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A Green and Low-Carbon Transformation of Oil and Gas Companies

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Abstract. Under the influence of multiple factors such as the double "black swan" time and climate change, major oil and gas companies have accelerated their business transformation from high-carbon to green and low-carbon, which can help to resist market risks by the adjustment of energy structure. Currently, there are two ways developed for the green and low-carbon transformation of oil and gas companies: renewable energy and low-carbon petroleum. This paper proposes a study focusing on the green and low-carbon transformation of oil and gas companies by analyzing the differences of the strategies based on Internal/External Factor Evaluation Method and then putting forward multi-angle suggestions for giving impetus to industrial transformation.

Keywords. Green and low-carbon transformation, international oil companies, strategic path

1. Introduction

As the crisis of global warming becomes more and more serious, the 2015 United Nations Climate Change Conference was held and passed the Paris Agreement, which included collective arrangements to cope with climate change after 2020. In order to address the threat of climate change to human society and the earth, the goal of achieving "net zero emissions" in the second half of this century is set, and all parties are expected to cooperate extensively in "nationally determined contribution" in order to achieve the big goal of reducing global greenhouse gas emissions [1].

The high-carbon oil and gas industry as a pillar of national economy deserves our attention. The positive low-carbon transformation of companies will play a leading role in the industry, influence the market consumption of the industry and gradually drive the oil and gas energy industry towards a greener and low-carbon direction.

In order to balance climate issues and corporate development, oil and gas companies are undergoing a transition to sustainable, green and low-carbon energy according to their own conditions [2]. Affected by carbon emission restrictions imposed by global climate governance, COVID-19, and the complex environment, international oil and gas prices have fluctuated dramatically in recent years and also found their business encountering unprecedented difficulties (see Figure 1) [3]. Before 2020, the net profit of oil and gas companies showed a positive trend. However, in 2020, the oil and gas

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companies in a single energy structure were hit hard by the impact of multiple factors such as the epidemic. The total losses of the five major oil and gas companies in Europe and the United States reached USD 76 billion in 2020. During the same period, a total of 108 oil and gas production and technical service companies in North America were struggling with a total debt of USD 102 billion filed for bankruptcy protection. Clearly, in the current international economic and political climates, a single oil and gas business structure will put any oil and gas company at significant risk. As emission reduction and low carbon become the development trend of the energy sectors in different countries, oil and gas companies are looking for a suitable path to shift to green and low-carbon energy, which is both a challenge and an opportunity for their future development.

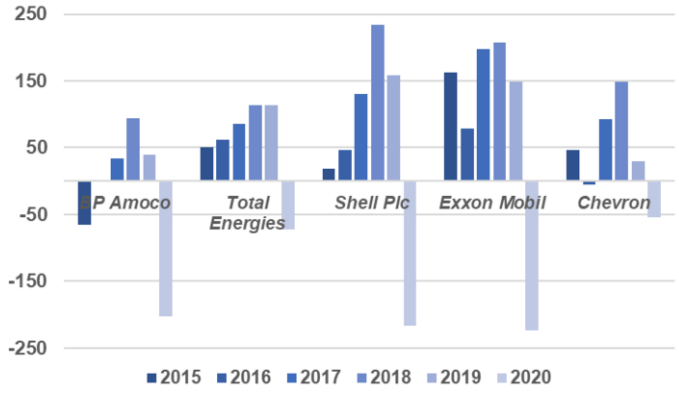

Figure 1. Net profit of major enterprises in the oil and gas companies from 2015 to 2020 (USD 100 million).

2. Major Oil and Gas Companies in Europe

2.1. BP Amoco

BP Amoco (BP) is one of the largest petroleum and petrochemical companies in the world. Performance problems and the "Oil Spill" accident once threw BP into an unprecedented predicament. Also driven by the promulgation of climate policies in Europe, the company has begun to transform into an "integrated low-carbon energy company" [4]. BP's annual net profit in 2021 was USD 12.85 billion, a record high since 2013, although it suffered a net loss of USD 5.7 billion just in 2020. BP said it was accelerating plans to cut carbon emissions and increase spending on low-carbon energy.

Traditional businesses are restructured towards a comprehensive transition to low-carbon energy. In a continuous attempt to adjust its chemical assets, BP sold its global chemical business to INEOS in 2020. This change effectively alleviated its financial problems while helping carbon emissions reduction, allowing BP to concentrate on business integration. BP also proposed to reduce the daily output of oil and gas by at least 1 million barrels of equivalent within ten years and gradually move to the upstream natural gas field with less carbon emissions. Focusing on low-carbon energy and its customers, BP will increase its future investment in low-carbon energy, including clean energy and CCUS, to build a portfolio of integrated low-carbon technologies. In terms of carbon offset, BP purchased a majority stake in Finite Carbon, the largest tree planting company in the United States, for USD 5 million in 2020. It is expected to exchange

about 100 tree planting projects for carbon emission permit to further achieve the goal of carbon neutrality by 2025.

With the advent of a low-carbon economy, BP strongly develops new energy sources such as solar energy, wind energy and biofuels and has achieved positive results. It ventured into the wind energy field by joining forces to form complementary advantages in capital, market and technology. It partnered with Public Service Company of Colorado, Edison and Westar Energy to develop wind energy, and the partnerships also included joint development of wind farms and wind turbines. In biofuels, another key new energy field, mergers and acquisitions were the main engine of BP, which successively purchased shares in Tropical BioEnergia SA in Brazil and acquired a US Biofuel Technology Company, paving the way for securing the leading position in bioenergy in the world.

As a global oil and gas giant with a century-old history, BP has experienced adversity of financial and social crises, but it seeks a balance between oil and gas business and sustainable development in line with its development goals. Changes from the inside out will lead it to a new path of growth.

2.2. Total Energies

As a traditional petrochemical company based in France, Total has strategically transformed into a diversified energy company in response to the dual pressures of reducing carbon emissions and increasing energy supply [5]. Total Energies reported adjusted profits of USD 18.1 billion in 2021, which were 4.4 times those of 2020, and its debts continued to decline. The company's transformation has a positive impact on the company’s economic situation.

Total attaches importance to the growth of the traditional oil and gas business. In traditional energy, Total focuses on improving the efficiency of traditional energy and regards eliminating associated gas as a priority. It systematically develops technologies like closed torch to reduce emissions from the traditional energy sector. As a relatively green energy source, natural gas is highly important in Total’s overall carbon neutrality strategy [6]. Its upstream natural gas business has expanded to 13 countries, and the company is actively expanding the natural gas business into new fields. In order to effectively deal with the carbon dioxide emissions from the production and use of fossil fuels, total invests in the research and development of CCUS are to study how to directly treat and reuse carbon dioxide.

Total invests heavily in renewable energy and low-carbon electricity. It fully develops solar energy, wind power, power storage and biofuels through acquisitions, creating joint ventures, and independent research and development. At the same time, Total undergoes an information-based transformation, promotes digital projects, solves problems in the oil and gas field by using digital technologies such as large platforms and artificial intelligence, and accelerates the automation of business processes. All of this assists Total in expanding into the new energy field.

While relying on the traditional oil and gas business to ensure stable cash flow, Total is active in developing business in diversified energy fields. At the same time, it develops emerging technologies to help it both enter the integrated energy field in a safer way and develop strong risk resistance and profitability.

2.3. Shell Plc

As one of the largest oil and gas producers in the world, Shell suffered asset impairments in 2020, because of losses in the upstream segment, declined fuel sales, and reduced integrated refining business. In addition, faced with the transformation of the world energy structure to the low-carbon direction, Shell is active in carrying out reforms based on mountain, ocean and sky scenarios to cope with climate change policy risks through different business segments [7]. In 2021, Shell's adjusted profits amounted to USD 19.3 billion, a y-o-y increase of about 300%, and its performance rebounded strongly due to their climate change policy risk response plan.

Shell adapts its traditional business to global demand. In response to the different demands for oil and gas in different countries, Shell evaluates and adjusts its business structure, improves the sustainability of oil and gas, and maximizes the benefits of traditional energy. At the same time, it strongly develops low-emission natural gas and increase the sales and trade of natural gas and electricity. It also simultaneously invests in the research and development of CCS and CCUS technologies in an attempt to reduce carbon emissions from traditional energy sources through internal and external efforts [8].

Renewable energy and downstream businesses are the focus to lay the foundation for a new business model. In the field of new energy, Shell mainly invests in wind, solar and natural gas power generation, and will also invest in biofuels and hydrogen energy. Shell steps up the research and development of biofuels. For example, it uses paper waste as raw materials to produce gasoline and diesel through hydropyrolysis and hydroconversion reactions. In the downstream field, Shell makes greater efforts to improve the competitiveness of refineries by increasing their complexity to accommodate more crude oil sources. It also optimizes the refinery business structure and integrates it closely with the chemical business. During the reform process, Shell continues to reduce the CO_2 emission intensity of some refineries.

Shell studies and identifies the long-term trends of the energy industry through data mining and makes energy development plans, which helps it avoid risks and seize new opportunities amid great changes.

3. Major Oil and Gas Companies in Americas

3.1. Exxon Mobil

Exxon Mobil is a century-old leading oil company and has the most proven oil and gas reserves in the world. In 2020, it was excluded from Wall Street's Dow Jones Industrial Average due to internal and external factors, including wrong decision-making, falling market value, declined energy demand caused by the COVID-19, as well as its relatively negative attitude towards carbon neutrality in recent years. There was an internal conflict between climate change and profits in Exxon Mobil. After Engine No.1 took over the board of directors in May 2021, Exxon Mobil underwent general strategical adjustments and stated that it would launch a resilient oil transition. In 2021, Exxon Mobil made a profit of USD 23 billion, a complete reversal of the huge loss measured USD 22.4 billion in 2020. Having gone through constant market changes, Exxon Mobil makes a number of internal reforms and adjustments to enhance its internal growth momentum and takes advantage of high oil prices to further accelerate the pace of decarbonization [9]. In early

2022, this U.S. energy giant announced a "net zero emissions" target for Scope 1 and Scope 2 by 2050.

The main strategy focuses on optimizing and applying the existing businesses. In oil and gas exploration and development, Exxon Mobil pours more investments to increase oil and gas reserves and production and shifts its focus to low-cost and high-return blocks. As a result, the rate of return on core assets is increased. It also invests in technological innovation and is open to technological cooperation to reduce production costs. For example, it improved the fracturing technology and developed the sensor network technology. Globally, Exxon Mobil chose to divest assets that involved high costs, low yields and unstable geopolitics, and shifted its focus back to the homeland to maintain a stable financial status. For refining and chemical assets, Exxon Mobil's low-carbon strategy plays a more significant role. It optimizes the refining and chemical business structure, eliminates inefficient capacity, improves energy utilization efficiency, and strengthens energy conservation and emission reduction capabilities. To deal with traditional fossil fuels that are hard to decarbonize, Exxon Mobil tends to treat the emitted carbon and thus prefers the CCUS option. It makes active investments in developing the CCUS technology and joins a partnership to build a large-scale carbon dioxide capture center costing USD 100 billion on the Gulf of Mexico, which is currently the largest carbon sequestration project in the world. Exxon Mobil's total investments in the traditional energy sector still account for up to 90%.

In the renewable energy sector, Exxon Mobil's investments concentrate in biofuel technologies, and other low-carbon new energy businesses are not given due attention [10]. Exxon Mobil develops biofuel technologies through cooperation and other methods. It signed a joint research agreement with the Swiss Clariant to evaluate the potential of using cellulosic sugars from sources like agricultural wastes and residues to produce biofuels. In 2020, it partnered with the shipping company Stena Bulk to successfully complete the first sea trial of marine biofuel oil.

Exxon Mobil believes that fossil energy drives global economic development. In order to meet global energy demand and a low-carbon future at the same time, it mainly relies on low-carbon technologies to address the carbon emissions from the major oil and gas businesses, supplemented by renewable energy to power operations.

3.2. Chevron

Although Chevron suffered huge operating losses caused by multiple "black swan factors" in 2020, this oil and gas giant with a history of more than 140 years is still positive about the long-term demand market under the major oil cycle. At the same time, the inclination of some investors to the transition has further forced the company to develop and introduce low-carbon transition strategies [11]. In October 2021, Chevron announced that it will achieve near zero emissions in its self-operated businesses by 2050. Chevron's adjusted profits in 2021 were USD 15.6 billion, nearly 91 times those of 2020; its debts were also declined.

Chevron sticks to traditional oil and gas business and invests in low-carbon technologies to reduce carbon emissions. Traditional oil and gas business remains the mainstream business of the company and accounts for over 75% of the total investments. The company carries out a "carbon reduction" program for the exploration and development business, uses renewable energy for power generation, and reduces the utilization rate of fossil energy in oil fields. It is active in investing in cleaner natural gas to reduce carbon emissions. In order to stabilize cash liquidity, financial status and

investor confidence, Chevron concentrates on certain development directions and divests non-core, high-carbon, high-cost, low-yield and high-risk assets. In order to further reduce carbon emissions, Chevron develops the CCS technology through independent research, mergers and acquisitions, and partnerships under the support of the government.

Chevron adjusts the proportions of investment and develops new energy. Considering technical difficulties and policy conditions, Chevron focuses on developing biofuel technologies. It creates a biofuel business unit to promote the industrial production and distribution of ethanol and biodiesel in the United States, and cooperates with Galveston Bay Biodiesel in Texas to run a large-scale biodiesel plant. It focuses on the research and development of solar energy, onshore wind power, and hydrogen energy.

Driven by investors' attitudes and the international climate issue, Chevron has begun a transition to green and low-carbon transition. However, most of its investments are concentrated in the traditional oil and gas field, and a small proportion of them goes to the development of new energy and low-carbon technologies so as to reduce carbon emissions while ensuring financial stability.

4. Major Oil and Gas Companies in Asia

4.1. CNPC

In 2020, China pledged to the world to increase its "nationally determined contribution" and announced the "carbon peaking and carbon neutrality" goals to be achieved through the following stated main pathways: increasing the proportion of non-fossil energy consumption, improving energy utilization efficiency, and reducing carbon dioxide emissions. In response to the country's call and in order to strengthen the sustainable development strategy, CNPC quickly incorporates green and low-carbon energy into its development strategy [12]. It builds a strategic system of "innovation, resources, market, internationalization, green and low-carbon energy", and proposes strategic deployments of "clean replacement, strategic succession, and transition to green energy" to conform to the global trend of transition to green and low-carbon energy.

To put the strategic deployments into actions, CNPC has also taken a series of positive and effective measures.

Firstly, CNPC optimizes the traditional oil and gas business, improves efficiency, and controls emissions. While stabilizing oil exploration and development and ensuring energy supply in the country, it upgrades related technologies and makes improvements in efficiency, energy consumption and carbon emissions. Compared with coal and oil, the carbon emissions from the development and use of natural gas have been greatly reduced. Thus, CNPC not only maintains energy supply in China, but also contributes to the "carbon peaking and carbon neutrality" goals. CNPC makes great efforts to promote the development of natural gas. According to the 2020 Corporate Social Responsibility Report of the company, its domestic natural gas production exceeded 130 billion cubic meters in 2020, and natural gas accounted for more than 50% of the oil and gas structure for the first time. Not only does it continue the green and low-carbon transition across energy types, CNPC is also optimizing the existing traditional energy sources. It conducts research on key low-carbon and clean development technologies, including building a demonstration area of energy system optimization in No. 4 Oil Extraction Plant of Daqing Oilfield and developing solid waste recycling technology. In addition, it also actively explores the comprehensive control technology of refining and chemical

pollutants. As a result, it realizes comprehensive control and recovery of volatile organic compounds throughout the industrial chain of refining and chemical enterprises and is able to continuously upgrade the sewage treatment system.

Secondly, CNPC develops clean energy, optimizes the energy structure, and quickens the pace of becoming an "integrated energy company". CNPC continues to increase the proportions of new energy sources such as hydrogen energy, geothermal energy, and combustible ice during the development process. By making use of the abundant geothermal, waste heat, wind, solar, and land resources within the areas to which it claims mining rights, CNPC strongly develops the new energy business. Given the fact that oil and gas production mainly consumes heat, CNPC develops innovative technical routes led by geothermal and photo thermal energy. According to its wind and solar power generation plan, Jilin Oilfield Company built a 330KW PV power generation pilot project around the well site of Xinli No. 1 Platform. CNPC has made some progress in accelerating the development of hydrogen energy. At present, CNPC has an annual hydrogen production capacity of more than 2.6 million tons. Now, Futian Hydrogen Refueling Station located in Changping District, Beijing, and the hydrogen refueling station in the Taizicheng service area located in Chongli District, Zhangjiakou City, have been put into operation as the first hydrogen refueling stations in the Beijing venue and the Zhangjiakou venue of the 2022 Beijing Winter Olympics, respectively. In the Zhangjiakou venue, the green hydrogen independently developed by CNPC was used to ignite the torch tower in Taizicheng, which was the first torch ever fueled by green hydrogen in the nearly centenary history of the Winter Olympics.

Thirdly, CNPC uses "intelligent technologies" to promote transformation and upgrading. In recent years, CNPC has used professional platform integration and sharing software, artificial intelligence digital tools and other technologies to assist the upstream, midstream and downstream industrial chains. For example, refining and chemical companies like Changqing Petrochemical built smart factories in which 3D digital factory models were developed and covered production, equipment, safety and energy to achieve the goal of achieving data-driven digital twin intelligence. They build an efficient, intelligent and safe systematic "smart brain" for CNPC. The application of intelligent technologies to assist the transformation of traditional energy business and the development of clean and renewable new energy business allows the company to not only meet energy demand but also contribute to the "carbon peaking and carbon neutrality" goals. The company is active in taking actions to realize the green and low-carbon strategy and the carbon neutrality vision, promotes the growth of the green and low-carbon energy industry, and contributes to the construction of an energy powerhouse in China.

4.2. Sinopec

As the largest supplier of refined oil and petrochemical products in China, Sinopec took the lead in publishing the White Paper on Environmental Protection back in 2012, in which it demonstrated to the whole society its philosophy, actions, responsibilities and commitments in implementing a green and low-carbon strategy [13].

For the traditional business, an "Energy Efficiency Multiplication" program is launched to comprehensively improve energy efficiency and actively increase the quality of oil products, thereby reducing carbon emissions. The "Clear Water and Blue Sky" environmental protection program is carried out for intensive and comprehensive environmental protection governance of the existing projects. For the upstream business,

Sinopec undertakes LNG and shale gas projects to ensure energy supply in the country while reducing carbon emissions. For the downstream business, Sinopec adjusts the refining structure to replace backward capacity with advanced capacity. It develops differentiated and high-end chemical business, optimizes the structure of the olefin industry chain, and enhances the competitiveness of the aromatic hydrocarbon industry chain, with the focus on solving bottlenecks to increase value. The company is committed to the research and development of the CCUS technology that can inject carbon dioxide into oil fields to enhance crude oil recovery. At present, East China Petroleum Bureau is planning to convert Huangqiao Gas Field into a gas sequestration and storage tank to prepare for the large-scale sequestration of carbon dioxide.

Sinopec develops diversified clean new energy and non-oil and gas business. Sinopec uses geothermal energy to heat the northern region, which reduces carbon dioxide emissions by 3.7 million tons. It explores biofuel technologies and works with the civil aviation sector to utilize bio-jet fuel in commercial passenger flights. It successfully converts kitchen waste oil into biodiesel that can be used in vehicles. At the same time, it promotes the construction of hydrogen refueling stations and hydrogen storage infrastructure for charging appropriately in key cities and roads. In terms of solar energy, Sinopec ventures into the solar PV industry and has built the first solar PV power station in Well AT22.

To realize the "carbon peaking and carbon neutrality" goals, Sinopec energetically implements the green and clean development strategy and actively promotes the development of clean fossil energy, large-scale utilization of clean energy, and low-carbon production processes. It treats new energy as a priority, increases the share of green energy in the business structure, and accelerates the transition to green and low-carbon energy.

4.3. Saudi Aramco

As an upstream and downstream integrated large oil company, Saudi Aramco owns abundant oil and gas resources, coupled with a superior geographical location. It is committed to the oil and gas exploration and production business. Embracing the global trend of emission reduction, Saudi Aramco implements an emission reduction strategy that runs through its oil and gas business, chemical business, new energy business, and digital technology applications [14].

It applies new technologies to improve the efficiency of traditional business and restructures the chemical business. Saudi Aramco puts traditional oil and gas exploration at the core of development. It independently develops the technology to turn crude oil directly into chemicals, simplifies the refining process, saves investments, and reduces carbon emissions. Natural gas, one of its leading business segment, is included in the "carbon reduction" program. While continuing to increase natural gas storage and production, the company cuts the exports of liquefied natural gas, promotes hydrogen production from natural gas, and reduces oil-fired power generation nationwide. Saudi Aramco's "Flare Emission Intensity Minimization Program" is also moving towards the goal of zero emissions from conventional flares. In the downstream chemical industry, Saudi Aramco's business scope ranges from basic chemicals to fine chemicals, and the company continues to expand its chemical business through investment and acquisition. It uses the advanced CCUS technology to capture and apply carbon dioxide, converting the captured carbon dioxide into industrial products, manufacturing raw materials, and products to serve oil fields.

Saudi Aramco explores the new energy business and focuses on hydrogen production and power generation from renewable energy. Relying on its excellent geographical advantages, Saudi Aramco invests heavily in solar energy and wind energy through cooperation to reduce diesel consumption. It realizes near-zero emissions from engines through the applications of both CO_2 capture and biomass technologies. The company plans to produce sufficient natural gas to meet domestic demand and stop burning oil in power plants. The surplus natural gas can further be converted into hydrogen. The hydrogen plants will be fueled by renewable energy. Coordinated development of new energy sources will be a reality.

Saudi Aramco's low-carbon strategy is assisted by digital technologies. The company is building LAB7, a park that supports digital technology projects to exploit the potential of clean renewable energy and reduce carbon emissions by using technologies such as artificial intelligence and machine learning. Combining the super computing power of computers, big data and artificial intelligence technology allows Saudi Aramco to avoid risks. Meanwhile, the company also applies automation technology in oil field business to guarantee best operation and minimal energy consumption.

By making full use of its advantages, Saudi Aramco actively explores emerging technologies and makes innovations in traditional technologies. It possesses clear advantages in both traditional oil and gas business and clean and renewable energy business.

5. Analysis on the Different Transition Paths of International Oil Companies

Since the Paris Agreement was signed, the strategies and paths of the oil and gas industries as the major source of carbon emissions to develop towards green and low-carbon energy have attracted social attention. Different energy structures and operating characteristics lead major companies to different paths of strategy decision-making and implementation. Such differences are mainly reflected in the formulation of mid-term and long-term plans and the selection of transition paths (see Table 1). These differences also result from the characteristics of the oil and gas markets and the strength of national policies.

The major oil companies in Europe and the United States, as well as in Saudi Arabia, are usually capital-oriented, and market characteristics are the main reason for these international oil companies to choose a transition to green and low-carbon energy. The oil consumption of European oil companies has begun to decline in recent years, at a much faster rate than that of U.S. oil companies. Sharper differences can be observed in natural gas consumption. The natural gas consumption is declining in Europe but continues to grow among U.S. oil companies. Such differences project the future needs of Europe and the United States. In terms of the independence in regional oil and gas supply, the United States and Saudi Arabia possess abundant oil and gas resources, while the oil and gas resources are so scarce in Europe that they cannot meet the demand of production. These are the reasons that put European and U.S. oil companies and Saudi Aramco on completely opposite paths. U.S. oil companies and Saudi Aramco, which have promising market demand and abundant oil and gas reserves, will not give up traditional oil and gas energy and choose instead to make a transition to mainly low-carbon petroleum. With the focus on traditional carbon-containing oil and gas resources, U.S. oil companies are not aggressive about setting long-term carbon neutrality/emission

reduction goals. On the contrary, European oil companies, whose traditional oil and gas energy markets fail to perform well, have begun to diversify their business and shift to renewable energy with active long-term decarbonization goals. Saudi Arabia is a major oil consumer in the world, where oil is used for power generation. With high power subsidies from the government, energy diversification is the solution to the energy crisis in the country. Saudi Aramco is a company wholly owned by the King of Saudi Arabia. As it shifts the focus to low-carbon petroleum, the company is also fully devoted to energy diversification and sets a long-term goal towards a low-carbon transition.

Table 1. Low carbon transformation goal and path of international oil companies.

Region	Company	Short-term goal	Long-term goal	Transition path	
				Renewable energy	Low-carbon petroleum
Europe	BP Amoco		To realize net zero emissions by 2050.	√	
	Total energies		To realize net zero emissions by 2050.	√	
	Shell Plc		To realize net zero emissions by 2050.	√	
Americas	Exxon Mobil	To cut the carbon intensity of oil and gas production by 15%-20% by 2025.	To realize net zero emissions by 2050.		√
	Chevron	To cut the carbon intensity of oil and gas production by 5%-10% by 2023.			√
Asia	CNPC	To supply more green and zero-carbon energy externally than the fossil energy consumed internally by 2035.	To realize “near-zero” emissions by around 2050.		√
	Sinopec		To realize carbon neutrality by 2050; and to eventually realize “net zero emissions”.	√	
	Saudi Aramco		To realize net zero emissions by 2050.		√

Since China clearly set the “carbon peaking” goal by 2030 and the “carbon neutrality” goal by 2060 in September 2020, CNPC and Sinopec, as central government-owned enterprises, have successively announced their long-term goals towards carbon neutrality and emission reduction to respond to the call of the country while taking into account their own responsibilities and development path. However, CNPC follows the path of transition to mainly low-carbon petroleum because of its focus on upstream oil exploration and development, while Sinopec, as a supplier of refined oil and petrochemical products, has begun to pursue energy diversification.

Due to inherent and regional differences, different oil and gas companies make the low-carbon transition in different ways. In spite of the different paths, the destination is the same-greener and more sustainable energy.

6. Conclusion

Solving environmental problems must start with emission sources. This paper summarizes the transformation strategies of oil and gas companies, including corporate structure, traditional energy, clean energy and digitization of plants. Combined with the international environment and market background of each major oil and gas company, the internal and external advantages and disadvantages of the enterprise in the green and low-carbon transformation are analyzed. Companies with high oil and gas marketing requirements and rich regional oil and gas resources tend to low-carbon petroleum transformation. Companies with poorly traditional energy markets tend to diversification.

In the future, oil and gas companies should cautiously and flexibly seek opportunities and changes in the green and low-carbon transformation. The following five inspirations are worth paying attention to:

- Optimize the organizational structure

  The reorganization of the global energy structure brings new opportunities for Chinese enterprises. They need to coordinate the top-level design and make the transition with a more scientific organizational structure. The suggestions for them include: setting up low-carbon related departments; keeping a close eye on the changes brought about by the external environment and making adjustments quickly; coordinating with other existing businesses and implementing resilient and flexible management to promote the low-carbon transition.

- Empower the oil and gas business by applying technologies

  The need to maintain global energy demand determines that traditional oil and gas still has to be relied upon in the short term. For the existing carbon-containing oil and gas business, oil and gas companies need to strongly develop advanced technologies that can improve energy utilization efficiency and reduce energy consumption. Efficient capture, storage and utilization of emitted greenhouse gases is a more direct solution to reduce carbon emissions in the traditional energy sector.

- Develop new energy

  Oil and gas companies should reasonably develop new energy and invest in renewable energy such as solar energy, wind energy, geothermal energy, hydrogen energy and biomass energy, based on the national conditions, geographical location and the demand for short-term/long-term income. Since venturing into a new field often involves many uncertainties at the beginning, reasonable investment choices and cooperation will be helpful to the progress of new energy.

- Assist the transition with intelligent technologies

  In this big data era, those who keep up with the latest trends undoubtedly master the focus of development. By using digital, intelligent and automation technologies, combined with big data, oil and gas companies can internally maximize the benefits from the development of upstream and downstream

sectors and externally make timely responses to the ever-changing market, seize opportunities, and avoid risks.

- Formulate standards to guide development

  Compared with the long-established traditional oil and gas business, the low-carbon industry is not mature enough and there is a huge gap in industry standards. In order to have a say in the future low-carbon development course, becoming a standard setter of low-carbon technologies will help oil and gas companies to increase the international market share and international competitiveness of their products and technologies.

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