Analysis of Oil Industry in Energy Transition Process—A PCA Approach to Analyse BP Company

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Abstract-Climate change has become an increasingly severe issue due to frequent human activity. The global temperature is rising faster than ever, and it damages the ecosystem while increasing extreme events and threats to humans' daily lives. The need of alleviating climate change has become the top priority for many industries. This paper is aimed to study the role of the oil and gas industry in the energy transition process, since oil and gas industry, as one of the main producers of carbon dioxide, should take active action in achieving the goal of transferring 'oil and gas' to 'renewable energy' eventually to protect the environment. In this article, the author takes BP company as an example to have a deeper insight into oil and gas industry. The author analyzes the financial statement data by calculating different ratios to better understand BP's financial situation. Then principle component analysis (PCA) method is used to filter important figures by reducing 120 selected variables to 8 final principle components. This reduces the dimension of the original data and will help further data analysis. Besides, this article deeply analysis the necessity of Carbon Capture and storage technology (CCS), Direct Air Carbon Capture and Sequestration (DACCS) and the application of renewable diesel. The author believed that the application of these will be extremely useful during the energy transition.

Keywords: energy transition, CCS technology, renewable diesel, oil industry, PCA

1 INTRODUCTION

Climate change is a global issue, which will increase global temperature and the occurrence of extreme events such as drought, flood and hurricanes. Our environment is suffered from climate change, and the well-being of future generations is affected. Therefore, strong policies are needed to cope with climate change so that businesses can ultimately transition towards low carbon. As Cherif, Hasanov, and Pande pointed out, oil could have a much shorter life span than assumed, which is likely to happen when electric cars replace motor vehicles [1]. It then brings the issue of the role of oil and gas companies in the energy transition. The oil and gas industry produces large amounts of greenhouse gas (GHG) emissions each year, which has accelerated the global warming problem. More importantly, investors also start investing in low carbon and low-emission projects. Therefore, oil and gas companies must adopt some useful and climate-friendly technologies as soon as possible to cope with the challenge of climate change. Currently, many oil companies have made the plan of shifting business towards low carbon. BP, Shell, Total and Equinor are beginning to curb oil as they tackle climate change implications. BP aims to decrease its fossil fuel output by 40% and increase renewable energy spending 10-fold by 2030 as it seeks to have net-zero emissions by 2050 [2]. To achieve low carbon during the energy transition, some useful technologies are needed to curb emissions, and the development of fossil fuel diesel

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substitute-renewable diesel is also of great importance in achieving a green economy. In this paper, the first Principal Component Analysis (PCA) is used to analyse BP's financial statements to extract most useful information and select crucial variables. Then crucial CCS and DACCS technology as well as the substitute renewable energy are discussed. Finally, the author will also give some relevant suggestions

2 ANALYSIS OF BP'S CONSOLIDATED FINANCIAL STATEMENTS

Several ratios are analyzed from the financial statement, including debt to equity ratio, current ratio, quick ratio, and liquid ratio. The debt to equity ratio is 1.98 [3]. This means that for every dollar of equity, the company has $1.98 in debt. 1.98 is a relatively normal ratio in this industry, because they are manufacturing and involve a lot of equipment. However, transitioning to renewable energy may intensify this ratio as implementing renewable energy projects is unprofitable at the start stage. BP's current ratio is 1.115 [3], which indicates that the company is stable and the risk of liquidity issues is low. BP's liquidity ratio is 1.12 [3], and bank overdrafts were zero in 2019, which shows that BP's liquidity is generally good and the company can quickly convert assets into cash.

In terms of profitability, Return on Capital Employed (ROCE) is only 11.6% [3]. This 11.6% means that for each $1 of capital employed BP can only generate $11.6 profit and implies low effectiveness of utilizing capital. One way of improving this figure is to remove unused and unnecessary assets and remain the assets with the highest return rate to increase capital employed efficiency. Besides, the figure for ROE is 4.07% and the dividend payout ratio is 1.17, meaning that BP reinvested very little back to the business and paid out large amounts of dividends instead. It should cut the dividend payout to shareholders and support renewable energy R&D using the retained earnings.

The energy transition for BP could be a hard time at the start, but this is an inevitable trend. Huge costs will be involved in R&D, innovating, implementing and collaborating of renewable energy and all of these require strong funding support. Therefore, BP should increase its assets' efficiency and transfer dividend payout to the research department for introducing renewable energy. However, apart from this development of renewable energy, other powerful technology should also be implemented in plants and factories during the transition.

3 METHODOLOGY

In this section, principal component analysis (PCA) is used to determine the relatively significant varying factors in bp's financial statements and constructed principle components.

3.1 About PCA

Principal component analysis (PCA) is an orthogonal transformation process to generate a set of values of linearly uncorrelated variables called principle components from the sample of possibly correlated variables. It is a technique to reduce the dimension of the original data, by finding directions that are mutually orthogonal. By doing this, the data interpreted by fitted line represents the horizontal axis of PCA diagram, and leave the other data represented by a vertical axis. This successfully reduces the dimension of the data. The decline in the dimension of variables makes diagrams are easily plotted and patterns hiding in the data revealed. Besides, PCA will generate a set of coefficients of principal components and order these components according to their variance in descending order.

The study uses principal component method to analysis 120 selected variables in bp's financial statements into a single index. According the this procedure the ith factor Ei can be expressed as:

Ei = W1 X1 + W2 X2 + W3 X3+…+ WJ XJ

Ei = estimatre of 120 factor

WJ = weight on factor score coefficient (0< J <121, integer)

X = number of variables

4 RESULTS AND DISCUSSION

4.1 PCA results

This section presents the discussion of the results of PCA. Because not all of the variables make contributions to the results, PCA is then used to extract useful information in bp's financial statements through reducing dimensions of data. This method also avoid the collinearity problem within the variables since all the principal components are independent of each other. Finally, 8 principal components are got through the PCA calculation, and these components are ordered desently by variance. In table 1, figures of three principal components are extracted in terms of variables.

Table 1 PCA for bp (2011-2020)

Variables	**component 1**	**component 2**	**Component3**
Total revenues and other income	0.570789077	0.141458911	-0.029248464
Sales and other operating revenues	0.54341429	0.132806154	-0.040730518
Purchases	0.460286744	0.109435106	-0.032408913
Total assets	0.1026847	-0.012493083	0.043755074
bp shareholders' equlty	0.101180069	0.058977295	0.004885777
Profit (loss) before taxation	0.099762303	-0.01751281	-0.026627447
Profit (loss) before interest and taxation	0.097046269	-0.022746124	-0.026456892
Net assets	0.086427677	0.043450995	0.019062696
Total equity	0.086427677	0.043450995	0.019062696
Profit (loss) for the year	0.072844955	-0.002760189	-0.014477187
bp shareholders	0.071705978	-0.00332727	-0.013895891
Total comprehensive income	0.065427425	-0.012096972	-0.004473753
BP shareholdiers	0.064333517	-0.012536788	-0.00417788
Trade and other receivables	0.049403759	0.021937893	0.015320905
Fixed assets	0.036743652	-0.011934385	-0.030079592
Net cash provided by operating activties	0.030433112	0.01505549	-0.012379805
Trade and other payables	0.030281102	-0.032277954	0.004562798
Proceeds from disposals of fixed assets	0.029754635	0.015246966	0.018714855
Inventories	0.028777983	-0.001756704	0.023414649

Taxation	0.026200454	-0.015038121	-0.012473134
deferred tax liabilities	0.024055204	0.015605699	0.003678879
Gains on sale of businesses and fixed assets	0.018157852	0.008619897	0.015837736
Production and similar taxes	0.016644222	0.007059874	0.00756043
Property, plant and equipment	0.013463612	0.002264051	-0.035052651
Provisions	0.012788955	0.077790304	-0.008383245
Intangible assets	0.009574103	0.013630062	-0.016192676
Increase (decreasel in cash and cash equivalents cash and cash equivalents at beeinning of year)	0.009341442	-0.005022885	0.035172151
Distribution and administration expenses	0.007332204	0.004171066	-0.003613632
defined benefit pension plan surpluses and other post-retirment benefit plan deficits	0.007284234	0.004188122	0.006446046
Accruals	0.007140351	0.009941618	0.003984698

Extraction method: principal component analysis

In table 2, the cumulative figures mean the percent variability explained by the principal components. As shown in the table, PCA results generate 8 principal components, and the first three components explain 99.95% of all variability. This means that these three principal components contain almost 99% traits of the data and can represent the rest. Then the useful variables will be selected from these three components.

Table 2 Components Explained coefficient matrix

Principle component	**Variance%**	**cumulative%**
1	2.026	61.914
2	0.595	18.172
3	0.508	15.527
4	0.091	2.773
5	0.021	0.630
6	0.017	0.530
7	0.010	0.291
8	0.005	0.164

Extraction method: principal component analysis

Table 3 Component score coefficient matrix (2012-2020)

1.71374109	0.20030805	0.19355827	-0.0840384	0.1127143	0.18824513	-0.1512871	0.04510669
1.91411593	0.32605161	0.3082953	0.29357612	0.09145709	0.01673089	0.1675249	-0.0575763
1.20215039	0.2096686	0.20279098	-0.4851644	-0.0211257	-0.2494793	-0.0187533	0.00264138
-1.5002172	1.71533753	-0.7217006	0.03898681	-0.0074293	0.0083667	-0.0019522	0.00383217
-1.5004607	-0.5401108	0.3511076	0.28389816	0.20390368	-0.1196128	0.0071164	- 0.09067505
-0.5805551	-0.3017313	0.3680629	0.2980226	-0.1028735	-0.0497083	-0.1281612	-0.1304128
0.48194409	-0.9948687	-1.6345675	0.0113551	-0.0290189	0.00758683	0.0161569	0.00059512
0.02701945	-0.1303085	0.5148978	0.10671603	-0.296413	0.05247286	0.04627363	0.0979842
-1.757738	-0.4843465	0.4175553	-0.4633519	0.04878531	0.14539803	0.07731473	-0.0528455

Extraction method: principal component analysis

By transforming the original data into the space of the principal components, the author gets a scores value. Table 3 shows the score coefficient for 8 principal components and the 'variance' value shown in Table 2 is the variance of the columns of SCORE. After converting the complex dimension of data to a single dimension, these PCA results tell us that in the first principal component total revenue and purchases are more relevant and more useful for analysis. Figure 1 and Figure 2 demonstrate the trends of these two areas over time. They both show a similar downward pattern.

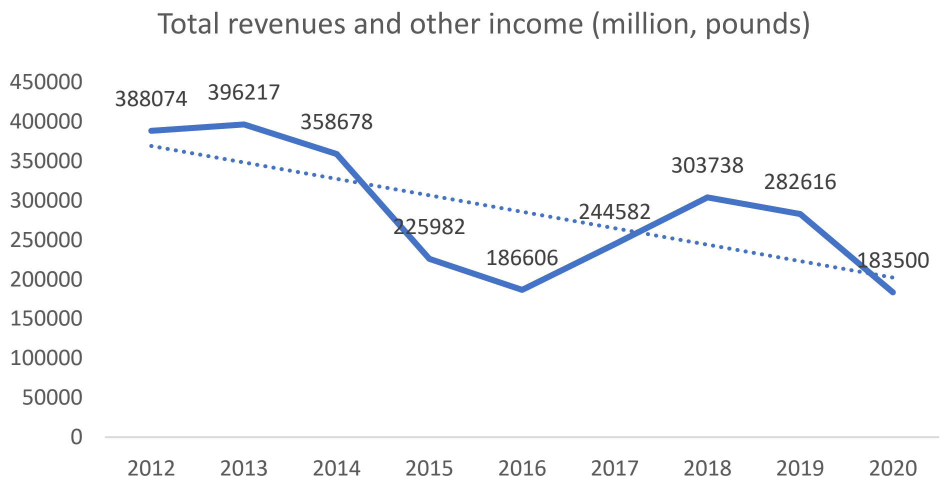

Figure 1. Total revenues and other income

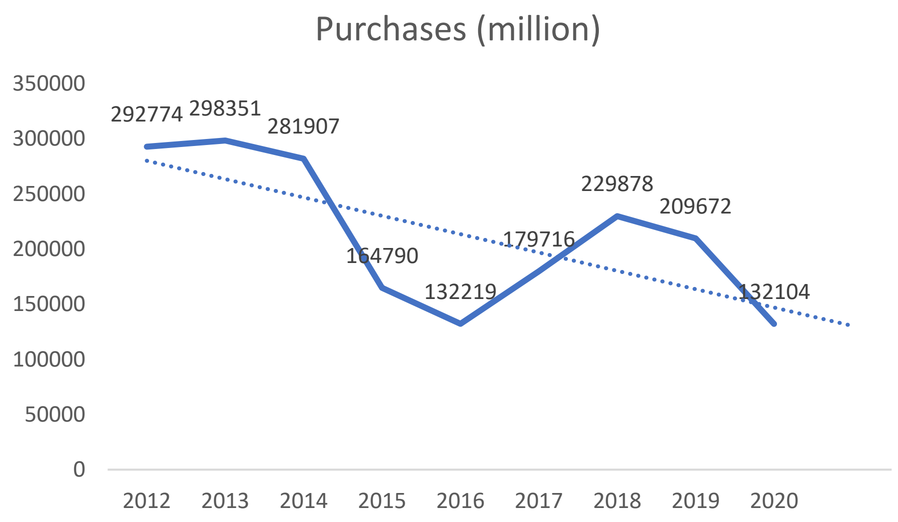

Figure 2. Purchases

4.2 Limits of this PCA results

Although the PCA can help reduce data dimensions and extract information, this dataset is too small to get obvious and accurate results. PCA only reflects the result of dimensionality reduction, so the variables selected from this result need to be analyzed together with financial report analysis. It may also be because the type of data selected is not comprehensive enough that the results did not show something insightful.

5 STRATEGY AND SUGGESTIONS FOR THE OIL INDUSTRY IN THE ENERGY TRANSITION

5.1 Bp's current efforts in the energy transition

Bp is committed to solving the challenge of meeting the increase in demand for energy and combating climate change. They established the belief that renewable energy is the ultimate future for the oil industry, but oil and gas will remain part of the energy mix for decades until fossil fuel energy is fully ready to be replaced by renewable energy. The three focused areas of bp are that [4]:

a) Low carbon electricity and energy: Building scale in renewables and bioenergy, seeking early positions in carbon capture technology and build out a customer gas portfolio to complement these low carbon energies.

b) Convenience and mobility: Putting Customers at the top priority of the firm and help accelerate the global revolution in mobility.

c) Resilient and focused hydrocarbons: maintaining an absolute focus on safety and operational reliability. They intend to continue to high-grade the portfolio that gradually resulting in significantly lower and more competitive producing and refining throughput. Bp will not explore countries where they do not have upstream activities.

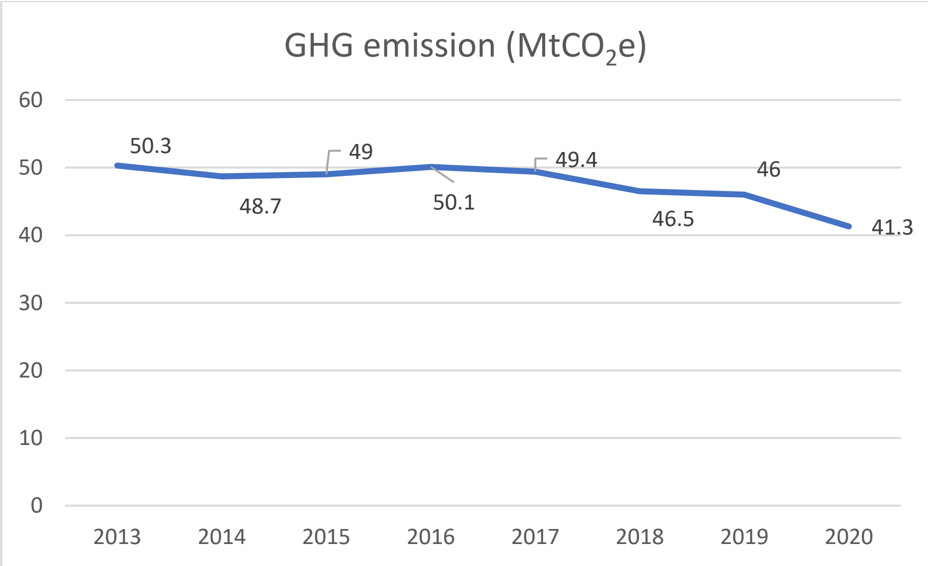

Figure 3. (GHG emission, MtCO2e from 2013 to 2020)

MtCO2e is Metric tons of carbon dioxide. The unit “CO2e” represents an amount of a GHG (Greenhouse Gas) whose atmospheric impact is standardized to that of one unit of CO2. In the above figure 3, the author can observe that the bp’s GHG emission saw a slight downward trend over the last 8 years and the decrease from 2017 to 2020 was relatively noticeable. Since 2016, bp has invested in renewable energy including sustainable biofuel and wind energy [5] and this reduction of carbon dioxide could be contributed to the development of renewable energy that relieves the pressure on the environment.

5.2 Necessity of CCS and DACCS technology

One of the useful technologies for the oil and gas industry is Carbon Capture and Storage (CCS), which captures carbon dioxide from factories or plants and stores it in underground geological formations. CEO Darren Woods has said that the accumulated carbon dioxide captured by the oil company ExxonMobil is more important than any other company. By 2020, ExxonMobil’s carbon dioxide production will account for more than 40% of the global total [6]. This indicates that oil companies indeed have the advanced technology and responsibility to implement it. According to the data, CCS applied to a modern conventional power plant could reduce CO2 emissions to the atmosphere by approximately 80–90 % compared to a plant without CCS [7]. This dramatic decrease in carbon dioxide emitted largely reduced the adverse effects of manufacturing and will solve the current issue of meeting the increasing demand for energy while reducing emissions. Apart from this, Direct Air Carbon Capture and Sequestration (DACCS), a more advanced technology than CCS, is also a great option for oil companies to adopt. It can remove carbon dioxide directly from the air, reducing the carbon dioxide total existing amounts [8]. It is different from CCS technology. CCS only reduces carbon dioxide emissions during production, whereas DACCS can reduce the existing amounts of carbon dioxide in the air, which was produced over the centuries. According to the prediction, the global temperature will increase by 4.8 degrees if no action is taken by the end of this century (figure 2). Hence, applying these technologies has great potential of preventing or slowing the rise in global temperature.

However, the challenge is that DACCS is an energy-consuming process, because the concentration of carbon dioxide in the atmosphere is very low, so the capture rate is very low. It means that in this process, large air volumes are required to gather meaningful amounts of carbon dioxide, leading to high capital costs [9]. These high costs will create barriers for the majority of oil companies to adopt this technology. The costs of capturing carbon dioxide were high in 2020 ($94 to $232 per ton of carbon dioxide), but these costs will continue decreasing by 2030 and are predicted to continue dropping below $60 by 2040 [10].

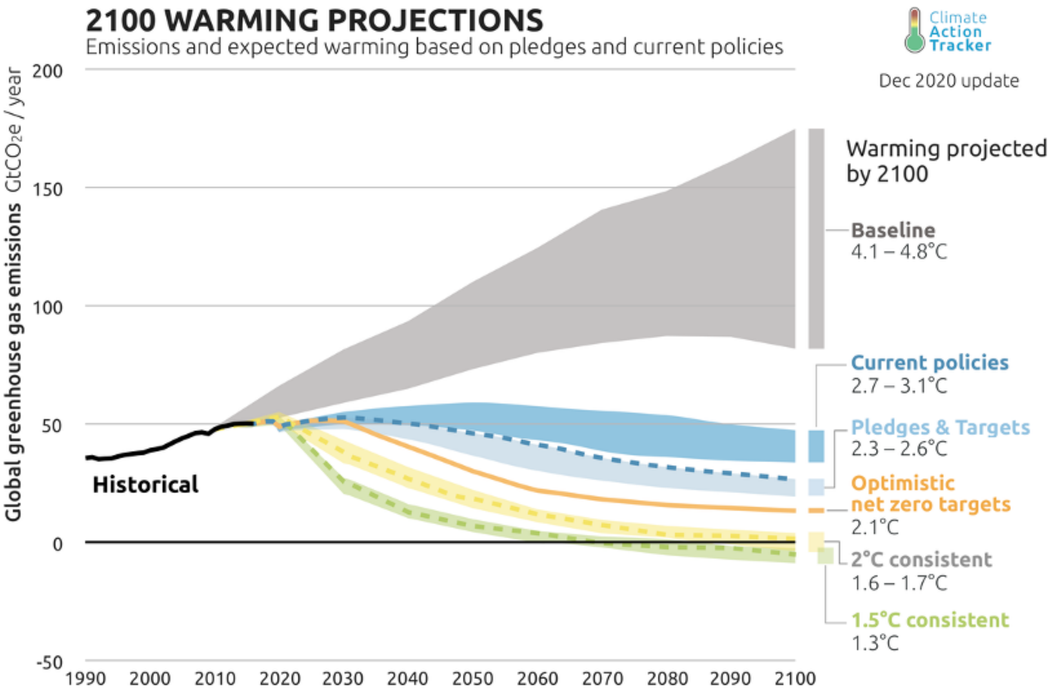

Figure 4. 2100 Warming Projections [14]

5.3 Renewable diesel and circular economy

In addition to applying technology, the oil and gas industry also needs to develop alternative fossil-based diesel-renewable diesel and gradually replace fossil fuel in the following decades.

Renewable energy is a green diesel made with vegetable oil and fats, suitable for diesel engines. Renewable diesel can offer the same advantages as other diesel, and in addition to this, it is completely renewable. Neste, the largest global renewable diesel producer, has used its technology to manufacture and produce renewable diesel and has innovated various products, such as aviation fuel, Neste diesel and Neste gasoline. Its Neste MY Sustainable Aviation Fuel has reduced up to 80% emissions than fossil fuel [11]. By implementing it, BP can provide energy that serves a dual purpose to meet the increasing demand for energy while mitigating climate change's adverse impacts. Simultaneously, BP also steps forward to reducing its carbon footprint in exploration and production by 35% to 40% and cutting oil production by 40% over the next decade.

The traditional energy production line is linear, which means that the raw materials were extracted, manufactured, used, and disposed of. The production line is irreversible, increasing the world's burden because most of waste is non-biodegradable. However, the application of renewable diesel can solve this problem. Because renewable diesel itself is renewable, it suits a circular economy's mindset fundamentally different from a linear economy. It reuses the waste and resources to meet the increasing demand for resources through innovation and creativity. By doing this, the products using life have been expanded, more resources will be saved, and the environment is protected at the same time. The production of renewable diesel is environmental-friendly because it can be produced from restaurants' used cooking oil. Therefore, it is a great opportunity for BP to partner with restaurants like MacDonald's and KFC to recycle their cooking oil for manufacturing and production. This partnership can then reduce the disposal of used cooking oil to the environment and ensures sustainability by providing energy to meet demands. In order to adopt this renewable diesel into production, BP could partner with Neste. This partnership will facilitate the sharing and mobilisation of renewable diesel knowledge and quickens BP's transition to a low-carbon economy.

However, for most oil and gas companies, low-carbon businesses' investment is less than 1% of their capital expenditure [12]. This will be against the whole energy transition process for the oil and gas industry. More research, collaboration and investment should be taken by the companies. Shifting from 'oil and gas' to 'energy' could be unprofitable and uncertain, but this effectively spreads the risk and provides oil and gas companies with more opportunities in future markets. Therefore, increasing the percentage of green energy investment is the necessary step for the whole industry.

5.4 Challenges for during the energy transformation

However, BP company may face some challenges during the transformation of the energy system. First, the most apparent barrier is the high capital costs of installing renewable technology equipment, such as solar systems and wind farms. For instance, the average cost of installing a solar system in 2017 ranges from $2000 per kilowatt to $3700 for large-scale systems per kilowatt [13]. The high costs of conducting renewable energy projects could make firms and investors unwilling to invest and threats the transform to replace fossil fuel with renewable energy. Second, Fossil fuels still play an important role in many countries. The reason for the important role is that fossil fuels, such as coal, are more efficient in producing energy than other resources. In addition, there is another reason that fossil fuel reserves are still abundant. However, in modern society, people generally believe that clean energy is cheap, easily available and efficient, and is more attractive than renewable energy. Therefore, the awareness of protecting the environment and contributing to alleviating climate change is of great importance in the energy transition. Although it may not be a profitable choice to invest and conduct renewable energy projects now, it is crucial to start transforming towards the low-carbon economy and make the whole industry ready for the transition in the future.

5.5 Suggestions for BP's development directions

From the perspectives of future decades, investment and development of renewable energy could provide it sufficient time to be developed and used largely. In support of this transition, some powerful technology should also be considered as mentioned, such as the CCS and DACCS. By adopting these technologies, firms can achieve a low carbon economy without the expense of losing profit and more retained earnings could be utilized to fund renewable energy development and installation. For long-term development, the oil and gas industry should recognize the importance of combating climate change and step forward towards a green economy. They should utilize their advantages in some high-profit margin projects and balance the profit and R&D expenses in renewable energy so that they can turn the tough challenge into opportunities in the future. Therefore, the suggestions for oil and gas companies are as follows: First, reinvest the retained earnings and cut the dividend to develop renewable diesel and introduce carbon capture technology. Second, remove the unnecessary assets and only maintain the assets with a high return rate to increase capital employed efficiency. Third, spread the risk of investing in renewable energy by increasing the size of the investment portfolio. The above suggestions could effectively guild the oil and gas industry to restructure their business model and plan their future strategy on the right path. by 2030 and are predicted to continue dropping below $60 by 2040 [10].

6 CONCLUSION

Global warming has become increasingly urgent, and the oil and gas industry should make this step forward towards a green economy as soon as possible. To slow down the rise in global temperature, transitioning from fossil fuel dominant to renewable energy-based in the energy sector at the current stage is the best choice for the oil and gas industry. Through the analysis of financial statements, the author found that the efficiency of capital utilization is low and the dividend paid to shareholders is high. This means that BP should re-adjust their business model, retain high-margin projects, and cut inefficient projects to increase ROCE. At the same time, it is also necessary to increase retained earnings for renewable energy research and development. Renewable energy plays an important role in moving towards a green economy. It can meet the increasing energy demand of mankind and prevent greenhouse gas emissions. Therefore, renewable energy is of great significance in the energy transition process. In addition, potential CCS and DACS technologies were also recommended to the petroleum industry. These technologies are key technologies for oil companies to achieve the dual purpose of reducing carbon dioxide emissions and meeting the growth of energy demand. However, there are also some limitations of the study. DACCS technology's adoption could significantly increase companies' expenses or liabilities due to the high capital cost of DACCS. This situation could challenge universal energy access as an increase in energy prices would make renewable energy lose comparative advantages over fossil fuel and is not favourable for promoting universal use of renewable diesel. The future study will continue adopting DACCS in the oil and gas industry and the blend ratio of renewable diesel to fossil fuel that the industry should take.

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REFERENCES

[1] Cherif R, Hasanov F, Pande A. Riding the Energy Transition: Oil beyond 2040. Asian Economic Policy Review. 2020 Aug 31;16(1):117–37.

[2] Financial Times. BP's Looney stakes future on producing less oil [Internet]. www.ft.com. 2020 [cited 2021 Mar 31]. Available from: https://www.ft.com/content/e1d53208-b460-4708-a89c-d8b418cceffb

[3] BP. Annual report. 2019;152–6. Available from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/investors/bp-annual-report-and-form-20f-2019.pdf

[4] BP. Our aims | Who we are | Home [Internet]. bp global. 2021. Available from: https://www.bp.com/en/global/corporate/who-we-are/our-ambition/our-aims.html

[5] BP. Sustainability Report [Internet].; 2016 p. 18–20. Available from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/ pdfs/sustainability/ archive/archived-reports-and-translations/2016/bp-sustainability-report-2016.pdf

[6] Crowley K, Rathi A. Exxon Holds Back on Technology That Could Slow Climate Change. Bloomberg [Internet]. 2020 Dec 7 [cited 2021 Mar 31]; Available from: https://www.bloomberg.com/news/features/2020-12-07/exxon-s-xom-carbon-capture-project-stalled-by-covid-19

[7] Cormos A-M, Simon A. Dynamic Modeling and Validation of Post-combustion Calcium-looping Process. Computer Aided Chemical Engineering. 2014;33:1645–50.

[8] Gambhir A, Tavoni M. Direct Air Carbon Capture and Sequestration: How It Works and How It Could Contribute to Climate-Change Mitigation. One Earth. 2019 Dec;1(4):405–9.

[9] Kiani A, Jiang K, Feron P. Techno-Economic Assessment for CO2 Capture From Air Using a Conventional Liquid-Based Absorption Process. Frontiers in Energy Research. 2020 May 29;8.

[10] Sutherland BR. Pricing CO2 Direct Air Capture. Joule. 2019 Jul;3(7):1571–3.

[11] Neste. Reduced emissions [Internet]. Neste worldwide. 2020 [cited 2021 Mar 31]. Available from: https://www.neste.com/products/all-products/renewable-road-transport/reduced-emissions#:~:text=Using%20Neste%20MY%20Renewable%20Diesel

[12] The Oil and Gas Industry in Energy Transitions – Analysis [Internet]. IEA. [cited 2021 Mar 31]. Available from: https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions

[13] Barriers to Renewable Energy Technologies [Internet]. Union of Concerned Scientists. 2017 [cited 2021 Mar 31]. Available from: https://www.ucsusa.org/resources/barriers-renewable-energy-technologies

[14] Climate action tracker. 2100 Warming Projections [Internet]. climateactiontracker. 2020 [cited 2021 Mar 31]. Available from: https://climateactiontracker.org/media/images/CAT-2100WarmingProjectionsGraph-PNGLarge500-2.width-1110_A0m0OZb.png