russia nationalism and many others [32]. At the same time, non-OPEC countries to enhance capacity is limited, for example, the United States, Mexico and the North Sea and others, due to the reduction of oil reserves[33]. On the contrary, the productions of Russia and Australia are new high, which means the future supply of crude oil is still in the hands of OPEC countries [34]. Although joint ventures have plans to increase production, they will still limit production to achieve higher profit targets.

With the development of the oil market and the increase of transparency and efficiency, the mechanism to deal with the energy crisis is more sound. Therefore, compared to the first and second energy crisis of the 1970s, people in the 21st century are more composed in facing the advent of high oil prices. However, these high oil prices and high inflationary pressures, for the global economic growth, does cause no small impact [35].

#### **2.5 2007-2016 period**

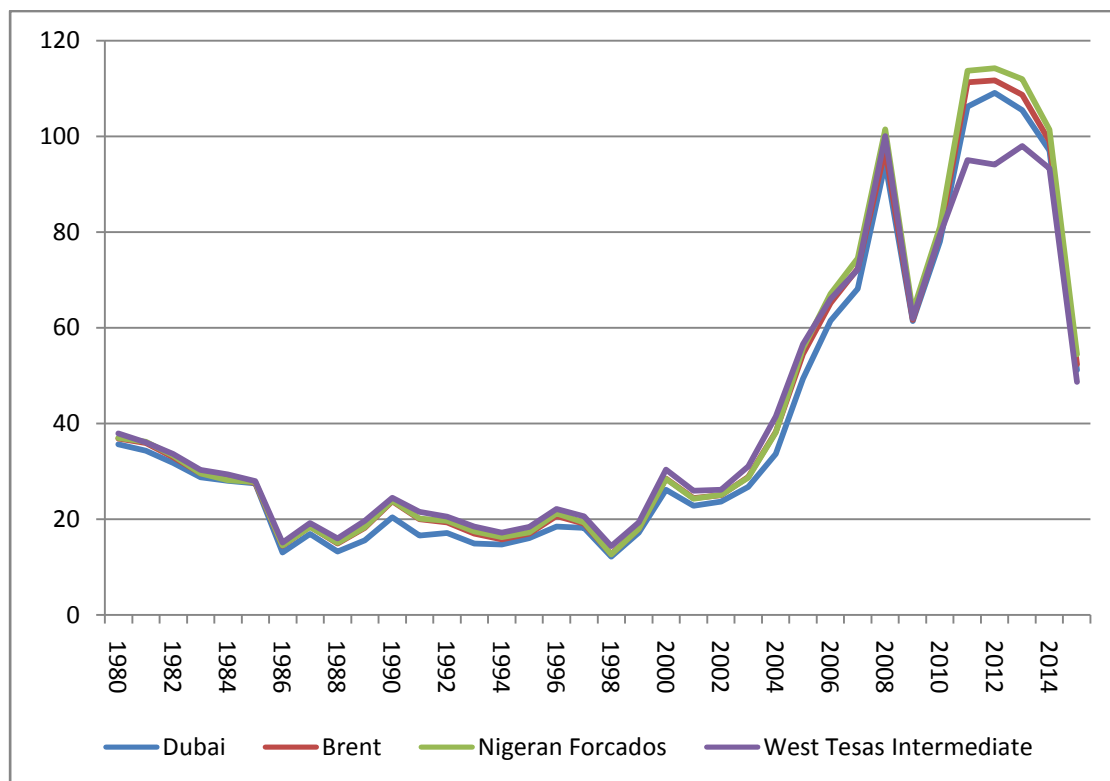
The emergence of shale oil in the United States, not only creates a new century energy revolution, but also shakes the global energy dominance by the OPEC. To combat the threat of shale oil penetrating into the global oil market, Saudi Arabia first launched the oil production increase plan, while Russia clings to the bottom line of not cutting down oil yield, with the lifting of oil transport ban on Iran, resulting in the surplus supply in global oil market, international oil prices continuously fell from \$107.9/barrel the historical peak since June 2014, eventually stopped at 27.0 US dollars/barrel of the lowest price in January 2016 [36]. Low oil prices cause the international financial and economic downturn; especially they are detrimental to the global economic development.

To this end, OPEC frequently held meetings to cut oil production to save the economy of oil production countries and the entire world. For example, at the end of November in Vienna, the OPEC Member States decided first time since 2008 to cut oil production. The production reduction agreement will be 1.2 million barrel/day expected to be effective on the new year day 2017 with the total reduction target of 3,250 million barrels, the review will be processed after 6 months since then. Stimulated by the news, the international spot oil prices were up to \$50 per barrel or more. Major industries and countries planned to raise international oil price target price, and \$60 a barrel is to return in next year, expected by UBS. The historical oil prices are shown in Table 2 and Fig. 2.

**Table 2** Spot crude oil prices in recent years(Unit: \$/barrel)

	Brent	Wet Texas Intermediat	Dubai	Nigerian Forcados
2010	79.5	79.45	78.06	81.05
2011	111.26	95.04	106.18	113.65
2012	111.67	94.13	109.08	114.21
2013	108.66	97.99	105.47	111.95
2014	98.95	93.26	97.07	101.35
2015	52.39	48.71	51.20	54.41

Data source: BP Statistical Review of World Energy June 2016.



**Fig. 2** Spot crude prices in last 35 years (1980-2015) (Unit: \$/bbl)

Data source: BP Statistical Review of World Energy June 2016.

### III. THE GLOBAL MARKET OVERVIEW

Most of the world's oil is used as energy sources, in which the main consumption sectors are transport and power generation. Among the global primary energy use mix, oil accounts for 32.9% of global primary energy consumption, followed by coal (29.2%), natural gas (24.3%), and other non-fossil energy sources, such as renewable energy (9.6%) and nuclear energy (4.4%). Non-energy uses of petroleum include the productions of plastic, synthetic fiber, rubber and other raw materials, with the ratio of about 10%.

The transportation sector accounts for 56 percent of global oil consumption, 33 percent for industry, 7 percent for households, and 4 percent for businesses [37]. In addition to the petrochemical products are exclusive for the transport sector, the energy use mixes in other parts of the various countries are very different.

Faced with competition from natural gas and coal, the proportion of oil used in power generation sector is declining [38]. Gas-fired power plants are cheaper to build and environmental friendly than most fuel-fired power plants, and coal-fired power generation is cheaper in countries with more coal production (e.g., China).

Oil dominates 95% of the energy demand in the transportation sector, but with the rises of gasoline and diesel prices, encouraging the rise of biofuels and high-pressure natural gas [39]. Ethanol is an important vehicle fuel in Brazil, and the US government is encouraging ethanol to become more and more important in the transportation sector. Over the next 25 years, oil still accounts for no less than 90% in transportation energy use. The IEA estimates that between 1997 and 2030, the transportation sector will account for two-thirds of the growth in oil consumption.



When autumn and winter are coming in the northern hemisphere, the oil consumption will gradually increase. When the cold is approaching, heating demand reaches its peak in North America, Europe and Asia, where the oil consumption will also reach the highest. This phenomenon in Europe and Asia is less obvious, where the natural gas is more used than oil in the space heating [40]. When the global weather backs to spring season with higher temperature, the oil consumption also slows down, but entering into summer, with the North American vehicle volume increases, the oil consumption will increase again.

**Table 3** Oil consumption in major regions/countries in the world (Unit: million barrels/day)

	2011	2012	2013	2014	2015
North America	23.33	22.93	23.36	23.42	23.64
Europe & Eurasia	19.08	18.60	18.37	18.27	18.38
Asia Pacific	28.89	30.00	30.59	31.12	32.44
OECD	46.07	45.51	45.55	45.13	45.64
China	9.79	10.23	10.73	11.20	11.97
S. & C. America	6.62	6.78	7.03	7.19	7.08
Middle East	8.46	8.77	9.01	9.35	9.57
Africa	3.41	3.58	3.68	3.76	3.89
Commonwealth of Independent States	4.14	4.23	4.20	4.28	4.09
Europe Union	13.51	12.95	12.71	12.51	12.71
Non-OECD	43.72	45.14	46.50	47.98	49.36
Total World	89.79	90.66	92.05	93.11	95.01
Annual Variation (%)	1.16	1.00	1.53	1.15	2.04

Data source: BP Statistical Review of World Energy June 2016.

Although oil consumption is directly proportional to GDP growth, the share of global consumption of oil in OECD countries had fallen from 70% in 1975 to 58% in 2006, due to the emphasis on global warming issues and efforts to energy saving [41]. On the contrary, non-OECD global oil consumption ratio is increasing. Since 2000, the annual growth rate is 4%, while only 0.4% for the OECD countries. According to the IEA's statistics of global oil consumption per capita, there are 3 gallons per day in the United States, 1.4 gallons per day in other OECD countries, and 0.2 gallons per day in other regions.

The fastest growing region of oil consumption in the non-OECD countries is in the Asia-Pacific region, with annual growth rates of more than 2.8 percent between 2005 and 2015. The region's current oil consumption accounts for 34.7% of the world, in which the most important reason is from China's rapid economic growth [42]. In China, although the use of coal increases rapidly, because of the rapid growth of cars, making the use of oil increased faster, as shown in Table 3.

In the oil industry structure of the past 30 years, Shells, BP, Mobil, Gulf, Texaco, Chevron, and so on, the so-called "Seven Sisters" dominated the global oil industry in the 1970s, as a result of mergers and acquisitions [43, 44, 45]. Moreover, due to the merger between Exxon-Mobil and Chevron-Texaco, there are only five international oil enterprises remained now, with the global share less than 20%. Mainly due to a large number of oil-producing countries had replaced the private oil companies, and took back the oil field ownership and production rights. In terms of capital, the conglomerate is still large, but in terms of resource holdings, the consortium has been dwarfed by the national oil companies. The largest holders of oil reserves are: Saudi Aramco, Gazprom, the Iraqi Ministry of Oil and Iranian Petroleum; the following are: ExxonMobil, Kuwait Petroleum, BP, Shell and Pemex. Almost all of the Middle East oil companies are included. As oil becomes scarcer and oil prices increase, interests in oil exploration and production increase: exploration spending increased by 20 per cent in 2005 and by 30 per cent in 2006. At the same time, production costs also rise rapidly. Since 2000, upstream capital costs have risen by 79 per cent as a result of rising steel prices and labor shortages, and in 2006 mining plans had expanded by 30 per cent.

In addition to mining, the global crude oil market also includes refining operations. Many refining operations are combined with the downstream marketing of gasoline products, or combined with the upstream mining operations. At present, the global refining capacity is 79.6 million barrels/day, of which more than half is in the OECD countries. Refining operations are generally implemented in gasoline-consuming areas to save costs, so the Middle East is the world's largest oil production region, but most of the refining industries are still concentrated in the United States, accounting for about 20% of the world, followed by Europe and Asia [46].

In the past, the profitability of refining oil was not high, and often compressed to meet the huge demand for environmental protection costs, but with the increase in demand for gasoline, refining operations once again become a high-profit industry due to short supply. New refineries continuously set up in the Middle East and the Asian regions, the rest of the regions are limited to the old factory renovation.

As revealed in Table 4, according to BP statistics, due to the continuous discovery of new oil sources, at the end of 2015, the global proven recoverable oil reserve is 1.70 billion barrels, which increases instead of decrease, compared with 1.21 billion barrels in 2006, 1.05 billion barrels in 1996 and 0.877 billion barrels in 1986. The R/P ratio (i.e., the total reserves divided by annual production) at the end of 2015 is about 50.

About half of the world's oil reserves are in the Middle East. According to the current production rate, the remaining volume can be in use for about 73 years. Other regions, such as North America about 33 years, OECD 30 years, the Asia-Pacific region 14 years. Outside the Middle East, there are 11 countries with the R/P ratios greater than 30 years: Canada, Ecuador, Chile, Venezuela, Kazakhstan, Chad, Libya, Nigeria, South Sudan, Sudan, Vietnam, and so on.

At the end of 2015, oil reserve in the Middle East is 803.5 billion barrels. Venezuela with 300.9 billion barrels is the world's largest oil reserved country, followed by Saudi Arabia's 266.6 million barrels; the third is Canada's 172.2 billion barrels. The most oil productive country in the world is the United States with production volume of 12.7 million barrels per day, followed by Saudi Arabia with 12.01 million barrels per day, and Russia with 10.98 million barrels per day.

**Table 4** Crude oil proven reserves in major countries/regions (unit: thousand million barrels)

	At end 1995	At end 2005	At end 2014	At end 2015	Share of total (at end 2015)	R/P ratio
US	29.8	29.9	55	55	3.2%	11.9
Canada	48.4	180	172.2	172.2	10.1%	107.6
<b>Total North America</b>	<b>126.9</b>	<b>223.6</b>	<b>238</b>	<b>238</b>	<b>14.0%</b>	<b>33.1</b>
Venezuela	66.3	80	300	300.9	17.7%	313.9
<b>Total S. &amp; Cent. America</b>	<b>83.7</b>	<b>103.6</b>	<b>331.7</b>	<b>329.2</b>	<b>19.4%</b>	<b>117</b>
Russian Federation	113.6	104.4	103.2	102.4	6.0%	25.5
<b>Total Europe &amp; Eurasia</b>	<b>141.2</b>	<b>139.5</b>	<b>154.6</b>	<b>155.2</b>	<b>9.1%</b>	<b>24.4</b>
Iran	93.7	137.5	157.8	157.8	9.3%	110.3
Iraq	100	115	143.1	143.1	8.4%	97.2
Kuwait	96.5	101.5	101.5	101.5	6.0%	89.8
Saudi Arabia	261.5	264.2	267	266.6	15.7%	60.8
Syria	2.6	3	2.5	2.5	0.1%	253.7
United Arab Emirates	98.1	97.8	97.8	97.8	5.8%	68.7
<b>Total Middle East</b>	<b>663.3</b>	<b>755.5</b>	<b>803.8</b>	<b>803.5</b>	<b>47.3%</b>	<b>73.1</b>
Libya	29.5	41.5	48.4	48.4	2.8%	306.8
Nigeria	20.8	36.2	37.1	37.1	2.2%	43.2
<b>Total Africa</b>	<b>72</b>	<b>111.3</b>	<b>129.3</b>	<b>129.1</b>	<b>7.6%</b>	<b>42.2</b>
<b>Total Asia Pacific</b>	<b>39.1</b>	<b>40.8</b>	<b>42.6</b>	<b>42.6</b>	<b>2.5%</b>	<b>14</b>
<b>Total World</b>	<b>1,126.2</b>	<b>1,374.4</b>	<b>1,700</b>	<b>1,697.6</b>	<b>100.0%</b>	<b>50.7</b>
of which OECD	149.2	244	253.9	255.3	15.0%	29.7
Non-OECD	976.9	1,130.4	1,446.1	1,442.3	85.0%	58
OPEC	786.6	927.8	1,211.1	1,211.6	71.4%	86.8
Non-OPEC	339.6	446.6	488.9	486	28.6%	24.9
CIS	121.5	122.2	141.9	141.1	8.3%	27.8
Canadian oil sands	41.5	173.6	166.2	166.2		

Data source: BP Statistical Review of World Energy June 2016.

The important oil-producing regions outside OPEC include the former Soviet Union, North America and the North Sea. The cost of oil production in these areas increases with the consumption of reserves, while the production of the rest of these oil fields is not much and it is difficult to mine.

As the shale oil revolution, the United States has become the world's largest oil-producer, and it is also considered as a major oil supplier. North Sea oil, mainly from Norway and the United Kingdom, after 25 years of sustained development, is now facing the moment of depletion. Other non-OPEC major oil producers in American continent are Canada, Mexico, Brazil, and Colombia, as shown in Table 5.

**Table 5** Annual crude oil production in the major countries/regions (unit: mb/day)

	2011	2012	2013	2014	2015
Saudi Arabia	11.14	11.64	11.39	11.50	12.01 (13.0%)
Iran	4.47	3.81	3.61	3.74	3.92 (4.2%)
Venezuela	2.76	2.70	2.68	2.68	2.63 (3.1%)
Iraq	2.80	3.12	3.14	3.28	4.03 (4.5%)
United Arab Emirates	3.32	3.40	3.64	3.68	3.90 (4.0%)
Nigeria	2.48	2.43	2.32	2.39	2.35
Kwait	2.92	3.71	3.13	3.12	3.10 (3.4%)
<b>OPEC</b>	<b>36.06</b>	<b>37.54</b>	<b>36.62</b>	<b>36.65</b>	<b>38.23 (41.4%)</b>
US	7.85	8.88	10.06	11.72	12.70 (13.0%)
Mexico	2.94	2.91	2.88	2.78	2.59
Canada	3.52	3.74	4.00	4.28	4.38 (4.9%)
United Kindom	1.12	0.95	0.87	0.86	0.96
Norway	2.04	1.92	1.84	1.89	1.95
<b>OECD</b>	<b>18.57</b>	<b>19.47</b>	<b>20.62</b>	<b>22.54</b>	<b>25.53 (24.9%)</b>
CIS	13.54	13.59	13.80	13.81	13.91 (15.6%)
Russian Federation	10.52	10.64	10.78	10.84	10.98 (12.4%)
China	4.07	4.16	4.22	4.25	4.31 (4.9%)
S. & Cent. America	7.40	7.32	7.34	7.60	7.71 (9.1%)
<b>Africa</b>	<b>8.55</b>	<b>9.33</b>	<b>8.71</b>	<b>8.37</b>	<b>8.38 (9.1%)</b>
<b>World in total</b>	<b>84.10</b>	<b>86.22</b>	<b>86.59</b>	<b>88.83</b>	<b>91.67 (100%)</b>
Growth (mb/day)	0.82	2.12	0.37	2.24	2.84
Growth rate (%)	0.98	2.52	0.43	2.59	3.20

Data source: BP Statistical Review of World Energy June 2016.

Regardless of quantity and amount, oil is the most internationalized trade commodity. 60% of the world's oil production is exported to other countries, including some refined petrochemical products. Most of the output oil is transported by tanker or piping. Because of low cost, high efficiency, and good flexibility, most of the intercontinental oil transport is by tankers.

The United States, the world's largest oil importer, imports a quota of 9.4mb/day, while Japan and Germany rely on more than 90% of imported crude oil. In 2015, the Middle East and Russia separately export 33.7% and 13.5% of the world's total oil output. Particularly, Asia-Pacific countries import 90% oil from the Middle East [47].

Since 1973, the oil market dominance was shifted from the joint venture to OPEC, oil price volatility increased. After the first energy crisis of 1973 (the Arab oil embargo) and the second energy crisis of 1979 (the Iran-Iraq war), global oil prices kept stable in a period of five years [48]. In 1986, Saudi Arabia to show its strength in the OPEC, resumed a full production, leading to the collapse of global oil prices [49]. The average price of oil plunged from 28 dollars/barrel in 1985 to 14 dollars/barrel in 1986. During this period, the oil prices remained sluggish. Until 1991, when Iraqi invaded Kuwait, once again the global oil prices slightly fluctuated. During the Asian financial turmoil, oil prices whipped to \$12/barrel [50].

In the early 2000s, after the US invaded Iraq, oil prices began to rise, coupled with increased demand in emerging countries, strong recovery in OECD market, and slow reaction by oil-producing countries, making oil prices out of control, from 25 dollars/barrel in 2002 up to \$38/barrel in 2004, \$54/barrel in 2005 and \$65/barrel in 2006. The political tensions in the oil-producing regions, coupled with the futility of future markets, had accelerated the surge of oil price, making oil prices break through the record high \$147.27 a barrel on July 14, 2008.

OPEC member countries produce about 41.4% of the world's oil production and reserve nearly 86.8% of global oil reserves [51]. For example, OPEC Member States own 1.21 trillion barrels in the global reserves of 1.70 million barrels. With the depletion of non-OPEC's oil reserves, the proportions of OPEC oil reserves with respect to the global oil reserve rise steadily. The major factors of this enterprise joint success of OPEC mainly come from Saudi Arabia's capability and perseverance [52]. Saudi Arabia voluntarily plays as the vital adjustment producer for OPEC, even at the expense of its own national interests [53].

The rise of shale oil in the United States creates a new era of energy revolution, and shakes the OPEC's global energy dominance. To combat the invasion of shale oil into global market, Saudi Arabia first launches the production increase action, while Russia clings to the bottom line with no cut in production, with the lifting of



oil transport ban on Iran, resulting in a phenomenon of supply greater than demand, making international oil prices continue to fall from the historical peak of \$107.9 per barrel in June 2014 to the lowest price of 27.0 US dollars/barrel in January 2016. Low oil prices cause the international financial and economic downturn. The situation is detrimental to the global economic development.

To save the economies of oil countries and the global economy, OPEC therefore frequently held production cut meeting. For example, at the end of November 2016 in Vienna, OPEC member countries came up with a production cut agreement first time since 2008. According to the oil production reduction agreement, OPEC will cut its daily oil production by 1.2 million barrels at the beginning of the next year, with a total reduction target of 3,250 million barrels, which will be reviewed after 6 months of agreement execution. Stimulated by the news, the international spot oil prices rise to \$50 a barrel or more. Major industries and countries sequentially raise the targets of international oil prices. For example, oil price of \$ 60 a barrel is expected by Swiss Bank in the coming year.

The production quotas for OPEC Member States in 2015 are as follows: Saudi Arabia (12.01mb/d); Iraq (4.03mb/d); Iran (3.92mb/d); United Arab Emirates (3.90mb/d); Kuwait (3.10mb/d); Venezuela (2.63mb/d); Nigeria (2.35mb/d); Qatar (1.90mb/d); and Algeria (1.59mb/d). These quotas are now considered more indicative than mandatory, since they are no longer subjective to compliance since November 2006. Nowadays, OPEC Member States are highly compliant with the revised targets of oil production.

On the other hand, the International Energy Agency (IEA), representing the interests of oil-consuming countries, namely, OECD, after the first energy crisis in 1973, was established in Paris, France, to coordinate the Western energy security promotion policy. Since then, IEA focuses on the collection and dissemination of oil information. IEA now more focuses on the resolution of a wider range of issues, for example, climate change, market restructuring, energy technology cooperation and promotion [54].

#### IV. THE CURRENT OIL SECURITY STATUS

Is it appropriate in dealing with the issues of current oil security with the current measures? This is a difficult question to answer because of a number of reasons: first, it is almost impossible to predict the timing, size or length of the oil crises, as they are usually sudden. Second, there are no reliable guidelines for accurately assessing the impact of any oil supply disruption on oil prices or the impact of high oil prices on oil demand, GDP and inflation. Finally, the effectiveness of stockpiling and other response measures remains to be determined, since the backlog of supply shortfalls does not ensure that oil prices will return to their origin. Therefore, it may be easier to speculate the future proper measures through the evolution of safe disposals over the years.

##### 4.1 The traditional security considerations

Several traditional security considerations still continue to be maintained, although the environment has changed. For example, oil resources are still largely concentrated in the Middle East, which is beyond doubt. Among them, there are six Middle East countries controlling about half of the world's oil reserves. Although the OPEC Middle East producers supply only 32.4 percent of the world's oil production, this figure is likely to double in the next 20 years, as the output in other regions has been already saturated and declining. Middle East oil trading volume at the same time accounts for 40% of the world. These factors basically do not pose any security problems, if these countries are in a state of political stability, while the market-oriented pricing policy will be maintained continuously. Unfortunately, these countries often cooperate through joint ventures in an attempt to influence the oil market.

Second, some Middle Eastern countries are not stable enough in terms of political safety. Based on the experiences of past oil crises, a temporary oil supply disruption might still occur in the market. In the past half century, there are more than 14 serious oil supply interruptions frequently occurred in a quantity shortage of 0.5mb/d or more. These disruptions have been linked to political or military events in the Middle East. Several events can be categorized as accidental impacts, such as civil strife in oil-producing countries (like the Iranian revolution), or wars between oil states (such as Kuwait invaded by Iraq in 1990).

As of 1973, in addition to the Suez War, which took place in 1956, the occurrence of supply disruption during this period was very scarce and small. There are four major crises occurred between 1973-2000, namely, Israel-Arabia war in 1973, Iranian revolution between 1978-79, Iran-Iraq war in 1980, Gulf war between 1990-91, resulting in the initial 3.0-5.6mb/d oil supply shortage [55]. In March 2003, the US-Iraq war was even more significant, doubtlessly calling it the fifth-largest oil crisis, which, as of now, oil price has not only kept in a high level, but also hit new highs continuously, which indirectly affect the supplies of live hood sources and

industrial raw materials. Obviously, even mankind has entered the twenty-first century, the Middle East oil-producing countries are still the key, on which the global social stability lies.

History also shows that short-term supply disruptions often occur in the oil market, but they did not cause too much price shocks, because of the execution of spare production capacity. Based on the historical experience and the application of strategy, several OPEC oil-producing countries have implemented the measures of spare production capacity, but most of the non-OPEC oil-producing countries do not have such a system [56]. Between 2006 and 2010, OPEC's estimated spare production capacity is approximately 4.0mb/d [57]. Based on the past experience, this buffer capacity is not high, especially in the Middle East - Saudi Arabia, Kuwait and the United Arab Emirates - so it is better to pray that the region has been always safe and sound [58].

#### **4.2 The new security considerations**

In addition to the traditional security considerations mentioned above, several new security considerations have recently emerged as a result of geopolitical developments. Among them, the most important one is the disintegration of the former Soviet Union, making people reminiscent of the possible oil production reduction and political instability in the region. On the positive side, the disintegration of the old Soviet Union should help the emerging countries of the Caspian Sea the implementation of new oil and energy policy, at the same time, transfer the tensions away from the Middle East, so that Western countries could pay more attention to Eastern European political development [59, 60]. At present, the search for new energy supply has become a geopolitical struggle for resources. For example, competing with the oil resources in Eastern Siberia, China persuades Russia to build oil-transporting pipes from East Siberia to Daqing, and Japan also hopes that the Russian oil pipe system could extend to Japan in the Far East. For its own energy security, Japan with a particularly strong ambition for Siberia's oil field has invested billions of dollars in Russia's social welfare program to facilitate the transportation of oil to Japan, who has an attempt to induce Russia's President Putin to choose the Pacific Ocean coast as another oil export destination [61].

Another geopolitical development with energy shocks is the growth of Asia's economy and its increasing political influence, especially China, emerging through economic reform. Because it is becoming a major energy importer, China has begun to study the policy of diversifying oil imports from the Middle East, now importing crude oil from more than 20 countries, and being able to establish a blue sea fleet to protect the transport of imported oil. Moreover, if China over-emphasizes the South China Sea Territorial ownership, it may deepen political instability in the region. By turn its attention to domestic production of energy, China recently announced the world's most ambitious nuclear development plan; that is, before 2020, China will build 24-32 new nuclear power plants.

At present, the IEA, which was full of confidence, may have lost on the original track of energy security policy. OECD has been continuously declining its oil safety stock, falling from the highest 160 days in 1986 to today's 90 days. The decline in total inventories stems from the fact that the industry has been pursuing low inventory marginal costs since the 1980s, and the continued stagnation of public inventories since 1986 has not increased. In recent years, the industry's inventory accelerates the decline to rationalize the cost. Another reason is the reduction in OPEC's own production.

Although the reduction in stocks is not conducive to the elasticity of response measures, according to the IEA's assessment, the global stock strategy is only effective for short-and-middle-term oil supply shortages. For addressing longer-term shortage or greater impact, in addition to the stock, there are still other supporting measures, such as reduced consumption, replacement of fuel or a surge in production. However, the function of these ancillary measures - in particular the reduction of consumption and the surge in production - is very limited currently. Measures to increase production can only be implemented in a small number of oil-rich countries such as Canada, Norway, the United Kingdom and the United States. However, in any case, the surge in output in these countries is still barely able to compare the outnumbered output of the key Middle East oil producers.

In addition, the sustained and rapid increase in the use of oil in the transport sector is a source of concern. Because the vehicle fuel price change rate cannot be too large, in the future, when encountering large-scale energy supply disruption, the oil price cannot increase too much. At present, the transport sector accounts for at least half of the amount of oil used. In today, when gasoline prices are soaring, everyone is anxious to seek oil alternatives, such as biofuels and hydrogen. In the short term future, replacing the traditional petrochemical transportation fuel ratio in large scale is a new energy security strategy [62].

With regard to the present state of petroleum security, we can conclude that in the new century, the world still cannot get rid of the energy crisis triggered by the Middle East, such as the US-Iraq war and the oil

market interferences from OPEC. In addition, because of new geopolitical changes, for example, the disintegration of the former Soviet Union, the creation of new Caspian oil-producing countries, coupled with the vigorous development of alternative fuels, making the developed economies of the West reduce a lot of harm [63]. However, the rise of the third world new economies, such as China and India, the oil demand burden has not reduced yet [64]. The traditional oil security considerations still exist, while the new oil security considerations rise. There is still a long way to go for the human being to get rid of the nightmare of oil.

## V. THE FUTURE OF OIL SECURITY TRENDS

In the coming decades, we will see many changes in the energy sector as environmental issues and fossil energy depletion have begun to change the existing energy scenarios. The future outlook for energy and oil markets and their safety significance need our further concerns.

Recent energy projections estimate that fossil fuels will continue to supply most of the increased energy demand over the next two decades and that, while renewable energy is gradually increasing its supply role, oil will continue to sustain its current 40 percent of total energy use [65]. Because of the reduction use of coal and nuclear energies, the proportion of natural gas will increase. Areas where energy demand is expected to grow significantly will be the developing countries that will have a total energy use share of nearly 50 percent by 2020.

According to the IEA's observations on energy consumption, global oil consumption has increased from 85mb/d in 2005 to 95mb/d in 2015, which is estimated to be around 100mb/d in 2020. The main areas of increase come from fast-growing Asian countries, and the main consumption sector is the transport sector. As the major consuming countries, for example, OECD and Asian countries, their imported oil is expected to continue to increase, making the relevant security considerations therefore promoted.

The global oil supply will try to meet this fast-growing demand; at least in the short period of time there is no problem. However, it cannot be determined whether the oil reserves, particularly in non-OPEC countries, will continue to supply the above-mentioned needs for a long time. Some experts had predicted in 2000 that in the next decade or so, the world would face a severe shortage of oil. Their projections are based on the argument that the economic growth, the increased consumption, the diminishing oil reserves, and the reduced probability of new oil discoveries have led to a gradual approach to depletion. However, a large number of optimists do not think so, because the obstacles to development are not geopolitical, they can be easier to overcome by the politics and regulatory. These optimists believe that more high-tech and high oil prices will make more oil be more economically extracted from the reserves. They assume that production will remain stable until oil is depleted.

The most important report on future petroleum resource assessments was published by the US Geological Survey (USGS) in June 2000 [66]. In this yearly report, there was an increase in oil reserve of 20% over the 1994 edition. Especially this the first time the USGS identified that the oil reserves were consistent with the new oil discoveries. If these projections are correct, the global oil production will be cut in the distant future.

In addition, in the IEA's latest Energy Outlook Report, the global oil source in the next two decades will fully meet the global needs, but one thing is sure that the non-OPEC oil production peak will be far ahead of OPEC peak oil production. It means that the reliance on OPEC will increase, especially dependent on the Middle East oil-producing countries. Non-OPEC oil production is expected to increase by 5mb/d by 2020, after which it will be saturated and flat. In other words, after 2020, OPEC will actually bear all the increased oil demand. To meet this increased demand, OPEC must significantly increase its production capacity. Therefore, the reconstruction of Iraq and the lifting of the embargo in Iran must be carried out rapidly; otherwise it cannot cope with this imminent urgent need.

The OECD's oil dependency will rise from 54 percent in 1997 to 70 percent by 2020, unreservedly. This dependency will decline after 2020, when unconventional liquefied fuels, such as oil sands, biomass, and natural gas, will gradually replace conventional oil. Although energy sector will gradually be dominated by renewable energy, this scenario will only happen after 2020.

For the security considerations on the transport sector that gradually increases the oil demand, the alternative fuels will reveal their appearance only at least after 2020. Of course, the growing use of oil in developing countries is inevitable. Most of the increase in oil demand should come from the emerging Asian countries that have not complete security strategy [67]. This means that the IEA emergency stock will inevitably become the global only tool to solve the energy supply crisis.

There is one hot issue inevitably to be mentioned here, namely, the global warming phenomenon. The Paris Climate Agreement, which came entered into force on 4 November 2016, regulates the UN Member States to give their promises on reducing greenhouse gases emissions to maintain the global temperature increase no higher than 1.5 degree Celsius or at least 2 degrees Celsius [68]. With the goal of carbon dioxide reduction targets, the substantial benefit is not only to get a solution to environmental problems, but more importantly, it can significantly get out of fossil fuels, in particular, the dependence on oil.

According to BP statistics as shown in Table 4, due to the continuous discovery of new oil sources, at the end of 2015, the global proven oil reserve is 1.70 million barrels. Compared with 1.37 million barrels in 2005 and 1.13 million barrels in 1995 the current oil reserve increases rather than reduces. The recoverable life (i.e., the total reserves divided by annual production) is about 50 years.

The long-term trends in the crude oil market include a slow global economic growth and other forward-looking analysis of data show that: the continuous improvement of transport fuel efficiency and oil exploration technology advances will make relatively low oil prices for at least ten years, with a prediction that the oil production reduction will be close to 120 million barrels/day.

OPEC, which is dominated by Saudi Arabia, will continue to be the world's largest factor in influencing the energy market. However, it will not regain the almost absolute control power over oil markets as in the past, especially, due to the rise of Russia, and the century energy revolution of shale oil in the United States, coupled with the lifting of the Iranian oil export ban and other factors. As a result, a small change in the oil market supply or demand curve will have a huge impact on the market clearing price.

Entering the twenty-first century, the human has tasted the bitter fruits of climate change. The uses of fossil fuels – the main emitters of greenhouse gas - will be gradually reduced in our daily lives. In the future transportation sector, the electric vehicles will become a revolutionary transport tool. In addition to run without gasoline, diesel and other fossil fuels, the advantages also include no air pollution and no noise. If electric vehicles are popularized in a large scale, they will also become a gigantic storage system for low-carbon energies. For example, renewable energy sources that are previously unstable in supply can be stored and become a major source of green power for a wide range of applications [69]. In this way, a significant shift away from fossil energy, especially oil, is possible. It can increase the energy supply diversification, in addition to strengthening energy independence policy and more solid energy security. Moreover, it will be great help for human to reduce the global warming.

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