

Outlook in Transformation Path of Chinese Oil Companies under Carbon Neutrality

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Abstract: In response to a call from Chinese President Xi Jinping to achieve a carbon dioxide emissions peak before 2030 and carbon neutrality before 2060, big Chinese oil companies have been taken action to transform into energy integrated companies. However, with the less-capitalized companies and lack of professional experience in transformation compared with companies in developed countries. Chinese oil companies' transformation paths have encountered problems that need to be addressed seriously. By comparing the main actions taken by big oil companies globally and locally, the paper will point out the main problems Chinese oil companies confronted during their transformation path and give out practical suggestions to address the problems.

1. Introduction

Addressing global warming has become a global duty driven by climate change, the development of technology, and social expectations. As a concept closely linked to global warming, carbon neutrality has been mentioned more frequently as climate conditions become worse. According to Jing M. Chen's article "Carbon neutrality: Toward a sustainable future", carbon neutrality refers to net-zero carbon dioxide (CO₂) emissions attained by making the quantity of production equal to its removal in the atmosphere. This stage can be achieved by taking methods such as replacing fossil fuels with carbon-free renewable energies, promoting CO₂ capture and storage, etc. However, to apply these actions, global oil companies should transit themselves to achieve the common goal of carbon neutrality. While envisioning a greener future trend, big international oil companies have been set up specialized strategy groups to begin the transformation path to integrated energy companies. However, compared with the companies in developed countries, Chinese oil companies are considered less capitalized and lack experience in strategic transformation. With the Paris Agreement setting out a global plan to limit global warming to 1.5-Celsius degrees, international big oil companies begin to speed up their transition pace, while Chinese oil companies did not have a clear transition plan until recent years. During the national conference in September 2020, Chinese President Xi Jinping announced the promise that China will have the CO₂ emissions peak before 2030 and carbon neutrality before 2060 in response to the agreement. To achieve this commitment, the transition of local oil companies is inevitable. As the country with the biggest CO₂ emission and energy consumption, China has the responsibility to address the problem of the climate issue. According to International Energy Agency's Executive Director Fatih Birol, "China has the means to accomplish a fast clean energy transition that would result in great social and economic benefits and increase the world's chances of limiting the rise in global temperatures to 1.5°C." All of these give an urgent call for the Chinese oil companies to take action. In this passage, we will compare the main actions big oil companies took during their transformation path between some international countries and China. While comparing the similarity and differences between the actions, we will define the local challenges faced by Chinese oil companies and give practical suggestions to solve the problem.

2. International Oil Companies Transformation Methods Overview

Under the primary goal of carbon neutrality, many big international oil companies have been taken actions to transform the company with different paths and focuses. Since most of the companies are well-capitalized and have a lot of experience in deploying strategy and establishing different phases in achieving carbon neutrality for almost twenty years, we can examine their methods and generate a suitable scheme used by Chinese oil companies based on the local conditions. In this part, ExxonMobil, Chevron, Royal Dutch Shell, BP, Total, Equinor, and other prominent international companies will be examined in their actions taken for transformation.

2.1 Natural Gas Development

Been viewed as the clean energy alternative for fossil fuel, natural gas has been the No.1 choice for oil companies to promote less overall pollution. According to the BP Statistical Review of World Energy, from 2000 to 2016, global natural gas production increased by over 46 percent, while crude oil production rose around 22 percent. A recent report showed that starting from 2010, natural gas production of the most significant international oil companies has accounted for more than 40 percent of their total oil production [1]. Even taking a large part of production, the big oil companies have not invested more natural gas assets. Royal Dutch Shell has acquired BG Group for \$70 billion in 2016, ExxonMobil has acquired InterOil for \$2.5 billion in 2017, Total has acquired Brazil's Pre-salt oil and gas assets for \$1.5 billion [1]. Although under the impact of Covid and low international oil prices, many big oil companies still choose to keep increasing the proportion of natural gas to fulfill their transition to carbon neutrality. For instance, Shell proposed growing natural gas production by over 55 percent by 2030 and 75 percent by 2050 [2]. These European international companies evaluate the importance of natural gas market will not only pertain but also flourish, eager to expand the production and strive their best efforts to transform to cleaner sources and better profits.

2.2 Investment in Renewable Sources

Knowing the importance of renewable sources in the future market, big international companies have been taken action to implement transformation strategies. This includes investing in different renewable energy portfolios and actively investing in the technology development of renewable sources. As one of the companies with the largest investment in renewable energy, BP has bought out a 43 percent stock share of Lightsource for \$200 million in 2017, with Lightsource as the biggest solar energy developer in Europe [3]. Moreover, BP has also intensified efforts in investing electric power, in 2018, BP has invested \$20 million in StoreDot, which focuses on developing ultra-fast recharging batteries; it has also announced the acquisition of Chargemaster, which is the UK's largest electric vehicle charging company [3]. Since then, BP has invested in Azure Capital, Dian Xiang Technology, a provider of electric vehicle charging platforms, and a joint venture with a Chinese taxi company to promote electric transportation [3]. Total also has been active in developing various new energy businesses. Early in 2011, Total has invested in Sunpower, the second-largest Solar panel maker in the United States, and has expanded its solar business covering nearly 40 countries as of 2019. The company has also acquired onshore wind projects through Total Quadran and Total Eren since 2016 and made a major foray into the offshore wind business in 2020. In addition, Total is also expanding into the field of electric energy storage by acquiring Saft and Lampiris, which are European companies with the green power utility [3]. In order to achieve carbon neutrality, Equinor has implemented technology investment in wind power, photovoltaic, and other renewable power and plan to spend \$5 billion on energy digitization and the use of grid power or wind power [4]. Other than directly investing in renewable sources, Chevron focuses more on technology research related to new energy sources. The company has committed \$100 million to its subsidiary Chevron Technology Ventures Corporation (CTV) Future Fund I, \$300 million to CTV Future Fund II, and \$100 million to the Oil and Gas Climate Initiative (OGCI) which focus on the technology development of renewable sources [3]. As shown above, European oil companies have performed a radical transformation, investing in renewable sources on a large scale. While North American oil

companies showed a more conservative approach, prefer to fund technology research and development of renewable sources, as they believe that oil and gas companies still have a large potential for development and profitability for a long time [5], [6], [7].

2.3 Carbon Capture, Utilization & Storage (CCUS)

As the main technology technique used for reducing emissions, carbon capture, utilization, and storage (CCUS) is the necessary tool to achieve carbon neutrality. It mainly encompassed technologies to capture the CO₂ from the atmosphere and use captured CO₂ for services or permanently store the CO₂ in underground geological formations. This technology was also heavily promoted by big international oil companies. Equinor is a pioneer in promoting CCUS, the company is committed to developing a new business model to make carbon capture and storage (CCS) commercially practicable [4],[8]. It has received approval for a CCS project on the continental shelf, with the proposed storage site near Norway's largest oil and gas field, aims in receiving CO₂ from onshore facilities such as power plants or cement plants, injects permanently store CO₂ to the seabed for reducing carbon emissions [4]. Equinor also plans to build a CCS industry chain in Europe, for instance, the Northern Lights project cooperated with Total and Shell will come into operation by 2024, and it will capture and store 1.5 million tons of CO₂ annually [4]. Moreover, Shell proposes to build 25 CCS facilities comparable in size with Canada's Quest project by 2035, adding 25 million tons of carbon storage capacity annually [2]. Add on to that, Chevron has proposed to invest in its subsidiary CTV Core fund for more than \$300 million. This investment aims to provide technology development support in CCUS. Chevron also announced a groundbreaking bioenergy and carbon capture and storage (BECCS) project in California with Schlumberger and Microsoft aimed at producing negative carbon electricity [3]. Additionally, ExxonMobil has invested more than \$10 billion in CCUS. The company's scientists and technologists are working with leading national laboratories in the United States, as well as more than 80 research universities, to develop scalable, affordable, low-emission technologies [3]. Early this year, ExxonMobil announced to form a new business unit to commercialize its portfolio of low-carbon technologies and plans to invest \$3 billion in CCS projects globally over the next few years [3]. Most of the big oil international companies are taken active actions to achieve carbon neutrality by promoting CCUS as the necessary step.

3. Chinese Big Three Oil Companies Transformation Actions

Set the primary goal as achieving the CO₂ emissions peak before 2030 and carbon neutrality before 2060. Chinese President Xi Jinping has led the country to follow the international low carbon transition trend and promised to fulfill the goal according to the Paris Agreement. Known as the big three oil companies in China, PetroChina, Sinopec, and CNOOC all has been taken serious actions and try their best to contribute to lower carbon emissions. In this part, we will evaluate how the big oil companies in China has been develop their transformation path according to their own situation.

3.1 PetroChina

Among the big three oil companies, PetroChina has the most upstream assets, with a low carbon strategy planned ahead, the company has been taken various actions such as increasing natural gas production, carrying out new energy projects related to oil and gas, and promoting CCUS. In 2020, PetroChina's natural gas production of 130.6 billion cubic meters has exceeded crude oil production for the first time [9]. The company took the lead among state-owned enterprises in formulating and implementing the Green Development Action Plan, giving priority to the development of natural gas [10],[11]. According to Caineng Zou from the Chinese Academy of Sciences, the surpass of natural gas production indicates Chinese oil companies steps into the next phase of "stabilized oil and increasing gas", he predicted by 2025, China national natural gas yield would exceed crude oil, with natural gas industry into new leaping development. With PetroChina setting the goal to increase the output of natural gas to 55 percent by 2025, the company has vigorously developed in the natural gas business [12]. Other than increasing the production of natural gas, PetroChina has intensified

exploration and development of unconventional natural gas such as natural gas, tight gas, shale gas, and coalbed methane to build a diversified natural gas supply system[13]. Additionally, the company has also studied new energy development projects related to carbon neutrality, and carried out specific projects that are closely linked with its main business and have the potential to further development. For instance, it has researched the application of technology in geothermal, combustible ice, biomass energy, hydrogen energy, and uranium mining, speeds up the formation of green growth poles dominated by oil and gas with multiple complementary energy sources [14]. Moreover, seeing the potential in new energy automobiles, PetroChina has signed a strategic cooperation agreement with FAW Group by 2017 to develop and strengthen the promotion of new energy vehicles; the company will build or add more electric vehicles (EV) charging stations and natural gas filling stations in key urban areas and expressways, and support FAW Group's manufacturing and promotion of new energy vehicles in the industrial chain [14]. The two companies will establish a joint laboratory, strengthen the research and development of lubricating oil follow-up products, and discuss the establishment of internal combustion engine oil specifications that meet China's national conditions and engine requirements [14]. Finally, the company also see the necessary need for carbon storage to carbon neutrality, PetroChina built its first CCUS base for the whole industrial chain of carbon dioxide separation, capture, and oil displacement in Jilin Oilfield, and achieved a total carbon dioxide sequestration of 940,000 tons by the end of 2015 [1]. According to the performance report, in the first half-year of 2021, PetroChina has gained a net profit of \$6.1 billion, compared with the net loss of \$3.6 billion in the corresponding period in 2020, the early transition strategies were considered a great success [15]. With the three main actions taken, PetroChina is strived to follow the overall deployment of "clean alternative, strategic replacement and green transformation" to respond to the call of President Xi's carbon neutrality plan by 2050.

3.2 Sinopec

Having one of the most advantageous downstream businesses, Sinopec has committed to achieve carbon neutrality through expanding its natural gas business and investing in renewable sources. Moreover, Sinopec has set the primary goal to become China's largest hydrogen energy company and has been focusing on the comprehensive layout of the complete hydrogen industry chain as their main transition strategy. As one of China's largest hydrogen energy suppliers, Sinopec has an annual hydrogen capacity of more than 3 million tons, accounting for about 14 percent of the country's total production [16]. By the end of 2020, more than 100 hydrogenation stations had been built in China, Sinopec also planned to build 1,000 hydrogenation stations or oil-hydrogen combination stations to accelerate its transformation into a comprehensive energy service provider of "oil-gas, hydrogen-electricity, and non-electricity" [16]. According to Yuzhuo Zhang, president of Sinopec, the company will set the primary goal as 0 emission and achieve carbon neutrality by 2050, which is 10 years early than the country's commitment. To fulfill its promise, Sinopec has accelerated the layout of new energy businesses by setting up and acquiring shares from new energy companies. In 2015, Sinopec Beijing Petroleum Company and BAIC New Energy Company has signed a strategic cooperation agreement which will make full use of Beijing's oil station network resources to build charging and changing stations which will not only provide electric taxis with electricity changing services but also provide charging services for users of pure electric vehicles [14]. In 2019, Sinopec has invested in different technology companies that focuses on the development of ultra-thin photovoltaic glass and photovoltaic film which are all the new energy that helps to reduce emission [13]. Moreover, Sinopec has also carried out experimental research on CCUS in Zhongyuan oilfield and injected about 2.7 million tons of carbon dioxide by the end of 2015, it also planned to build a million-ton scale CCUS demonstration base in the east China oil field and Jiangsu oil field, promote the industrialization development of CCUS [1]. By investing in renewable sources, implementing the CCUS technique, and promoting the layout of the hydrogen energy industry chain, Sinopec has strived to achieve the carbon peak and carbon neutrality on the promised time. Moreover, according to the company's performance report, Sinopec has gained a net profit of \$8.3 billion in the first half-

year of 2021, compared with the net loss of \$4.7 billion in the corresponding period in 2020, transition strategy was a great move [15].

3.3 CNOOC (China National Offshore Oil Corporation)

Responding to the call from Chinese President Xi, CNOOC has set up plans to achieve carbon peak and carbon neutrality by expanding the natural gas business, investing in renewable sources, and promoting offshore wind power as the main way to reduce offshore gas emissions. According to their strategic plan for carbon neutrality, CNOOC will aim to increase the proportion of clean and low-carbon energy to more than 60 percent. For the natural gas business, the company has planned to increase natural gas production to 50 percent of total production by 2035. By speeding up the construction of the trillion cubic meter scale "gas zone" in the South China Sea, developing unconventional natural gas, and accelerating the construction of the whole liquified natural gas (LNG) industry chain, the company can significantly increase the supply capacity of natural gas [17]. It has not only effectively developed offshore gas fields and become the world's third-largest LNG importer, but also directly engaged in the natural gas power generation business [1]. For renewable sources, CNOOC has made full use of its advantage in the marine industry, developed new energy industries dominated by marine resources [9]. Moreover, it has been doing continuous exploration and research on combustible ice (natural gas hydrates), ocean tidal current energy, ocean temperature difference energy, hydrogen energy, and other new green low-carbon energy development technologies [1]. For promoting offshore wind power, by realizing the first grid-connected offshore wind power project in 2020, the company committed to accelerate the industrialization and large-scale development of offshore wind power, exploring the comprehensive utilization of marine energy [9],[18]. By promoting offshore wind power, CNOOC can significantly improve the power generating efficiency, and reduce offshore gas emission, which paves an important way to achieve carbon neutrality. According to the performance report of CNOOC, in the first half-year of 2021, CNOOC has gained a net profit of \$5.2 billion, compared with the net profit of \$1.6 billion in the corresponding period in 2020, the profit increased by 221 percent which showed that CNOOC's transition actions were considered a great success [15].

4. Suggestions Toward Big Challenges Faced by Chinese Oil Companies During Transformation

After taking a look through the actions taken by big international oil companies and Chinese oil companies, we saw the similarity between the main actions taken and how these actions have led to an increase in net profit of the big three Chinese oil companies. However, integrating existing circumstances and local conditions in China, we can generalize the challenges that Chinese oil companies face during transformation toward carbon neutrality. With the lack of assets and experience in forming transition strategy, China oil companies should confront the challenges they encountered during the transition path by making more efforts in different fields in order to achieve carbon neutrality on time. In this part, we will list out the problems faced by Chinese oil companies during transformation and try to come up with suggestions addressing this issue.

4.1 High Carbon Emissions with Great Pressure to Reduce Energy Consumption

According to the BP Statistical Review of World Energy, in 2019, China's CO₂ emissions were 9.8 billion tons which accounted for 28.8 percent of global emissions. For energy consumption, coal accounted for 57.64 percent of China's primary energy consumption, which is much higher than the global average of 27.09 percent. Oil and natural gas, which have lower carbon emissions and are more efficient than coal, accounted for 19.69 percent and 7.81 percent of primary energy consumption, which is lower than the global average of 33.06 percent and 24.23 percent [19]. Compared with developed countries, China's energy consumption intensity is 1.43 times the world average, 2.15 times that of the United States, and 2.72 times that of Germany [13]. All these statistical data indicate that our transition period toward carbon neutrality has a long way to go compared with developed

countries. High CO₂ emission and high energy consumption intensity indicate we should intensify efforts in the transformation path to low carbon emissions. Below are the suggestions on how we should address this challenge.

4.1.1 Promoting CCUS and Other Low emission Techniques

According to the International Energy Agency's (IEA) Sustainable Development Scenario (SDS), global CO₂ capture and storage will reach 1.03 billion tons of CO₂ equivalent in 2040, it is concluded that carbon neutrality cannot be achieved without CO₂ capture and storage [20]. While all the big oil companies from Europe and North America are all developing related projects, Chinese oil companies should leverage their expertise more to actively promote CCUS projects to help China achieve carbon neutrality. Noticing the relatively high cost of CCUS projects, well-capitalized companies such as the big three in China should intensify efforts on investing in the projects. They should also pay attention to summarizing the development status of CCUS related technologies and business models, and make early preparations on how to promote demonstration projects and expand application scale in the next step [21]. Moreover, Nature-based solutions such as forest carbon sequestration and tropical rainforest conservation are also important means to achieve "net-zero" carbon emissions [20]. These techniques are all investable projects that big oil companies should address attention to. While other medium-sized or small-sized companies should also attribute to the reduction of CO₂ by investing in other low emission techniques within their own limit.

4.1.2 Increase Production of Natural Gas with Cleaner Utilization of Other Energy

While seeing the high proportion of coal and natural gas as the primary energy consumption in China. Local oil companies should follow the lead by the big oil companies, speed up the increase in the production of natural gas as natural gas still has a strong resource base with large profitability. While big international oil companies have enough capital to transit according to their own will and pace, Chinese oil companies are only one of the components with strong expertise in national energy production. Several other professional new energy industries have attempted to participate in upstream oil and gas exploration and development, but there are few successful cases and their contributions are not significant [5]. Therefore, oil companies may not be able to achieve the desired results by forcing themselves into the new energy industry with insufficient technology reserves and capital [5], [22]. Other than blindly following big oil international companies and investing in a large amount in renewable sources companies, Chinese oil companies should try to substitute coal and fossil fuel with natural gas as the main step taken to achieve the primary goal. At the same time, they should promote cleaner utilization of energy used by making the production and operation process more efficient and enforcing higher energy consumption and emissions standards, such as increasing the use of CO₂ injection to enhance oil and gas recovery, and the elimination of leakage in the production chain [23], [24], [25].

4.2 Immature National Transition Strategy Group with Low Incentive for New Energy Innovation

Although the big three oil companies have responded to the call from President Xi by actively taking actions to lower carbon emissions. All the other oil companies in China do not have a clear understanding and direction for the transformation path overall. The main problems are the lack of strategic research support and no specific department responsible for organization and management which resulted in multiple management, unclear responsibilities, and repetitive work [8],[1]. Moreover, the main reason for oil companies' limited technology investment in renewable sources is the small number of professionals in the area. Since many renewable sources of technology were imitated and acquired directly from international professionals or companies, with few local technology patents formed, and no collaborative mechanism set up between government, enterprises, universities, and research institutions, people have a low incentive for new energy innovation [1]. Hence, we want to address this situation as it is critical for the country to achieve carbon neutrality.

4.2.1 Form Specialized Strategy Group for Transition According to Individual Companies

For each local oil company, the specialized strategy group should be formed and establish practicable actions by setting up the specific quantified goal. The group should set goals for each stage in the carbon-neutral strategic path, discuss major climate issues at regular meetings, monitor and report key indicators quarterly, semi-annually, or annually to keep up with the goal on time [2]. Meanwhile, specific operational action plans should be formulated in various dimensions such as technology, management, and finance. Moreover, knowing the transition trend will lean toward natural gas and renewable energy, the strategy group should design a specific plan that transforms the company into an integrated energy service provider [26],[27],[28]. Company should perform data analysis and innovate on business models in the integrated energy market based on its own pros and cons, therefore speeding up the transition toward a low emission or zero emission company on time.

4.2.2 Establish Reasonable Subsidy and Financial Guarantee Mechanism for New Energy Technology Projects

Technology investment in new energy will be the necessary step toward carbon neutrality. Without blindly following or acquiring technology from international companies, Chinese oil companies should combine the transition path with the corporate social responsibility system, accept supervision from society [1]. Moreover, the government can establish subsidies and financial guarantee mechanisms to increase incentives in new energy development. With increasing subsidies and other policy support for strategic new energy technology projects, it can maintain the continuity and integrity of the innovation chain [29],[30]. These can help the problem of low incentive on new energy technology efficiently.

5. Conclusion

The passage gives a general outlook on Chinese oil companies' transformation path toward carbon neutrality by comparing the main actions taken by big oil companies globally and locally. Based on existing national circumstances, practical advice was given to achieve the primary goal of carbon neutrality by the right time. Through comparing the actions taken by big oil companies, we are informed that each company has its own vision of how the future trend would look like and set up a corresponding transformation path based on its own capacity. Big oil international companies from Europe were more radical in the investment of new energy. While companies from North America were more conservative, believing that there's still a long period for natural gas profitability, most of them only invest in technology innovation of energy rather than new energy itself. With different visions on the future trend toward carbon neutrality, big international oil companies have formed strategy groups that require increased production of natural gas and promote the CCUS technique. Although the company's transformation path was specialized by its group, the main attitudes toward natural gas and low carbon technique are the same. While the big three oil companies in China have different focuses during the transformation process, their actions were all considered a great move by a great leap in their net profit. With PetroChina's natural gas production exceeding crude oil production for the first time; Sinopec focuses on becoming China's largest hydrogen energy company; CNOOC continues to develop its strengths in offshore wind power by investing in offshore wind power projects. Add on to that, all three companies have continuously promoted the CCUS technique during the transformation path. To achieve carbon neutrality by the promised time, we listed the main problems faced by the Chinese oil companies during their transformation and listed out specific suggestions hope to solve these problems. With the No.1 CO₂ emission and high consumption of coal and fossil fuel, China is facing high pressure on reducing emission. Without more efforts taken, the transition path cannot lead to low carbon emission on schedule. Hence two suggestions were made: actively promoting the technology with low emissions such as CCUS, forest carbon sequestration, and tropical rainforest conservation; increasing production of natural gas and promoting cleaner utilization of energy. By following the suggestions, China can achieve carbon neutrality without facing huge pressure on reducing emissions, since the actions taken well gradually reduce emissions.

The other critical problem for Chinese oil companies is the lack of professionals in transition strategy groups and low incentive for new energy innovation. Envisioning a transformed company as an integrated energy provider, oil companies should stop blindly following the technology developed by international professionals. Each company should form a specialized strategy group for transition according to companies' local conditions, at the same time, the government should increase subsidies in order to promote technology innovation on new energy. To achieve sustainable development toward low emission oil companies, Chinese companies should figure out the transition path from their own perspective, cooperate with other companies and government, carbon neutrality will come as each component of the country are united together to solve this issue.

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